Engineering Evaluation/Cost Assessment (EE/CA) for the Union-Zaar Mine Six Rivers National Forest Del Norte County, California

November 2007

Contract No. AG-91S8-C06-0056

Prepared for:

Six Rivers National Forest
United States Department of Agriculture
Forest Service Region 5
Eureka, California

Prepared by:

Engineering/Remediation Resources Group, Inc.

ERRG

185 Mason Circle, Suite A
Concord, California 94520
(925) 969-0750

Engineering Evaluation/Cost Assessment (EE/CA)
for the
Union-Zaar Mine
Six Rivers National Forest
Del Norte County, California

Submitted by:

Engineering/Remediation Resources Group, Inc.

Signature

2/15/08

Date

Caitlin Gorman, P.G.

Name

Project Manager

Title

Table of Contents

Table of Contents *(continued)*

Table of Contents *(continued)*

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BLM	Bureau of Land Management
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	contaminants of potential concern
DWR	California Department of Water Resources
EE/CA	Engineering Evaluation/Cost Assessment
EPA	U.S. Environmental Protection Agency
ERRG	Engineering/Remediation Resources Group, Inc.
ESL	Environmental Screening Level
FDEP	Florida Department of Environmental Protection
Forest Service	U.S. Department of Agriculture, Forest Service Region 5
HRS	Hazard Ranking Score
MCL	Maximum Contaminant Levels
mg/kg	milligrams per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRA	National Recreation Area
OSC	On-Scene Coordinator

Acronyms and Abbreviations *(continued)*

PEC	probable effects concentrations
PEL	probable effects level
PPE	probable point of entry
PA/SI	Preliminary Assessment/Site Investigation
PRAG	preliminary removal action goal
PRAO	preliminary removal action objective
PRG	Preliminary Remediation Goal
QC	quality control
RAP	remedial action plan
RWQCB	Regional Water Quality Control Board
SPLP	Synthetic Precipitation Leaching Procedure
SRE	Streamlined Risk Evaluation
Tetra Tech	Tetra Tech, EM Inc
TEC	threshold effect concentration
TEL	threshold effects level
USGS	U.S. Geological Survey

Executive Summary

The Union-Zaar Mine is an inactive copper mine located in Section 35, T18N, R1E, within the Smith River National Recreation Area in the Six Rivers National Forest, about 25 miles northeast of Crescent City, in Del Norte County, California. The 20-acre site includes roads, adits, and mine waste piles located along the banks of Copper Creek. Copper Creek, a tributary to the Smith River, runs north through the middle of the site. A number of sensitive environments exist at the site and downstream from the site, including habitat known to be used by the following species listed by the federal government as Endangered: McDonald's Rock Cress, Coho salmon, cutthroat and steelhead trout.

The waste rock piles associated with the mine site are in direct contact with Copper Creek. Investigations conducted at the mine site from 1991 to 2007 indicate that the mine waste piles along the creek are the source of the metals contamination observed in the sediments of Copper Creek. The primary pathway for contaminants to migrate from source materials (mine waste piles) to sediment in Copper Creek is via physical erosion of the waste piles where they are in contact with Copper Creek. Materials eroded from the underwater portions of the mine waste piles are transported downstream and re-deposited as sediment in Copper Creek. High creek flow during the Winter and Spring likely contributes more significantly to erosion of the waste piles than low flow during Summer/Fall. The concentrations of metals in sediment decrease with distance downstream from the waste piles, indicating that natural sediments are likely being deposited with contaminated sediments and diluting the effects of the metals-impacted sediment.

Surface water quality in Copper Creek in the vicinity of the Union-Zaar Mine Site has not been affected by metals in mine waste piles, likely as a result of a natural buffering effect of the slightly alkaline native surface and groundwater. Groundwater and surface water are not considered exposure pathways for contaminants from this site.

A streamlined risk evaluation (SRE) was conducted to evaluate potential risks to human health and the environment. The SRE concluded surface water at the Union Zaar Mine site does not pose unacceptable risk to human health or the environment, but that sediment in Copper Creek may pose unacceptable risk to ecological receptors and source materials (mine waste piles) may pose unacceptable risk to human health and the environment.

Humans who come in contact with the mine waste piles at the Union-Zaar mine site (through extended recreational activities such as camping) may be exposed to arsenic at concentrations that pose a significant health risk. Ecological receptors may also be exposed to arsenic, copper, and mercury in the mine waste piles and downstream sediments at concentrations that pose unacceptable risk.

Additional evaluation of potential risks for ecological receptors exposed to sediment included conducting bioassay analyses of upstream and downstream sediment to evaluate adverse effects to survival and growth of freshwater amphipods. The results of this evaluation indicated that organisms in both upstream and downstream samples exhibited below average growth. This is likely due to the low levels of organic carbon (food source) in the sediment combined with the background concentrations of metals in both upstream and downstream sediment. Survival of organisms in upstream and downstream samples was not considered adversely affected. While concentrations of metals in sediment may pose unacceptable risk to ecological receptors, the results of the bioassay sampling indicate that the adverse effects of metals in downstream sediment are equivalent to those of the upstream sediment. Metals in sediment due to releases from the site are therefore not expected to have a negative impact on downstream ecological receptors (including freshwater amphipods, or spawning sensitive fish).

Metals in surface water at the site were below all applicable criteria for the protection of human health and ecological receptors. Surface water is therefore not expected to have a negative impact on human recreational users or on spawning or downstream sensitive fish (including Coho salmon, cutthroat trout, and steelhead trout).

The goal of this EE/CA is to develop and select a removal action alternative that is in accordance with CERCLA criteria to ensure that the selected action is protective of human health and the environment and compliant with Applicable or Relevant and Appropriate Requirements (ARARs).

The following preliminary remedial action objective (PRAO) was developed for the site to ensure that potential human and ecological receptors are protected from elevated metals concentrations in the source materials (mine waste piles) and to eliminate downstream migration of source materials to sediment in Copper Creek:

- **Prevent human or ecological exposure to the waste piles which contain metals at concentrations exceeding the removal action goals.** Direct exposure to metals in the waste piles poses an unacceptable site risk and may impact downstream sediments in Copper Creek.

The preliminary remedial action goals (PRAGs) associated with the site are as follows:

- The threat to potential human or ecological receptors of exposure to metals concentrations in the waste piles shall be eliminated.
- The threat of downstream migration of metals from waste piles to sediments of Copper Creek shall be eliminated.

The following four removal action alternatives were evaluated in the EE/CA to address these PRAGs:

- No Action
- Engineering Controls by In-situ Slope Stabilization with Rip Rap
- Removal of Source Materials followed by On-site Encapsulation and Creek Bank Restoration
- Removal and Off-site Disposal of Source Materials followed by Creek Bank Restoration.

Each alternative was analyzed for effectiveness, implementability, and cost. Following the alternatives analysis, a comparative analysis was conducted for all alternatives and the following alternative was selected as the recommended removal alternative:

Alternative 3, Removal of Source Materials followed by On-site Encapsulation and Creek Bank Restoration.

The primary components of the recommended alternative are as follows:

- An engineering design will be completed for an on-site soil cell, and the excavation and creek bank restoration process. The design will identify an appropriate site for the on-site cell and will outline required geotechnical testing to be accomplished prior to building the cell. The on-site encapsulation design will be submitted to appropriate regulatory agencies.
- An on-site backfill source will be identified and tested for geotechnical and chemical properties to ensure a suitable material for creek bank restoration.
- The current access route to the creek banks will be improved to support the removal activities.
- Temporary sandbags will be placed in the creek on the upstream side of the work areas, creek water will be diverted away from the work area.
- The mine waste piles on the creek banks will be excavated and brought to the on-site stockpile area. The excavated soil will be placed inside the soil cap footprint and stockpiled and compacted by a loader and a dozer.
- After all mine wastes are excavated (estimated 10,000 tons) from the creek banks, minimal amounts of fill will be excavated from an on-site source, and trucked to the excavated area to backfill along the creek banks and restore them to as close to pre-mining conditions as possible. After backfilling is completed, minimal amounts of rip rap may be placed at the toe of the backfill for erosion control.
- The surface of the backfill area will be covered with erosion control mat, and the steep slopes will be hydroseeded and/or live-staked with native plants for slope stabilization.
- The soil cell will be constructed at the designated stockpile area. After all mine wastes are placed inside the soil cell area, a soil cover will be placed on top of the compacted mine waste (specifications for the soil cover will be included in the final design).
- After the removal action and soil cap construction are completed, a focused monitoring and inspection program will be conducted during the first 12 months of the long-term maintenance

program to ensure the planted vegetation is growing and meets expectations, and the erosion controls are functioning as intended.

- After the first year, periodic inspection and maintenance activities will be carried out in subsequent years to maintain the integrity of the soil cap and the restored creek banks.

The estimated cost of the recommended removal action alternative is $678,000. This cost represents an order-of-magnitude estimate, in accordance with guidance for conducting EE/CAs, with an intended accuracy of +50 to -30 percent.

Section 1. Introduction

Engineering/Remediation Resources Group, Inc. (ERRG) has prepared this Engineering Evaluation/Cost Assessment (EE/CA) Report for the U.S. Department of Agriculture Forest Service Region 5 (Forest Service) for the Union-Zaar Mine Site in the Smith River National Recreation Area (NRA) of the Six Rivers National Forest in Del Norte County, California. This work was conducted under the Regional Environmental Response Action Contract (AG-91S8-C06-0056) Activity II, Task 2: EE/CA Support. The EE/CA is preceded by a Preliminary Assessment/Site Investigation (PA/SI) conducted at the site by Tetra Tech, EM Inc. (Tetra Tech) in 2005. The PA/SI recommended that further action should be taken at the site to address and reduce site risks from: (1) impacted sediment at Copper Creek at the probable point of entry (PPE) and downstream from the site and (2) elevated metals in rock piles associated with adits that are in direct contact with the Copper Creek and an unnamed ephemeral creek. This EE/CA is part of the non-time critical removal action to implement these recommendations.

The Union-Zaar Mine is an inactive copper mine located in Section 35, T18N, R1E, within the Smith River NRA in the Six Rivers National Forest, about 25 miles northeast of Crescent City, in Del Norte County, California (Figure 1). The 20-acre site includes roads, adits, and mine waste piles located along the banks of Copper Creek. The mine features consist of one shaft (the Union-Zaar Shaft), two primary adits (the North Adit and the South Adit), several smaller adits and prospect pits, and associated mine waste piles (Figure 2). Copper Creek, a tributary to the Smith River, runs north through the middle of the site. A number of sensitive environments exist at the site and downstream from the site, as summarized in the PA/SI for the site (Tetra Tech, 2005). Sensitive environments include habitat known to be used by the following species listed by the federal government as endangered: McDonald's Rock Cress, Coho salmon, cutthroat and steelhead trout. Sediment in Copper Creek has been impacted by a release of metals (primarily arsenic and copper) from waste rock piles that are in direct contact with the creek.

1.1. REGULATORY FRAMEWORK

Authority for responding to releases from a hazardous waste site is addressed in Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Executive Order 12580 delegates to the U.S. Department of Agriculture (USDA) the authority for removal actions at Forest Service sites whether or not the sites are on the National Priorities List (NPL). The Forest Service, under the delegation of the USDA's authority, is the lead federal agency for the environmental investigation and cleanup of the site, and as such will oversee all project activities. Other federal, state, or local agency representatives may be consulted, at the discretion of the Forest Service's On-Scene Coordinator (OSC). The Forest Service will ensure that all removal action tasks are in compliance with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and Division 20, Chapter 6.8, of the State of California Health and Safety Code.

The U.S. Environmental Protection Agency (EPA) has classified removal actions into three types: emergency, time-critical, and non-time critical. The classification is based on the type of situation, the urgency to take action, the threat of release or potential release, and the period of time in which the action must be initiated (EPA, 1993). The removal action at the Union-Zaar Mine site will be non-time critical because a 6-month period is available before a removal action should be taken at the site and the threat to human health and/or ecological receptors is not immediate. Section 300.415(b)(4)(i) of the NCP requires that an EE/CA is produced for all non-time-critical removal actions to evaluate removal alternatives for the site.

1.2. PURPOSE

The purpose of the EE/CA is as follows: (1) meet the environmental review requirements for removal actions; (2) satisfy administrative record requirements for unproved documentation of removal action selection; and (3) identify the objectives of a removal action and analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives.

1.3. REPORT ORGANIZATION

The EE/CA presents background information, analytical results, removal action alternatives, and alternatives analysis. The EE/CA is separated into the following sections:

- **Section 1.0, Introduction -** briefly describes the site location and background, previous findings, and the content of the EE/CA. The section also states the purpose of the EE/CA and the regulatory framework in which the EE/CA resides.
- **Section 2.0, Site Characterization –** states the description and background of the mine site, including previous investigations and the source, nature, and extent of known contamination. This section also makes references to previous analytical data which has characterized the on-site contamination.
- **Section 3.0, Streamlined Risk Evaluation –** provides a screening evaluation of site risks to human health and the environment
- **Section 4.0, Removal Action Objectives and Goals –** states the preliminary removal action objectives and goals that, if met, will result in the protection of human health and the environment, pursuant to CERCLA criteria.

- **Section 5.0, Applicable or Relevant and Appropriate Requirements (ARARs) –** lists and details potential chemical-specific, location-specific, and action-specific ARARs which aid in establishing cleanup criteria for the site.
- **Section 6.0, Identification and Analysis of Removal Action Alternatives –** describes four removal action alternatives and analyzes each for effectiveness, implementability, and cost.
- **Section 7.0, Recommended Removal Action Alternative –** provides a comparative analysis of the four removal action alternatives and analyzes each for effectiveness, implementability, and cost.

Section 2. Site Characterization

This section presents a description of the Union-Zaar Mine site and its historical use as part of the "Low Divide" mining district. It also details the source, nature, and extent of known metal contamination at the site and references analytical data resultant of previous investigations conducted at the site that aided in the assessment of said contamination. This section provides the basis for understanding the contaminants of potential concern (COPCs) and media of potential concern at the mine site, including their derivation, and the setting in which they are currently found.

2.1. SITE DESCRIPTION AND BACKGROUND

The Union-Zaar Mine site is an inactive copper mine located in Section 35, T18N, R1E, within the Smith River NRA in the Six Rivers National Forest, about 25 miles northeast of Crescent City, in Del Norte County, California. The site is accessed via an improved gravel road (County Road 308) and then by narrow unimproved roads. Direct access to the site is via old mining roads and is limited to hikers. The 20-acre site includes roads, adits, and mine waste piles located along the banks of Copper Creek. The mine features consist of one shaft (the Union-Zaar Shaft), two primary adits (the North Adit and the South Adit), several smaller adits and prospect pits, and associated mine waste piles. To ensure site safety and limit access to the mine openings, bat gates have been placed over the adits and shaft. Copper Creek, a tributary to Rowdy Creek and the Smith River, runs north through the middle of the site.

The Union-Zaar Mine was originally called the Union Mine and was part of the "Low Divide" mining district, which included the Alta, Union, Crescent, Mammoth, and Star mines. The now-abandoned town of Altaville was also a part of the district. The Low Divide mining district was established in the 1860s as a copper mining district, and in later years chromium mines were also included in the district. As summarized in the PA/SI by Tetra Tech EM Inc. (Tetra Tech, 2005), the bulk of ore production at the Union-Zaar mine occurred in the 1860s, which is when the adits and waste piles that are still present at the site were built.

2.2. GEOLOGY AND SOILS

The Union-Zaar Mine Site is located at the western boundary of the Klamath Mountains geomorphic provinces (Norris and Webb 1990; Harden 1998). The Klamath Mountains province is composed of accreted oceanic terranes divided by roughly north-south trending faults that become younger to the west.

The westernmost of these terranes is separated from the Coast Ranges geomorphic province to the west by the South Fork Mountain Fault. The geologic basement in the region primarily consists of metamorphosed Mesozoic sedimentary and volcanic rocks, including ophiolite suites underlain by older ultramafic rocks, chiefly Mesozoic in age (California Division of Mines and Geology, 1966).

Soils in the vicinity of the site consist of shallow (1-3 foot-thick) soils developed from serpentenite parent rock. According to a study completed in 1985 (Forest Service, 2007) the soils in the vicinity of the site correlate to two main soil series; the Huse Series and the Weitchpec Series. The Huse series soils extend 2 to 3 feet below ground surface (bgs) and consist of A and C horizons. The A Horizon is primarily clay, clay loam, or stony clay loam with the C Horizon composed of clay or loamy clay. The measured pH range is 6.2 in the upper (A) horizon to 6.9 in the lower (C horizon). The surface layer of these soils often exhibits iron-manganese pellets similar to an erosion pavement. The Weitchpec series extend only 1 to 2 feet deep and are also composed of A and C horizons. The A Horizon consists of a dense sod of grass roots and stony loam underlain by clay loam in the C Horizon. The pH range for this soil series was from 6.3 near the surface to 6.8 in lower portions of the C Horizon.

2.3. ENVIRONMENTAL SETTING AND CLIMATE

The Union-Zaar Mine is located in the Six Rivers Forest, approximately 9 miles east of the Pacific Ocean coastline, on the northeastern edge of the Klamath Mountains, at an average elevation of 1,600 feet above mean sea level. The sections below briefly describe the climate, ecological communities, and nearby sensitive environments of the Union-Zaar Mine Site.

The coastal portion of Del Norte County exhibits a temperate coastal climate, with average temperature variations of less than 10 °F throughout the year. The average temperature in the nearby town of Crescent City, approximately 25 miles southwest of the Union-Zaar Mine Site, is 57.7 °F in the summer and 48.0 °F in the winter. Total average annual precipitation is about 66 inches, with about 47 percent of the rainfall in winter, 24 percent rainfall in spring, and 24 percent rainfall in fall. Snow accounts for only about 0.03 percent of the average annual precipitation (Western Regional Climate Center, 2005).

A number of sensitive environments exist at the site and downstream from the site. Specifically, Copper Creek has been identified as spawning habitat for cutthroat and steelhead trout and Chinook and Coho salmon (Tetra Tech, 2005). Surveys conducted by the California Department of Fish and Game (CDFG) in the 1980s identified Copper Creek as “anadromous fish habitat” with a habitat suitability rating of “very high” (Dames and Moore, 1985). In 1972, coho, chinook, and steelhead fingerlings were present in the upper reaches of Copper Creek (Dames and Moore, 1985). In addition, the National Oceanic and Atmospheric Administration (NOAA)’s National Marine Fisheries Service (NMFS) included Copper Creek in their compilation of streams for which historical (pre-1989) or current (1989-2000) records exist documenting the occurrence of coho salmon (NMFS, 2001). Sensitive species (including threatened and endangered species) in the vicinity of the Union-Zaar Mine site are summarized in Table 1.

Sensitive environments within a 4-mile radius of the Union-Zaar Mine site were identified during the PA/SI (Tetra Tech, 2005). These include habitat known to be used by McDonald's Rock Cress, Coho salmon, cutthroat and steelhead trout (Forest Service, 2007). Copper Creek may serve as habitat for species documented in adjacent areas, including the Mardon Skipper and Oregon Silverspot Butterfly (Tetra Tech, 2005).

Sensitive environments within the 15-mile target distance limit downstream of the Union-Zaar Mine Site include (1) a 3-mile stretch of the Smith River designated as a National Wild and Scenic River and (2) habitats known to be used by the Bald Eagle, Bank Swallow, Tidewater Goby, and the Western Snowy Plover (Tetra Tech, 2005). Other sensitive species that are potentially present within the 15-mile target distance limit include the Marbled Murrelet, Northern Spotted Owl, and Pacific Fisher (Tetra Tech, 2005).

No towns or other human population centers were identified within the 4-mile target distance limit, during the PA/SI (Tetra Tech, 2005).

2.4. HYDROLOGY AND HYDROGEOLOGY

The site is located in the Smith River Plain Groundwater Basin, specifically in the Lower Rowdy Creek Watershed of the North Coast Hydrologic Region. Copper Creek runs north through the site from its headwaters (directly south of the site at the Low Divide) to Rowdy Creek, approximately 3.5 miles downstream. Copper Creek is characterized by a steep gradient in the vicinity of the site (the upper reaches of the creek) which becomes much more gradual before entering Rowdy Creek. Rowdy Creek eventually discharges to the Smith River, approximately 5 miles east of the river’s outlet to the sea.

The Smith River Plain is an emerged low-relief marine terrace, the surface of which is characterized by sand dunes, floodplain deposits, unconsolidated river terrace deposits, and marine deposits (California Department of Water Resources [DWR], 2003). Marine deposits of the Battery and St. George formations underlie the floodplain deposits and are in turn underlain by metamorphic basement rock of the Jurassic-Cretaceous Franciscan Complex.

The basin’s water-bearing formations are composed of the Quarternary alluvial fan, terrace, flood-plain, and Battery Formation deposits (DWR, 2003). The depth to groundwater varies from 10 to 35 feet over the estimated 31,000-acre basin. Most groundwater in this region is derived from shallow wells (Ranney collectors) installed in the gravel and sand beds of several of the rivers in the region. Local towns, including Smith River and Crescent City receive their water supply from groundwater beneath the Smith River, Rowdy Creek, Klamath River, and Mad River (DWR, 2003).

Two domestic groundwater wells were identified within four miles of the Union-Zaar Mine site with reported static water levels of 29 and 12 feet below ground surface, respectively (Tetra Tech 2005).

2.5. SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The waste rock piles associated with three adits (the North and South Adits and the West Collapsed Adit) are in direct contact with Copper Creek as shown on Figure 3. As summarized in the PA/SI (Tetra Tech, 2005), the Forest Service conducted an investigation in 1991 that included collection of soil and water samples. Results indicated that only one sample, a soil sample containing an elevated concentration of copper collected from the South Adit, posed a potential chemical water quality concern. Additional chemical analyses were performed by the Forest Service in 1998 for preparation of an Abandoned Mine Land Summary Sheet, but none of the samples collected yielded concentrations that would present a chemical water quality concern.

2.5.1. Preliminary Assessment/Site Investigation Results

In 2004 and 2005, soil, surface water, and sediment samples were collected for the PA/SI to assess the level of contamination due to the waste rock piles. Samples taken from the waste rock piles in direct contact with the creek had elevated concentrations (at least three times background levels) of metals, including copper, arsenic, chromium, and nickel. Sediment samples from Copper Creek showed elevated levels of metals, including copper, chromium, and nickel. Surface water analytical results indicated that surface water has not been impacted by the metals in the waste rock piles. No surface water samples collected from Copper Creek showed metals at elevated concentrations with respect to background and water quality criteria. It is assumed that the relatively high pH of the water (pH in Copper Creek is as high as 8.3) inhibits the metals from significantly dissolving from solid media into the water. In addition, leachability testing results from Synthetic Precipitation Leaching Procedure (SPLP) analysis of a sample taken from the waste piles yielded concentrations below EPA Water Quality Criteria and Safe Drinking Water Levels (Maximum Contaminant Levels [MCLs] (Tetra Tech, 2005). Given the SPLP results and the low metals levels in surface water, neither surface water nor groundwater at the site were considered media of potential concern.

2.5.2. Additional Background and Downstream Sediment Sampling

On May 18, 2007 additional sediment sampling was performed by ERRG with the objective of further delineating metals concentrations in the downstream sediments. One upstream sample was collected from approximately the same location as the background sample collected for the PA/SI to evaluate variability in upstream/background metal concentrations in the sediment. Beginning at the West Collapsed adit, four downstream samples were collected at approximately 500 ft. intervals to determine the extent of the metals in the downstream sediments (Figure 4). Samples were collected upstream of the first downstream tributary into Copper Creek, downstream of the Site. All four downstream sediment samples yielded results for metals that were above background concentrations and screening criteria for the site. Further discussion of the background levels and screening criteria is provided in Section 3.0.

Further downstream sediment sampling was conducted by the Forest Service on July 6, 2007. One sample was collected downstream of the confluence of Copper Creek and the first downstream tributary and one was collected from the unnamed tributary, upstream of its confluence with Copper Creek (Figure 4). Both of these samples contained metals at concentrations above background levels for the site, but did not exceed the screening criteria for the site. Therefore, the extent of metals in sediment is considered delineated by these two samples and does not extend beyond the confluence of Copper Creek and the unnamed tributary.

The complete analytical results for sediment samples collected by ERRG and the Forest Service in 2007 are presented in Appendix A.

2.5.3. Background and Downstream Sediment Bioassay Sampling

On August 23, 2007 two additional sediment samples were collected by the Forest Service, one upstream and one downstream, for bioassay testing, to evaluate whether elevated metals concentrations in sediment in Copper Creek were likely to have adverse effects to the growth or survival of ecological receptors potentially present downstream from the site[1].

Sediment samples were submitted for bioassay testing using *Hyalella azteca*, a freshwater amphipod. This amphipod, a very sensitive ecological receptor, was chosen as a conservative measure to ensure that the test results would be applicable to higher trophic levels (such as sensitive spawning fish in and downstream from Copper Creek). Complete results of the bioassay sampling are presented in Appendix B.

Bioassay testing was conducted using bulk sediment from the site to which filtered water and the amphipods (*Hyalella azteca*) were added. The test was conducted for 10-days and measured both survival and growth endpoints. The test design utilizes eight test chambers for each sediment sample, with each test chamber containing 10 amphipods. The amphipods are added to each test chamber at the start of the test. Following the 10-day exposure period, the amphipods are sieved from the sediment and evaluated for survival. Growth is evaluated by comparing the starting weight of the amphipods to the final weight. A survival rate below 70% was considered indicative of adverse effects on the organism. Measurable growth was compared for upstream and downstream samples to determine whether there

---

[1] Bioassay data are a more precise evaluation method than a simple comparison of sediment sampling results to ecological screening criteria (see Section 3) since the data are site-specific data reflecting actual toxicity, rather than relying on the assumptions used in development of the ecological screening criteria.

were any adverse effects on the downstream sample. A third (standard or control sediment) test was also run simultaneously to ensure that the starting organism population was healthy and to provide a benchmark for “normal” survival and growth conditions.

The results of the bioassay sampling indicated that both the downstream and upstream sample exhibited more than 80% survival (within the acceptable range) and that survival rate in both samples was reduced when compared to the control sample. The growth testing showed measurable growth in both upstream and downstream samples. When compared to the control sediment, the rate of growth in both upstream and downstream samples was reduced (or below “normal” rates). The reduced growth may be attributed to the fact that the sediment contains little organic carbon[2] and that metals concentrations in both upstream and downstream samples are elevated above those in the control sample.

2.6. CONCEPTUAL SITE MODEL

Investigations conducted at the mine site from 1991 to 2007 indicate that the mine waste piles along Copper Creek are the source of the metals contamination at the site. In addition, results from the PA/SI sampling effort indicate that the elevated metals concentrations are limited to the waste piles and the sediments downstream of the PPE and are not a concern in groundwater or the surface water of Copper Creek. The extent of elevated metals concentrations in sediment is delineated by concentrations below screening criteria. The screening criteria are based on risk assessment data provided in Section 3.0. Sediment concentrations decrease downstream of the confluence of the first tributary and Copper Creek.

The primary pathway for contaminants to migrate from source materials (mine waste piles) to sediment in Copper Creek is via physical erosion of the waste piles where they are in contact with Copper Creek. Materials eroded from the underwater portions of the mine waste piles are transported downstream and re-deposited as sediment in Copper Creek. High creek flow during the winter and spring likely contributes more significantly to erosion of the waste piles than low flow during summer/fall. The concentrations of metals in sediment decrease with distance downstream from the waste piles, indicating that native sediments with lower metals concentrations may be diluting the effects of the metals-impacted sediment.

Surface water quality in Copper Creek in the vicinity of the Union-Zaar Mine Site has not been affected by metals in mine waste piles, likely as a result of a natural buffering effect of the slightly alkaline native subsurface and groundwater. Groundwater and surface water are not considered exposure pathways for contaminants from this site.

---

[2] Organic carbon is the primary amphipod food source and was sampled in sediment from Copper Creek during the PA/SI. The maximum detected concentration of total organic carbon in sediment was 0.2 mg/kg (Tetra Tech, 2005).

Section 3. Streamlined Risk Evaluation

The following Streamlined Risk Evaluation (SRE) is intended to evaluate potential risk to human health and ecological receptors from exposure to metals contamination at the Union-Zaar Mine site. Potential risks were evaluated for exposure to soil, sediment and surface water.

Potential risks to human health were evaluated based on consumption of water from Copper Creek and recreational uses at the site (camping, hunting, and fishing). Ecological risk was evaluated based on metals toxicity effect on select sensitive species exposed to contaminated source materials, water and sediment. An additional evaluation of sediment toxicity was conducted following the SRE, to evaluate site-specific effects on ecological receptors.

Prior to conducting the SRE, concentrations of all metals were initially screened against site-specific background concentrations. Concentrations that were deemed elevated with respect to background (ambient) concentrations were further evaluated in the SRE.

The following sections present the background screen for all site data and the Human Health and Ecological SRE results.

3.1. BACKGROUND COMPARISON VALUES

In order to exclude metals concentrations that represent background (ambient) concentrations, all data was screened against background values prior to conducting the SRE. Soil, surface water, and sediment background comparison values were established for a suite of 24 inorganic constituents, including aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

3.1.1. Soil

Background concentrations for soil and source sample comparison were based on upgradient soil samples collected in June 2004 as shown on Table 2. Where analytes were not detected, the sample detection limits were used. These background soil concentrations were compared against the regional background concentrations referenced from the U.S. Geological Survey (USGS) and included in the PA/SI (Tetra Tech, 2005). As presented on Table 2, the concentrations in the site-specific background soil sample (UZBS001) were generally within the range of the regional background concentrations, with the exception of aluminum, barium, calcium, chromium, cobalt, iron, magnesium, nickel, potassium, and selenium. Calcium, iron, magnesium, and potassium are considered essential nutrients that are generally excluded from the risk analysis.

3.1.2. Surface Water

The background values selected for the dry- and wet-season surface water comparisons were measured in upstream water samples collected in June 2004 and February 2005, respectively. Table 2 presents the background concentrations for surface water samples for both seasons.

3.1.3. Sediment

The available data for sediment background concentrations included one sediment sample (UZS007) collected in June 2004 and one (UZS014) collected from the same upstream location in May 2007. Because these samples represent solid matrix and relatively coarse material (fine sand to gravel), the metals concentrations between the two samples were variable. Because no single sediment value was available for comparison, the range of concentrations in the two background samples was used to represent site-specific upstream (background) concentrations (see Table 2).

3.2. CONTAMINANTS OF POTENTIAL CONCERN

Source (waste pile), surface water, and sediment concentrations were compared to background concentrations, as shown in tables 3 through 5. Inorganic constituents detected at concentrations below the background values were removed from the risk evaluation as a contaminant of potential concern (COPC). In addition, several inorganic constituents, including calcium, iron, magnesium, and potassium, are considered essential nutrients and were also not considered COPCs.

As a conservative measure, an inorganic constituent is included as a COPC if the maximum concentration detected exceeds the background comparison value. Tables 3 through 5 compare the data for each media type against the background comparison values.

Concentrations of several metals in source, surface water, and sediment exceeded background concentrations. The following metals and media were considered elevated with respect to background and were retained for further analysis in the SRE:

- Antimony, arsenic, chromium, copper, mercury, nickel, selenium, silver, thallium, vanadium, and zinc in source (mine waste) materials (Table 3)
- Aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, molybdenum, selenium, sodium, and zinc in surface water (Table 4)

- Arsenic, beryllium, cadmium, chromium, cobalt, copper, manganese, mercury, vanadium, and zinc in sediment (Table 5)

3.3. EXPOSURE POINT CONCENTRATIONS

The exposure point concentrations (EPC) for each COPC for each affected media have been conservatively estimated to be the maximum concentration detected in the data set. Table 6 summarizes the EPC for each COPC.

3.4. HUMAN HEALTH RISK SCREENING

Potential risks to human health were evaluated by comparing EPCs for each COPC to appropriate screening benchmarks developed for protection of human health. To determine the appropriate benchmarks for the risk screen, exposure pathways were established for affected site media. Three direct exposure media were identified for humans: source material (waste rock), surface water, and sediment. Human receptors can access the site via off road vehicles or on foot and may be exposed to metals contamination in the identified media through ingestion or dermal contact.

Soil, sediment and surface water benchmarks have been developed by the Bureau of Land Management (BLM) for protection of residents, campers, all-terrain vehicle drivers, site workers, and surveyors exposed to metals at BLM mining sites (BLM, 1996). Of these, the camper benchmarks were deemed the most appropriate screening-level benchmarks for protection of human health. For comparison, the BLM soil benchmarks were also evaluated against EPA’s Preliminary Remediation Goals (PRGs) for protection of industrial site workers (EPA, 2004) (Table 7). Additional surface water benchmarks include EPA’s PRG for tap water (EPA, 2004) and the MCL for drinking water (Marshack, 2003) (Table 7). These secondary benchmarks were used in the absence of BLM criteria as part of the human health risk screen; however, they are deemed conservative given the remoteness of the site, the fact that there are no regular on-site workers, and the absence of drinking water intakes in Copper Creek.

Table 8 presents the results of the human health SRE for COPCs in source materials, surface water, and sediment. Arsenic, chromium, and nickel concentrations in source materials exceeded the human health benchmarks in source materials. No other human health benchmarks were exceeded for source, surface water, or sediment.

The SRE for human health indicates that humans who use Copper Creek for recreational activities or work at the site will not be exposed to metals in surface water or sediment at concentrations that pose an unacceptable health risk. Humans who are exposed to the mine waste piles at the Union-Zaar mine site (through extended recreational activities such as camping) may be exposed to arsenic, chromium, and nickel at concentrations that may pose a significant health risk. Elevated chromium concentrations were present in all of the waste piles at the site; elevated arsenic concentrations were present at the waste piles associated with the South, West Collapsed, and Midslope adits; and elevated nickel concentrations were present at the West Collapsed Adit waste pile only.

Exposure to source materials in the waste piles that are located along the creek (North Adit, South Adit, and West Collapsed Adit waste piles) is considered more likely than exposure to source materials at the Midslope Adit, due to the remote location of the Midslope Adit and the steepness of the slope to access it. It is reasonable to conclude that human visitors will have limited to no exposure to arsenic from the Midslope Adit.

3.5. ECOLOGICAL RISK SCREENING

Potential risks to ecological receptors were evaluated by comparing the EPC for each COPC to appropriate ecological screening benchmarks developed for protection of environmental receptors. As discussed in subsection 2.3, sensitive environments within a four mile radius of the site include suitable habitat for the McDonald's Rock Cress, Coho salmon, cutthroat trout, and steelhead trout. Coho, Chinook, and steelhead have been observed to be present in Copper Creek in the past (Dames and Moore, 1985; NMFS, 2001). To determine the appropriate benchmarks, exposure pathways were established for affected site media and key receptors.

Three direct exposure media were identified: source material (waste rock), surface water, and sediment. Mammals were identified as the key receptors that may be exposed to metals in source materials by ingestion or dermal contact. The key receptors that may be exposed to surface water include mammals, birds, fish, fish eggs from spawning fish, and fish fry. These receptors may be exposed to metals in surface water through ingestion or dermal contact. Invertebrates were identified as the key receptors for sediment.

3.5.1. Ecological Benchmarks

Soil, sediment and surface water benchmarks have been developed by the BLM for protection of birds, wildlife, and livestock exposed to metals at BLM mining sites (BLM, 1996). The benchmarks for each media type were developed from several resources:

- **Surface Water Ecological Benchmarks.** Ecological benchmarks presented in "*A Compilation of Water Quality Goals*" (Marshack, 2003), including the California Toxics Rule Criteria for Freshwater Aquatic Life Protection and EPA's National Ambient Water Quality Criteria for Freshwater Aquatic Life Protection, were developed to protect fish and lower trophic levels in fresh waters. The EPA's National Ambient Water Quality Criteria were deemed most appropriate.

- **Sediment Ecological Benchmarks.** Ecological criteria developed to evaluate sediment quality in freshwater ecosystems, including the threshold effect concentrations (TEC), the probable effects concentrations (PEC) (EPA, 2002), as well as the threshold effects level (TEL) and probable effects level (PEL) developed specifically for invertebrates living in freshwater sediment (FDEP, 1994). Of these benchmarks, the PECs were deemed most appropriate and protective for sediment comparisons.

- **Soil Ecological Benchmarks.** EPA's Environmental Screening Levels (ESLs) (EPA 2003a, 2003b, 2003c, 2003d, 2003e), ecological PRGs for soil (Efroymson and others, 1997) and BLM wildlife and livestock criteria for soil were evaluated and selected as screening criteria. Of these, the soil Environmental Screening Levels (ESL) were deemed most appropriate for comparison to source materials. In the absence of an ESL, the other criteria listed were evaluated and the most appropriate was selected.

All criteria evaluated are presented in Table 9. Table 10 presents the results of the ecological SRE for COPCs in source materials, surface water, and sediment.

3.5.2. Ecological Benchmark Comparison Results

The EPCs for each COPC were compared against the selected ecological benchmarks for soil, surface water, and sediment. Based on this comparison, mammals and other receptors exposed to the mine waste piles may be exposed to metals at concentrations that may pose unacceptable risks. Invertebrates or other ecological receptors exposed to sediment in Copper Creek may be exposed to chromium, nickel and copper in sediment at levels that may pose unacceptable risk. The ecological SRE indicates that fish and other ecological receptors exposed to surface water in Copper Creek will not be exposed to metals at concentrations that pose unacceptable risk. A discussion of each media and the corresponding evaluation results is provided in the following subsections.

3.5.2.1. Source Material Results

Concentrations of antimony, arsenic, chromium, cobalt, copper, mercury, nickel, selenium, thallium, and vanadium in source (waste rock) materials exceeded ecological benchmarks (Table 10). Based on the EPC value and toxicity characteristics, arsenic, chromium, copper, nickel, and mercury are considered the primary risk drivers with a high risk of adverse effects to wildlife receptors exposed to the waste piles.

3.5.2.2. Surface Water Results

In surface water, none of the COPCs exceeded their respective benchmarks with the exception of selenium and lead, which are discussed below.

- **Selenium in Surface Water.** The EPC for selenium in surface water (5.6 micrograms per liter [µg/L]) exceeded the ecological benchmark of 5 µg/L. The range of detected concentrations for selenium in surface water at the site is 3.1 µg/L to 5.6 µg/L with a background (upstream) concentration of 4.3 µg/L. The selenium EPC is not significantly elevated with respect to the background concentration.

- **Lead in Surface Water.** The EPC for lead in water (7.4 µg/L) exceeded the hardness-corrected ecological benchmark (6.7 µg/L) but was within the range of lead benchmarks for the hardness range of all samples at the site (2.0 to 11.5 µg/L). The range of detected concentrations for lead in surface water at the site is less than 2.3 to 7.4 µg/L. The EPC selected for lead represents a sample collected from the drainage of the South Adit during the wet season (UZW010). The second-highest lead concentration in surface water (5.8 µg/L), collected from the North Adit drainage during the dry season (UZW002), was well below the hardness-corrected benchmark (11 µg/L). In addition, the lead EPC is not significantly elevated with respect to the background (upstream) concentrations for lead (4.8 µg/L).

To further evaluate the potential adverse effects of selenium and lead in surface water, a comparison was made to acute criteria for aquatic life protection (Marshack, 2003). The hardness-corrected acute exposure concentration (1-hour average) for lead in surface water is 280 µg/L. The EPC for lead is nearly 38-times lower than the acute exposure value. The acute exposure concentration for selenium is 20 µg/L, 3.6-times the EPC for selenium.

The fact that the maximum concentrations (EPCs) for selenium and lead concentrations are not significantly elevated with respect to the background and that both metals are well below any acute effects levels indicates that they represent acceptable incremental risk above background and are not likely to significantly contribute to adverse effects to ecological receptors in contact with surface water at the site. Receptors exposed to surface water in Copper Creek (including fish, birds, and mammals) are not likely to be adversely affected by these concentrations.

3.5.2.3. Sediment Results

Concentrations of chromium, copper, and nickel in sediment exceeded screening-level benchmarks for protection of invertebrates in sediment. The maximum chromium concentration (1,120 mg/kg) was just over 10-times the PEC; the maximum nickel concentration (2,910 mg/kg) was 60-times the PEC and the maximum copper concentration (1,040 mg/kg) was approximately 7-times the PEC. These levels of chromium, nickel and copper indicate a moderate to high risk of adverse effects to receptors exposed to sediment in Copper Creek.

To further evaluate site-specific effects of metals in sediment, bioassay data for freshwater amphipod testing were used. A discussion of bioassay sampling and results is presented in subsection 2.5.3 with the complete bioassay test results in Appendix B. Sediment bioassay data indicated that survival and growth of the freshwater amphipod *Hyalella azteca* were not adversely effected when downstream sediment test was compared to the upstream sediment test.

3.6. STREAMLINED RISK EVALUATION CONCLUSIONS

The results of the SRE indicate that surface water at the Union Zaar Mine site does not pose unacceptable risk to human health or the environment, but that source materials (mine waste piles) may pose unacceptable risk to human health and the environment.

Humans who come in contact with the mine waste piles at the Union-Zaar mine site (through extended recreational activities such as camping) may be exposed to arsenic at concentrations that pose a significant health risk. Elevated arsenic concentrations were present in all of the waste piles at the site, but humans are expected to have extremely limited exposure to the Midslope Adit, given its remote location. Ecological receptors may also be exposed to arsenic, copper, and mercury in the mine waste piles at concentrations that pose unacceptable risk.

Metals in surface water at the site were below applicable criteria for the protection of human health and ecological receptors. Surface water is therefore not expected to have a negative impact on human recreational users or on spawning or downstream sensitive fish (including Coho salmon, cutthroat trout, and steelhead trout).

Concentrations of chromium, copper, and nickel in sediment were greater than screening criteria protective of invertebrates. Further sediment toxicity evaluation (bioassay testing) indicated no increase in toxicity in downstream sediment when compared to upstream sediment. Thus, although metals concentrations in downstream sediment samples were greater than background and screening levels, the effect of these concentrations on survival and growth of invertebrates was no greater in the downstream sediment when compared to background effects. Based on the SRE, sediment is not expected to pose unacceptable risk to human recreational users of Copper Creek or to invertebrates or higher trophic levels (fish, birds, or mammals).

Section 4. Removal Action Objectives and Goals

The goal of this EE/CA is to develop and analyze removal action alternatives in accordance with CERCLA criteria, and to recommend a removal action alternative which is protective of human health and the environment and compliant with ARARs. The removal action alternative will be selected in an Action Memorandum, which is to be prepared by the lead federal agency (Forest Service). The preliminary removal action objective (PRAO) and preliminary removal action goals (PRAGs) that have been selected for the site are in compliance with these criteria and are detailed in the following subsections. These preliminary goals for the site may be altered following the submittal of this EE/CA, if additional information that requires re-evaluation of the PRAO becomes available from stakeholders or other interested parties. As such, the final removal action objectives and goals will reflect these alterations and refinements, if any, and will be defined in the action memorandum.

4.1. PRELIMINARY REMOVAL ACTION OBJECTIVE

The PRAO for the Union-Zaar Mine site ensures that potential human and ecological receptors are protected from elevated metals concentrations in the source materials (mine waste piles) and potential downstream erosion to Copper Creek sediments at the site. The objective is as follows:

- **Prevent human or ecological exposure to the waste piles which contain metals at concentrations exceeding the removal action goals.** Direct exposure to metals in the waste piles poses an unacceptable site risk and may impact downstream sediments in Copper Creek.

The attainment of the PRAO is expected to result in achieving compliance with CERCLA criteria.

4.2. PRELIMINARY REMOVAL ACTION GOALS

Due to the inherent high levels of metals found at mine sites, generic cleanup goals such as PRGs are not applicable. As such, the higher value of background concentrations (see Table 5) and soil benchmarks for the protection of human health (see Table 6) and ecological receptors (see Table 10) will be used for the waste piles to determine if the metals contamination has been reduced to acceptable levels. Although the cleanup criteria shall act as alternative-specific PRAGs, general goals for all alternatives are as follows:

- The threat to potential human or ecological receptors of exposure to metals concentrations in the waste piles shall be eliminated.

- The threat of erosion of contamination to sediments of Copper Creek by the waste piles shall be eliminated.

By achieving the PRAGs, the PRAO will be met and the potential risks to human health and the environment will be eliminated.

Section 5. Applicable or Relevant and Appropriate Requirements (ARARs)

Section 300.415(i) of the NCP provides that removal action must attain Applicable or Relevant and Appropriate Requirements (ARARs) to the extent practical, considering the exigencies of the situation.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the law or regulation directly address the circumstances at the site. An applicable federal requirement is considered an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed removal action and are well suited to the conditions of the site (EPA, 1988a). A requirement must be determined to be both relevant and appropriate to be considered an ARAR.

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be a promulgated law, substantive, consistently applied, and more stringent than a federal requirement. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or nonenvironmental, including permit requirements, are not considered to be ARARs. Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. However, such requirements may be useful and are “to be considered” (TBC) for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

The EPA has developed three categories of ARARs to assist in the identification of Site requirements. The three categories are (1) chemical-specific, (2) location-specific, (3) and action-specific ARARs. EPA guidance recognizes that some requirements do not fall neatly into this classification; however, the following definitions provide a general guideline for each of these categories:

- Chemical-Specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numeric values (cleanup levels). These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to the ambient environment.
- Location-Specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations. Location-specific ARARs relate to the geographical or physical position of the site (e.g., presence of wetlands, sensitive species, flood plains, etc.).
- Action-Specific ARARs are activity- based requirements or limitations on actions taken with respect to hazardous substances.

The Forest Service has primary responsibility for identifying federal ARARs. On November 28, the Forest Service requested ARARs from NOAA’s NMFS, the CDFG and the North Coast Regional Water Quality Control Board (RWQCB). The federal and state ARARs that are presented in this document represent a preliminary analysis of potential ARARs. In addition, standards and statutes developed and compiled from the Six Rivers Land and Resource Management Plan and the Smith River NRA were included as “to be considered” in the ARARs evaluation. The complete text of these statutes is presented in Appendix C. Any additional ARARs received from the federal or state agencies (listed above) will be evaluated and included in a revised ARARs table for the final EE/CA. Other federal and state advisories, criteria or guidance may, as appropriate, be considered in formulating the removal action. Table 11 summarizes the potential ARARs for this project.

Section 6. Development, Identification and Analysis of Removal Action Alternatives

The development of removal action alternatives for the Union-Zaar Mine site began with a determination of potential response actions based on the PRAO, ARARs, and EPA guidance. Appropriate response actions were then identified. The retained technologies and process options were assembled into removal action alternatives, which are identified and analyzed in this section and evaluated in Section 7.0.

As described in subsection 4.1, the PRAO for the Union-Zaar Mine Site is:

- **Prevent human or ecological exposure to the waste piles which contain metals at concentrations exceeding the removal action goals.** Direct exposure to metals in the waste piles poses an unacceptable site risk and may impact downstream sediments in Copper Creek.

This section evaluated remedial alternatives for meeting the PRAO.

6.1. GUIDANCE DOCUMENTS

Response actions for CERCLA chemicals were identified based on regulatory agency guidance documents for feasibility studies (EPA, 1988b) and guidance on evaluating non-time critical removal actions (EPA, 1993).

6.2. RESPONSE ACTIONS CONSIDERED

Three general response action categories were considered for this EE/CA:

1. No action
2. Engineering/institutional controls
3. Removal by excavation of source materials (mine waste piles) at three stretches of the creek bank to eliminate erosion of the source materials into Copper Creek and to reduce human and ecological exposure to source materials

The no-action category is required for consideration in CERCLA and EPA guidance for conducting EE/CAs. Table 12 summarizes the screening of technologies and processes associated with these response actions.

6.3. RESPONSE ACTION EVALUATION CRITERIA

Response actions were evaluated in accordance with EPA guidance on conducting feasibility studies (EPA, 1988b), Guidance On Conducting Non-Time Critical Removal Actions Under CERCLA", OSWER 9360.0-32 and "Outline of EE/CA Guidance", EPA, March 30, 1988. The criteria that were used in the evaluation are effectiveness, implementability, and cost, as discussed in the following subsections.

6.3.1. Effectiveness

In accordance with EPA guidance, the effectiveness screening criterion included the following elements:

- Ability to achieve PRAO
- Permanent removal and reduction of site-specific COPCs
- Long-term effectiveness (with technologies that have significantly lower long-term risks being preferred)
- Short-term effectiveness (with technologies that minimize safety risks in planning, conducting, and implementing removal actions being preferred)

6.3.2. Implementability

The screening criterion of implementability included the following elements:

- Ability to implement the removal action alternative under existing site conditions
- Ability to remove COPCs from the Union-Zaar Mine Site
- Availability of necessary materials and equipment (with the preferred technologies being those that are commercially developed and readily available, or innovative technologies that have been field-tested with documented results)
- Regulatory and community acceptance

6.3.3. Cost

Technologies were evaluated based on qualitative costs. Alternatives with lower costs were preferred if the effectiveness and implementability criteria were judged to be similar.

The cost estimates were prepared to aid in the evaluation of alternatives using information that is currently available. These costs are order-of-magnitude estimates with an intended accuracy of +50 to -30 percent (EPA, 2000). These costs are not construction bid costs, nor are they final project costs. Final project costs will depend on actual labor and material costs, actual engineering design costs, actual site conditions (including the actual quantities of mine waste excavated and the amount of material that may be classified as hazardous waste), competitive market conditions, the final project scope, the final project schedule, and other variables. As a result, the final project costs will vary from these estimates.

6.4. REMOVAL ACTION ALTERNATIVES

The following removal action alternatives were developed for the Union-Zaar Mine Site based on the three response action categories described in subsection 6.2:

1. No Action
2. Engineering Controls by In-situ Slope Stabilization with Rip Rap
3. Removal of Source Materials followed by On-site Encapsulation and Creek Bank Restoration
4. Removal and Off-site Disposal of Source Materials followed by Creek Bank Restoration

Each alternative was analyzed for its capability to reduce the risks detailed in Section 3. Specifically, the alternatives are analyzed for effectiveness, implementability, and cost. Following the alternatives analysis, a comparison will be made, and one alternative will be selected as the recommended removal action (Section 7).

6.4.1. Alternative 1: No Action

Under the No Action alternative, no remedial or removal action would be taken at the site. As such, the human and ecological risks relating to the site would remain unchanged. The No Action alternative is used as a baseline for all other alternatives and will be retained for the alternative analysis.

6.4.1.1. Effectiveness

The No Action alternative is expected to have low effectiveness for achieving the PRAO at the site. The alternative would not remove the source (i.e. mine waste piles). As such, the COPCs will remain in place and would likely continue to pose potential unacceptable risk to human health and the environment. In addition, no action would be taken to reduce or eliminate the erosion of materials from the waste piles to the sediment in the creek and the waste piles will continue to contribute to the downstream sediment impacts. This alternative would not reduce or eliminate the risk to ecological and human receptors.

As no action would be taken to reduce or eliminate the COPCs at the site this alternative would not meet potential ARARs.

6.4.1.2. Implementability

The No Action alternative would be readily implementable and administratively feasible. No federal agency authorization would be required to implement this alternative. No services or materials would be needed for the implementation of this alternative.

6.4.1.3. Cost

There are no foreseen costs associated with the implementation of the No Action alternative, other than nominal long-term administrative costs.

6.4.2. Alternative 2: In-Situ Slope Stabilization of Mine Waste Piles using Rip Rap

Alternative 2 employs an engineering control approach, which requires the placement of filter-fabric on the existing mine waste piles, followed by the placement of a layer of large rocks (as rip rap) on top of the filter fabric to physically stabilize the existing mine waste piles. The filter fabric will prevent the release of fine sediment (silts) into the creek, while the rip rap will prevent future creek bank erosion. This alternative would not remove COPCs from the site.

Based on the size of the creek, one-man rock[3] should provide adequate protection from erosion along the slopes of the waste piles even during wet seasons. Larger, two- and three-man rock[4] would be necessary at the toe of the rip rap embankment to keep the rip rap on the upper slope from sliding along the steep slope of the embankment. A final engineering study and design is required as part of this alternative to ensure its implementability and to appropriately size the rocks to be used as rip rap for effective erosion control. An evaluation of the availability and suitability of local quarry sources to supply the rip rap must also be conducted as part of the design.

Under this alternative, the existing mine waste piles will be left in place, therefore, no mine waste pile removal or off-site disposal are required. If this work is to be conducted during the dry season, no creek diversion would be required. The toe and portions of the slope of the mine waste piles may need to be cut when larger rip rap is placed at the toe area. A detailed engineering study would be required prior to cutting back the toe, to ensure the feasibility of this alternative, including evaluation of overall slope stability, determination of space requirements for the final modified slope, and determining the appropriate size and volume of rip rap to be placed for slope stabilization. Placement of large (two- and three-man) rock at the toe of the slopes may alter the course of the creek and (depending on the volume of

---

[3] A one-man rock is typically up to300 pounds.

[4] A two-man rock is typically 300 to 800 pounds; a three-man rock is typically 800 to 1,500 pounds.

rock required) may some rock may be placed on top of portions of the existing natural creek bed. Mine waste removed from the toe or slope will likely need to be put on the top of the mine waste piles (where the current bench/road is) before the piles could be lined with filter fabric and armored by the rip rap. The limited distance (i.e. width) between the current edge of the top of the waste piles (bench) and the bedrock of the hillslope (especially in the area of the North and South adits) will limit the amount of excavated waste materials that can be placed on top of the piles, and therefore may render this alternative less implementable. If there is insufficient space for stockpiling excavated material on the bench, some material may need to be hauled off site (see Alternative 4). This evaluation would be determined in the engineering study. For the purposes of this analysis, it is assumed that there will be sufficient space to place any excavated materials on top of the bench above the current waste piles and that adequate drainage from and access to the North and South adits will be able to be maintained.

Long-term maintenance associated with this alternative would include periodic inspection and repair of the rip rap embankment. No creek bank restoration or revegetation is included in this alternative.

Based on the results of the risk evaluation (Section 3), it is anticipated that by effectively preventing erosion of the source material (mine waste piles), the influx of additional sediment into the creek will be significantly reduced. Periodic monitoring of metals levels in the sediments at and downstream of the impacted creek sections will be conducted to evaluate long term protection of downstream sediment.

Future institutional controls may be required to accompany the engineering control design, such as placing signs along the rip rap banks to warn people not to dig through or disturb the rip rap or filter fabric, thus compromising the integrity of the capping materials.

6.4.2.1. Effectiveness

The filter fabric and rip rap would physically prevent the continued erosion of sediment from the mine waste piles into Copper Creek, therefore reducing the volume of contaminated sediments in the creek. This will in turn eliminate the direct contact of the in-stream invertebrates with hazardous substances. This alternative would leave waste materials in place on site and would not permanently reduce or remove the COPCs from the site. This alternative is effective in the short-term at achieving the PRAO by reducing exposure to wastes for humans and ecological receptors. This alternative is effective in short-term protection of human health because the site workers will have minimal exposure to contaminated mine waste piles as no removal of the mine waste is required.

If the rip rap along the creek banks are adequately inspected and maintained, this alternative is moderately effective in providing long-term protection to human health and ecological receptors. It is expected that long-term maintenance of the rip rap slopes and the filter fabric would be required to minimize further erosion of the waste piles. The effectiveness of the filter fabric and rip rap in preventing erosion of the waste piles is highly dependent on the ability of the cover to withstand erosion of Copper Creek at the site. Long-term monitoring would be required to fully evaluate the effectiveness of this alternative.

While this alternative will meet some potential ARARs, several potential federal and State ARARs may not be attainable without significant additional study, including:

- Federal regulations pertaining to the protection of floodplains requiring that actions within floodplains should avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values and must be designed, constructed, and operated to avoid washout.
- Federal regulations for protection of endangered species, including requirements that actions may not jeopardize the continued existence of any Federally listed species or cause the destruction or adverse modification of critical habitat or negatively effect survival or reproduction of any state threatened or endangered species.
- Federal regulations specific to the Smith River and its tributaries that require improving the anadromous fishery and water quality, including improving fish spawning and rearing habitat, and placing appropriate restrictions or limitations on soil disturbing activities and providing for the restoration of landscapes damaged by past human activity consistent with the purposes of the act.

This alternative would not comply with the stated objectives in the standards and guides for the Smith River NRA which include maintaining and restoring the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations; and maintaining and restoring the sediment regime under which aquatic ecosystems evolved (see Appendix C). Potential negative impacts to the stretch of creek in the vicinity of the mine site would need to be thoroughly evaluated as part of the engineering study prior to implementing this alternative. There is a possibility that placing large rocks in the creek bed will have negative effects on the sensitive creek habitat and would restrict access to spawning fish.

This alternative has short-term effectiveness, except that may not meet certain potential ARARs. This alternative is relatively effective in the long-term, but its effectiveness in achieving the PRAO and PRAGs would need to be weighed against possible long-term degradation of creek habitat due to the addition of large rip rap to the creek bed. Regulatory and community acceptance of this alternative is assumed to be low, because COPCs would be left in place and the creek bank would be un-vegetated and exposed (possible aesthetic impact).

6.4.2.2. Implementability

This alternative is readily implementable using existing construction technology. Some improvement of the site access road would be required in order to transport large rocks to the site and place the rip rap along the creek bank using an excavator. Portions of the waste piles would need to be disturbed, excavated, and placed on the upper bench (where the old access road to the site currently exists). The volume of material required for excavation may exceed the available space on the narrow bench. In addition, placing the material on this bench may obstruct access to the North and South adits and may block the perennial drainage of water from these adits. Otherwise, the implementation of this alternative is relatively straightforward.

The procurement of the rip rap rock for this alternative is dependent on the availability and suitability of rip rap materials from a local quarry source. If a local source cannot be identified, the implementabiliy of this alternative will be less favorable, because rip rap rock will have to be trucked to the site.

Long-term inspection and maintenance would be required to ensure the integrity of the filter fabric and rip rap embankment over time and its usage as a detaining device against contaminant mobility and toxicity.

6.4.2.3. Cost

The estimated cost for implementing this alternative is $495,000. Detailed cost estimate is included in Appendix D. The following are major assumptions for this alternative:

- The site management personnel would consist of a site superintendent, three operators, two laborers, and a site quality control (QC) representative/health and safety/site engineer.
- A long-arm large excavator will be used to place the rocks, and a mid-size front-end loader will be used for transporting rocks to the site from haul trucks.
- The estimated duration of field activities is 15 days.
- Estimated quantities of filter fabric to be used is 10,000 square feet.
- Estimated tonnage of rip rap for this project is 700 tons (including both two- and three-man rock).
- A local quarry source for rip rap is assumed to be available. If a local source is not available, the costs may be increased by a significant factor.
- Minimal excavation and relocation of mine waste piles are assumed.
- Road improvement ($10,000) costs are included in the total costs.
- Level D personal protection equipment is assumed for aspects of this project that include handling waste materials.
- Long-term inspection and maintenance for the rip rap embankment will be required for the next 10 years ($9,000 per year).
- The category of “Field, Planning, Reporting, and Regulatory Support” includes costs for home office support; project management; health, safety, and regulatory compliance review; meetings and client support; and preparation of the Removal Action Summary Report.

6.4.3. Alternative 3: Removal of Source Materials followed by On-Site Encapsulation and Creek Bank Restoration

Alternative 3 requires the removal of source materials (mine waste piles) currently lining the creek banks (a total of approximately 250 linear feet in three locations) and the transportation of removed source materials to a designated on-site upland impoundment area. The creek will be temporary dammed and diverted to lower the water level at the creek while the toe of the mine waste piles are being excavated and backfilled from above. Creek water upstream of the construction area will be dammed using sandbags, diverted from the creek bed, and released at a location downstream of the active construction area. A tracked excavator with a long-arm will be used to remove the mine waste piles on the creek bank, and a dump truck will be used to transport the excavated materials to the on-site impoundment area. A front-end loader and a dozer will be used to build the stockpile and the soil cap.

The removed and stockpiled mine waste will be capped and graded for drainage, and topped with approximately 6-inches of top soil as a vegetative layer. This soil cap would essentially encapsulate the removed mine waste and eliminate any future exposure to human or ecological receptors. Clean, on-site material free of mine waste and constituents of concern and with similar gradation to the natural creek bank would be used to backfill the excavated areas along the creek bank. If suitable materials are not found at the site, backfill that meets the gradation requirement will be trucked in from the nearest source. For the purposes of this evaluation, an appropriate on-site source of backfill material is assumed. Minimal backfilling will be done to restore, to the degree practicable, the natural, pre-mining contours and morphology of the creek bank. The backfilled creek bank material will be compacted and the creek bank will be restored using a biodegradable erosion control mat. The erosion control mat would be used as a creek bank liner and would be temporary stabilized by staking and with sandbags. Rip rap (rock) may be placed at the bottom of the restored creek bank to prevent scouring of the newly placed bank materials and to better simulate the natural (bedrock) creek bed substrate. Live staking of native plants may be completed on the restored creek bank for long-term stabilization.

As with Alternative 2, this alternative would require a final engineering study and design to establish siting requirements for the mine waste encapsulation area, to locate and conduct geotechnical and chemical testing for an on-site source for backfilling the excavated creek banks, and to ensure appropriate requirements are met in terms of waste placement and capping.

Future institutional controls may be required to accompany the engineering control design, such as placing signs or fencing around the encapsulation area to reduce the potential for erosion of the cap by site visitors.

6.4.3.1. Effectiveness

This alternative is effective in removing the source materials from the creek, thereby eliminating future release of contaminated materials into the creek. It is anticipated that by removing the source material (mine waste piles) from the creek banks, there will be no future influx of additional material from the waste piles into the creek. Periodic monitoring of metals concentrations in sediments at and downstream of the restored creek sections will be conducted to evaluate long term health of the creek. As such, it is expected that chemical-specific ARARs will be met over the long term.

The on-site capping of the excavated materials should eliminate human and ecological exposure to metals at the site, although long-term periodic inspection and maintenance of the soil cap may be required to ensure the long-term integrity of the cap will not be compromised by natural erosion or human activities.

It is assumed that removal activities associated with this alternative would not have severe and lasting effects on the sensitive species at and downstream of the site. The PRAO would be met under Alternative 3.

This alternative would meet the potential ARARs specified in Table 11 and would comply with the stated objectives in the standards and guides for the Smith River NRA which include maintaining and restoring the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations; and maintaining and restoring the sediment regime under which aquatic ecosystems evolved (see Appendix C).

Regulatory and community acceptance of this alternative is assumed to be high, given the overall benefits of restoring the creek to its natural condition and improving/restoring the habitat for spawning fish. This alternative meets both short- and long-term effectiveness.

6.4.3.2. Implementability

This alternative is readily implementable using existing construction technologies. The site access road will likely require some modification to allow heavy equipment and import materials to be transported to the site after improvement work to the road is done. Encapsulation of contaminated materials is a proven technology that has been used extensively for mine waste treatment. Because of the short duration of draining of the affected creek section for source material removal and creek bank restoration, no long-term effect is expected on the ecological health of the affected creek section.

Because mine waste is exempt from RCRA waste disposal criteria while it is located within a mining area (40 Code of Federal Regulations [CFR] §261.4(b)(7)), on-site encapsulation of mine waste will not be regulated under hazardous waste disposal and landfill regulations. However, other federal or state requirements regarding appropriate siting, construction, and long-term inspection and maintenance may apply (e.g., Corrective Action Management Units [CAMU] regulations at 40 CFR 264 Subpart S, and 40 CFR Part 264.552(c) and mining waste regulations pursuant to California Water Code Section 13172 [at 27 CCR § 22470-22510]).

Because the waste piles would be consolidated and encapsulated on-site, the Forest Service would ensure that substantive requirements for siting and construction of mine waste impoundments to ensure protection of groundwater and surface water downgradient from the consolidation unit were met (27 CCR §22510). Existing leaching test data indicated that the encapsulated mine waste should not pose future threat to water quality if the integrity of the cap is maintained.

This alternative is implementable if a suitable on-site repository can be identified. Several potential sites for the repository have been identified. One is a relative flat area of approximately 1.5 acres at the southern part of the site, north of the Site's historic ore loading platform that is suitable for stockpiling purposes. This flat area is near the site boundary and is immediately adjacent to a privately owned (patented) mine claim. Appropriate notifications and collaboration with the adjacent property owner would be required in order to transport materials to this location (because portions of the access road cross the private claim). A second potential site for the repository is located upslope from and east of the site, east and north of the area where prospect pits 1 and 2 are shown on the map (see Figure 3). This area is slightly further from the site than the first (by approximately 1,000 feet), and may require some additional road improvement work, but would not require transportation across any private roads or collaboration with the adjacent property owner, because it is entirely on Forest Service land. A third potential site for the repository is along the flat portion of the roadway leading to the upper portion of the site. This location may be the most preferable, given its proximity to the site (shorter travel distance) and the fact that it would not require transportation across private roads or property.

The final decision regarding the location for the repository would be made during the design phase of the project.

6.4.3.3. Cost

The estimated cost for implementing this alternative is $678,000. Detailed cost estimate is included in Appendix D. The following are major assumptions for this alternative:

- The site management personnel would consist of a site superintendent, three operators, two laborers, and a site QC representative/health and safety/site engineer.
- A long-arm large excavator will be used to excavate the mine waste piles, and for backfilling. A mid- to large-size front-end loader will be used for transporting excavated materials and for placing materials in the stockpile area
- One solo dump truck will be used for transporting excavated materials to the stockpile area.
- A dozer will also be needed for constructing the soil cell and cover.

- The estimated duration of field activities is 30 days.
- Estimated quantity of mine waste to be excavated is 10,000 tons.
- For estimating purposes, 5,000 tons of backfill be used for restoring the creek banks. Less backfill is required because it is expected that the creek banks will be restored to natural contour instead of the present shape which are intruding into the creek. It is assumed that this material will be available from an on-site source, such as the area to be graded/excavated for the repository. The potential on-site source will needed to be tested prior to use to ensure it is suitable (geotechnically) for stream bank use, and also that the concentrations of metals in the native material are within background concentrations for site sediment. If an appropriate on-site backfill source is not located, the cost of implementation would increase to account for importing backfill from off site.
- $10,000 is allowed for live-staking of native plants as part of the bank restoration effort.
- 1,500 tons of top soil are estimated for the construction of the soil cap (assumes no impermeable cap layer).
- Road improvement ($10,000) costs are included in the total costs.
- An estimated $9,500 per year is assumed for long-term inspection and maintenance for the soil capped cell and restore banks for the next 10 years.
- The category of “Field, Planning, Reporting, and Regulatory Support” includes costs for home office support; project management; health, safety, and regulatory compliance review; meetings and client support; and preparation of the Removal Action Summary Report.

6.4.4. Alternative 4: Removal and Off-Site Disposal of Source Materials Followed by Creek Bank Restoration

Alternative 4 is similar to Alternative 3 in terms of source materials removal and creek bank restoration. However, rather than on-site consolidation, the removed source materials (mine waste piles) will be loaded into dump trucks for off-site disposal at the nearest permitted disposal facility. A front end loader will be used for loading the mine waste into dump trucks for off-site disposal.

Creek restoration will be achieved with the approach described in Alternative 3.

6.4.4.1. Effectiveness

This alternative is very effective in removing the source materials, thereby eliminating future releases of contaminated sediment into the creek. It is anticipated that by effectively removing the source material (mine waste piles) from the creek banks, there will be no future influx of additional sediment from the waste piles into the creek.

Because the waste piles will be transported off-site, there will be no future threat to on-site water quality, and 27 CCR §22510 does not apply to this alternative. Furthermore, no long-term monitoring of the soil cap for onsite mine waste is required.

It is assumed that removal activities associated with this alternative would not have severe or lasting effects on the sensitive species at and downstream of the site. The PRAO and action-specific ARARs would be met under this alternative.

6.4.4.2. Implementability

This alternative may be implemented using existing construction technology. Significant improvements to the site access road would be required to allow access to heavy equipment and dump trucks for off-site transportation and disposal. Because of the short duration of the removal activities, no long-term effect is expected on the ecological health of the affected creek section. Because the contaminated material will be transported off-site for disposal, no on-site soil cell will be constructed, thus eliminating the long-term inspection and maintenance requirements of an on-site soil cell

Off-site waste disposal is a proven remedial alternative for contaminated site, and there are numerous RCRA- and State-permitted landfills that could accept the mine waste piles, albeit a relatively long distance from the site. There are numerous licensed trucking companies in the State of California that could be subcontracted to provide transportation of the mine waste.

This alternative would meet the potential ARARs specified in Table 11.

Regulatory and community acceptance of this alternative is assumed to be high, given the overall benefits of restoring the creek to its natural condition and improving/restoring the habitat for spawning fish. This alternative meets both short- and long-term effectiveness.

6.4.4.3. Cost

The estimated cost for implementing this alternative is $2,585,000. Detailed cost estimate is included in Appendix D. The following are major assumptions for this alternative:

- The site management personnel would consist of a site superintendent, three operators, a laborer, and a site QC representative/health and safety/site engineer.
- A long-arm large excavator will be used to excavate the mine waste piles, and for backfilling. A mid- to large-size front-end loader will be used for transporting excavated materials and for loading haul trucks for off-site disposal.
- One solo dump truck will be used for transporting excavated materials to the staging area for truck loading.

- The estimated duration of field activities is 25 days.
- Estimated quantity of mine waste to be excavated and disposed of is 10,000 tons.
- For estimating purposes, 5,000 tons of backfill be used for restoring the creek banks. Less backfill is required because it is expected that the creek banks will be restored to natural contour instead of the present shape which are intruding into the creek. It is assumed that this material will be available from an on-site source, such as the area to be graded/excavated for the repository. The potential on-site source will needed to be tested prior to use to ensure it is suitable (geotechnically) for stream bank use, and also that the concentrations of metals in the native material are within background concentrations for site sediment. If an appropriate on-site backfill source is not located, the cost of implementation would increase to account for importing backfill from off site.
- $10,000 is allowed for live-staking of native plants as part of the bank restoration effort.
- An estimated $3,000 is assumed for long-term inspection and maintenance for the restored creek banks for the next 10 years.
- Costs for significant road improvement ($13,000) are included in the total costs.
- Mine waste is assumed to be non-hazardous waste for off-site disposal. It is assumed that the mine waste will be trucked to the Central Valley for disposal purposes, because there is no suitable landfill in Del Norte and adjacent counties. As a result, the transportation costs will be $105/ton, and the disposal costs will be $40/ton.
- The category of “Field, Planning, Reporting, and Regulatory Support” includes costs for home office support; project management; health, safety, and regulatory compliance review; meetings and client support; and preparation of the Removal Action Summary Report.

Section 7. Comparative Analysis and Recommended Removal Action Alternative

The removal action alternatives identified in Section 6.4 were compared with one another by using the evaluation criteria described in Section 6.3. This section describes the results of the comparative evaluation and one alternative will be selected as the recommended removal action.

7.1. COMPARISON OF ALTERNATIVES

7.1.1. Alternative 1: No Action

Alternative 1 does not meet the effectiveness criterion because it does not meet the PRAO and PRAGs of the proposed removal action. Although it is easily implementable and the alternative with the lowest cost, it is not likely to be acceptable to the community or the regulatory agencies. Alternative 1 was retained as required by regulatory guidance and for comparative purposes.

7.1.2. Alternative 2: In-Situ Slope Stabilization of Mine Waste Piles with Rip Rap

Alternative 2 partially meets the effectiveness criterion but does not meet the requirement for permanent removal of mine waste piles from the creek banks. It is implementable, provided that an engineering study is conducted to confirm the engineering and institutional controls and appropriate land use restrictions are acceptable to federal, state, and local authorities. Alternative 2 meets the PRAO for reduction of human health and ecological risks, although it does not eliminate future risk of erosion and sedimentation of the mine waste piles. Waste material may potentially migrate downstream if the filter fabric and rip rap degrade. Alternative 2 is relatively low in cost, but would require long-term inspection and maintenance of the rip rap embankment. This alternative does not meet all potential ARARs. Potential negative impacts to the stretch of creek in the vicinity of the mine site would need to be thoroughly evaluated as part of the engineering study prior to implementing this alternative. This alternative has a likelihood of degrading the overall creek habitat because of the need to place large rip-rap rock within the creek bed and along the flood plain of the creek, which would likely negate any benefits to the habitat that could be gained by controlling waste rock erosion. This alternative would not comply with the stated objectives in the standards and guides for the Smith River NRA regarding maintaining and restoring aquatic shorelines, banks, and bottom configurations; and maintaining and restoring the sediment regime under which aquatic ecosystems evolved (see Appendix C).

The long-term maintenance requirements of the rip rap embankment will be somewhat less than the long-term maintenance of the on-site encapsulation of the excavated source materials required under Alternative 3, but more than those under Alternative 4. In the short term, it would pose slightly less risk to construction workers than Alternatives 3 and 4 because there would be minimal intrusive activities that would potentially expose the workers to metal-contaminated mine waste piles.

7.1.3. Alternative 3: Removal of Source Materials followed by On-site Encapsulation and Creek Bank Restoration

Alternative 3 gives additional protection beyond what is offered in Alternative 2, providing for the removal and on-site encapsulation of the source materials (mine waste piles). As opposed to Alternative 2, no mine waste would be left in the vicinity of the creek bed under this alternative. The removal of the mine waste piles will eliminate future erosion of source materials into Copper Creek, would meet the potential ARARs and would comply with the stated objectives in the standards and guides for the Smith River NRA regarding maintaining and restoring aquatic shorelines, banks, and bottom configurations; and maintaining and restoring the sediment regime under which aquatic ecosystems evolved (see Appendix C).

Because the excavated mine waste piles will be relocated, stockpiled, and encapsulated in an upland area with a vegetated low-permeability soil cap, the PRAO and PRAG for mine waste will be achieved, provided that the integrity of the soil cap for the mine waste cell is maintained by a long-term inspection and maintenance program. It is implementable using existing construction technology. It is more costly than Alternatives 1 and 2, and would pose somewhat more risk to site workers during implementation of the removal action.

This alternative has similar long-term maintenance costs to those of Alternative 2. An engineering study would need to be conducted prior to implementation of this alternative to determine an appropriate site for the construction of the on-site permanent cell.

7.1.4. Alternative 4: Removal and off-site disposal of Source Materials followed by Creek Bank Restoration

Alternative 4 is effective in eliminating future human health and ecological risks from exposure to source materials (mine waste piles) at the Site, by removing mine waste piles that are in contact with the creek and transporting them off-site for disposal. Like Alternative 3,,no mine waste will be left in the vicinity of the creek bed. However, since waste would be disposed of off site, no long-term maintenance and inspection would be required with this alternative. The PRAO and PRAG will be met at the site with this alternative.

This alternative is implementable, provided the required modifications to Site access roads are able to be made to accommodate haul trucks. The removal of the mine waste piles will eliminate future erosion of source materials into Copper Creek, would meet the potential ARARs and would comply with the stated objectives in the standards and guides for the Smith River NRA regarding maintaining and restoring aquatic shorelines, banks, and bottom configurations; and maintaining and restoring the sediment regime under which aquatic ecosystems evolved (see Appendix C).

Because of the remoteness of the site, off-site disposal of the contaminated mine waste would result in significant costs when compared to Alternatives 1 through 3. In addition, the excavated mine waste might need to be staged on site prior to load-out, because the site dirt roads can not support truck and trailer operation, thereby adding material handling costs. As a result, the cost for this off-site disposal alternative would be prohibitively high.

This alternative would pose some short-term risk during implementation of the removal action, similar to that posed by Alternative 3.

7.2. RECOMMENDED REMOVAL ACTION ALTERNATIVES

The removal action alternative recommended for the Union-Zaar Mine site is **Alternative 3, Removal of Source Materials followed by On-site Encapsulation and Creek Bank Restoration.** Alternative 3 will meet the PRAO and PRAGs at the site, eliminate future introduction of mine waste to Copper Creek, and exposure pathway human and ecological receptors to the encapsulated mine waste will be minimal if the integrity of the soil cap is maintained. This alternative is preferable to Alternative 2, because the removal of the mine waste piles will eliminate future erosion of source materials into Copper Creek, would restore the creek banks to their pre-mining conditions, and would meet the potential ARARs and standards and guides of the Smith River NRA. Overall it affords the same level of protection of human health and ecological receptors as in Alternative 4, at less than one-third of the estimated cost of Alternative 4.

The primary components of the recommended alternative are as follows:

- An engineering design will be completed for an on-site soil cell, and the excavation and creek bank restoration process. The design will identify an appropriate site for the on-site cell and will outline required testing to be accomplished prior to building the cell. The on-site encapsulation design will be submitted to appropriate regulatory agencies for review prior to mobilization to the site.
- An on-site backfill source will be identified and tested for geotechnical and chemical properties to ensure a suitable material for creek bank restoration.
- The current access route to the creek banks will be improved to support the removal activities.
- Temporary sandbags will be placed in the creek on the upstream side of the work areas, and water will be temporarily diverted away from the work area.

- The mine waste piles on the creek banks will be excavated and brought to the on-site stockpile area. The excavated soil will be placed inside the soil cap footprint and stockpiled and compacted by a loader and a dozer.
- After all mine wastes are excavated (estimated 10,000 tons) from the creek banks, minimal amounts of fill will be excavated from an on-site source, and trucked to the excavated area to backfill along the creek banks and restore them to as close to pre-mining conditions as possible. After backfilling is completed, minimal amounts of rip rap may be placed at the toe of the backfill for erosion control.
- The surface of the backfill area will be covered with erosion control mat, and the steep slopes will be hydroseeded and/or live-staked with native plants for slope stabilization.
- The soil cell will be constructed at the designated stockpile area. After all mine wastes are placed inside the soil cell area, a soil cover will be placed on top of the compacted mine waste (specifications for the soil cover will be included in the final design).
- After the removal action and soil cap construction are completed, a focused monitoring and inspection program will be conducted during the first 12 months of the long-term maintenance program to ensure the planted vegetation is growing and meets expectations, and the erosion controls are functioning as intended.
- After the first year, periodic inspection and maintenance activities will be carried out in subsequent years to maintain the integrity of the soil cap and the restored creek banks.

The estimated cost of the recommended removal action alternative is $678,000. As discussed in subsection 6.3.3, this cost represents an order-of-magnitude estimate with an intended accuracy of +50 to -30 percent (EPA, 2000). Final project costs will depend on actual labor and material costs, actual engineering design costs, actual site conditions (including the actual quantities of mine waste excavated and the amount of material that may be classified as hazardous waste), competitive market conditions, the final project scope, the final project schedule, and other variables.

Section 8. References

Back, W. 1957. Geology and Groundwater Features of Smith River Plain. USGS Water Supply Paper 1254.

California Department of Fish and Game (CDFG). 2004. Wildlife Habitat Data Analysis Branch “Special Animals (673 taxa).” Available on-line at http://www.dfg.ca.gov/whdab/pdfs/TEAnimals.pdf. August.

California Department of Water Resources (DWR). 1975. California’s Groundwater. California Department of Water Resources Bulletin 118.

Dames and Moore. 1985. “Aquatic Biological Resources, Gasquet Mountain Project, Del Norte County, California.” April.

DWR. 2003. California’s Groundwater Update 2003. California Department of Water Resources Bulletin 118. Individual Basin Descriptions (Smith River Plain). available online at: http://www.groundwater.water.ca.gov/bulletin118/

California Division of Mines and Geology (CDMG) 1966. “Geologic Map of California.” Ian Campbell, State Geologist. 1:2,500,000.

Florida Department of Environmental Protection (FDEP) 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Vol. 1. Development and Evaluation of Sediment Quality Assessment Guidelines.

Forest Service, 2007. Data reviewed on May 17, 2007 by ERRG staff available in Forest Service files from a 1985 aquatic biological resources evaluation for the Gasquet Mountain Project, Del Norte County, CA.

Harden, D. R. 1998. “California Geology.” Prentice-Hall Inc., Simon and Schuster. New Jersey.

Gustavson et al. 2001. Geochemical Landscapes of the Conterminous United States, New Map Presentations for 22 Elements. USGS Professional Paper 1648. 44 pages.

MacDonald DD, Ingersoll CG, Berger TA. January 2000. Development and Evaluation of Sediment Quality Guidelines for Freshwater Ecosystems: Archives of Environmental Contamination and Toxicology, v. 39, p. 20-31.

National Marine Fisheries Service (NMFS) 2001. "Status Review Update for Coho Salmon (Oncorhynchus kisutch), from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units." Southwest Fisheries Science Center, Santa Cruz Laboratory. Table A-1. April 12

National Resources Council (NRC). 1997. Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies. National Academy Press. Washington, D.C.

Norris and Webb 1990. "Geology of California." John Wiley and Sons, Inc. Second Edition.

Tetra Tech, EM, Inc. September 2005. Final Preliminary Assessment/Site Investigation (PA/SI) Report, Union Zaar Mine Site, Del Norte County, California.

United States Environmental Protection Agency (EPA). August 1993. Guidance on Conducting Non-Time-Critical Removal Action Under CERCLA. Office of Emergency and Remedial Response, Washington, D.C. (OSWER) Directive 9360.0-32. August.

EPA. August 1988 (1988a). CERCLA Compliance with Other Laws Manual: Interim Final. Office of Emergency and Remedial Response, Washington, D.C.

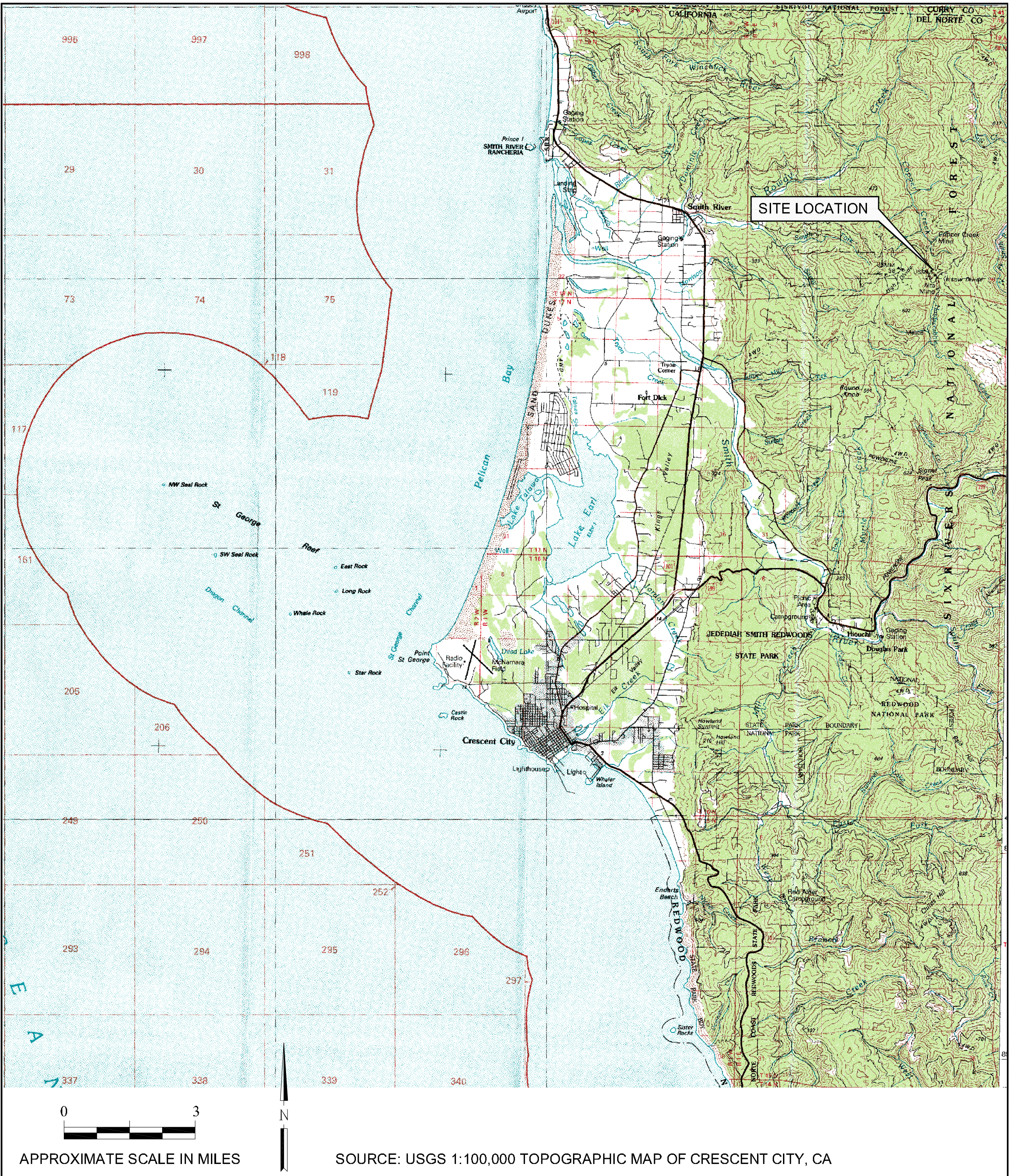
EPA. 1988 (1988b). Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final.

EPA. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. OSWER Directive 9355.0-75. July.

EPA, 1992, Hazard Ranking System Guidance Manual. OSWER Directive 9345.1-07. November.

Western Regional Climate Center 2005. "General Climate Summary" and "Monthly Climate Summary" for Station No. 042147, Crescent City, California. Northern California Climate Summaries. Data from 1948 to 2004. Available Online at: http://www.wrcc.dri.edu/summary/climsmnca.html

Figures



APPROXIMATE SCALE IN MILES

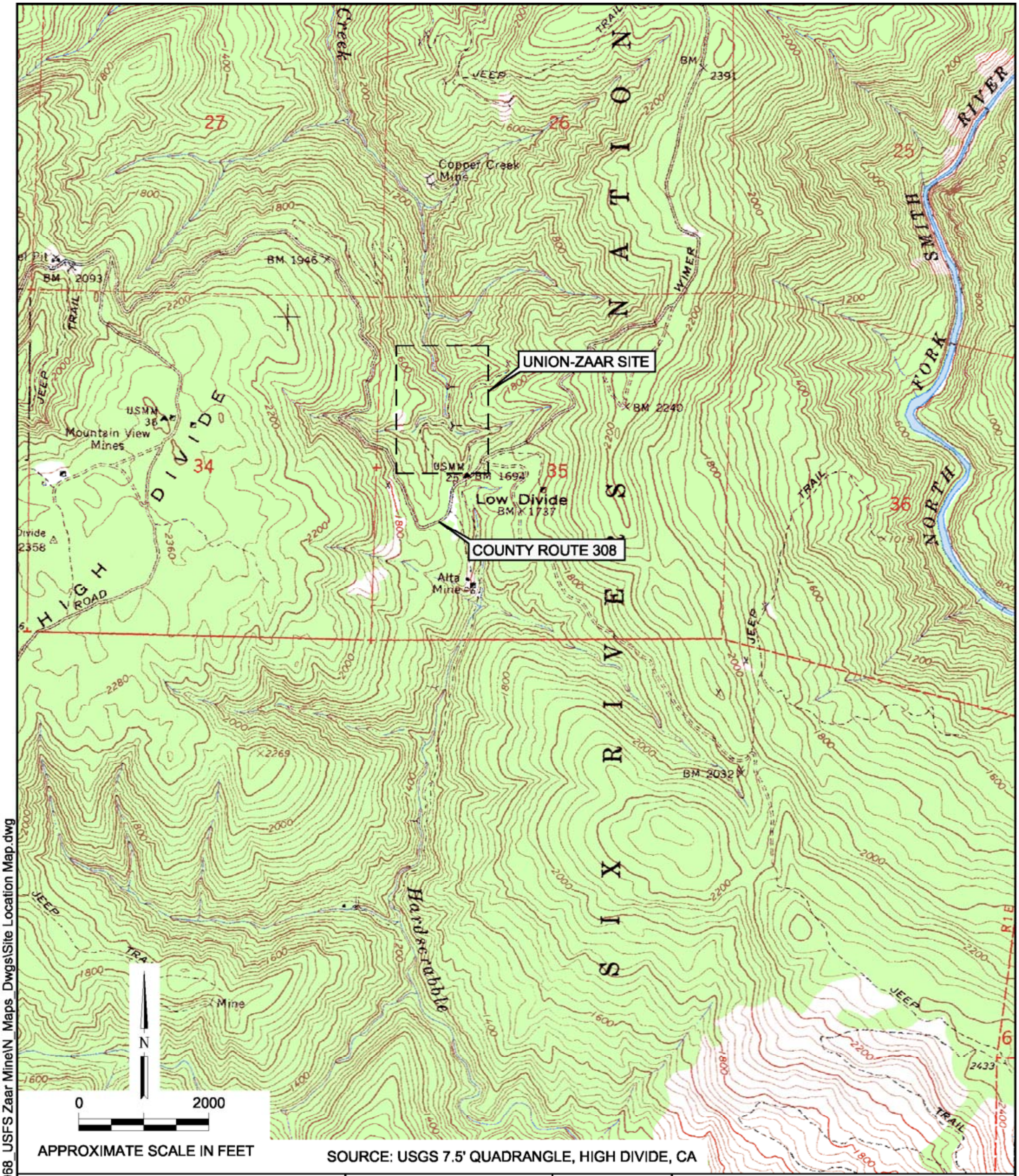
SOURCE: USGS 1:100,000 TOPOGRAPHIC MAP OF CRESCENT CITY, CA

ERRG

Engineering/Remediation Resources Group, Inc.
185 Mason Circle, Suite A/B
Concord, California 94520
(925) 969-0750

CLIENT: UNITED STATES FOREST SERVICE	DESIGNED BY: RDB 5-28-07	UNION-ZAAR MINE SITE VICINTY MAP			
	CHECKED BY: CEG 5-29-07				
LOCATION: SMITH RIVER NATIONAL RECREATION AREA, CA	P.E/P.G.: -	ERRG PROJECT NO. 27-068	REVISION NO. 0	SHEET 1 OF 1	FIG NO. 1

P:\2007_Projects\27-068_USFS Zaar Mine\N_Maps_Dwgs\Site Vicinity Map.dwg



SOURCE: USGS 7.5' QUADRANGLE, HIGH DIVIDE, CA

ERRG
Engineering/Remediation Resources Group, Inc.
185 Mason Circle, Suite A/B
Concord, California 94520
(925) 969-0750

CLIENT: UNITED STATES FOREST SERVICE

LOCATION: SMITH RIVER NATIONAL RECREATION AREA, CA

DESIGNED BY: RDB 7-31-07

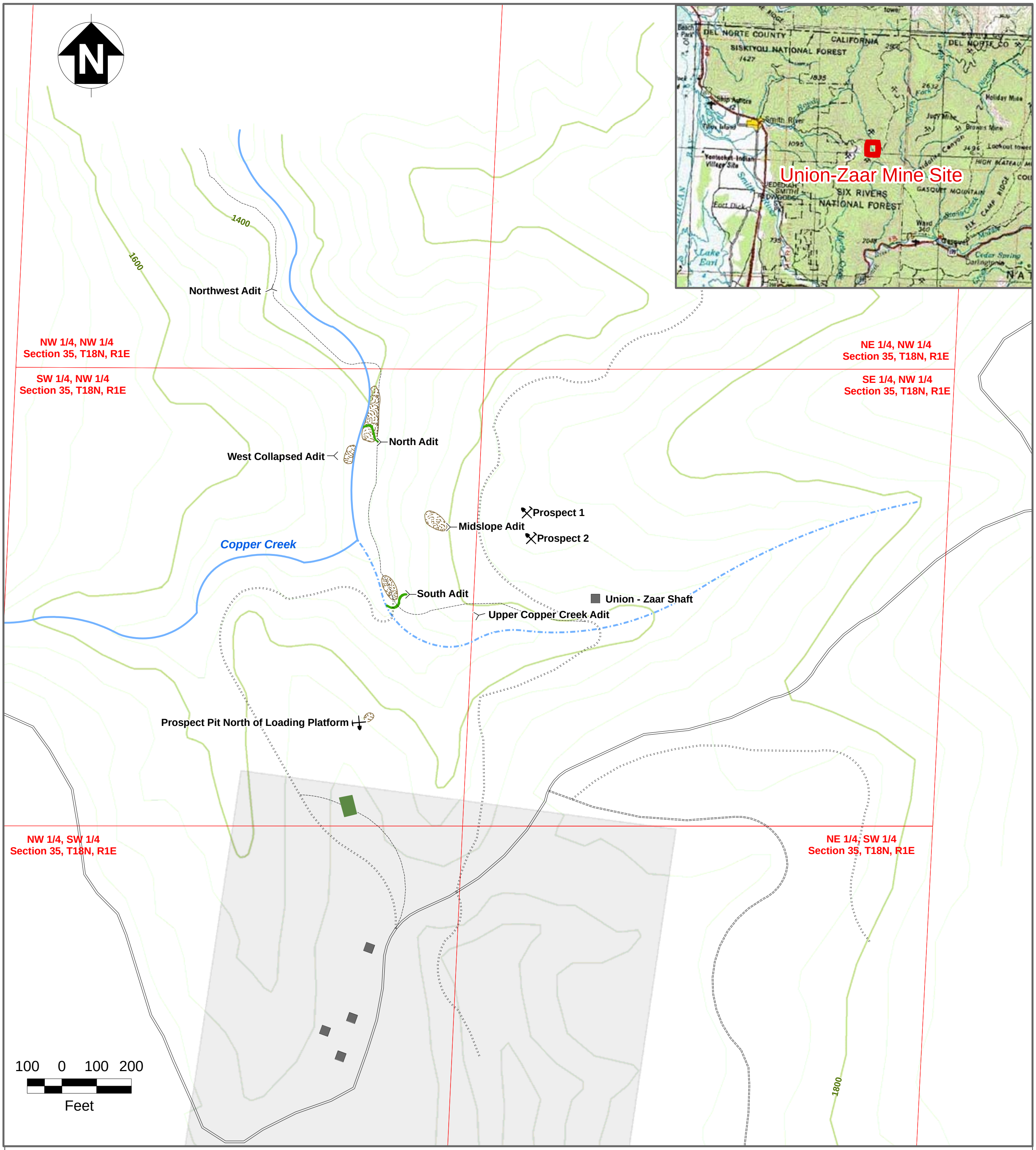
CHECKED BY: CEG 7-31-07

P.E/P.G.: -

UNION-ZAAR MINE SITE LOCATION MAP

ERRG PROJECT NO.	REVISION NO.	SHEET	OF	FIG NO.
27-068	0	1	1	2

P:\2007_Projects\27-068_USFS Zaar Mine\N_Maps_Dwgs\Site Location Map.dwg



■	Shaft	🟩	Loading Platform
⚒	Prospect	▨	Waste Rock Pile
⅄	Adit	═	Improved Road, Dirt
-·-	Intermittent Stream	┅	Unimproved Road, Dirt
—	Stream	⋯	Unimproved Road, 4WD
—	Leachate Flow	- - -	Trail
■	Non-Forest Service Land (Alta Mine Claim)		

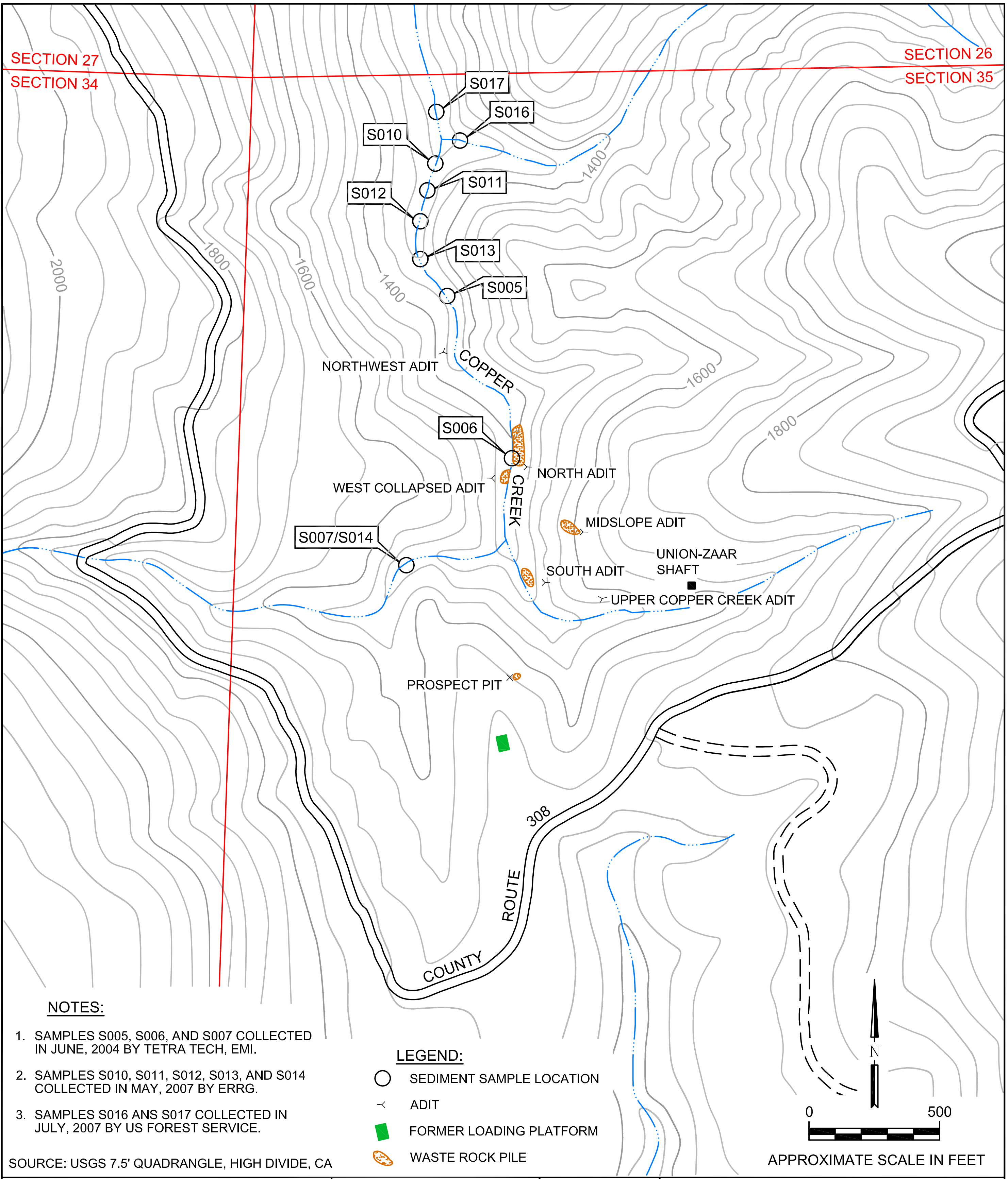
Basemap digitized from: U.S. Geologocal Survey
High Divide Quadrangle

Union-Zaar Mine
Smith River National Recreation Area, California

FIGURE 3

Site Layout

Referenced from the *Final Preliminary Assessment/Site Investigation (PA/SI) Report, Union Zaar Mine Site,DelNorte County,California*(Tetra Tech, 2005)



NOTES:

1. SAMPLES S005, S006, AND S007 COLLECTED IN JUNE, 2004 BY TETRA TECH, EMI.
2. SAMPLES S010, S011, S012, S013, AND S014 COLLECTED IN MAY, 2007 BY ERRG.
3. SAMPLES S016 ANS S017 COLLECTED IN JULY, 2007 BY US FOREST SERVICE.

SOURCE: USGS 7.5' QUADRANGLE, HIGH DIVIDE, CA

LEGEND:

- ○ SEDIMENT SAMPLE LOCATION
- ≺ ADIT
- 🟩 FORMER LOADING PLATFORM
- ● WASTE ROCK PILE

P:\2007_Projects\27-068_USFS Zaar Mine\N_Maps_Dwgs\Sample Location Map.dwg

Engineering/Remediation Resources Group, Inc.
185 Mason Circle, Suite A/B
Concord, California 94520
(925) 969-0750
ERRG

CLIENT:
UNITED STATES FOREST SERVICE

LOCATION:
SMITH RIVER NATIONAL RECREATION AREA, CA

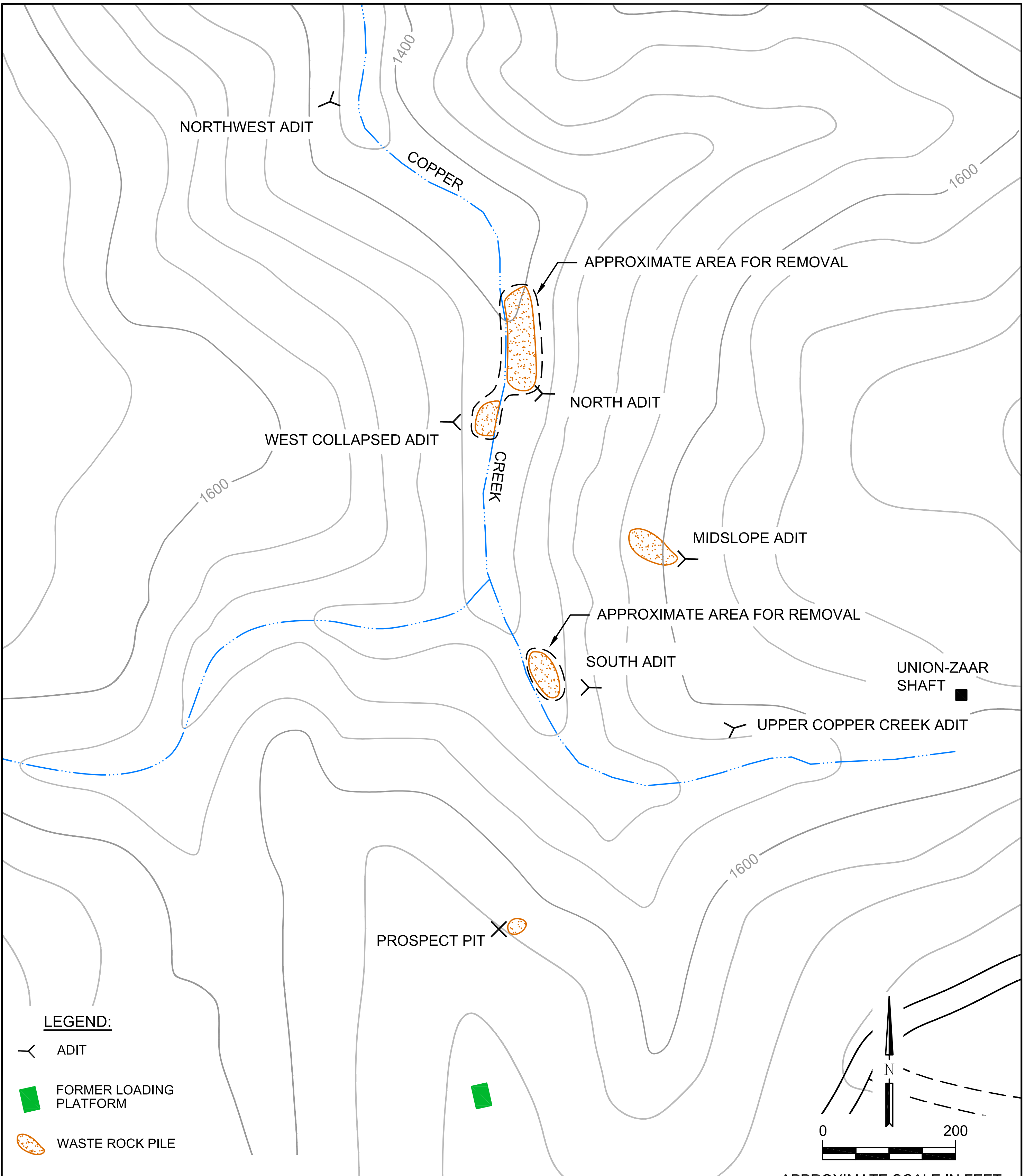
DESIGNED BY:
RDB 7-31-07

CHECKED BY:
CEG 10-17-07

P.E/P.G.:
-

UNION-ZAAR MINE SEDIMENT SAMPLE LOCATION MAP

ERRG PROJECT NO.	REVISION NO.	SHEET	OF	FIG NO.
27-068	0	1	1	4



SOURCE: USGS 7.5' QUADRANGLE, HIGH DIVIDE, CA

Engineering/Remediation Resources Group, Inc.
185 Mason Circle, Suite A/B
Concord, California 94520
(925) 969-0750
ERRG

CLIENT:
UNITED STATES FOREST SERVICE

LOCATION:
SMITH RIVER NATIONAL RECREATION AREA, CA

DESIGNED BY:
RDB 10-16-07

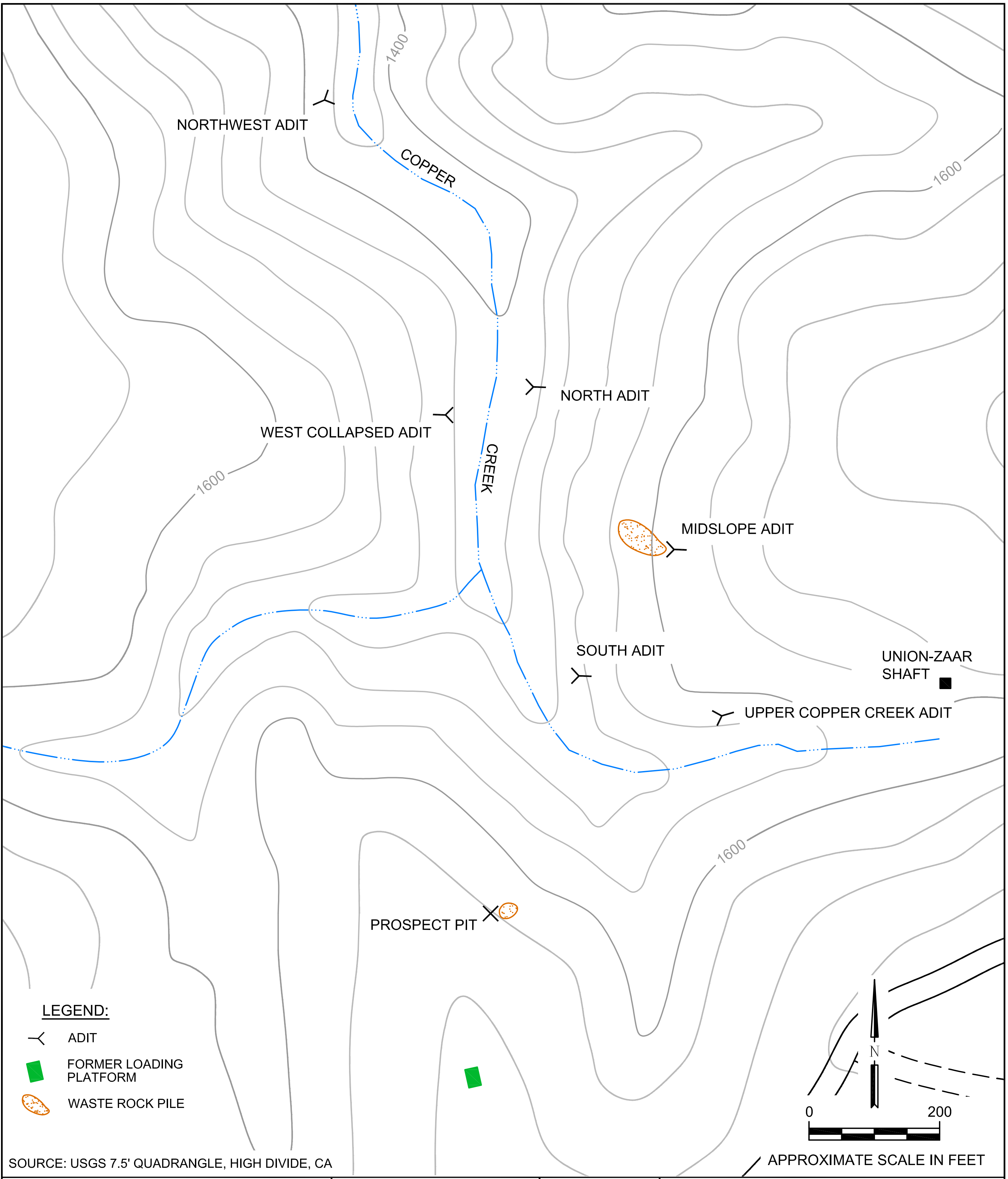
CHECKED BY:
CEG 10-17-07

P.E/P.G.:
-

UNION-ZAAR MINE
PRE-REMOVAL CONDITIONS

ERRG PROJECT NO.	REVISION NO.	SHEET	OF	FIG NO.
27-068	0	1	1	5

P:\2007_Projects\27-068_USFS Zaar Mine\N_Maps_Dwgs\Pre-Removal Conditions.dwg



SOURCE: USGS 7.5' QUADRANGLE, HIGH DIVIDE, CA

P:\2007_Projects\27-068_USFS Zaar Mine\N_Maps_Dwgs\Post-Removal Conditions.dwg

Engineering/Remediation
Resources Group, Inc.
185 Mason Circle, Suite A/B
Concord, California 94520
(925) 969-0750
ERRG

CLIENT:
UNITED STATES
FOREST SERVICE

LOCATION:
SMITH RIVER NATIONAL
RECREATION AREA, CA

DESIGNED BY: RDB 10-16-07

CHECKED BY: CEG 10-17-07

P.E/P.G.: -

UNION-ZAAR MINE
POST-REMOVAL CONDITIONS

ERRG PROJECT NO.	*REVISION NO.*	*SHEET*	*OF*	*FIG NO.*
27-068	0	1	1	6

Tables

Table 1. Sensitive Species in the Vicinity of the Union-Zaar Mine Site

Common Name	Federal Status	California Status	California Department of Fish and Game (CDFG)/California Native Plant Society (CNPS)
Bald Eagle	Threatened	Endangered	None
Bank Swallow	None	Threatened	None
Coast Cutthroat Trout*	None	None	CDFG California Species of Special Concern, Forest Service Sensitive Species
Coho Salmon - Southern Oregon/Northern California ESU[3]	Threatened [1]	Threatened [2]	CDFG California Species of Special Concern
Chinook Salmon - Southern Oregon/Northern California ESU[3]	Not Warranted		
Howell's jewel flower[3]	None	None	CNPS Rare, Threatened or Endangered in California and Elsewhere
Mardon Skipper	Candidate	None	None
Marbled Murrelet	Threatened	Endangered	None
McDonald's Rock Cress	Endangered	Endangered	CNPS Rare, Threatened or Endangered in California and Elsewhere
Steelhead Trout - Northern California ESU[3]	Threatened	None	CDFG California Species of Special Concern
Northern Spotted Owl	Threatened	None	None
Oregon Silverspot Butterfly	Threatened	None	None
Pacific Fisher	Candidate	None	CDFG California Species of Special Concern
Tidewater Goby	Endangered	None	CDFG California Species of Special Concern
Waldo buckwheat[3]	None	None	CNPS Rare, Threatened or Endangered in California, but more common elsewhere
Western Bog Violet[3]	None	None	CNPS Rare, Threatened or Endangered in California and Elsewhere
Western Snowy Plover	Threatened	None	CDFG California Species of Special Concern

Notes:

Table from PA/SI (Tetra Tech, 2005). Species status information from CDFG, CNPS, and NOAA databases available online at http://www.dfg.ca.gov/whdab/html/cnddb.html, http://cnps.org/index.htm, and http://www.nmfs.noaa.gov/, respectively.

* Potentially present at the Union-Zaar Mine Site

1 Populations between Cape Blanco, Oregon and Punta Gorda, California

2 The California Fish and Game Commission determined that the Coho from Punta Gorda to the Oregon border should be listed as Threatened in February 2004. As part of the normal listing process, this determination is currently under review by the Office of Administrative Law. The state listing includes the San Francisco portion of the federal Central California Coast ESU and the northern California portion of the federal So. Oregon/No. Calif. ESU

3 Identified in field surveys conducted within Copper Creek and in the vicinity of the Union-Zaar Mine SIte between 1978 and 1982 (Dames and Moore 1985a; 1985b)

ESU Evolutionarily significant unit (a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout)

Table 2. Summary of Background Values

	Soil		Surface Water		Sediment	
Analyte	Regional Background Concentration (mg/kg)[a]	Sample UZBS001 Upgradient Soil Collected in May 2007 (mg/kg)	Sample UZW007 Upstream (Dry Season) Collected in June, 2004 (µg/L)[b]	Sample UZW009 Upstream (Wet Season) Collected in February, 2005 (µg/L)[c]	Sample UZS007 Upstream Sediment Collected in June, 2004 (mg/kg)	Sample UZS014 Upstream Sediment Collected in May 2007
Aluminum	10	7,020	42.0 J	44.4 J	7,040	--
Antimony	1	6.6 J	4.5 J	3.2 J	5.5 J	ND (<1.83)[e]
Arsenic	3.11	ND (<1.5)[e]	ND (<3.4)[e]	ND (<3.4)[e]	ND (<1.6)[e]	ND (<1.0)[e]
Barium	700	27.8 J	3.2 J	1.5 J	14.3 J	1.8
Beryllium	1	ND (<0.05)[e]	ND (<0.60)[e]	ND (<0.60)[e]	ND (<0.06)[e]	ND (<0.5)[e]
Cadmium	--	ND (<0.34)[e]	1.7 J	0.44 J	ND (<0.39)[e]	ND (<0.5)[e]
Calcium	0.64	501	999 J	709 J	2,110	--
Chromium	500	1,450	1.7 J	2.2 J	1,090	290
Cobalt	20	209	ND (<0.50)[e]	ND (<0.50)[e]	167	58
Copper	70	17.4	1.1 J	ND (<0.70)[e]	16.2	2.6
Iron	7	134,000	16.3 J	18.5 J	114,000	--
Lead	15	ND (<1.9)[e]	4.8 J	ND (<2.2)[e]		ND (<1.0)[e]
Magnesium	1	150,000	20,400	19,300	157,000	--
Manganese	1,000	2,300	ND (<0.30)[e]	0.77 J	1,430	--
Mercury	0.08	0.025 J	0.064 J	0.050 J	ND (<0.006)[e]	ND (<0.05)[e]
Molybdenum	3	ND (<0.14)[e]	ND (<1.6)[e]	9 J	ND (<0.15)[e]	ND (<1.0)[e]
Nickel	100	2,880	28.4 J	28.7 J	3,180	1,500
Potassium	0.83	229 J	51.6 J	46.4 J	119 J	--
Selenium	1	9.1	4.3 J	4.3 J	11.3	ND (<2)[e]
Silver	--	ND (<0.03)[e]	ND (<0.40)[e]	0.47 J	ND (<0.04)[e]	ND (<1.0)[e]
Sodium	1	ND (<7.9)[e]	1,950 J	1,240 J	ND (<9.0)[e]	--
Thallium	7.2	ND (<5.6)[e]	ND (<3.3)[e]	ND (<3.3)[e]	ND (<3.2)[e]	ND (<1.0)[e]
Vanadium	200	38.2 J	ND (<0.3)[e]	0.36 J	35.9 J	11
Zinc	102	45.4 J	ND (<7.3)[e]	ND (<7.3)[e]	29.9 J	19

Notes:

[a] Regional background concentrations Gustavsson, and others (2001) and United States Geological Survey (USGS) (2004) (data for Del Norte County used to develop the maps for USGS Professional Paper 1648) as cited in Tetra Tech, 2005

[b] Dry season background concentration based on Sample UZW007.

[c] Wet season background concentration based on Sample UZW009.

[d] Sediment background concentration based on results for samples UZS007 and UZS014.

[e] Concentration based on the sample's detection limit, where analyte not detected.

ERRG

Table 3. Summary of Source Sample Analytical Results Compared to Background

Analyte	Minimum	Maximum	No. Samples Exceeding Background/ No. of Samples	Sample UZS001 (South Adit Waste Pile)	Sample UZS002 (North Adit Waste Pile)	Sample UZS003 (West Collapsed Adit Waste Pile)	Sample UZS004 (Midslope Adit Waste Pile)	Sample UZBS001 (Upgradient soil, background comparison) Detected Concentration	Regional Background[a]
Aluminum	1,850	8,300	0/4	1,850	2,000	8,300	1,940	7,020	10
Antimony	3.3 J	8 J	4/4	3.7 J	3.3 J	**8 J**	4 J	6.6 J	1
Arsenic	11.9 J	339 J	4/4	**339 J**	**11.9 J**	**181 J**	**116 J**	ND (<1.5)	3.11
Barium	1.5 J	13.9 J	0/4	3.1 J	1.9 J	13.9 J	1.5 J	27.8 J	700
Beryllium	ND (<0.05)	ND (<0.06)	0/4[b]	ND (<0.05)	ND (<0.05)	ND (<0.06)	ND (<0.05)	ND (<0.05)	1
Cadmium	ND (<0.34)	ND (<0.94)	0/4[b]	ND (<0.36)	ND (<0.36)	ND (<0.94)	ND (<0.36)	ND (<0.34)	--
Calcium*	689	6,290	4/4	**6,290**	**4,390**	**689**	**1,520**	501	0.64
Chromium	616	1,520	1/4	666	616	**1,520**	672	1,450	500
Cobalt	94.4	291	2/4	**291**	94.4	**230**	192	209	20
Copper	378	4,570	4/4	**3,440**	**378**	**712**	**4,570**	17.4	70
Iron*	61,100	181,000	1/4	70,400	61,100	**181,000**	67,500	134,000	7
Lead	ND (<1.9)	ND (<5.2)	0/4[b]	ND (<2.0)	ND (<1.9)	ND (<5.2)	ND (<2.0)	ND (<1.9)	15
Magnesium*	81,000	221,000	3/4	**199,000**	**202,000**	81,000	**221,000**	150,000	1
Manganese	828	1,790	0/4	828	884	1,790	913	2,300	1,000
Mercury	0.078 J	0.24 J	4/4	**0.078 J**	**0.08 J**	**0.13 J**	**0.24 J**	0.025 J	0.08
Molybdenum	ND (<0.14)	ND (<0.15)	0/4[b]	ND (<0.14)	ND (<0.14)	ND (<0.15)	ND (<0.14)	ND (<0.14)	3
Nickel	1,930	3,690	1/4	1,930	1,950	**3,690**	2,160	2,880	100
Potassium	21.9 J	105	0/4	51.6 J	21.9 J	105 J	59.3 J	229 J	0.83
Selenium	5.7 J	17.3 J	1/4	8.3 J	5.7 J	**17.3 J**	6.7 J	9.1	1
Silver	ND (<0.03)	0.28 J	3/4	**0.28 J**	ND (<0.04)	**0.22 J**	**0.24 J**	ND (<0.03)	--
Sodium	ND (<7.9)	ND (<8.8)	0/4[b]	ND (<8.4)	ND (<8.1)	ND (<8.8)	ND (<8.3)	ND (<7.9)	1
Thallium	ND (<5.6)	8.2 J	1/4	ND (<3.0)	ND (<2.9)	**8.2 J**	ND (<3.0)	ND (<5.6)	7.2
Vanadium	15.9 J	47.4 J	1/4	15.9 J	17.3 J	**47.4 J**	17.7 J	38.2 J	200
Zinc	24.2 J	71.3 J	3/4	**71.3 J**	24.2 J	**54.4 J**	**59 J**	45.4 J	102

Notes:

Bold font indicates analyte is significantly elevated with respect to background.

Highlighted cell indicates maximum concentration detected and subsequently used to represent the exposure point concentration

Samples were collected on June 24 and 25, 2004.

All concentrations are in milligrams per kilogram (mg/kg)

* constituent is considered an essential nutrient, therefore no EPC was calculated for this constituent

-- Not applicable/not available/not analyzed

J Estimated value

ND Not detected (detection limit in parantheses)

[a] Regional background concentrations Gustavsson, and others (2001) and United States Geological Survey (USGS) (2004) (data for Del Norte County used to develop the maps for USGS Professional Paper 1648).

[b] where all samples including background were not detected, no samples were considered to exceed background.

Table 4. Summary of Surface Water Sample Analytical Results Compared to Background

				Dry Season Samples					Wet Season Samples				
Analyte	**Minimum**	**Maximum**	**No. Samples Exceeding Background/ No. of Samples**	**Sample UZW001 (South Adit)**	**Sample UZW002 (North Adit)**	**Sample UZW005 (Downstream Copper Creek)**	**Sample UZW006 (PPE in Copper Creek)**	**Background Sample (Dry Season)**	**Sample UZW010 (South Adit)**	**Sample UZW011 (North Adit)**	**Sample UZW012 (PPE in Copper Creek)**	**Sample UZW013 (Downstream Copper Creek)**	**Background Sample (Wet Season)**
Aluminum	ND (<29.1)	60.4 J	3/8	33.1 J	**51.9 J**	ND (<29.1)	ND (29.1)	42 J	41.1 J	**57.6 J**	**60.4 J**	**50.6 J**	44.4 J
Antimony	ND (<2.6)	5.7 J	2/8	3.9 J	**5.4 J**	**5.7 J**	4.4 J	4.5 J	3 J	ND (<2.6)	2.7 J	ND (<2.6)	3.2 J
Arsenic	ND (<3.4)	5.2 J	1/8	ND (<3.4)	**5.2 J**	ND (<3.4)	ND (<3.4)	ND (<3.4)[a]	ND (<3.4)	ND (<3.4)	ND (<3.4)	ND (<3.4)	ND (<3.4)[e]
Barium	1 J	6.3 J	3/8	2.2 J	**6.3 J**	2.4 J	**3.8 J**	3.2 J	1.2 J	**2.9 J**	1 J	1.1 J	1.5 J
Beryllium	ND (<0.60)	ND (<0.60)	0/8[a]	ND (0.60)	ND (<0.60)	ND (<0.60)	ND (<0.60)	ND (<0.60)[a]	ND (<0.60)	ND (<0.60)	ND (<0.60)	ND (<0.60)	ND (<0.60)[e]
Cadmium	ND (0.40)	1.8 J	1/8	0.74 J	1.4 J	0.95 J	**1.8 J**	1.7 J	ND (0.40)	ND (0.40)	ND (0.40)	ND (0.40)	0.44 J
Calcium*	655 J	5,130	6/8	**3,030 J**	**5,130**	**1,070 J**	**1,050 J**	999 J	**4,860 J**	**4,200 J**	655 J	692 J	709 J
Chromium	1.4 J	2.7 J	3/8	1.4 J	1.5 J	**2.2 J**	1.7 J	1.7 J	1.5 J	1.5 J	**2.6 J**	**2.7 J**	2.2 J
Cobalt	ND (<0.50)	ND (<0.50)	0/8[a]	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)[a]	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)[e]
Copper	ND (<0.70)	3.7 J	4/8	**2.2 J**	**3.7 J**	**2 J**	1.1 J	1.1 J	**1.5 J**	**0.74 J**	ND (<0.70)	ND (<0.70)	ND (<0.70)[e]
Hardness	82	460	6/8	**390**	**460**	100	96	110	**250**	**420**	**82**	**82**	78
Iron*	ND (<13.9)	52 J	3/8	ND (<13.9)	**49.7 J**	ND (<13.9)	ND (<13.9)	16.3 J	**52 J**	**22.2 J**	14.5 J	ND (<13.9)	18.5 J
Lead	ND (<2.2)	7.4 J	5/8	**4.9 J**	**5.8 J**	4.6J	4 J	4.8 J	**7.4 J**	**4.4 J**	**2.3 J**	ND (<2.2)	ND (<2.2)[e]
Magnesium*	20,500	111,000	8/8	**84,000**	**111,000**	**21,700**	**20,900**	20,400	**57,500**	**103,000**	**20,500**	**20,500**	19,300
Manganese	ND (<0.30)	0.3 J	0/8	ND (<0.30)	0.3 J	ND (<0.30)	ND (<0.30)	ND (<0.30)[a]	ND (<0.30)	ND (<0.30)	ND (<0.30)	ND (<0.30)	0.77 J
Mercury	0.044 J	0.088 J	4/8	0.063 J	**0.084 J**	**0.088 J**	**0.065 J**	0.064 J	0.036 J	0.038 J	0.044 J	**0.055 J**	0.050 J
Molybdenum	ND (<1.6)	10.8 J	3/8	**2.3 J**	**10.8 J**	**7.2 J**	**2.1 J**	ND (<1.6)[a]	1.9 J	ND (<1.6)	ND (<1.6)	ND (<1.6)	9 J
Nickel	3.4 J	27.6	0/8	4.3 J	4.6 J	23.9 J	26.3 J	28.4 J	5.1 J	3.4 J	27.6 J	26 J	28.7 J
Potassium*	34.9 J	1,650 J	6/8	**665 J**	**1,650 J**	**74.6 J**	**54.9 J**	51.6 J	**374 J**	**1,410 J**	40 J	34.9 J	46.4 J
Selenium	3.1 J	5.6 J	3/8	**5.3 J**	3.1 J	**5.4 J**	3.1 J	4.3 J	**5.6 J**	3.9 J	3.3 J	3.7 J	4.3 J
Silver	ND (<0.40)	ND (<0.40)	0/8[a]	ND (<4.0)	ND (<0.40)	ND (<0.40)	ND (<0.40)	ND (<0.40)[a]	ND (<0.40)	ND (<0.40)	ND (<0.40)	ND (<0.40)	0.47 J
Sodium	1,460 J	12,900	8/8	**12,900**	**3,930 J**	**2,230 J**	**1,990 J**	1,950 J	**5,180**	**3,380 J**	**1,450 J**	**1,460 J**	1,240 J
Thallium	ND (<3.3)	ND (<3.3)	0/8[a]	ND (<3.3)	ND (<3.3)	ND (<3.3)	ND (<3.3)	ND (<3.3)[e]	ND (<3.3)	ND (<3.3)	ND (<3.3)	ND (<3.3)	ND (<3.3)[e]
Vanadium	ND (<0.30)	0.47 J	1/8	ND (<0.30)	0.38 J	ND (<0.30)	**0.47 J**	ND (<0.30)[e]	ND (<0.30)	ND (<0.30)	ND (<0.30)	ND (<0.30)	0.36 J
Zinc	ND (<7.3)	23.2 J	2/8	**23.2 J**	**7.4 J**	ND (<7.3)	ND (<7.3)	ND (<7.3)[e]	ND (<7.3)	ND (<7.3)	ND (<7.3)	ND (<7.3)	ND (<7.3)[e]

Notes:

Dry Season samples were collected on June 24 and 25, 2004. Wet Season samples were collected on February 18, 2005.

Bold font indicates result is significantly elevated with respect to background

Highlighted cell indicates maximum concentration detected and subsequently used to represent the exposure point concentration

All concentrations are in µg/L, except for hardness, which is expressed in mg/L as $CaCO_3$

* constituent is considered an essential nutrient, therefore no EPC was calculated for this constituent

-- Not applicable/not available/not analyzed

µg/L micrograms per liter

[e] where all samples including background were not detected, no samples were considered to exceed background.

ND Not detected (detection limit in parantheses)

Table 5. Summary of Sediment Analytical Results Compared to Background

Analyte	Minimum	Maximum	No. Samples Exceeding Background/ No. of Samples	Sample UZS005 (Downstream)[a]	Sample UZS006 (PPE)[a]	Sample UZS010 (Downstream)[b]	Sample UZS011 (Downstream)[b]	Sample UZS012 (Downstream)[b]	Sample UZS013 (Downstream)[b]	Sample UZS016 (Unnamed tributary upstream of confluence with Copper Creek)[c]	Sample UZS017 (Downstream of confluence of Copper Creek and unnamed tributary)[c]	Background Sediment Concentration Range
Aluminum	5,770	6,420	0/8	6,420	5,770	--	--	--	--	--	--	7,040
Antimony	ND (<2.0)	2	0/8[d]	*5.3 J*	*4.4 J*	ND (<2.0)	ND (<2.0)	ND (<2.0)	ND (<2.0)	*2.1*	*2.2*	1.83 - 5.5
Arsenic	ND (<1.0)	31	6/8	**4.1 J**	**14.1 J**	**7.7**	**4.6**	**31**	**6.4**	ND (<1.0)	*1.4*	1.0 - 1.6
Barium	3.7	12.1 J	0/8[d]	*12.1 J*	*11.1 J*	*3.9*	*9.1*	*3.7*	*4.6*	*5.3*	*6.7*	1.8 - 14.3
Beryllium	ND (<0.06)	0.53	1/8	ND (<0.06)	ND (<0.06)	ND (<0.5)	**0.53**	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	0.06 - 0.5
Cadmium	ND (<0.43)	0.52	1/8	ND (<0.43)	ND (<0.42)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	**0.52**	ND (<0.50)	0.39 - 0.5
Calcium	507 J	742	0/2	742	507 J	--	--	--	--	--	--	2,110
Chromium	410	1,120	1/8	**1,120**	*964*	*410*	*640*	*420*	*480*	*740*	*760*	290 - 1,090
Cobalt	63	180	1/8	**180**	*146*	*67*	*96*	*71*	*77*	*69*	*63*	58 - 167
Copper	30	1,040	8/8	**107**	**1,040**	**180**	**180**	**200**	**180**	**30**	**35**	2.6 - 16.2
Iron	93,500	107,000	0/2	107,000	93,500	--	--	--	--	--	--	114,000
Lead	ND (<1.0)	ND (<1.0)	0/8[e]	ND (<2.4)	ND (<2.3)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<0.99)	1.0
Magnesium*	165,000	172,000	2/2	**165,000**	**172,000**	--	--	--	--	--	--	157,000
Manganese	1,520	1,530	2/2	**1,530**	**1,520**	--	--	--	--	--	--	1,430
Mercury	ND (<0.048)	0.24 J	1/8	**0.24 J**	*0.013 J*	ND (<0.048)	ND (<0.051)	ND (<0.049)	ND (<0.051)	ND (<0.050)	ND (<0.051)	0.006 - 0.05
Molybdenum	ND (<0.99)	ND (<0.17)	0/8[e]	ND (<0.17)	ND (<0.17)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<0.99)	0.15 - 1.0
Nickel	1,100	2,910	0/8[d]	*2,910*	*2,720*	1,200	1,300	1,400	1,500	1,500	1,100	1500 - 3,180
Potassium*	56.7 J	222 J	1/2	56.7 J	**222 J**	--	--	--	--	--	--	119
Selenium	ND (<2.0)	8.2 J	0/8[d]	*6.1 J*	*8.2 J*	ND (<2.0)	ND (<2.0)	ND (<2.0)	ND (<2.0)	ND (<2.0)	ND (<2.0)	2 - 11.3
Silver	ND (<0.04)	ND (<1.0)	0/8[d]	ND (<0.04)	ND (<0.04)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<0.99)	0.04 - 1.0
Sodium	ND (<9.8)	ND (<10.0)	0/8[d]	ND (<10.0)	ND (<9.8)	--	--	--	--	--	--	9.0
Thallium	ND (<0.99)	ND (<3.6)	0/8[d]	ND (<3.6)	ND (<3.5)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<0.99)	1.0 - 3.2
Vanadium	13	37.6 J	1/8	**37.6 J**	*28.1 J*	*15*	*21*	*13*	*14*	*14*	*18*	11 - 35.9
Zinc	19	32.4 J	2/8	**31 J**	**32.4 J**	19	*23*	*20*	*22*	*23*	*21*	19 - 29.9

Notes:

Bold font indicates result is elevated with respect to background concentration range

Italic font indicates result falls within the range of background concentrations

Highlighted cell indicates maximum concentration detected and subsequently used as the exposure point concentration.

All concentrations are in mg/kg, except for total organic carbon, which is in percent dry weight

-- constituent is considered an essential nutrient, therefore no EPC was calculated for this constituent

[a] Samples collected on June 24 and 25, 2004.

[b] Sample collected on May 18, 2007.

[c] Samples collected on July 6, 2007.

[d] detections within the range of background samples were not counted as exceedances

[e] where all samples including background were not detected, no samples were considered to exceed background.

J

ND Not detected (detection limit in parantheses)

PPE Probable Point of Entry

Table 6. Summary of Exposure Point Concentrations for each Contaminant of Potential Concern

Analyte	Exposure Point Concentration for Source Material	Exposure Point Concentration for Surface Water	Exposure Point Concentration for Sediment
Aluminum	NA	60.4	NA
Antimony	8	5.7	5.3*
Arsenic	339	5.2	31
Barium	NA	6.3	12.1*
Beryllium	NA	NA	0.53
Cadmium	NA	1.8	0.52
Calcium	NA	NA	NA
Chromium	1,520	2.7	1,120
Cobalt	291	NA	180
Copper	4,570	3.7	1,040
Iron	NA	NA	NA
Lead	NA	7.4	NA
Magnesium	NA	NA	NA
Manganese	NA	NA	1,530
Mercury	0.24	0.088	0.24
Molybdenum	NA	10.8	NA
Nickel	3,690	NA	2,910*
Potassium	NA	NA	NA
Selenium	17.3	5.6	8*
Silver	0.28	NA	NA
Sodium	NA	12,900	NA
Thallium	8.2	NA	NA
Vanadium	47.4	NA	37.6
Zinc	59	23.2	32.4

Notes:

NA not applicable (not a COPC for that media type)

* Concentration falls within the range of measured background values at the site

Table 7. Summaruy of Human Health Rosk Screening Benchmarks

	Soil/Source		Surface Water			Sediment
Analyte	BLM Soil Risk Management Criteria for Camper[a]	Industrial PRG for Soil[b]	BLM Surface Water Risk Management Criteria for Camper[a]	PRG For Tap Water[b]	EPA Drinking Water MCL[d]	BLM Sediment Risk Management Criteria for Camper[a]
Aluminum	**--**	**100,000**	**--**	--	--	**--**
Antimony	**50**	410	**124**	--	6	**62**
Arsenic	**20**	1.6	**93**	--	10	**46**
Barium	**--**	**67,000**	**--**	**2,600**	2,000	**--**
Beryllium	**--**	**1900**	**--**	**7,100**	4	**--**
Cadmium	**70**	450	**155**	18	5	**155**
Calcium	**--**	**--**	**--**	--	--	**--**
Chromium	**--**	**450**	**--**	--	**100**	**--**
Cobalt	**--**	**1900**	**--**	**730**	--	**--**
Copper	**5,000**	41,000	**11,490**	1,500	1,300	**5,745**
Iron	**--**	**100,000**	**--**	--	--	**--**
Lead	**1,000**	800	**50**	--	15	**1,000**
Magnesium	**--**	**--**	**--**	--	--	**--**
Manganese	**19,000**	**19,000**	**1,548**	876	50	**21,679**
Mercury	**40**	310	**93**	11	--	**46**
Molybdenum	**--**	**5,100**	**--**	**180**	--	**--**
Nickel	**2,700**	11,000	**6,194**	730	100	**3,094**
Potassium	**--**	**--**	**--**	--	--	**--**
Selenium	**700**	5,100	**1,548**	180	50	**774**
Silver	**700**	5,100	**1,548**	180	100	**774**
Sodium	**--**	**--**	**--**	--	--	**--**
Thallium	**--**	**67**	**--**	**2.4**	2	**--**
Vanadium	**--**	**1,000**	**--**	**36**	--	**--**
Zinc	**40,000**	100,000	**92,909**	11,000	5,000	**46,455**

Notes:

All concentrations are in milligrams per kilogram (mg/kg)

Bold font indicates selected human health benchmark

[a] From the BLM Risk Management Criteria (BLM 1996). Criteria for camper chosen from human health criteria listed for camper, ATV driver, worker, or surveyor, are the most conservative listed for non-residential visitors. Criteria for Robin chosen as the m

[b] From EPA 2004.

[d] From Marshack 2003; drinking water standards. California MCL used where no EPA value available.

BLM Bureau of Land Management

EPA Environmental Protection Agency

SCDM Superfund Chemical Data Matrix

Table 8. Exposure Point Concentrations Compared to Applicable Human Health Benchmarks

Analyte	Source (Mine Waste Piles)		Surface Water		Sediment	
	Source EPC (mg/kg)	Human Health Soil Benchmark (mg/kg)	Surface Water EPC (µg/L)	Human Health Surface Water Benchmark (µg/L)	Sediment EPC (mg/kg)	Human Health Sediment Benchmark (mg/kg)
Aluminum	NA	100,000	60.4	--	NA	--
Antimony	8	50	5.7	124	5.3*	62
Arsenic	**339**	20	5.2	93	31	46
Barium	NA	67,000	6.3	2,600	12.1*	--
Beryllium	NA	--	NA	7,100	0.53	--
Cadmium	NA	70	1.8	155	0.52	155
Calcium	NA	--	NA	--	NA	--
Chromium	**1,520**	450	2.7	--	1,120	--
Cobalt	291	1,900	NA	730	180	--
Copper	4,570	5,000	3.7	11,490	1,040	5,745
Iron	NA	100,000	NA	--	NA	--
Lead	NA	1,000	7.4	50	NA	1,000
Magnesium	NA	--	NA	--	NA	--
Manganese	NA	19,000	NA	1,548	1,530	21,679
Mercury	0.24	40	0.088	93	0.24	46
Molybdenum	NA	5,100	10.8	180	NA	--
Nickel	**3,690**	2,700	NA	6,194	2,910*	3,094
Potassium	NA	--	NA	--	NA	--
Selenium	17.3	700	5.6	1,548	8	774
Silver	0.28	700	NA	1,548	NA	774
Sodium	NA	--	12,900	--	NA	--
Thallium	8.2	67	NA	2.4	NA	--
Vanadium	47.4	1,000	NA	36	37.6	--
Zinc	59	40,000	23.2	92,909	32.4	46,455

Notes:

-- not available/not analyzed

NA not applicable (not a COPC)

* Concentration falls within the range of measured background values at the site

Bold font indicates analyte is significantly elevated with respect to background.

Table 9. Summary of Ecological Risk Screening Benchmarks

	Soil/Source		Surface Water		Sediment			
Analyte	Ecological Soil Benchmark[a]	BLM Soil Risk Management Criteria for Wildlife and Livestock[b]	California Toxics Rule Criteria; Freshwater Aquatic Life Protection[c]	EPA Criteria; Freshwater Aquatic Life Protection[c]	Consensus-Based PEC[d]	FDEP PEL Sediment Screening Benchmark	Consensus-Based TEC[e]	FDEP TEL Sediment Screening Benchmark
Aluminum	**--**	--	**--**	**87**	**--**	--	--	--
Antimony	**0.29**	--	**--**	**1,600**	**--**	--	--	--
Arsenic	**9.9**	4	**150**	150	**33**	41.6	9.79	7.24
Barium	**330**	--	**--**	--	**--**	--	--	--
Beryllium	**36**	--	**--**	**5.3**	**--**	--	--	--
Cadmium	**0.38**	0.3	**1.9 - 6.4**	0.2 - 0.7	**4.98**	4.21	0.99	0.676
Calcium	**--**	--	**--**	--	**--**	--	--	--
Chromium	**0.4**	--	**145.2 - 550**	60.5 - 230	**111**	160	43.4	52.3
Cobalt	**13**	--	**--**	--	**--**	--	--	--
Copper	**60**	7	**7.2 - 30.5**	2.4 - 30.5	**149**	108	32	18.7
Iron	**--**	--	**--**	--	**--**	--	--	--
Lead	**16**	6	**2.0 - 11.5**	2.4 - 11.5	**128**	112	36	30.2
Magnesium	**--**	--	**--**	--	**--**	--	--	--
Manganese	**--**	--	**--**	--	**--**	--	--	--
Mercury	**0.00051**	1	**--**	**0.77**	**1**	0.696	0.18	0.13
Molybdenum	**2**	--	**--**	--	**--**	-	--	-
Nickel	**30**	--	**42.1 - 175.1**	42.1 - 175.1	**49**	42.8	23	15.9
Potassium	**--**	--	**--**	--	**--**	--	--	--
Selenium	**0.21**	--	**5**	5	**--**	--	--	--

Table 9. Summary of Ecological Risk Screening Benchmarks (continued)

	Soil/Source		Surface Water		Sediment			
Analyte	Ecological Soil Benchmark[a]	BLM Soil Risk Management Criteria for Wildlife and Livestock[b]	California Toxics Rule Criteria; Freshwater Aquatic Life Protection[c]	EPA Criteria; Freshwater Aquatic Life Protection[c]	Consensus-Based PEC[d]	FDEP PEL Sediment Screening Benchmark	Consensus-Based TEC[e]	FDEP TEL Sediment Screening Benchmark
Silver	**2**	--	**2.3 - 37**	2.3 - 37	**--**	**1.77**	--	0.733
Sodium	**--**	--	**--**	--	**--**	--	--	--
Thallium	**1**	--	**--**	**40**	**--**	--	--	--
Vanadium	**2**	--	**--**	--	**--**	--	--	--
Zinc	**8.5**	43	**95.7 - 398.5**	95.7 - 398.5	**459**	271	121	124

Notes:

All concentrations are in milligrams per kilogram (mg/kg)

Bold font indicates selected ecological benchmark

[a] Ecological benchmarks are based on ESL from EPA 2003a, 2003b, 2003c, 2003d,2003e for mammals. Where no ESL is available, ecological benchmarks are based on the ecological preliminary remediation goals from Efroymson and others (1997).

[b] From the BLM Risk Management Criteria (BLM 1996). Criteria for camper chosen from human health criteria listed for camper, ATV driver, worker, or surveyor, are the most conservative listed for non-residential visitors. Criteria for Robin chosen as the most-protective criteria listed for wildlife and livestock

[c] From Marshack 2003; Criteria for dissolved metals for freshwater aquatic life protection.
Criteria with ranges listed are hardness-dependent (range represents range of hardnesses [82-460 mg/L as $CaCO_3$] in all samples.

[d] Based on probable effect concentrations from MacDonald and others 2000a as cited in EPA 2002

[e] Based on threshold effect concentration from MacDonald and others 2000a as cited in EPA 2002

BLM	Bureau of Land Management
EPA	Environmental Protection Agency
ESL	Ecological environmental screening level
FDEP	Florida Department of Environmental Protection
PEC	Probable effect concentration
PEL	Probable effects level
TEC	Threshold effect concentration
TEL	Threshold effects level

Table 10. Exposure Point Concentrations Compared to Applicable Ecological Benchmarks

	Source (Mine Waste Piles)		Surface Water		Sediment	
Analyte	Source EPC (mg/kg)	Ecological Soil Benchmark	Surface Water EPC (µg/L)	Ecological Surface Water Benchmark (µg/L)	Sediment EPC (mg/kg)	Ecological Sediment Benchmark (mg/kg)
Aluminum	NA	--	60.4	87	NA	--
Antimony	**8**	0.29	5.7	1,600	5.3*	--
Arsenic	**339**	9.9	5.2	150	31	33
Barium	NA	330	6.3	--	12.1*	--
Beryllium	NA	36	NA	5.3	0.53	--
Cadmium	NA	0.38	1.8	1.9 - 6.4	0.52	4.98
Calcium	NA	--	NA	--	NA	--
Chromium	**1,520**	0.4	2.7	145.2 - 550	**1,120**	111
Cobalt	**291**	13	NA	--	180	--
Copper	**4,570**	60	3.7	7.2 - 30.5	**1,040**	149
Iron	NA	--	NA	--	NA	--
Lead	NA	16	**7.4**[a]	2.0 - 11.5	NA	128
Magnesium	NA	--	NA	--	NA	--
Manganese	NA	--	NA	--	1,530	--
Mercury	**0.24**	0.00051	0.088	0.77	0.24	1.06
Molybdenum	NA	2	10.8	--	NA	--
Nickel	**3,690**	30	NA	42.1 - 175.1	**2,910***	48.6
Potassium	NA	--	NA	--	NA	--
Selenium	**17.3**	0.21	**5.6**	5	8*	--
Silver	0.28	2	NA	2.3 - 37	NA	1.77
Sodium	NA	--	12,900	--	NA	--
Thallium	**8.2**	1	NA	40	NA	--
Vanadium	**47.4**	2	NA	--	37.6	--
Zinc	59	8.5	23.2	95.7 - 398.5	32.4	459

Notes:

-- not available/not analyzed

NA not applicable (not a COPC)

[a] hardness for the sample with selected EPC = 250 mg/L as $CaCO_3$. Corresponding lead criterion is 6.7µg/L

* Concentration falls within the range of measured background values at the site

TABLE 11A. POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARS

Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
Clean Water Act of 1977, as Amended (33 USC, Chapter 26, §§ 1313–1314)[a]				
Establishes surface water quality criteria for priority toxic pollutants in the State of California for inland surface waters and enclosed bays and estuaries.	Discharges to waters of the United States	40 CFR § 131.38(a)	Applicable	Surface water at the site is considered inland surface water in California. These standards (known as EPAs California Toxics Rule) are applicable surface water ARARs. Any discharges to Site surface waters would comply with this ARAR.
Establishes ambient water quality criteria (AWQCs) as water quality standards.	Potential drinking water or surface water with beneficial uses that include protection of aquatic life	Non-promulgated guidance developed by EPA as required by Section 304(a)(1) of the Clean Water Act	Relevant and appropriate	AWQCs are non-enforceable guidance developed by EPA and used to establish water quality standards. Generally, AWQC are considered potentially relevant and appropriate for surface water considered a potential drinking water source in the absence of promulgated MCLs. However, if the surface water's designated beneficial use includes protection of aquatic life, the AWQC may be more stringent than the MCL
Resource Conservation and Recovery Act (RCRA)				
Bevill Amendment § 3001(a)(3)(A)(ii), 42 USC, 6921(a)(3)(A)(ii)[a]				
Excludes from hazardous waste classification solid waste from the extraction, beneficiation, and processing of ores and minerals	Mining waste from extraction is exempt from Subtitle C of RCRA.	40 CFR §261.4(b)(7)	Applicable	Mine waste piles at the Site are from the extraction of minerals, therefore do not warrant regulation as hazardous waste and are not subject to RCRA Subtitle C regulation.

Notes:

a. Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs; only pertinent substantive requirements of the specific citations are considered potential ARARs

§ = Section
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
EPA = U.S. Environmental Protection Agency
RWQCB = Regional Water Quality Control Board
USC	United States Code
CCR = California Code of Regulations
MCL = Maximum contaminant level
RCRA = Resource Conservation and Recovery Act
SWRCB =State Water Resources Control Board

TABLE 11B. POTENTIAL STATE CHEMICAL-SPECIFIC ARARS

Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
California's Health and Safety Code[a]				
California's Health and Safety Code recognizes the Bevill Amendment exclusion, so that wastes that would otherwise be regulated by the California Hazardous Waste Control Law, the California analogue to RCRA, are instead subject only to the requirements of Water Code Section 13172, detailed in 27 CCR Section 22470 (see Table 11E).	Wastes from the extraction, beneficiation, and processing of ores and minerals that Bevill exempt	Health and Safety Code Section 25143.1(b)(1 & 2)	Applicable	According to the exclusion, "wastes from the extraction, beneficiation, and processing of ores and minerals that are not subject to regulation under Subchapter III (commencing with Section 6921) of Chapter 82 of Title 42 of the United States Code are exempt from the requirements of this chapter, except the requirements of Article 9.5 (commencing with Section 25208) and Chapter 6.8 (commencing with Section 25300)." Mine waste piles at the Site are mine waste from extraction of minerals, therefore this exclusion applies.
State and Regional Water Quality Control Boards[a]				
Authorizes SWRCB and RWQCB to establish in water quality control plans, beneficial uses and numerical and narrative standards to protect both surface water and groundwater quality	Waters of the state	California Water Code, Division 7, §§13241, 13243, 13263(a), 13269, and 13360	Applicable	The substantive provisions of these sections of the California Water Code are applicable, as implemented through the beneficial uses and water quality objectives of the North Coast Regional Water Quality Control Board's water quality control plans.
Specifies that all surface and ground waters of the State are considered suitable, or potentially suitable, for municipal or domestic water supply with the following exceptions: (1) those water bodies with yields below 200 gallons per day (gpd), (2) total dissolved solids exceeding 3,000 mg/L (ppm), or (3) contamination that cannot reasonably be treated for domestic use by either best management practices or best economically achievable treatment practices.	Waters of the state	SWRCB Resolution 88-63	Applicable	This is applicable to surface water at the Site. This resolution would be an ARAR for any discharges to surface water during the removal action.

Notes:

a. = Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs; only pertinent substantive requirements of the specific citations are considered potential ARARs

§ = Section
CCR = California Code of Regulations
ARAR = Applicable or Relevant and Appropriate Requirement
RWQCB Regional Water Quality Control Board
SWRCB = State Water Resources Control Board

TABLE 11C. POTENTIAL FEDERAL LOCATION-SPECIFIC ARARS

Location	Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
Endangered Species Act of 1973 (916 USC §§ 1531-1543)[a]					
Habitat upon which endangered species or threatened species depend	Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat	Determination of effect upon endangered or threatened species or its habitat; critical habitat upon which endangered species or threatened species depend	16 USC § 1536(a),(h)(1)(B)	Applicable	The Site contains habitat of several federally listed species (see Table 1 of EE/CA). Prior to any removal action, a biological evaluation may be required to determine the potential for adverse effects or harm to any listed species or the destruction or adverse modification of in-stream aquatic habitats along and downstream of the section of Copper Creek within the Site.
Smith River National Recreation Act (16 USC §§ 460bbb-6–460bbb-11) [a]					
Smith River and tributaries	Improve the anadromous fishery and water quality, including improving fish spawning and rearing habitat, and placing appropriate restrictions or limitations on soil disturbing activities. Provide for the restoration of landscapes damaged by past human activity consistent with the purposes of the act	Area designated as national recreation area	16 USC §§ 460bbb	Applicable	The Site lies on along the banks of Copper Creek, a tributary to the Smith River
Wild and Scenic River Act, 16 USC §§ 1271-1287, October 2, 1968, as amended[a]					
Designated portions of the Smith River and its tributaries	Establishes a National Wild and Scenic Rivers System for the protection of rivers with important scenic, recreational, fish and wildlife, and other values. Rivers are classified as wild, scenic or recreational. The Act contains procedures and limitations for control of lands in federally administered components of the System and for disposition of lands and minerals under federal ownership.	Area designated as wild and scenic	16USC §1274(a)(111)	Applicable	The act designates as wild and scenic the Smith River from the confluence of the Middle Fork and the North Fork to the Six Rivers National Forest boundary, including Rowdy Creek from the California-Oregon State line to the National Forest boundary. The Site is located along Copper Creek, a tributary to Rowdy Creek, therefore this designation applies to the Site.

TABLE 11C. POTENTIAL FEDERAL LOCATION-SPECIFIC ARARS *(continued)*

Location	Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
USDA Forest Service Land Management Plan Standards and Guides and National Recreation Area Act provisions					
Smith River National Recreation Area of the Six Rivers National Forest	Establishes standards and guides for the Smith River NRA, including restrictions on solid and sanitary waste facilities in Riparian Reserves, requirements for watershed habitat restoration, and the following aquatic conservation strategy objectives: Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems Maintain and restore the sediment regime under which aquatic ecosystems evolved. Watershed habitat restoration requirements state that mitigation not be used as a substitute for preventing habitat degradation	Management direction from the Six Rivers Land and Resource Management Plan and the Smith River NRA Act	Riparian Management Standards and Statutes for Copper Creek CERCLA Mine Tailing Abatement, Management Direction from Six Rivers LRMP and Smith River NRA Act Provisions (USDA Forest Service, undated)	To be considered	Standards and guides established for the Smith River NRA that are not otherwise promulgated will be used as guidance in selecting and implementing the removal action at the Site. Complete text of the standards and guides is included in Appendix C.
Migratory Bird Treaty Act of 1972 (916 USC §§ 703-712) [a]					
Migratory bird area	Protects almost all species of native migratory birds in the US from unregulated "take."	Presence of migratory birds	16 USC § 703	Relevant and appropriate	To date, no migratory birds have been identified at the Site. Compliance with this act will be required if migratory birds are identified.

TABLE 11C. POTENTIAL FEDERAL LOCATION-SPECIFIC ARARS *(continued)*

Location	Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
Exec. Order No. 11988, Floodplain Management					
Floodplain area	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values	Action that will occur in a floodplain and relatively flat areas adjoining inland and coastal waters and other flood-prone areas	40 CFR § 6.302(b)	Applicable	Floodplain management actions should be considered and incorporated in the proposed removal action work plan, since work will be conducted along Copper Creek, including flood plain areas.
Magnuson-Stevens Fishery Conservation and Management Act of 1976, as Amended (16 USC §§ 1801-1882)[a]					
Fishery under management	Provides for conservation and management of specified fisheries within specified fishery conservation zones	Presence of managed fisheries	16 USC §§ 1801-1882	Relevant and appropriate	Site actions will evaluate potential adverse effects or harm to managed fisheries downstream from the Site. To date, surface water at the Site has not been identified as a medium of concern.
National Historic Preservation Act of 1966, as Amended (16 USC §§ 470)[a]					
Federal land	Establishes a program for the preservation of historic federal properties within the US.	Property included in or eligible for the National Register of Historic Places	16 USC § 470-470x-6 36 CFR 800 40 CFR § 6.301(b)	Not an ARAR	Remaining structures within the Union-Zaar mine site boundary are not classified as being of historic importance according to available records and the Site is not on the National Register of Historic Places.

TABLE 11C. POTENTIAL FEDERAL LOCATION-SPECIFIC ARARS *(continued)*

Location	Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
Archaeological and Historic Preservation Act (16 USC § 469)[a]					
Federal land	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.	Federal construction project or federally licensed activity or program	16 USC. § 469-469(c)(1) 40 CFR § 6.301(c)	Applicable	If any removal action would cause irreparable loss or destruction of significant scientific, prehistoric, historical, or archeological data, it will be necessary to follow the procedures in the statute to provide for data recovery and preservation activities. Applicable to construction of an on-site encapsulated soil cell on undisturbed land, if this alternative is selected
Archaeological Resources Protection Act of 1979, as Amended (16 USC § 470aa-470mm)[a]					
Public lands	Prohibits unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources located on public lands unless such action is conducted pursuant to a permit	Archaeological resources on federal land	Pub. L. No. 96-95 16 USC § 470aa-470mm	Applicable	If any removal action would cause irreparable loss or destruction of significant scientific, prehistoric, historical, or archeological data, it will be necessary to follow the procedures in the statute to provide for data recovery and preservation activities. Applicable to construction of an on-site encapsulated soil cell on undisturbed land, if this alternative is selected.

Notes:
a. = Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs; only pertinent substantive requirements of the specific citations are considered potential ARARs
§ = Section
CFR = Code of Federal Regulations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
RCRA = Resource Conservation and Recovery Act
USC = United States Code
CCR = California Code of Regulations
RWQCB = Regional Water Quality Control Board
USDA = United States Department of Agriculture
ARAR = Applicable or Relevant and Appropriate Requirement
NRA = National Recreation Area
TBC = To be considered

TABLE 11D. POTENTIAL FEDERAL ACTION-SPECIFIC ARARs

Action	Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments
Clean Water Act, as Amended (33 U.S.C., ch. 26, §§ 1251–1387)[a]					
Construction activities	Construction that disturbs at least 1 acre must use best management practices to control storm water discharges.	Construction activities at least 1 acre in size.	Clean Water Act §402 40 CFR § 122.44(k)(2) and (4) (SWRCB Order 99-08-DWQ was adopted pursuant to this section)	Applicable	Applicable to alternatives that will disturb more than 1 acre. The Forest Service will use the requirements of state general storm water discharge permit, Order 99-08-DWQ, as TBCs for complying with the storm water discharge requirements under the Clean Water Act.
Fish and Wildlife Coordination Act [a]					
Controls or structural modifications of a natural stream	Enacted to protect fish and wildlife when federal actions result in the control or structural modification of a natural stream or body of water. The statute requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife and then take action to prevent loss or damage to these resources.	Action that occurs within a stream of body of water	16 USC Section 661	Applicable	This act applies to all Site actions, since part of the area to be addressed is currently in the Copper Creek stream bed.
Corrective Action Management Units and Temporary Units regulations, EPA, 1993 [a]					
Construction of on-site corrective action management unit for waste consolidation and repository	These regulations allow for the designation and creation of a Corrective Action Management Unit (CAMU) for the on-site consolidation of contaminated soil and debris.	Construction of an on-site contaminated materials repository must meet designation requirements outlined in 40 CFR Part 264.552(c)	40 CFR 264 Subpart S, and 40 CFR Part 264.552(c)	Relevant and appropriate	These rule may apply if an on-site encapsulated soil cell is constructed to contain excavated mine waste piles from the Creek banks.

Notes:

a. = Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs; only pertinent substantive requirements of the specific citations are considered potential ARARs

§ = Section
CFR = Code of Federal Regulations
CCR = California Code of Regulations
ARAR = Applicable or Relevant and Appropriate Requirement
CAMU = Corrective Action Management Unit
DWQ Division of Water Quality
SWRCB State Water Resources Control Board
USC = United States Code

TABLE 11E. POTENTIAL STATE ACTION-SPECIFIC ARARs

Action	Requirement	Prerequisite	Citation	Preliminary ARAR Determination	Comments and Compliance Measures
North Coast Regional Water Quality Control Board Draft Basin Plan Amendment[a]					
Earth-disturbing construction activities	Proposed Basin Plan amendment that prohibits the discharge of excess sediment. This amendment is necessary to comply with 23 CCR 2915	Anthropogenic activities that could result in a discharge of excess sediment	*Draft Measures to Reduce Excess Sediment,* SWRCB, July 18, 2007	To be considered	Should be considered in the development of design documents for the selected removal action. The amendment states: “The discharge or threatened discharge of excess sediment from human caused activities to waters of the state is prohibited.” Excess sediment is defined as “soil, rock, or sediment discharged to waters of the state in an amount that could be deleterious to beneficial uses or cause a nuisance.” The design should take into account this proposed amendment. Activities should be planned in such a way that discharges of excess sediment do not occur.
California Mining Waste Regulations Pursuant to California Water Code Section 13172 [a]					
On-site encapsulation of mining waste	The State of California has adopted regulations designed to address the management of mining waste. The regulations contain specific requirements on siting, construction, monitoring, closure and post-closure maintenance of existing and new units.	Mining waste	27 CCR 22470-22510	Relevant and appropriate	The regulations establish three groups of mining waste: Group A – mining waste that must be managed as hazardous waste provided the Water Board finds that such mining wastes pose a significant threat to water quality Group B – mining wastes that consist of or contain hazardous wastes that qualify for a variance, provided that the Water Board finds that such mining wastes pose a low risk to water quality, or mining wastes that consist of or contain nonhazardous soluble pollutants of concentrations which exceed water quality objectives for, or could cause, degradation of waters of the state Group C – wastes from which any discharge would be in compliance with the applicable water quality control plan, including water quality objectives other than turbidity Classification of the mining waste as hazardous under the Hazardous Waste Control Act is used to determine which group designation is appropriate. Mining wastes at the Site may be classified as either Group B or Group C wastes, depending on hazardous characteristic and the level of threat to water quality. These requirements are ARARs for alternatives that involve the creation of an on-site disposal unit.

Notes:

a. = Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs; only pertinent substantive requirements of the specific citations are considered potential ARARs

§ = Section
CFR = Code of Federal Regulations
CCR = California Code of Regulations
ARAR = Applicable or Relevant and Appropriate Requirement
RCRA = Resource Conservation and Recovery Act
SWRCB = State Water Resources Control Board

Table 12. Summary of Response Action Screening

Response Action	Technology and Process	Description	Screening Summary
1. No Action	None	None	Not Applicable
2. Engineering Controls	On-Site Slope Stabilization	▪ Line the mine waste piles with filter fabric to prevent silt from eroding out of the waste piles. ▪ Place a layer of rocks (rip rap) over fabric for slope stabilization and erosion control (some rock may be placed in the creek bed).	Effective and moderately implementable, with moderate costs. Very effective in controlling erosion and minimizing sediment transport to Copper Creek. Does not meet potential ARARs. May have negative impact on stream bed because of the potential need to place large rip rap within the creek bed and flood zone to stabilize the rip rap walls. Need detailed engineering design to determine if it is implementable on the steep-sloped mine waste piles.
3. Removal Action, On-site Encapsulation, and Engineering Controls	Removal of Source Materials (Mine Waste Piles) and Encapsulation of Source Materials On-site, Site Restoration, and Installation of Erosion Control Measures	▪ Excavate mine waste piles from three locations along Copper Creek. Construct an on-site soil cell to accommodate the excavated mine waste and sediment. ▪ Restore the excavated areas along creek banks as close to pre-mining conditions as possible, using minimal on-site backfill. ▪ Cover the backfilled slope with erosion mat and native plants for erosion control	Highly effective in meeting PRAOs and PRAGs. Eliminates future risk of erosion of materials into Creek. Meets potential ARARs. Implementable, provided that the construction of an on-site encapsulated mine waste cell is acceptable to federal, state, and local agencies. Moderate cost when compared to Alternative 4.
4. Removal Action, Off-site Disposal, and Engineering Controls	Removal of Source Materials (Mine Waste Piles), Off-site Disposal, Site Restoration, and Installation of Erosion Control Measures	▪ Excavate mine waste piles from three locations along Copper Creek. ▪ Load wastes and sediment into dump trucks and transport to an off-site landfill for disposal. ▪ Restore the excavated areas along creek banks as close to pre-mining conditions as possible, using minimal on-site backfill. ▪ Cover the backfilled slope with erosion mat and native plants for erosion control.	Highly effective and relatively implementable, but requires significant expansion of access roads to the site and is also the most expensive action to consider. PRAO and PRAG will be met under this response action. Meets potential ARARs.

Notes

ARARs = Applicable or Relevant and Appropriate Requirements
PRAGs = Preliminary Remedial Action Goals
COPCs = chemical of potential concern
PRAOs = Preliminary Remedial Action Objectives

Appendix A. Analytical Results for 2007 Sediment Sampling

STL

ANALYTICAL REPORT

Job Number: 720-9222-1

Job Description: Union Zaar Mine

For:
ERRG
251 Kearny St.
Suite 502
San Francisco, CA 94108

Attention: Ms. Caitlin Gorman

DSharma

Dimple Sharma
Project Manager I
dsharma@stl-inc.com
05/29/2007

Project Manager: Dimple Sharma

Severn Trent Laboratories, Inc.
STL San Francisco 1220 Quarry Lane, Pleasanton, CA 94566
Tel (925) 484-1919 Fax (925) 484-1096 www.stl-inc.com

Job Narrative
720-J9222-1

I. Comments

No additional comments.

II. Receipt

All samples were received in good condition within temperature requirements.

III. Metals

Method 6010B: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for batch 21967 were outside control limits. The associated laboratory control standard (LCS) met acceptance criteria.

Method 6010B: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for batch 21998 were outside control limits. The associated laboratory control standard (LCS) met acceptance criteria.

Method 6010B: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for batch 22019 were outside control limits. The associated laboratory control standard (LCS) met acceptance criteria.

No other analytical or quality issues were noted.

IV. General Chemistry

No analytical or quality issues were noted.

EXECUTIVE SUMMARY - Detections

Client: ERRG

Job Number: 720-9222-1

Lab Sample ID Analyte	Client Sample ID	Result / Qualifier	Reporting Limit	Units	Method
720-9222-1	**UZS010**				
Arsenic		7.7	1.0	mg/Kg	6010B
Barium		3.9	1.0	mg/Kg	6010B
Chromium		410	1.0	mg/Kg	6010B
Cobalt		67	1.0	mg/Kg	6010B
Copper		180	1.0	mg/Kg	6010B
Nickel		1200	1.0	mg/Kg	6010B
Vanadium		15	1.0	mg/Kg	6010B
Zinc		19	1.0	mg/Kg	6010B
Soluble					
pH-S		6.86	0.100	SU	9045C
720-9222-2	**UZS011**				
Arsenic		4.6	1.0	mg/Kg	6010B
Barium		9.1	1.0	mg/Kg	6010B
Beryllium		0.53	0.50	mg/Kg	6010B
Chromium		640	1.0	mg/Kg	6010B
Cobalt		96	1.0	mg/Kg	6010B
Copper		180	1.0	mg/Kg	6010B
Nickel		1300	1.0	mg/Kg	6010B
Vanadium		21	1.0	mg/Kg	6010B
Zinc		23	1.0	mg/Kg	6010B
Soluble					
pH-S		7.01	0.100	SU	9045C
720-9222-3	**UZS012**				
Arsenic		31	1.0	mg/Kg	6010B
Barium		3.7	1.0	mg/Kg	6010B
Chromium		420	1.0	mg/Kg	6010B
Cobalt		71	1.0	mg/Kg	6010B
Copper		200	1.0	mg/Kg	6010B
Nickel		1400	1.0	mg/Kg	6010B
Vanadium		13	1.0	mg/Kg	6010B
Zinc		20	1.0	mg/Kg	6010B
Soluble					
pH-S		7.34	0.100	SU	9045C

EXECUTIVE SUMMARY - Detections

Client: ERRG

Job Number: 720-9222-1

Lab Sample ID Analyte	Client Sample ID	Result / Qualifier	Reporting Limit	Units	Method
720-9222-5	**UZS013**				
Arsenic		6.4	1.0	mg/Kg	6010B
Barium		4.6	1.0	mg/Kg	6010B
Chromium		480	1.0	mg/Kg	6010B
Cobalt		77	1.0	mg/Kg	6010B
Copper		180	1.0	mg/Kg	6010B
Nickel		1500	1.0	mg/Kg	6010B
Vanadium		14	1.0	mg/Kg	6010B
Zinc		22	1.0	mg/Kg	6010B
Soluble					
pH-S		7.42	0.100	SU	9045C
720-9222-6	**UZS014**				
Barium		1.8	0.99	mg/Kg	6010B
Chromium		290	0.99	mg/Kg	6010B
Cobalt		58	0.99	mg/Kg	6010B
Copper		2.6	0.99	mg/Kg	6010B
Nickel		1500	0.99	mg/Kg	6010B
Vanadium		11	0.99	mg/Kg	6010B
Zinc		19	0.99	mg/Kg	6010B
Soluble					
pH-S		7.06	0.100	SU	9045C

METHOD SUMMARY

Client: ERRG

Job Number: 720-9222-1

Description	Lab Location	Method	Preparation Method
Matrix: Solid			
Inductively Coupled Plasma - Atomic Emission Spectrometry	STL SF	SW846 6010B	
Acid Digestion of Sediments, Sludges, and Soils	STL SF		SW846 3050B
Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)	STL SF	SW846 7471A	
Mercury in Solid or Semi-Solid Waste (Manual	STL SF		SW846 7471A
Soil and Waste pH	STL SF	SW846 9045C	
Deionized Water Leaching Procedure (Routine)	STL SF		ASTM NONE

LAB REFERENCES:

STL SF = STL San Francisco

METHOD REFERENCES:

SW846 - "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

SAMPLE SUMMARY

Client: ERRG

Job Number: 720-9222-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
720-9222-1	UZS010	Solid	05/18/2007 1025	05/21/2007 1215
720-9222-2	UZS011	Solid	05/18/2007 1150	05/21/2007 1215
720-9222-3	UZS012	Solid	05/18/2007 1205	05/21/2007 1215
720-9222-5	UZS013	Solid	05/18/2007 1230	05/21/2007 1215
720-9222-6	UZS014	Solid	05/18/2007 1320	05/21/2007 1215

Analytical Data

Client: ERRG

Job Number: 720-9222-1

Client Sample ID: UZS010

Lab Sample ID:	720-9222-1	Date Sampled:	05/18/2007 1025
Client Matrix:	Solid	Date Received:	05/21/2007 1215

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-22012	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-21967	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.00 g
Date Analyzed:	05/25/2007 0852		Final Weight/Volume:	50 mL
Date Prepared:	05/24/2007 1441			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		ND		2.0
Arsenic		7.7		1.0
Barium		3.9		1.0
Beryllium		ND		0.50
Cadmium		ND		0.50
Chromium		410		1.0
Cobalt		67		1.0
Copper		180		1.0
Lead		ND		1.0
Molybdenum		ND		1.0
Nickel		1200		1.0
Selenium		ND		2.0
Silver		ND		1.0
Thallium		ND		1.0
Vanadium		15		1.0
Zinc		19		1.0

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-22096	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-22023	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.05 g
Date Analyzed:	05/29/2007 1050		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1200			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.048

Client Sample ID: UZS011

Lab Sample ID:	720-9222-2	Date Sampled:	05/18/2007 1150
Client Matrix:	Solid	Date Received:	05/21/2007 1215

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-22012	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-21998	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.00 g
Date Analyzed:	05/25/2007 0930		Final Weight/Volume:	50 mL
Date Prepared:	05/24/2007 1943			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		ND		2.0
Arsenic		4.6		1.0
Barium		9.1		1.0
Beryllium		0.53		0.50
Cadmium		ND		0.50
Chromium		640		1.0
Cobalt		96		1.0
Copper		180		1.0
Lead		ND		1.0
Molybdenum		ND		1.0
Nickel		1300		1.0
Selenium		ND		2.0
Silver		ND		1.0
Thallium		ND		1.0
Vanadium		21		1.0
Zinc		23		1.0

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-22096	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-22023	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	0.99 g
Date Analyzed:	05/29/2007 1051		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1200			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.051

Client Sample ID: UZS012

Lab Sample ID:	720-9222-3	Date Sampled:	05/18/2007 1205
Client Matrix:	Solid	Date Received:	05/21/2007 1215

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-22085	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-22019	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.00 g
Date Analyzed:	05/29/2007 1037		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1140			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		ND		2.0
Arsenic		31		1.0
Barium		3.7		1.0
Beryllium		ND		0.50
Cadmium		ND		0.50
Chromium		420		1.0
Cobalt		71		1.0
Copper		200		1.0
Lead		ND		1.0
Molybdenum		ND		1.0
Nickel		1400		1.0
Selenium		ND		2.0
Silver		ND		1.0
Thallium		ND		1.0
Vanadium		13		1.0
Zinc		20		1.0

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-22096	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-22023	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.02 g
Date Analyzed:	05/29/2007 1052		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1200			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.049

Client Submit Sample ID: UZS013

Lab Sample ID:	720-9222-5	Date Sampled:	05/18/2007 1230
Client Matrix:	Solid	Date Received:	05/21/2007 1215

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-22085	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-22019	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.00 g
Date Analyzed:	05/29/2007 1040		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1140			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		ND		2.0
Arsenic		6.4		1.0
Barium		4.6		1.0
Beryllium		ND		0.50
Cadmium		ND		0.50
Chromium		480		1.0
Cobalt		77		1.0
Copper		180		1.0
Lead		ND		1.0
Molybdenum		ND		1.0
Nickel		1500		1.0
Selenium		ND		2.0
Silver		ND		1.0
Thallium		ND		1.0
Vanadium		14		1.0
Zinc		22		1.0

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-22096	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-22023	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	0.99 g
Date Analyzed:	05/29/2007 1054		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1200			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.051

Analytical Data

Client: ERRG

Job Number: 720-9222-1

Client Sample ID: UZS014

Lab Sample ID:	720-9222-6	Date Sampled:	05/18/2007 1320
Client Matrix:	Solid	Date Received:	05/21/2007 1215

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-22085	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-22019	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.01 g
Date Analyzed:	05/29/2007 1044		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1140			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		ND		2.0
Arsenic		ND		0.99
Barium		1.8		0.99
Beryllium		ND		0.50
Cadmium		ND		0.50
Chromium		290		0.99
Cobalt		58		0.99
Copper		2.6		0.99
Lead		ND		0.99
Molybdenum		ND		0.99
Nickel		1500		0.99
Selenium		ND		2.0
Silver		ND		0.99
Thallium		ND		0.99
Vanadium		11		0.99
Zinc		19		0.99

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-22096	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-22023	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.00 g
Date Analyzed:	05/29/2007 1057		Final Weight/Volume:	50 mL
Date Prepared:	05/25/2007 1200			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.050

General Chemistry

Client Sample ID: **UZS010**

Lab Sample ID:	720-9222-1	Date Sampled:	05/18/2007 1025
Client Matrix:	Solid	Date Received:	05/21/2007 1215

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	6.86		SU	0.100	1.0	9045C

Anly Batch: 720-22102 Date Analyzed 05/29/2007 1340 DryWt Corrected: N

Client Sample ID: **UZS011**

Lab Sample ID:	720-9222-2	Date Sampled:	05/18/2007 1150
Client Matrix:	Solid	Date Received:	05/21/2007 1215

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	7.01		SU	0.100	1.0	9045C

Anly Batch: 720-22102 Date Analyzed 05/29/2007 1343 DryWt Corrected: N

Client Sample ID: **UZS012**

Lab Sample ID:	720-9222-3	Date Sampled:	05/18/2007 1205
Client Matrix:	Solid	Date Received:	05/21/2007 1215

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	7.34		SU	0.100	1.0	9045C

Anly Batch: 720-22102 Date Analyzed 05/29/2007 1348 DryWt Corrected: N

Client Sample ID: **UZS013**

Lab Sample ID:	720-9222-5	Date Sampled:	05/18/2007 1230
Client Matrix:	Solid	Date Received:	05/21/2007 1215

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	7.42		SU	0.100	1.0	9045C

Anly Batch: 720-22102 Date Analyzed 05/29/2007 1350 DryWt Corrected: N

General Chemistry

Client Sample ID: **UZS014**

Lab Sample ID: 720-9222-6
Client Matrix: Solid

Date Sampled: 05/18/2007 1320
Date Received: 05/21/2007 1215

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	7.06		SU	0.100	1.0	9045C

Anly Batch: 720-22102 Date Analyzed 05/29/2007 1400 DryWt Corrected: N

DATA REPORTING QUALIFIERS

Client: ERRG

Job Number: 720-9222-1

Lab Section	Qualifier	Description
Metals		
	F	MS or MSD exceeds the control limits
	4	MS, MSD: The analyte present in the original sample is 4 times greater than the matrix spike concentration; therefore, control limits are not applicable.
	F	RPD of the MS and MSD exceeds the control limits

Client: ERRG

Job Number: 720-9222-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
Metals					
Prep Batch: 720-21967					
LCS 720-21967/2-AA	Lab Control Spike	T	Solid	3050B	
LCSD 720-21967/3-AA	Lab Control Spike Duplicate	T	Solid	3050B	
LCSSRM 720-21967/4-AA	LCS-Standard Reference Material	T	Solid	3050B	
MB 720-21967/1-AA	Method Blank	T	Solid	3050B	
720-9222-1	UZS010	T	Solid	3050B	
720-9222-1MS	Matrix Spike	T	Solid	3050B	
720-9222-1MSD	Matrix Spike Duplicate	T	Solid	3050B	
Prep Batch: 720-21998					
LCS 720-21998/2-AA	Lab Control Spike	T	Solid	3050B	
LCSD 720-21998/3-AA	Lab Control Spike Duplicate	T	Solid	3050B	
LCSSRM 720-21998/4-AA	LCS-Standard Reference Material	T	Solid	3050B	
MB 720-21998/1-AA	Method Blank	T	Solid	3050B	
720-9222-2	UZS011	T	Solid	3050B	
720-9222-2MS	Matrix Spike	T	Solid	3050B	
720-9222-2MSD	Matrix Spike Duplicate	T	Solid	3050B	
Analysis Batch:720-22012					
LCS 720-21967/2-AA	Lab Control Spike	T	Solid	6010B	720-21967
LCSD 720-21967/3-AA	Lab Control Spike Duplicate	T	Solid	6010B	720-21967
LCSSRM 720-21967/4-AA	LCS-Standard Reference Material	T	Solid	6010B	720-21967
MB 720-21967/1-AA	Method Blank	T	Solid	6010B	720-21967
LCS 720-21998/2-AA	Lab Control Spike	T	Solid	6010B	720-21998
LCSD 720-21998/3-AA	Lab Control Spike Duplicate	T	Solid	6010B	720-21998
LCSSRM 720-21998/4-AA	LCS-Standard Reference Material	T	Solid	6010B	720-21998
MB 720-21998/1-AA	Method Blank	T	Solid	6010B	720-21998
720-9222-1	UZS010	T	Solid	6010B	720-21967
720-9222-1MS	Matrix Spike	T	Solid	6010B	720-21967
720-9222-1MSD	Matrix Spike Duplicate	T	Solid	6010B	720-21967
720-9222-2	UZS011	T	Solid	6010B	720-21998
720-9222-2MS	Matrix Spike	T	Solid	6010B	720-21998
720-9222-2MSD	Matrix Spike Duplicate	T	Solid	6010B	720-21998
Prep Batch: 720-22019					
LCS 720-22019/2-AA	Lab Control Spike	T	Solid	3050B	
LCSD 720-22019/3-AA	Lab Control Spike Duplicate	T	Solid	3050B	
LCSSRM 720-22019/4-AA	LCS-Standard Reference Material	T	Solid	3050B	
MB 720-22019/1-AA	Method Blank	T	Solid	3050B	
720-9222-3	UZS012	T	Solid	3050B	
720-9222-5	UZS013	T	Solid	3050B	
720-9222-6	UZS014	T	Solid	3050B	

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
Metals					
Prep Batch: 720-22023					
LCS 720-22023/2-AA	Lab Control Spike	T	Solid	7471A	
LCSD 720-22023/3-AA	Lab Control Spike Duplicate	T	Solid	7471A	
MB 720-22023/1-AA	Method Blank	T	Solid	7471A	
720-9222-1	UZS010	T	Solid	7471A	
720-9222-2	UZS011	T	Solid	7471A	
720-9222-3	UZS012	T	Solid	7471A	
720-9222-5	UZS013	T	Solid	7471A	
720-9222-6	UZS014	T	Solid	7471A	
Analysis Batch:720-22085					
LCS 720-22019/2-AA	Lab Control Spike	T	Solid	6010B	720-22019
LCSD 720-22019/3-AA	Lab Control Spike Duplicate	T	Solid	6010B	720-22019
LCSSRM 720-22019/4-AA	LCS-Standard Reference Material	T	Solid	6010B	720-22019
MB 720-22019/1-AA	Method Blank	T	Solid	6010B	720-22019
720-9222-3	UZS012	T	Solid	6010B	720-22019
720-9222-5	UZS013	T	Solid	6010B	720-22019
720-9222-6	UZS014	T	Solid	6010B	720-22019
Analysis Batch:720-22096					
LCS 720-22023/2-AA	Lab Control Spike	T	Solid	7471A	720-22023
LCSD 720-22023/3-AA	Lab Control Spike Duplicate	T	Solid	7471A	720-22023
MB 720-22023/1-AA	Method Blank	T	Solid	7471A	720-22023
720-9222-1	UZS010	T	Solid	7471A	720-22023
720-9222-2	UZS011	T	Solid	7471A	720-22023
720-9222-3	UZS012	T	Solid	7471A	720-22023
720-9222-5	UZS013	T	Solid	7471A	720-22023
720-9222-6	UZS014	T	Solid	7471A	720-22023

Report Basis

T = Total

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
General Chemistry					
Prep Batch: 720-22090					
LCS 720-22090/1-AA	Lab Control Spike	S	Solid	NONE	
720-9222-1	UZS010	S	Solid	NONE	
720-9222-2	UZS011	S	Solid	NONE	
720-9222-3	UZS012	S	Solid	NONE	
720-9222-5	UZS013	S	Solid	NONE	
720-9222-6	UZS014	S	Solid	NONE	
720-9222-6DU	Duplicate	S	Solid	NONE	
Analysis Batch:720-22102					
LCS 720-22090/1-AA	Lab Control Spike	S	Solid	9045C	
720-9222-1	UZS010	S	Solid	9045C	
720-9222-2	UZS011	S	Solid	9045C	
720-9222-3	UZS012	S	Solid	9045C	
720-9222-5	UZS013	S	Solid	9045C	
720-9222-6	UZS014	S	Solid	9045C	
720-9222-6DU	Duplicate	S	Solid	9045C	

Report Basis

S = Soluble

Client: ERRG

Job Number: 720-9222-1

Method Blank - Batch: 720-21967

Method: 6010B
Preparation: 3050B

Lab Sample ID: MB 720-21967/1-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0716
Date Prepared: 05/24/2007 1441

Analysis Batch: 720-22012
Prep Batch: 720-21967
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

Analyte	Result	Qual	RL
Antimony	ND		2.0
Arsenic	ND		1.0
Barium	ND		1.0
Beryllium	ND		0.50
Cadmium	ND		0.50
Chromium	ND		1.0
Cobalt	ND		1.0
Copper	ND		1.0
Lead	ND		1.0
Molybdenum	ND		1.0
Nickel	ND		1.0
Selenium	ND		2.0
Silver	ND		1.0
Thallium	ND		1.0
Vanadium	ND		1.0
Zinc	ND		1.0

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

LCS-Standard Reference Material - Batch: 720-21967

Method: 6010B
Preparation: 3050B

Lab Sample ID: LCSSRM 720-21967/4-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0727
Date Prepared: 05/24/2007 1441

Analysis Batch: 720-22012
Prep Batch: 720-21967
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 0.99 g
Final Weight/Volume: 50 mL

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Antimony	27.4	13.9	51	14 - 96	
Arsenic	22.7	20.1	89	72 - 128	
Barium	145	127	87	80 - 120	
Beryllium	1.09	0.919	84	65 - 134	
Cadmium	42.2	37.7	89	80 - 120	
Chromium	246	219	89	80 - 120	
Cobalt	65.1	61.2	94	72 - 128	
Copper	58.5	54.2	93	80 - 120	
Lead	44.1	38.3	87	75 - 126	
Molybdenum	61.0	55.7	91	62 - 138	
Nickel	96.8	85.9	89	80 - 120	
Selenium	165	149	90	80 - 120	
Silver	79.5	60.3	76	72 - 127	
Thallium	55.9	50.8	91	79 - 121	
Vanadium	56.7	51.6	91	63 - 137	
Zinc	44.0	37.3	85	75 - 125	

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

Lab Control Spike/
Lab Control Spike Duplicate Recovery Report - Batch: 720-21967

Method: 6010B
Preparation: 3050B

LCS Lab Sample ID: LCS 720-21967/2-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0719
Date Prepared: 05/24/2007 1441

Analysis Batch: 720-22012
Prep Batch: 720-21967
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

LCSD Lab Sample ID: LCSD 720-21967/3-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0723
Date Prepared: 05/24/2007 1441

Analysis Batch: 720-22012
Prep Batch: 720-21967
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Antimony	91	95	80 - 120	4	20		
Arsenic	100	101	80 - 120	1	20		
Barium	101	102	80 - 120	1	20		
Beryllium	98	99	80 - 120	1	20		
Cadmium	100	101	80 - 120	1	20		
Chromium	99	100	80 - 120	1	20		
Cobalt	102	103	80 - 120	1	20		
Copper	101	102	80 - 120	1	20		
Lead	100	101	80 - 120	1	20		
Molybdenum	103	105	80 - 120	2	20		
Nickel	99	100	80 - 120	1	20		
Selenium	100	102	80 - 120	2	20		
Silver	100	101	80 - 120	1	20		
Thallium	100	101	80 - 120	1	20		
Vanadium	102	103	80 - 120	1	20		
Zinc	100	101	80 - 120	1	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 720-21967

Method: 6010B
Preparation: 3050B

MS Lab Sample ID: 720-9222-1
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0856
Date Prepared: 05/24/2007 1441

Analysis Batch: 720-22012
Prep Batch: 720-21967

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1.01 g
Final Weight/Volume: 50 mL

MSD Lab Sample ID: 720-9222-1
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0900
Date Prepared: 05/24/2007 1441

Analysis Batch: 720-22012
Prep Batch: 720-21967

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 0.98 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Antimony	9	10	75 - 125	21	20	F	F
Arsenic	83	83	75 - 125	3	20		
Barium	82	82	75 - 125	2	20		
Beryllium	77	77	75 - 125	3	20		
Cadmium	72	72	75 - 125	3	20	F	F
Chromium	64	107	75 - 125	9	20	4	4
Cobalt	74	78	75 - 125	5	20	F	
Copper	119	116	75 - 125	0	20		
Lead	72	72	75 - 125	3	20	F	F
Molybdenum	74	75	75 - 125	5	20	F	
Nickel	92	146	75 - 125	4	20	4	4
Selenium	72	71	75 - 125	2	20	F	F
Silver	83	82	75 - 125	3	20		
Thallium	71	71	75 - 125	4	20	F	F
Vanadium	79	79	75 - 125	3	20		
Zinc	72	74	75 - 125	4	20	F	F

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

Method Blank - Batch: 720-21998

Method: 6010B
Preparation: 3050B

Lab Sample ID: MB 720-21998/1-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0904
Date Prepared: 05/24/2007 1943

Analysis Batch: 720-22012
Prep Batch: 720-21998
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

Analyte	Result	Qual	RL
Antimony	ND		2.0
Arsenic	ND		1.0
Barium	ND		1.0
Beryllium	ND		0.50
Cadmium	ND		0.50
Chromium	ND		1.0
Cobalt	ND		1.0
Copper	ND		1.0
Lead	ND		1.0
Molybdenum	ND		1.0
Nickel	ND		1.0
Selenium	ND		2.0
Silver	ND		1.0
Thallium	ND		1.0
Vanadium	ND		1.0
Zinc	ND		1.0

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

LCS-Standard Reference Material - Batch: 720-21998

Method: 6010B
Preparation: 3050B

Lab Sample ID: LCSSRM 720-21998/4-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0914
Date Prepared: 05/24/2007 1943

Analysis Batch: 720-22012
Prep Batch: 720-21998
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1.02 g
Final Weight/Volume: 50 mL

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Antimony	27.4	12.6	46	14 - 96	
Arsenic	22.7	20.3	89	72 - 128	
Barium	145	123	85	80 - 120	
Beryllium	1.09	0.971	89	65 - 134	
Cadmium	42.2	37.7	89	80 - 120	
Chromium	246	221	90	80 - 120	
Cobalt	65.1	62.9	97	72 - 128	
Copper	58.5	54.1	93	80 - 120	
Lead	44.1	37.8	86	75 - 126	
Molybdenum	61.0	53.5	88	62 - 138	
Nickel	96.8	85.2	88	80 - 120	
Selenium	165	148	90	80 - 120	
Silver	79.5	71.1	89	72 - 127	
Thallium	55.9	50.9	91	79 - 121	
Vanadium	56.7	51.6	91	63 - 137	
Zinc	44.0	35.8	81	75 - 125	

Calculations are performed before rounding to avoid round-off errors in calculated results.

Lab Control Spike/ Lab Control Spike Duplicate Recovery Report - Batch: 720-21998

Method: 6010B
Preparation: 3050B

LCS Lab Sample ID: LCS 720-21998/2-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0907
Date Prepared: 05/24/2007 1943

Analysis Batch: 720-22012
Prep Batch: 720-21998
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

LCSD Lab Sample ID: LCSD 720-21998/3-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0910
Date Prepared: 05/24/2007 1943

Analysis Batch: 720-22012
Prep Batch: 720-21998
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Antimony	91	97	80 - 120	6	20		
Arsenic	97	101	80 - 120	4	20		
Barium	99	103	80 - 120	4	20		
Beryllium	96	100	80 - 120	4	20		
Cadmium	97	101	80 - 120	4	20		
Chromium	97	100	80 - 120	4	20		
Cobalt	99	103	80 - 120	4	20		
Copper	98	102	80 - 120	4	20		
Lead	97	101	80 - 120	4	20		
Molybdenum	100	105	80 - 120	4	20		
Nickel	97	100	80 - 120	4	20		
Selenium	96	100	80 - 120	4	20		
Silver	98	101	80 - 120	4	20		
Thallium	97	101	80 - 120	4	20		
Vanadium	99	103	80 - 120	4	20		
Zinc	97	101	80 - 120	4	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Client: ERRG

Job Number: 720-9222-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 720-21998

Method: 6010B
Preparation: 3050B

MS Lab Sample ID: 720-9222-2
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0934
Date Prepared: 05/24/2007 1943

Analysis Batch: 720-22012
Prep Batch: 720-21998

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1.03 g
Final Weight/Volume: 50 mL

MSD Lab Sample ID: 720-9222-2
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/25/2007 0938
Date Prepared: 05/24/2007 1943

Analysis Batch: 720-22012
Prep Batch: 720-21998

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1.03 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Antimony	26	24	75 - 125	5	20	F	F
Arsenic	78	80	75 - 125	2	20		
Barium	72	74	75 - 125	3	20	F	F
Beryllium	72	75	75 - 125	4	20	F	
Cadmium	65	68	75 - 125	5	20	F	F
Chromium	122	-29	75 - 125	22	20	4	4
Cobalt	54	57	75 - 125	2	20	F	F
Copper	505	41	75 - 125	102	20	F	F
Lead	65	68	75 - 125	5	20	F	F
Molybdenum	71	73	75 - 125	4	20	F	F
Nickel	190	195	75 - 125	0	20	4	4
Selenium	70	74	75 - 125	6	20	F	F
Silver	80	84	75 - 125	5	20		
Thallium	64	67	75 - 125	5	20	F	F
Vanadium	72	71	75 - 125	1	20	F	F
Zinc	66	62	75 - 125	4	20	F	F

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

Method Blank - Batch: 720-22019

Method: 6010B
Preparation: 3050B

Lab Sample ID: MB 720-22019/1-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/29/2007 1023
Date Prepared: 05/25/2007 1140

Analysis Batch: 720-22085
Prep Batch: 720-22019
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

Analyte	Result	Qual	RL
Antimony	ND		2.0
Arsenic	ND		1.0
Barium	ND		1.0
Beryllium	ND		0.50
Cadmium	ND		0.50
Chromium	ND		1.0
Cobalt	ND		1.0
Copper	ND		1.0
Lead	ND		1.0
Molybdenum	ND		1.0
Nickel	ND		1.0
Selenium	ND		2.0
Silver	ND		1.0
Thallium	ND		1.0
Vanadium	ND		1.0
Zinc	ND		1.0

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

LCS-Standard Reference Material - Batch: 720-22019

Method: 6010B
Preparation: 3050B

Lab Sample ID: LCSSRM 720-22019/4-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/29/2007 1033
Date Prepared: 05/25/2007 1140

Analysis Batch: 720-22085
Prep Batch: 720-22019
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1.01 g
Final Weight/Volume: 50 mL

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Antimony	27.4	16.0	58	14 - 96	
Arsenic	22.7	20.9	92	72 - 128	
Barium	145	129	89	80 - 120	
Beryllium	1.09	0.896	82	65 - 134	
Cadmium	42.2	37.7	89	80 - 120	
Chromium	246	216	88	80 - 120	
Cobalt	65.1	64.4	99	72 - 128	
Copper	58.5	54.0	92	80 - 120	
Lead	44.1	37.5	85	75 - 126	
Molybdenum	61.0	59.3	97	62 - 138	
Nickel	96.8	84.1	87	80 - 120	
Selenium	165	152	92	80 - 120	
Silver	79.5	72.5	91	72 - 127	
Thallium	55.9	50.4	90	79 - 121	
Vanadium	56.7	50.8	90	63 - 137	
Zinc	44.0	37.9	86	75 - 125	

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

Lab Control Spike/
Lab Control Spike Duplicate Recovery Report - Batch: 720-22019

Method: 6010B
Preparation: 3050B

LCS Lab Sample ID: LCS 720-22019/2-AA	Analysis Batch: 720-22085	Instrument ID: Varian ICP	
Client Matrix: Solid	Prep Batch: 720-22019	Lab File ID: N/A	
Dilution: 1.0	Units: mg/Kg	Initial Weight/Volume: 1 g	
Date Analyzed: 05/29/2007 1025		Final Weight/Volume: 50 mL	
Date Prepared: 05/25/2007 1140			

LCSD Lab Sample ID: LCSD 720-22019/3-AA	Analysis Batch: 720-22085	Instrument ID: Varian ICP
Client Matrix: Solid	Prep Batch: 720-22019	Lab File ID: N/A
Dilution: 1.0	Units: mg/Kg	Initial Weight/Volume: 1 g
Date Analyzed: 05/29/2007 1029		Final Weight/Volume: 50 mL
Date Prepared: 05/25/2007 1140		

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Antimony	104	106	80 - 120	1	20		
Arsenic	101	103	80 - 120	1	20		
Barium	102	104	80 - 120	1	20		
Beryllium	99	100	80 - 120	1	20		
Cadmium	100	103	80 - 120	2	20		
Chromium	100	101	80 - 120	1	20		
Cobalt	103	104	80 - 120	1	20		
Copper	103	105	80 - 120	1	20		
Lead	101	103	80 - 120	2	20		
Molybdenum	105	107	80 - 120	2	20		
Nickel	101	102	80 - 120	1	20		
Selenium	102	103	80 - 120	1	20		
Silver	101	103	80 - 120	3	20		
Thallium	98	101	80 - 120	3	20		
Vanadium	103	104	80 - 120	1	20		
Zinc	101	103	80 - 120	2	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Method Blank - Batch: 720-22023

Method: 7471A
Preparation: 7471A

Lab Sample ID: MB 720-22023/1-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/29/2007 1043
Date Prepared: 05/25/2007 1200

Analysis Batch: 720-22096
Prep Batch: 720-22023
Units: mg/Kg

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

Analyte	Result	Qual	RL
Mercury	ND		0.050

Lab Control Spike/ Lab Control Spike Duplicate Recovery Report - Batch: 720-22023

Method: 7471A
Preparation: 7471A

LCS Lab Sample ID: LCS 720-22023/2-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/29/2007 1044
Date Prepared: 05/25/2007 1200

Analysis Batch: 720-22096
Prep Batch: 720-22023
Units: mg/Kg

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

LCSD Lab Sample ID: LCSD 720-22023/3-AA
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/29/2007 1045
Date Prepared: 05/25/2007 1200

Analysis Batch: 720-22096
Prep Batch: 720-22023
Units: mg/Kg

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Mercury	98	98	85 - 115	0	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: ERRG

Job Number: 720-9222-1

Duplicate - Batch: 720-22102

Method: 9045C
Preparation: N/A

Lab Sample ID: 720-9222-6
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 05/29/2007 1403
Date Prepared: N/A
Date Leached: 05/29/2007 1205

Analysis Batch: 720-22102
Prep Batch: N/A
Units: SU
Leachate Batch: 720-22090

Instrument ID: No Equipment Assigned
Lab File ID: N/A
Initial Weight/Volume: 20 mL
Final Weight/Volume: mL

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
pH-S	7.06	7.080	0	20	

Calculations are performed before rounding to avoid round-off errors in calculated results.

STL

720-9222

STL San Francisco Chain of Custody
1220 Quarry Lane ● Pleasanton CA 94566-4756
Phone: (925) 484-1919 ● Fax: (925) 484-1096
Email: sfloqin@stl-inc.com

10556-2

Reference #: 27-068

Date 5·19·07 Page 1 of 1

Report To

Attn: CAITLIN GORMAN
Company: ERRG
Address: 251 KEARNY ST, SUITE 502
Phone: 415-559-8176 Email: caitlin.gorman@errg.com
Bill To: 27-068
Sampled By: CG + AV
Attn:
Phone:

Analysis Request

Sample ID	Date	Time	Matrix	Preserv.	TPH EPA - ☐ 8015/8021 ☐ 8260B ☐ Gas w/ ☐ BTEX ☐ MTBE	Purgeable Aromatics BTEX EPA - ☐ 8021 ☐ 8260B	TEPH EPA 8015M* ☐ Silica Gel ☐ Diesel ☐ Motor Oil ☐ Other ___	Fuel Tests EPA 8260B: ☐ Gas ☐ BTEX ☐ Five Oxyenates ☐ DCA, EDB ☐ Ethanol	Purgeable Halocarbons (HVOCs) EPA 8021 by 8260B	Volatile Organics GC/MS (VOCs) ☐ EPA 8260B ☐ 624	Semivolatiles GC/MS ☐ EPA 8270 ☐ 625	Oil and Grease ☐ Petroleum (EPA 1664) ☐ Total	Pesticides ☐ EPA 8081 ☐ 608 PCBs ☐ EPA 8082 ☐ 608	PNAs by ☐ 8270 ☐ 8310	CAM17 Metals (EPA 6010/7470/7471)	Metals: ☐ Lead ☐ LUFT ☐ RCRA ☐ Other: ___	Low Level Metals by EPA 200.8/6020 (ICP-MS): ___	☐ W.E.T (STLC) ☐ TCLP	☐ Hexavalent Chromium ☐ pH (24h hold time for H_2O)	☐ Spec Cond. ☐ Alkalinity ☐ TSS ☐ TDS ☐	Anions : ☐ Cl ☐ SO_4 ☐ NO_3 ☐ F ☐ Br ☐ NO_2 ☐ PO_4	pH			Number of Containers (8oz JAR)
UZS010	5/18/07	1025	SED	ICE											X							X			1
UZS011	5/18/07	1150		ICE											X							X			1
UZS012	5/18/07	1205		ICE											X							X			1
⊛ UZS015 ⊛	5/18/07	1220		ICE											X							X			1
UZS013	5/18/07	1230		ICE											X							X			1
UZS014	5/18/07	1320		ICE											X							X			1

CG

Project Info.

Project Name: Union-Zaar Mine
Project#:
PO#:
Credit Card#:

Sample Receipt

\# of Containers:
Head Space:
Temp: 2.1°C
Conforms to record:

T A T	5 Day	72h	48h	24h	Other:

Report: ☐ Routine ☐ Level 3 ☐ Level 4 ☐ EDD ☐ State Tank Fund EDF ☐ Global ID ______
Special Instructions / Comments:

⊛ HOLD UZS015 FOR ANALYSIS FOLLOWING RESULTS FROM OTHER SAMPLES.
PLEASE AVOID ROOTS + LARGE ROCKS / GRAVEL

See Terms and Conditions on reverse
*STL SF reports 8015M from C_9-C_{24} (industry norm). Default for 8015B is C_{10}-C_{28}.

1) Relinquished by:
Signature Time 1020
Printed Name CAITLINE. GORMAN Date 5/21/07
Company ERRG

2) Relinquished by:
Signature Time 1215
Printed Name Bryan Thomas Date 5/21/07
Company STL-SF

3) Relinquished by:
Signature Time
Printed Name Date
Company

1) Received by:
Signature Time 1020
Printed Name Bryan Thomas Date 5/21/07
Company STL-SF

2) Received by:
Signature Joan Mullen Time 1215
Printed Name Joan Mullen Date 5-21-07
Company STLSF

3) Received by:
Signature Time
Printed Name Date
Company

Rev 06/04

LOGIN SAMPLE RECEIPT CHECK LIST

Client: ERRG

Job Number: 720-9222-1

Login Number: 9222

Question	T/F/NA	Comment
Radioactivity either was not measured or, if measured, is at or below background	NA	
The cooler's custody seal, if present, is intact.	NA	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	

STL

ANALYTICAL REPORT

Job Number: 720-9863-1

Job Description: Union - Zaar Mine

For:
Six Rivers National Forest
1330 Bayshore Way
Eureka, CA 95501

Attention: Mr. Curtis Cross

DSharma

Dimple Sharma
Project Manager I
dsharma@stl-inc.com
07/17/2007

Project Manager: Dimple Sharma

Severn Trent Laboratories, Inc.
STL San Francisco 1220 Quarry Lane, Pleasanton, CA 94566
Tel (925) 484-1919 Fax (925) 484-1096 www.stl-inc.com

EXECUTIVE SUMMARY - Detections

Client: Six Rivers National Forest Job Number: 720-9863-1

Lab Sample ID Analyte	Client Sample ID	Result / Qualifier	Reporting Limit	Units	Method
720-9863-1	**UZ S016**				
Antimony		2.1	2.0	mg/Kg	6010B
Barium		5.3	1.0	mg/Kg	6010B
Cadmium		0.52	0.50	mg/Kg	6010B
Chromium		740	10	mg/Kg	6010B
Cobalt		69	1.0	mg/Kg	6010B
Copper		30	1.0	mg/Kg	6010B
Nickel		1500	1.0	mg/Kg	6010B
Vanadium		14	1.0	mg/Kg	6010B
Zinc		23	1.0	mg/Kg	6010B
Soluble					
pH-S		6.88	0.100	SU	9045C
720-9863-2	**UZ S017**				
Antimony		2.2	2.0	mg/Kg	6010B
Arsenic		1.4	0.99	mg/Kg	6010B
Barium		6.7	0.99	mg/Kg	6010B
Chromium		760	9.9	mg/Kg	6010B
Cobalt		63	0.99	mg/Kg	6010B
Copper		35	0.99	mg/Kg	6010B
Nickel		1100	0.99	mg/Kg	6010B
Vanadium		18	0.99	mg/Kg	6010B
Zinc		21	0.99	mg/Kg	6010B
Soluble					
pH-S		7.00	0.100	SU	9045C

METHOD SUMMARY

Client: Six Rivers National Forest

Job Number: 720-9863-1

Description	Lab Location	Method	Preparation Method
Matrix: Solid			
Inductively Coupled Plasma - Atomic Emission Spectrometry	STL SF	SW846 6010B	
Acid Digestion of Sediments, Sludges, and Soils	STL SF		SW846 3050B
Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)	STL SF	SW846 7471A	
Mercury in Solid or Semi-Solid Waste (Manual	STL SF		SW846 7471A
Soil and Waste pH	STL SF	SW846 9045C	
Deionized Water Leaching Procedure (Routine)	STL SF		ASTM NONE

LAB REFERENCES:

STL SF = STL San Francisco

METHOD REFERENCES:

SW846 - "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

SAMPLE SUMMARY

Client: Six Rivers National Forest

Job Number: 720-9863-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
720-9863-1	UZ S016	Solid	07/06/2007 1055	07/10/2007 0935
720-9863-2	UZ S017	Solid	07/06/2007 1115	07/10/2007 0935

Analytical Data

Client: Six Rivers National Forest

Job Number: 720-9863-1

Client Sample ID: UZ S016

Lab Sample ID:	720-9863-1	Date Sampled:	07/06/2007 1055
Client Matrix:	Solid	Date Received:	07/10/2007 0935

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-23673	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-23623	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.00 g
Date Analyzed:	07/13/2007 0805		Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		2.1		2.0
Arsenic		ND		1.0
Barium		5.3		1.0
Beryllium		ND		0.50
Cadmium		0.52		0.50
Cobalt		69		1.0
Copper		30		1.0
Lead		ND		1.0
Molybdenum		ND		1.0
Nickel		1500		1.0
Selenium		ND		2.0
Silver		ND		1.0
Thallium		ND		1.0
Vanadium		14		1.0
Zinc		23		1.0

Method:	6010B	Analysis Batch: 720-23673	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-23623	Lab File ID:	N/A
Dilution:	10		Initial Weight/Volume:	1.00 g
Date Analyzed:	07/13/2007 1005		Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Chromium		740		10

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-23705	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-23667	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.01 g
Date Analyzed:	07/13/2007 1348		Final Weight/Volume:	50 mL
Date Prepared:	07/13/2007 0813			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.050

Client Sample ID: UZ S017

Lab Sample ID:	720-9863-2	Date Sampled:	07/06/2007 1115
Client Matrix:	Solid	Date Received:	07/10/2007 0935

6010B Inductively Coupled Plasma - Atomic Emission Spectrometry

Method:	6010B	Analysis Batch: 720-23673	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-23623	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	1.01 g
Date Analyzed:	07/13/2007 0809		Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Antimony		2.2		2.0
Arsenic		1.4		0.99
Barium		6.7		0.99
Beryllium		ND		0.50
Cadmium		ND		0.50
Cobalt		63		0.99
Copper		35		0.99
Lead		ND		0.99
Molybdenum		ND		0.99
Nickel		1100		0.99
Selenium		ND		2.0
Silver		ND		0.99
Thallium		ND		0.99
Vanadium		18		0.99
Zinc		21		0.99

Method:	6010B	Analysis Batch: 720-23673	Instrument ID:	Varian ICP
Preparation:	3050B	Prep Batch: 720-23623	Lab File ID:	N/A
Dilution:	10		Initial Weight/Volume:	1.01 g
Date Analyzed:	07/13/2007 1051		Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Chromium		760		9.9

7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)

Method:	7471A	Analysis Batch: 720-23705	Instrument ID:	FIMS 100
Preparation:	7471A	Prep Batch: 720-23667	Lab File ID:	N/A
Dilution:	1.0		Initial Weight/Volume:	0.98 g
Date Analyzed:	07/13/2007 1349		Final Weight/Volume:	50 mL
Date Prepared:	07/13/2007 0813			

Analyte	DryWt Corrected: N	Result (mg/Kg)	Qualifier	RL
Mercury		ND		0.051

Analytical Data

Client: Six Rivers National Forest Job Number: 720-9863-1

General Chemistry

Client Sample ID: **UZ S016**

Lab Sample ID: 720-9863-1
Client Matrix: Solid
Date Sampled: 07/06/2007 1055
Date Received: 07/10/2007 0935

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	6.88		SU	0.100	1.0	9045C

Anly Batch: 720-23802 Date Analyzed 07/12/2007 1415 DryWt Corrected: N

Client Sample ID: **UZ S017**

Lab Sample ID: 720-9863-2
Client Matrix: Solid
Date Sampled: 07/06/2007 1115
Date Received: 07/10/2007 0935

Analyte	Result	Qual	Units	RL	Dil	Method
pH-S	7.00		SU	0.100	1.0	9045C

Anly Batch: 720-23802 Date Analyzed 07/12/2007 1420 DryWt Corrected: N

DATA REPORTING QUALIFIERS

Client: Six Rivers National Forest

Job Number: 720-9863-1

Lab Section	Qualifier	Description
Metals		
	F	MS or MSD exceeds the control limits

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
Metals					
Prep Batch: 720-23623					
LCS 720-23623/2-A	Lab Control Spike	T	Solid	3050B	
LCSD 720-23623/3-A	Lab Control Spike Duplicate	T	Solid	3050B	
LCSSRM 720-23623/4-A	LCS-Standard Reference Material	T	Solid	3050B	
MB 720-23623/1-A	Method Blank	T	Solid	3050B	
720-9787-A-19-B MS	Matrix Spike	T	Solid	3050B	
720-9787-A-19-C MSD	Matrix Spike Duplicate	T	Solid	3050B	
720-9863-1	UZ S016	T	Solid	3050B	
720-9863-2	UZ S017	T	Solid	3050B	
Prep Batch: 720-23667					
LCS 720-23667/2-A	Lab Control Spike	T	Solid	7471A	
LCSD 720-23667/3-A	Lab Control Spike Duplicate	T	Solid	7471A	
MB 720-23667/1-A	Method Blank	T	Solid	7471A	
720-9523-A-11-K MS	Matrix Spike	T	Solid	7471A	
720-9523-A-11-L MSD	Matrix Spike Duplicate	T	Solid	7471A	
720-9863-1	UZ S016	T	Solid	7471A	
720-9863-2	UZ S017	T	Solid	7471A	
Analysis Batch:720-23673					
LCS 720-23623/2-A	Lab Control Spike	T	Solid	6010B	720-23623
LCSD 720-23623/3-A	Lab Control Spike Duplicate	T	Solid	6010B	720-23623
LCSSRM 720-23623/4-A	LCS-Standard Reference Material	T	Solid	6010B	720-23623
MB 720-23623/1-A	Method Blank	T	Solid	6010B	720-23623
720-9787-A-19-B MS	Matrix Spike	T	Solid	6010B	720-23623
720-9787-A-19-C MSD	Matrix Spike Duplicate	T	Solid	6010B	720-23623
720-9863-1	UZ S016	T	Solid	6010B	720-23623
720-9863-2	UZ S017	T	Solid	6010B	720-23623
Analysis Batch:720-23705					
LCS 720-23667/2-A	Lab Control Spike	T	Solid	7471A	720-23667
LCSD 720-23667/3-A	Lab Control Spike Duplicate	T	Solid	7471A	720-23667
MB 720-23667/1-A	Method Blank	T	Solid	7471A	720-23667
720-9523-A-11-K MS	Matrix Spike	T	Solid	7471A	720-23667
720-9523-A-11-L MSD	Matrix Spike Duplicate	T	Solid	7471A	720-23667
720-9863-1	UZ S016	T	Solid	7471A	720-23667
720-9863-2	UZ S017	T	Solid	7471A	720-23667

Report Basis

T = Total

Client: Six Rivers National Forest

Job Number: 720-9863-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
General Chemistry					
Prep Batch: 720-23627					
LCS 720-23627/1-A	Lab Control Spike	S	Solid	NONE	
720-9863-1	UZ S016	S	Solid	NONE	
720-9863-2	UZ S017	S	Solid	NONE	
720-9863-2DU	Duplicate	S	Solid	NONE	
Analysis Batch:720-23802					
LCS 720-23627/1-A	Lab Control Spike	S	Solid	9045C	
720-9863-1	UZ S016	S	Solid	9045C	
720-9863-2	UZ S017	S	Solid	9045C	
720-9863-2DU	Duplicate	S	Solid	9045C	

Report Basis
S = Soluble

Quality Control Results

Client: Six Rivers National Forest

Job Number: 720-9863-1

Method Blank - Batch: 720-23623

Method: 6010B
Preparation: 3050B

Lab Sample ID:	MB 720-23623/1-A	Analysis Batch:	720-23673	Instrument ID:	Varian ICP
Client Matrix:	Solid	Prep Batch:	720-23623	Lab File ID:	N/A
Dilution:	1.0	Units:	mg/Kg	Initial Weight/Volume:	1 g
Date Analyzed:	07/13/2007 0747			Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722				

Analyte	Result	Qual	RL
Antimony	ND		2.0
Arsenic	ND		1.0
Barium	ND		1.0
Beryllium	ND		0.50
Cadmium	ND		0.50
Chromium	ND		1.0
Cobalt	ND		1.0
Copper	ND		1.0
Lead	ND		1.0
Molybdenum	ND		1.0
Nickel	ND		1.0
Selenium	ND		2.0
Silver	ND		1.0
Thallium	ND		1.0
Vanadium	ND		1.0
Zinc	ND		1.0

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: Six Rivers National Forest

Job Number: 720-9863-1

LCS-Standard Reference Material - Batch: 720-23623

Method: 6010B
Preparation: 3050B

Lab Sample ID: LCSSRM 720-23623/4-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 0758
Date Prepared: 07/12/2007 0722

Analysis Batch: 720-23673
Prep Batch: 720-23623
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1.00 g
Final Weight/Volume: 50 mL

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Antimony	27.4	16.2	59	14 - 96	
Arsenic	22.7	21.6	95	72 - 128	
Barium	145	138	95	80 - 120	
Beryllium	1.09	0.980	90	65 - 134	
Cadmium	42.2	39.9	95	80 - 120	
Chromium	246	232	94	80 - 120	
Cobalt	65.1	66.1	102	72 - 128	
Copper	58.5	56.9	97	80 - 120	
Lead	44.1	39.8	90	75 - 126	
Molybdenum	61.0	61.8	101	62 - 138	
Nickel	96.8	91.1	94	80 - 120	
Selenium	165	157	95	80 - 120	
Silver	79.5	74.3	93	72 - 127	
Thallium	55.9	52.8	94	79 - 121	
Vanadium	56.7	56.4	99	63 - 137	
Zinc	44.0	47.8	109	75 - 125	

Calculations are performed before rounding to avoid round-off errors in calculated results.

Client: Six Rivers National Forest
Job Number: 720-9863-1

Lab Control Spike/ Lab Control Spike Duplicate Recovery Report - Batch: 720-23623

Method: 6010B
Preparation: 3050B

LCS Lab Sample ID: LCS 720-23623/2-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 0750
Date Prepared: 07/12/2007 0722

Analysis Batch: 720-23673
Prep Batch: 720-23623
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

LCSD Lab Sample ID: LCSD 720-23623/3-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 0754
Date Prepared: 07/12/2007 0722

Analysis Batch: 720-23673
Prep Batch: 720-23623
Units: mg/Kg

Instrument ID: Varian ICP
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Antimony	106	105	80 - 120	1	20		
Arsenic	103	102	80 - 120	1	20		
Barium	108	107	80 - 120	2	20		
Beryllium	102	101	80 - 120	2	20		
Cadmium	104	103	80 - 120	2	20		
Chromium	105	103	80 - 120	2	20		
Cobalt	105	103	80 - 120	2	20		
Copper	104	103	80 - 120	2	20		
Lead	104	103	80 - 120	2	20		
Molybdenum	110	110	80 - 120	0	20		
Nickel	104	103	80 - 120	2	20		
Selenium	104	103	80 - 120	1	20		
Silver	104	102	80 - 120	1	20		
Thallium	102	101	80 - 120	1	20		
Vanadium	107	105	80 - 120	2	20		
Zinc	104	102	80 - 120	2	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 720-23623

Method: 6010B
Preparation: 3050B

MS Lab Sample ID:	720-9787-A-19-B MS	Analysis Batch:	720-23673	Instrument ID:	Varian ICP
Client Matrix:	Solid	Prep Batch:	720-23623	Lab File ID:	N/A
Dilution:	1.0			Initial Weight/Volume:	1.03 g
Date Analyzed:	07/13/2007 0816			Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722				

MSD Lab Sample ID:	720-9787-A-19-C MSD	Analysis Batch:	720-23673	Instrument ID:	Varian ICP
Client Matrix:	Solid	Prep Batch:	720-23623	Lab File ID:	N/A
Dilution:	1.0			Initial Weight/Volume:	1.01 g
Date Analyzed:	07/13/2007 0820			Final Weight/Volume:	50 mL
Date Prepared:	07/12/2007 0722				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Antimony	12	12	75 - 125	6	20	F	F
Arsenic	84	92	75 - 125	10	20		
Barium	66	83	75 - 125	6	20	F	
Beryllium	88	95	75 - 125	9	20		
Cadmium	78	83	75 - 125	8	20		
Chromium	77	92	75 - 125	12	20		
Cobalt	79	85	75 - 125	8	20		
Copper	89	98	75 - 125	9	20		
Lead	79	87	75 - 125	7	20		
Molybdenum	81	88	75 - 125	10	20		
Nickel	77	86	75 - 125	9	20		
Selenium	83	90	75 - 125	10	20		
Silver	91	98	75 - 125	10	20		
Thallium	73	78	75 - 125	8	20	F	
Vanadium	82	91	75 - 125	9	20		
Zinc	70	83	75 - 125	10	20	F	

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: Six Rivers National Forest

Job Number: 720-9863-1

Method Blank - Batch: 720-23667

Method: 7471A
Preparation: 7471A

Lab Sample ID: MB 720-23667/1-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 1343
Date Prepared: 07/13/2007 0813

Analysis Batch: 720-23705
Prep Batch: 720-23667
Units: mg/Kg

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

Analyte	Result	Qual	RL
Mercury	ND		0.050

Lab Control Spike/
Lab Control Spike Duplicate Recovery Report - Batch: 720-23667

Method: 7471A
Preparation: 7471A

LCS Lab Sample ID: LCS 720-23667/2-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 1344
Date Prepared: 07/13/2007 0813

Analysis Batch: 720-23705
Prep Batch: 720-23667
Units: mg/Kg

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

LCSD Lab Sample ID: LCSD 720-23667/3-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 1345
Date Prepared: 07/13/2007 0813

Analysis Batch: 720-23705
Prep Batch: 720-23667
Units: mg/Kg

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 1 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Mercury	99	98	85 - 115	1	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 720-23667

Method: 7471A
Preparation: 7471A

MS Lab Sample ID: 720-9523-A-11-K MS
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 1352
Date Prepared: 07/13/2007 0813

Analysis Batch: 720-23705
Prep Batch: 720-23667

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 0.99 g
Final Weight/Volume: 50 mL

MSD Lab Sample ID: 720-9523-A-11-L MSD
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/13/2007 1354
Date Prepared: 07/13/2007 0813

Analysis Batch: 720-23705
Prep Batch: 720-23667

Instrument ID: FIMS 100
Lab File ID: N/A
Initial Weight/Volume: 0.99 g
Final Weight/Volume: 50 mL

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Mercury	94	92	85 - 115	1	20		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quality Control Results

Client: Six Rivers National Forest

Job Number: 720-9863-1

Lab Control Spike - Batch: 720-23802

Method: 9045C
Preparation: N/A

Lab Sample ID: LCS 720-23627/1-A
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/12/2007 1400
Date Prepared: N/A
Date Leached: 07/12/2007 0826

Analysis Batch: 720-23802
Prep Batch: N/A
Units: SU
Leachate Batch: 720-23627

Instrument ID: No Equipment Assigned
Lab File ID: N/A
Initial Weight/Volume: 50 mL
Final Weight/Volume: mL

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
pH-S	7.00	7.000	100	99 - 101	

Duplicate - Batch: 720-23802

Method: 9045C
Preparation: N/A

Lab Sample ID: 720-9863-2
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 07/12/2007 1423
Date Prepared: N/A
Date Leached: 07/12/2007 0826

Analysis Batch: 720-23802
Prep Batch: N/A
Units: SU
Leachate Batch: 720-23627

Instrument ID: No Equipment Assigned
Lab File ID: N/A
Initial Weight/Volume: 20 mL
Final Weight/Volume: mL

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
pH-S	7.00	7.010	0	20	

Calculations are performed before rounding to avoid round-off errors in calculated results.

STL

STL San Francisco Chain of Custody

1220 Quarry Lane ● Pleasanton CA 94566-4756
Phone: (925) 484-1919 ● Fax: (925) 484-1096
Email: sflogin@stl-inc.com

720-9863

Reference #: 106212

Date 7/6/07 Page 1 of 1

Report To

Attn: Curtis Cross
Company: Six Rivers NF
Address: 1330 Bayshore Way
Phone (707) 441-3506 Email: ccross@fs.fed.us
Bill To: Forest Service
Sampled By: CDC
Attn: Curtis Cross
Phone (707) 441-3508

Analysis Request

Sample ID	Date	Time	Matrix	Preserv.	TPH EPA - ☐ 8015/8021 ☐ 8260B ☐ Gas w/ ☐ BTEX ☐ MTBE	Purgeable Aromatics BTEX EPA - ☐ 8021 ☐ 8260B	TEPH EPA 8015M* ☐ Silica Gel ☐ Diesel ☐ Motor Oil ☐ Other ___	Fuel Tests EPA 8260B: ☐ Gas ☐ BTEX ☐ Five Oxygenates ☐ DCA, EDB ☐ Ethanol	Purgeable Halocarbons (HVOCs) EPA 8021 by 8260B	Volatile Organics GC/MS (VOCs) ☐ EPA 8260B ☐ 624	Semivolatiles GC/MS ☐ EPA 8270 ☐ 625	Oil and Grease ☐ Petroleum (EPA 1664) ☐ Total	Pesticides ☐ EPA 8081 ☐ 608 PCBs ☐ EPA 8082 ☐ 608	PNAs by ☐ 8270 ☐ 8310	CAM17 Metals (EPA 6010/7470/7471)	Metals: ☐ Lead ☐ LUFT ☐ RCRA ☐ Other: ___	Low Level Metals by EPA 200.8/6020 (ICP-MS): ___	☐ W.E.T (STLC) ☐ TCLP	☐ Hexavalent Chromium ☐ pH (24h hold time for H_2O)	☐ Spec Cond. ☐ Alkalinity ☐ TSS ☐ TDS	Anions : ☐ Cl ☐ SO_4 ☐ NO_3 ☐ F ☐ Br ☐ NO_2 ☐ PO_4	PH			Number of Containers
UZS016	7/6/07	1055	Sed	Ice											X							X			1
UZS017	7/6/07	1115	Sed	Ice											X							X			1

CDC

Project Info.

Project Name: Union -Zeal Mine
Project#:
PO#:
Credit Card#:

Sample Receipt

of Containers:
Head Space:
Temp: 3.3
Conforms to record:

T A T	5 Day	72h	48h	24h	Other:

Report: ☐ Routine ☐ Level 3 ☐ Level 4 ☐ EDD ☐ State Tank Fund EDF ☐ Global ID ______

Special Instructions / Comments:
Please avoid roots, large Rocks/Gravel

See Terms and Conditions on reverse

*STL SF reports 8015M from C_9-C_{24} (industry norm). Default for 8015B is C_{10}-C_{28}.

1) Relinquished by:
Signature Time 0900
Printed Name Curtis D. Cross Date 7/9/07
Company Six Rivers NF

2) Relinquished by:
Signature Time
Printed Name Date
Company

3) Relinquished by:
Signature Time
Printed Name Date
Company

1) Received by:
Signature Joan Mullen Time 9:35
Printed Name Joan Mullen Date 7-10-07
Company STL SF (TA)

2) Received by:
Signature Time
Printed Name Date
Company

3) Received by:
Signature Time
Printed Name Date
Company

Rev 06/04

LOGIN SAMPLE RECEIPT CHECK LIST

Client: Six Rivers National Forest

Job Number: 720-9863-1

Login Number: 9863

Question	T/F/NA	Comment
Radioactivity either was not measured or, if measured, is at or below background	NA	
The cooler's custody seal, if present, is intact.	NA	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	

Appendix B. Results of Bioassay Sampling

BES

BLOCK ENVIRONMENTAL SERVICES

2451 Estand Way
Pleasant Hill, CA 94523-3911
(925) 682-7200 FAX 686-0399

Whole Sediment Toxicity Testing Results for Sediment – Two One-Species Screening Bioassays

September 2007

Prepared For:
Curtis Cross
Six Rivers National Forest
1330 Bayshore Way
Eureka, CA 95501

BES Sample # 24369-70

Prepared By:
Block Environmental Services, Inc.
2451 Estand Way
Pleasant Hill, CA 94523-3911
(925) 682-7200

October 16, 2007

David Block, Ph.D.
Laboratory Director

Nanette Lake
Nanette Malan Lake
Laboratory Manager

1. INTRODUCTION

The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), the Clean Water Act (CWA) of 1977 (PL 95-217), and the Water Quality Act of 1987 (PL 100-4) explicitly state that it is the national policy that the discharge of toxic substances in toxic amounts be prohibited. Toxicity to aquatic life is one of the criteria used to gauge the hazardous potential of a discharged waste. The type of toxicity test and particular species used for testing of effluents is dictated under the framework of the National Pollutant Discharge Elimination System and falls under the jurisdiction of the local Regional Water Quality Control Board.

Block Environmental Services (BES) has conducted two sediment bioassays for Six Rivers National Forest. The testing organism of interest is the amphipod *Hyalella azteca.* The bioassay was performed using 100% test sediment (no dilution). A reference sediment was run concurrently with these bioassays. This report describes the procedures used and the results obtained for the toxicity tests initiated on September 20, 2007.

BES is an Environmental Laboratory Accreditation Program certified laboratory (#1812).

3. MATERIALS AND METHODS

3.1 SAMPLE COLLECTION AND HANDLING

3.1.1 Site Sample Collection – Sediment was collected into glass wide mouth jars and transported to the BES laboratory for testing. All samples were stored at 4 °C until time of use. Standard chain of custody documentation was used during the transportation process.

3.1.2 Reference Sediment – A formulated sediment was used for this study. This sediment consisted of 75% sand, 12.5% Kaolin, 0.5% dolomite, 11.99% α-cellulose and 0.01% humic acid.

3.2 TOXICITY TEST PROCEDURES

3.3.1 Test Procedures – A detailed procedure for each test is outlined in standard operating procedures (SOPs), which are on file at the BES laboratory. The SOPs are based upon the following reference:

- Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates (EPA/600/R-99/064).

Test conditions are summarized in Table 3-1.

3.3.2 Data Analysis – All toxicity testing results will be analyzed using the software program ToxCalc (Version 5.0). This program determines if there is a statistically significant reduction in response at the p = 0.05 level and utilizes the flowchart for statistical analysis outlined in EPA/600/4-91/002. The testing compared the sample responses with the reference control sediment. The parameters of interest for the sediment tests are the No Observed Effect Concentration (NOEC), the Lowest Observed Effect Concentration (LOEC) and the resultant Toxic Units (TU = 100/NOEC). In addition, Lethal (LC) Concentrations were calculated for reference toxicant tests. The LC values will show the point estimate of the toxicant concentration that causes a given percent reduction.

Table 3-1 Summary Of Testing Parameters by Organism

Test Conditions	*H. azteca*
Test Type	Whole-sediment toxicity test with renewal of overlying water
Temperature	23 ± 1 °C
Light Intensity	About 100-1000 lux
Photoperiod	16L:8D
Test Chamber	300 ml high form lipless beaker
Sediment Volume	100 ml
Overlying water volume	175 ml
Renewal of overlying water	2 volume additions/day
Organism Age	7-14 days (1-2 day range in age)
Organism Source	Aquatic Biosystems, Fort Collins, CO
Organisms/Chamber	10
Replicates/treatment	8
Food Source	YCT
Feeding	1 ml after am water renewal
Overlying water	Carbon Filtered Water
Aeration	None, unless DO drops below 2.5 mg/L
Reference Toxicant	KCl
Reference Toxicant Concentrations	Control, 37.5, 75, 150, 300 and 600 mg/L
Test Duration	10 days
Effects Measured	Survival & growth
Test Acceptability	≥ 80% survival, measurable growth

4. RESULTS

4.1 SAMPLE AND TESTING SUMMARY

Client Sample Identification	BES Sample #	Sample Date	Sample Time
UZBA01	24369	08/23/2007	0930
UZBA02	24370	08/23/2007	1000

4.2 SAMPLE TEST DURATION SUMMARY

Test Time	*H. azteca*	
	Date	Time
Initiation	09/20/07	0825
Termination	09/30/07	1630

4.3 *H. azteca* END POINT VALUES –

Raw Data Summary – Reference Sediment

Sample Identification	10 Day Survival	10 Day Dry Weight/Organism	
	Average (%)	Average (mg)	Std Dev.
Reference sediment	95	0.17	0.02

Raw Data Summary – UZBA01 & UZBA02

Sample Identification	10 Day Survival	10 Day Dry Weight/Organism	
	Average (%)	Average (mg)	Std Dev.
UZBA01	88	0.08	0.02
UZBA02	84	0.07	0.02

Initial weight at test initiation: 0.04mg

4.3.1 Testing Notes

As per client instruction, survival and growth of *H. azteca* exposed to UZBA02 was compared to *H. azteca* survival and growth measured in UZBA01. There were not any statistically significant reductions in the survival or growth response for the UZBA02 sample with respect to the UZBA01 sample.

The reference sediment passed the survival (≥ 80%) and growth (measurable growth) test acceptability criteria.

5. CONCLUSIONS

The objective of these tests was to satisfy the sediment one species bioassay requirements for six Rivers National Forest. The results for the sediment bioassay test indicate that:

- *H. azteca* survival and growth in the UZBA02 sample were not adversely affected when compared to the UZBA01 control.

BLOCK ENVIRONMENTAL SERVICES

10 Day Sediment Test Data Sheet

Six Rivers National Forest
Client: ~~AGI~~ NL Client Sample ID: UZBA 01, UZBA 02 Species: H. azteca Age: ~~10-12~~ 11-13 days BES #: 24369-70
Control Water: CFW Batch: NA

Initial Monitoring	Survival A	B	C	D	E	F	G	H	pH	Conductivity	Ammonia	Alkalinity	Hardness
C1	10	10	10	10	10	10	10	10	8.2	514	0.09	70	114
UZBA 01	10	10	10	10	10	10	10	10	8.0	287	ND	68	120
UZBA 02	10	10	10	10	10	10	10	10	8.1	534	0.05	78	114

Daily Monitoring	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Sample ID: C1											
D.O.	8.0	5.7	6.3	6.3	5.2		4.1	3.8	4.3	5.4	4.0
Temp.	23.2	23.5	22.4	23.0	23.0	22.2	22.1	23.5	22.0	23.0	22.0
Sample ID: UZBA 01 24369											
D.O.	8.1	6.1	6.6	6.5	5.8		4.9	4.4	4.4	6.5	6.4
Temp.	23.2	23.5	22.4	23.0	23.0	22.2	22.1	23.5	22.0	23.0	22.0
Sample ID: UZBA 02 24370											
D.O.	8.0	5.8	6.4	6.3	5.7	5.4	4.4	4.3	4.4	6.4	5.5
Temp.	23.2	23.5	22.4	23.0	23.0	22.2	22.1	23.5	22.0	23.0	22.0
AM/- Water Change/Organism Monitoring/Feeding											
Tech.	NL	NL	SH	SH	SH	SH	SH	SC	SC	SH	SH
Date	9-20-07	9-21-07	9-22-07	9-23-07	9-24-07	9-25-07	9-26-07	9-27-07	9-28-07	9-29-07	9-30-07
Time	0825	0835	0930	0830	0830	0840	0840	0900	0815	0830	0930
PM - Water Change											
Tech.	NL	NL	SH	GF	SH	SC	SC	SC	SC	SH	SH
Time	1530	1525	1530	1545	1530	~~SH~~ 1606	1615	1600	1500	1500	1630

Final Monitoring	Survival A	B	C	D	E	F	G	H	pH	Conductivity	Ammonia	Alkalinity	Hardness
C1	10	10	9	10	10	8	10	9	8.2	544	ND	66	106
UZBA 01 (24369)	8	8	9	9	7	9	~~10~~ 9	10	7.4	567	0.42	70	110
UZBA 02 (24370)	9	7	9	10	9	—	9	7	NA	NA	NA	NA	NA

Test Supervisor: Nanette Lake QA/QC Check: Kathie Evers

9-21-07 UZBA 02 rep F dropped during AM water change NL

9/27/07 - one animal returned to 24369 G after overflow from DO

BLOCK ENVIRONMENTAL SERVICES - Mysid Chronic Growth Test Data Sheet

Client: ~~AGtte~~ Six Rivers Natl. Forest Sample ID: 42BA 01 & 02 BES Sample #: 24369-70

Required Oven Temp. = 103 – 105 °C Dry Time = At least 6 hours Pan Dry @ ≤ 0.5 mg difference

Treatment		Initial Dry Weight (mg)			Final Dry Weight (mg)		
		1st Dry	2nd Dry	Dry?	1st Dry	2nd Dry	Dry?
QA/QC	1	209.2	208.9	✓	209.2	209.3	✓
	2	209.3	209.0	✓	209.3	209.4	✓
Control	1	209.0	209.1	✓	210.6	210.7	✓
	2	209.5	209.7	✓	211.4	211.6	✓
	3	209.9	209.6	✓	211.4	211.4	✓
	4	207.9	208.0	✓	209.7	209.6	✓
	5	206.7	206.7	✓	208.5	208.7	✓
	6	210.6	210.4	✓	211.8	211.9	✓
	7	208.9	209.1	✓	210.6	210.5	✓
	8	208.4	208.4	✓	210.0	210.1	✓
	1	205.8	205.9	✓	206.7	206.5	✓
	2	208.9	208.6	✓	209.5	209.4	✓
	3	210.5	210.5	✓	211.3	211.3	✓
	4	206.0	205.8	✓	206.4	206.5	✓
	5	211.5	211.5	✓	212.0	212.1	✓
	6	207.7	207.5	✓	208.5	208.7	✓
	7	210.0	210.0	✓	210.6	210.6	✓
	8	209.7	209.5	✓	210.4	210.2	✓
	1	208.7	208.9	✓	209.7	209.7	✓
	2	209.3	209.1	✓	209.8	209.7	✓
	3	209.6	209.5	✓	210.4	210.3	✓
	4	208.5	208.3	✓	209.4	209.3	✓
	5	206.9	207.1	✓	207.8	207.6	✓
	6	211.9	211.9	✓			
	7	211.8	211.9	✓	212.7	212.6	✓
	8	211.0	210.9	✓	211.5	211.4	✓
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
Tn	1	1119.3	1119.4	✓	1120.8	1120.8	✓
	2						
	3						
	4						
	5						
	6						
	7						
	8						
Technician:		NL NL	XE NL		NL NL	NL NL	
Date/Time:		9-19-07 9-28-07	9-19-07 9-28-07		9-21-07 10-1-07	9-21-07 10-1-07	

-Proportion Survived

Start Date: 9/20/2007 Test ID: 24369ha Sample ID: UZBA01
End Date: 9/30/2007 Lab ID: CABES-Block Environmental Sample Type: PR-Product
Sample Date: 8/23/2007 Protocol: EPAS 00 Test Species: HA-Hyalella azteca
Comments:

Conc-%	1	2	3	4	5	6	7	8
CI	1.0000	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	0.9000
100	0.8000	0.8000	0.9000	0.9000	0.7000	1.0000	0.9000	1.0000

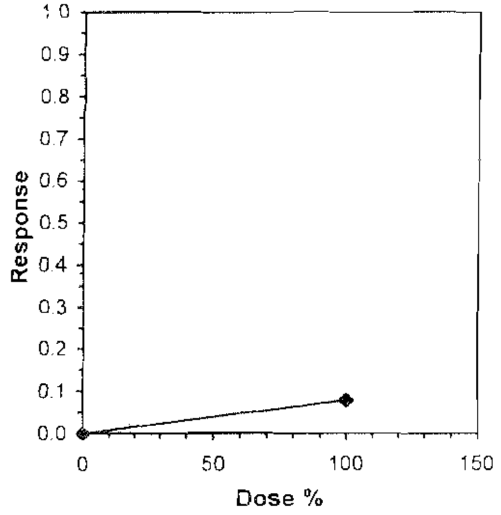
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
CI	0.9500	1.0000	1.3332	1.1071	1.4120	8.799	8				0.9500	1.0000
100	0.8750	0.9211	1.2221	0.9912	1.4120	12.140	8	1.661	1.761	0.1178	0.8750	0.9211

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.91668		0.844		-0.4194	-0.5982
F-Test indicates equal variances (p = 0.55)	1.59959		8.88531			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates no significant differences	0.06567	0.06952	0.04936	0.01789	0.11888	1, 14
Treatments vs CI						

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05*	63.333			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			

* indicates IC estimate less than the lowest concentration



Reviewed by: M

-Growth

Start Date: 9/20/2007 Test ID: 24369ha Sample ID: UZBA01
End Date 9/30/2007 Lab ID: CABES-Block Environmental Sample Type: PR-Product
Sample Date: 8/23/2007 Protocol: EPAS 00 Test Species: HA-Hyalella azteca
Comments:

Conc-%	1	2	3	4	5	6	7	8
Cl	0.1600	0.1900	0.1800	0.1600	0.2000	0.1500	0.1400	0.1700
100	0.0600	0.0800	0.0800	0.0700	0.0600	0.1200	0.0600	0.0700

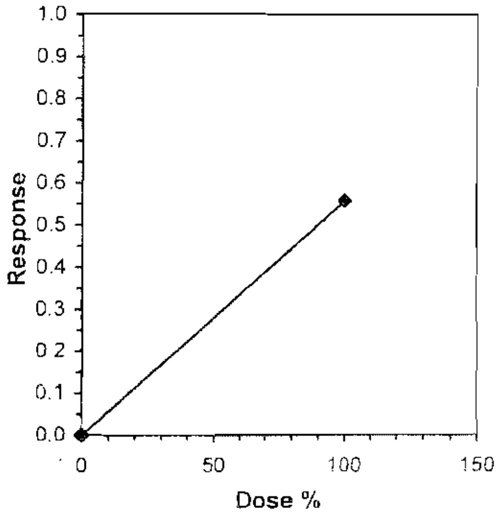
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Cl	0.1688	1.0000	0.1688	0.1400	0.2000	12.036	8				0.1688	1.0000
*100	0.0750	0.4444	0.0750	0.0600	0.1200	26.667	8	9.303	1.761	0.0178	0.0750	0.4444

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93275		0.844		0.93746	0.6206
F-Test indicates equal variances (p = 0.97)	1.03125		8.88531			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.01775	0.10519	0.03516	0.00041	2.3E-07	1, 14
Treatments vs Cl						

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	9.000	0.654	7.730	11.034	0.6299
IC10*	18.000	1.308	15.460	22.068	0.6299
IC15*	27.000	1.962	23.190	33.103	0.6299
IC20*	36.000	2.615	30.919	44.137	0.6299
IC25*	45.000	3.269	38.649	55.171	0.6299
IC40*	72.000	5.231	61.839	88.273	0.6299
IC50*	90.000				

* indicates IC estimate less than the lowest concentration



Reviewed by:

Test: AM
Species: HA-Hyalella azteca
Sample ID: UZBA01
Start Date: 9/20/2007 End Date: 9/30/2007
Test ID: 24369ha
Protocol: EPAS 00
Sample Type: PR-Product
Lab ID: CABES-Block Environmental Services

Pos	ID	Rep	Group	Initial Number	Final Number	Total Weight	Tare Weight	Weight	Weight Count	Std Dev. Surv	Std Dev. Growth	Notes
	1	1	CI	10	10	210.7	209.1	0.16	10	0.75592895	0.0203101	
	2	2	CI	10	10	211.6	209.7	0.19	10			
	3	3	CI	10	9	211.4	209.6	0.18	10			
	4	4	CI	10	10	209.6	208	0.16	10			
	5	5	CI	10	10	208.7	206.7	0.2	10			
	6	6	CI	10	8	211.9	210.4	0.15	10			
	7	7	CI	10	10	210.5	209.1	0.14	10			
	8	8	CI	10	9	210.1	208.4	0.17	10			
	9	1	100.000	10	8	206.5	205.9	0.06	10	1.03509834	0.02	
	10	2	100.000	10	8	209.4	208.6	0.08	10			
	11	3	100.000	10	9	211.3	210.5	0.08	10			
	12	4	100.000	10	9	206.5	205.8	0.07	10			
	13	5	100.000	10	7	212.1	211.5	0.06	10			
	14	6	100.000	10	10	208.7	207.5	0.12	10			
	15	7	100.000	10	9	210.6	210	0.06	10			
	16	8	100.000	10	10	210.2	209.5	0.07	10			

Comments:

Reviewed by:

-Proportion Survived

Start Date:	9/20/2007	Test ID:	24370ha	Sample ID:	UZBA02
End Date:	9/30/2007	Lab ID:	CABES-Block Environmental	Sample Type:	PR-Product
Sample Date:	8/23/2007	Protocol:	EPAS 00	Test Species:	HA-Hyalella azteca
Comments:					

Conc-%	1	2	3	4	5	6	7	8
Cl	1.0000	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	0.9000
100	0.9000	0.7000	0.9000	1.0000	0.9000	0.8000	0.7000	

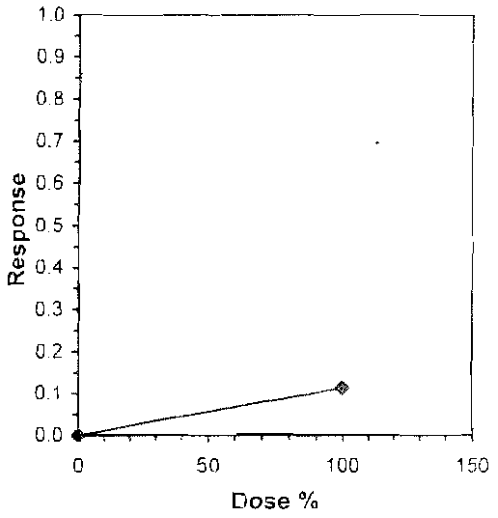
			Transform: Arcsin Square Root						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Cl	0.9500	1.0000	1.3332	1.1071	1.4120	8.799	8				0.9500	1.0000
*100	0.8429	0.8872	1.1784	0.9912	1.4120	13.181	7	2.196	1.771	0.1248	0.8429	0.8872

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.86609		0.835		-0.3632	-0.641
F-Test indicates equal variances (p = 0.48)	1.75317		9.15543			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.0703	0.07442	0.08945	0.01854	0.04681	1, 13
Treatments vs Cl						

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05*	44.333			
IC10*	88.667			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			

* indicates IC estimate less than the lowest concentration



-Growth

Start Date:	9/20/2007	Test ID:	24370ha	Sample ID:	UZBA02
End Date:	9/30/2007	Lab ID:	CABES-Block Environmental	Sample Type:	PR-Product
Sample Date:	8/23/2007	Protocol:	EPAS 00	Test Species:	HA-Hyalella azteca
Comments:					

Conc-%	1	2	3	4	5	6	7	8
Cl	0.1600	0.1900	0.1800	0.1600	0.2000	0.1500	0.1400	0.1700
100	0.0800	0.0600	0.0800	0.1000	0.0500	0.0700	0.0500	

			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Cl	0.1688	1.0000	0.1688	0.1400	0.2000	12.036	8				0.1688	1.0000
*100	0.0700	0.4148	0.0700	0.0500	0.1000	26.082	7	9.840	1.771	0.0178	0.0700	0.4148

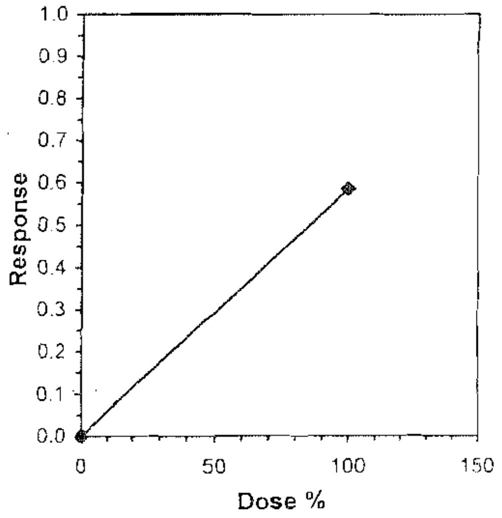
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95012	0.835	0.276	-0.9271
F-Test indicates equal variances (p = 0.81)	1.2375	10.7857		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Homoscedastic t Test indicates significant differences	0.01777	0.10531	0.03641	0.00038	2.2E-07	1, 13
Treatments vs Cl						

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	8.544	0.626	7.327	10.270	0.4369
IC10*	17.089	1.251	14.654	20.540	0.4369
IC15*	25.633	1.877	21.981	30.811	0.4369
IC20*	34.177	2.502	29.308	41.081	0.4369
IC25*	42.722	3.128	36.636	51.351	0.4369
IC40*	68.354	5.004	58.617	82.161	0.4369
IC50*	85.443				

* indicates IC estimate less than the lowest concentration



Reviewed by:

Test: AM
Species: HA-Hyalella azteca
Sample ID: UZBA02
Start Date: 9/20/2007 End Date: 9/30/2007

Test ID: 24370ha
Protocol: EPAS 00
Sample Type: PR-Product
Lab ID: CABES-Block Environmental Services

Pos	ID	Rep	Group	Initial Number	Final Number	Total Weight	Tare Weight	Weight	Weight Count	Std Dev. Surv	Std Dev. Growth	Notes
	1	1	CI	10	10	210.7	209.1	0.16	10	0.75592895	0.0203101	
	2	2	CI	10	10	211.6	209.7	0.19	10			
	3	3	CI	10	9	211.4	209.6	0.18	10			
	4	4	CI	10	10	209.6	208	0.16	10			
	5	5	CI	10	10	208.7	206.7	0.2	10			
	6	6	CI	10	8	211.9	210.4	0.15	10			
	7	7	CI	10	10	210.5	209.1	0.14	10			
	8	8	CI	10	9	210.1	208.4	0.17	10			
	9	1	100.000	10	9	209.7	208.9	0.08	10	1.13389342	0.01825742	
	10	2	100.000	10	7	209.7	209.1	0.06	10			
	11	3	100.000	10	9	210.3	209.5	0.08	10			
	12	4	100.000	10	10	209.3	208.3	0.1	10			
	13	5	100.000	10	9	207.6	207.1	0.05	10			
	14	6	100.000	10	8	212.6	211.9	0.07	10			
	15	7	100.000	10	7	211.4	210.9	0.05	10			

Comments

Reviewed by:

24369-70

AGI
TECHNOLOGIES

CHAIN-OF-CUSTODY

Date 8/23/07 Page 1 of 1

PROJECT INFORMATION

Project Manager: Curtis Cross
Project Name: Union-Zaca EECA
Project Number:
Site Location: Union-Zaca Sampled By: CDC

DISPOSAL INFORMATION

☐ Lab Disposal (return if not indicated)
Disposal Method:
Disposed by: Disposal Date:

QC INFORMATION (check one)

☐ SW-846 ☐ CLP ☐ Screening ☐ AGI Std. ☐ Special

Laboratory Number:

ANALYSIS REQUEST

					PETROLEUM HYDROCARBONS						ORGANIC COMPOUNDS								PESTS/PCBs					METALS						LEACHING TESTS				OTHER					
SAMPLE ID	DATE	TIME	MATRIX	LAB ID	WTPH-HCID	WTPH-G	WTPH-D	WTPH-418.1	8015M Fuel Hydrocarbon	TPH Special Instructions	8010 Halogenated VOCs	8020 Aromatic VOCs	8020M - BETX only	8240 GC/MS Volatiles	8270 GC/MS Semivolatiles	8310 PAHs	8040 Phenols	DWS - Volatiles and Semivolatiles	8080 OC Pest/PCBs	8080M PCBs only	8140 OP Pesticides	8150 OC Herbicides	DWS - Herb/Pest	Selected Metals: list	Organic Lead (Ca)	TCL Metals (23)	Priority Poll. Metals (13)	DWS - Metals	MFSP - Metals (W/s)	TCLP - Volatiles (ZHE)	TCLP - Semivolatiles	TCLP - Pesticides	TCLP - Metals					Survival and Growth	NUMBER OF CONTAINERS
UZBA01	8/23/07	0930	Sed																																			X	1
UZBA02	8/23/07	1000	Sed																																			X	1

LAB INFORMATION

Lab Name: Block Environmental
Lab Address: 2451 Eastand Way
Pleasant Hill CA
Via

SAMPLE RECEIPT

Total Number of Containers:	2
Chain-of-Custody Seals: Y/N/NA	
Intact?: Y/N/NA	
Received in Good Condition/Cold:	

Turn Around Time: ☒ Standard ☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 1 wk.

PRIOR AUTHORIZATION IS REQUIRED FOR RUSH DATA

Special Instructions:

RELINQUISHED BY: 1.	RELINQUISHED BY: 2.	RELINQUISHED BY: 3.
Signature Time 1000	Signature Time	Signature Time
Printed Name Curtis Cross Date 8/24/07	Printed Name Date	Printed Name Date
Company 6 Rivers NF	Company	Company

RECEIVED BY: 1.	RECEIVED BY: 2.	RECEIVED BY: 3.
Signature Time 1100	Signature Time	Signature Time
Printed Name Date 8-25-07	Printed Name Date	Printed Name Date
Company BES	Company	Company

AGI OFFICES: Bellevue: (206) 453-8383 Gig Harbor: (206) 851-5562

DISTRIBUTION: White, Canary to Analytical Laboratory, Pink to AGI Project Files, Gold to AGI Disposal Files

Appendix C. Riparian Management Standards and Statutes for Copper Creek CERCLA Mine Tailing Abatement

Riparian Management standards and statutes for Copper Creek CERCLA mine tailing abatement

Management Direction from Six Rivers LRMP and Smith River NRA Act provisions

LMP S&Gs for Minerals Management (LRMP IV-47-48)

MM-1. Require a reclamation plan, approved Plan of Operations, and reclamation bond for all minerals operations that include Riparian Reserves. Such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring disturbed areas to near pre-mining topography; isolating and neutralizing or removing toxic or potentially toxic materials; salvage and replacement of topsoil; and seedbed preparation and revegetation to meet Aquatic Conservation Strategy objectives.

MM-2. Locate structures, support facilities, and roads outside Riparian Reserves. Where no alternative to siting facilities in Riparian Reserves exists, locate them in a way compatible with Aquatic Conservation Strategy objectives. Road construction will be kept to the minimum necessary for the approved mineral activity. Such roads will be constructed and maintained to meet roads management standards and to minimize damage to resources in the Riparian Reserve. When a road is no longer required for mineral or land management activities, it will be closed, obliterated, and stabilized.

MM-3. Prohibit solid and sanitary waste facilities in Riparian Reserves. If no alternative to locating mine waste (waste rock, spent ore, tailings) facilities in Riparian Reserves exists, and releases can be prevented, and stability can be ensured, then:

a. analyze the waste material using the best conventional sampling methods and analytic techniques to determine its chemical and physical stability characteristics.

b. locate and design the waste facilities using best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials. If the best conventional technology is not sufficient to prevent such releases and ensure stability over the long term, prohibit such facilities in Riparian Reserves.

c. monitor waste and waste facilities after operations to ensure chemical and physical stability and to meet Aquatic Conservation Strategy objectives.

d. reclaim waste facilities after operations to ensure chemical and physical stability and to meet Aquatic Conservation Strategy objectives.

e. require reclamation bonds adequate to ensure long-term chemical and physical stability of mine waste facilities.

MM-4. For leasable minerals, prohibit surface occupancy within Riparian Reserves for oil, gas, and geothermal exploration and development activities where leases do not already exist. Where possible, adjust the operating plans of existing contracts to eliminate impacts that retard or prevent the attainment of Aquatic Conservation Strategy objectives.

MM-5. Salable mineral activities such as sand and gravel mining and extraction within Riparian Reserves will occur only if Aquatic Conservation Strategy objectives can be met.

MM-6. Include inspection and monitoring requirements in mineral plans, leases or permits. Evaluate the results of inspection and monitoring to effect the modification of mineral plans, leases and permits as needed to eliminate impacts that retard or prevent attainment of Aquatic Conservation Strategy objectives.

LRMP S&Gs for Watershed and Habitat Restoration

WR-1. Design and implement watershed restoration projects in a manner that promotes long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and attains Aquatic Conservation Strategy objectives.

WR-2. Cooperate with federal, state, local, and tribal agencies, and private landowners to develop watershed-based Coordinated Resource Management Plans or other cooperative agreements to meet Aquatic Conservation Strategy objectives.

WR-3. Do not use mitigation or planned restoration as a substitute for preventing habitat degradation.

The Smith River NRA Act (1990) designated Rowdy Creek (including Copper Cr – a tributary to Rowdy Cr.) as part of the Smith River Wild And Scenic System.

SEC. 10. WILD AND SCENIC RIVERS.
(a) PREVIOUS DESIGNATIONS- Previous designations dated January 19, 1990, by the Secretary of the Interior (46 Fed. Reg. 7483-84) under section 2(a)(ii) of the Wild and Scenic Rivers Act (16 U.S.C. 1273) of rivers within the exterior boundary of the recreation area are superseded by this Act.
(b) DESIGNATIONS- Section 3(a) of the Wild and Scenic Rivers Act (16 U.S.C. 1274) is amended by adding at the end thereof the following new paragraphs:
`( ) SMITH RIVER, CALIFORNIA- The segment from the confluence of the Middle Fork Smith River and the North Fork Smith River to the Six Rivers National Forest boundary, including the following segments of the mainstem and certain tributaries, to be administered by the Secretary of Agriculture in the following classes:
`(A) The segment from the confluence of the Middle Fork Smith River and the South Fork Smith River to the National Forest boundary, as a recreational river.
`(B) Rowdy Creek from the California-Oregon State line to the National Forest boundary, as a recreational river.

Recreational River S&Gs (LRMP IV-60) for Minerals include:

> Mineral activity will be conducted in a manner that minimizes surface disturbance, sedimentation, pollution, and visual impairment.

LMP Aquatic Conservation Strategy (ACS) Objectives 3, 4, and 5 relate to the mine waste deposits along Copper Creek (LRMP IV-108). These 3 Objectives

address bank and channel integrity, water quality, and sedimentation – which all relate to the impacts from the tailings sites.

ACS Objective 3.

Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

ACS Objective 4.

Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

ACS Objective 5.

Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

References

USDA Forest Service. 1995. Six Rivers National Forest land and resource management plan (Six Rivers LRMP). Pacific Southwest Region, San Francisco, CA.

Smith River National Recreation Area Act. 1990. Public Law PL-101-612.

Appendix D. Detailed Cost Estimate

APPENDIX D-1
ALTERNATIVE 2: IN-SITU STABILIZATION

COST ESTIMATE SUMMARY

Site: Union/Zaar Mine
Location: Six Rivers NF
Phase: EE/CA (-30% / +50%)
Base Year: 2007

Description: Alternative 2 consists of implementing engineering controls to stabilize the slope and prevent future erosion of waste piles into the creek. Includes lining the mine waste piles with filter fabric to prevent silt from eroding out of the waste piles and placing a layer of large rocks (rip rap) over the fabric for slope stabilization and erosion control.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilzation					
Equipment	8	TRIP	$500	$4,000	Excavators, loaders, up to 100 mi one way
Personnel	1	LS	$4,000	$4,000	Local recruitment, set up temporary lodging
Temporary Facilities & Utilities	1	LS	$1,000	$1,000	Trailers, signs, portable toilets, etc.
SUBTOTAL:				$9,000	
Site Personnel					
Site Superintendent	15	DAY	$950	$14,250	10 total work days
Operator 1	15	DAY	$800	$12,000	
Operator 2	15	DAY	$800	$12,000	
Operator 3 (truck driver)	15	DAY	$800	$12,000	
Labor 1	15	DAY	$600	$9,000	
Labor 2	15	DAY	$600	$9,000	
Site Engineer	15	DAY	$750	$11,250	
SUBTOTAL:				$79,500	
Equipment					
Long Arm CAT 225	15	DAY	$800	$12,000	
Loader John Deere 644	15	DAY	$750	$11,250	
Dozer JD700	15	DAY	$705	$10,575	
10-yard dump truck 1	15	DAY	$500	$7,500	
SUBTOTAL:				$41,325	
Site Facilities					
Trailer, Connex & toilet	3	WEEK	$1,000	$3,000	
Road Improvement	1	LS	$10,000	$10,000	
SUBTOTAL:				$13,000	
Materials and Supplies					
PPE (Level D)	15	DAY	$20	$300	
Import - rip rap	700	TON	$75	$52,500	Assume local source (within 50 mi)
Geotextile	10000	SQ FT	$0.50	$5,000	Price includes delivery
SUBTOTAL:				$57,800	
SUBTOTAL:				$200,625	
Contingency			25%	$50,156	10% scope + 15% bid
SUBTOTAL:				$250,781	
Project Management			10%	$20,063	10% of Capital Costs
Engineering Design/Permitting		LS		$70,000	Intensive design and pre-design studies
Post-Construction Submittals		LS		$10,000	
SUBTOTAL:				$100,063	
Prime Contractor Overhead			7%	$24,559	
Profit			10%	$35,084	
TOTAL CAPITAL COSTS:				**$410,487**	

OPERATION AND MAINTENANCE COSTS:

Field inspection	1	LS	$2,000	$2,000	
Minor Repair	1	LS	$7,000	$7,000	
SUBTOTAL O&M COSTS:				$9,000	
Project Management			5%	$450	
Contingency			20%	$1,890	10% scope and 10% bid
Prime Contractor Overhead			7%	$1,152	
Profit			10%	$1,134	
TOTAL ANNUAL O&M COSTS:				**$13,626**	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER	DISCOUNT FACTOR (7%)	PRESENT VALUE
Capital Cost	0	$410,487	$410,487	1.000	$410,487
Annual O&M Cost	1-10	$136,255	$13,626	7.024	$95,706
		$546,742			$506,193

TOTAL PRESENT VALUE OF ALTERNATIVE NO. 2 **$506,193**

APPENDIX D-2

COST ESTIMATE SUMARY

ALTERNATIVE 3: SOURCE REMOVAL AND ON-SITE ENCAPSULATION

Site: Union/Zaar Mine
Location: Six Rivers NF
Phase: EE/CA (-30% / +50%)
Base Year: 2007

Description: Alternative 3 consists of excavating mine waste piles from three locations along Copper Creek, constructing an on-site, encapsulated soil cell to accommodate the excavated mine waste and sediment. Includes restoring the excavated areas with on-site backfill and covering the backfilled slope with erosion mats and native plants for erosion control.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilzation					
Equipment	8	TRIP	$500	$4,000	Excavators, loaders, up to 100 mi one way
Personnel	1	LS	$4,000	$4,000	Local recruitment, set up temporary lodging
Temporary Facilities & Utilities	1	LS	$1,000	$1,000	Trailers, signs, portable toilets, etc.
SUBTOTAL:				$9,000	
Site Personnel					
Site Superintendent	30	DAY	$950	$28,500	30 total work days
Operator 1	30	DAY	$800	$24,000	
Operator 2	30	DAY	$800	$24,000	
Operator 3 (truck driver)	30	DAY	$800	$24,000	
Labor 1	30	DAY	$600	$18,000	
Labor 2	30	DAY	$600	$18,000	
Site Engineer	30	DAY	$750	$22,500	
SUBTOTAL:				$159,000	
Equipment					
Long Arm CAT 225	30	DAY	$800	$24,000	
Loader John Deere 644	30	DAY	$750	$22,500	
Dozer JD700	10	DAY	$705	$7,050	
10-yard dump truck 1	20	DAY	$500	$10,000	
SUBTOTAL:				$63,550	
Site Facilities					
Trailer, Connex & toilet	6	WEEK	$1,000	$6,000	
Road Improvement	1	LS	$10,000	$10,000	Including improvement to soil cell location
SUBTOTAL:				$16,000	
Materials and Supplies					
PPE (Level D)	30	DAY	$20	$600	
On site - Structural Fill	5000	TON	$6	$30,000	Assumes minimal creek bank restoration
Erosion Mats	10000	SQFT	$0.75	$7,500	Price include delivery
Planting Subcontractor	1	LS	$10,000	$10,000	Local subcontractor (within 100 miles)
Top Soil	1500	TON	$25.00	$37,500	Assume local source <30 miles away
SUBTOTAL:				$85,600	
SUBTOTAL:				$333,150	
Contingency			20%	$66,630	10% scope + 10% bid
SUBTOTAL:				$399,780	
Project Management			10%	$33,315	10% of Capital Costs
Engineering Design/Permitting		LS		$40,000	
Post-Construction Submittals		LS		$15,000	
SUBTOTAL:				$88,315	
Prime Contractor Overhead			7%	$34,167	
Profit			10%	$48,810	
TOTAL CAPITAL COSTS:				**$571,071**	

OPERATION AND MAINTENANCE COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Field inspection	1	LS	$2,000	$2,000	
Minor Repair	1	LS	$7,500	$7,500	Assumes minimal repair of soil cap
SUBTOTAL O&M COSTS:				$9,500	
Project Management			5%	$475	
Contingency			20%	$1,995	10% scope and 10% bid
Prime Contractor Overhead			7%	$1,223	
Profit			10%	$1,197	
TOTAL ANNUAL O&M COSTS:				**$14,390**	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER	DISCOUNT FACTOR (7%)	PRESENT VALUE
Capital Cost	0	$571,071	$571,071	1.000	$571,071
Annual O&M Cost	1-10	$143,903	$14,390	7.024	$101,077
		$714,974			$672,148

TOTAL PRESENT VALUE OF ALTERNATIVE NO. 3 **$672,148**

APPENDIX D-3

ALTERNATIVE 4: SOURCE REMOVAL AND OFF-SITE DISPOSAL

COST ESTIMATE SUMMARY

Site: Union/Zaar Mine
Location: Six Rivers NF
Phase: EE/CA (-30% / +50%)
Base Year: 2007

Description: Alternative 4 consists of excavating mine waste piles from three locations along Copper Creek, loading wastes and sediment into dump trucks, and transporting the waste to an off-site landfill for disposal. Includes restoring the excavated areas with on-site backfill and covering the backfilled slopes with erosion mats and native plants for erosion control.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilzation					
Equipment	8	TRIP	$500	$4,000	Excavators, loaders, up to 100 mi one way
Personnel	1	LS	$4,000	$4,000	Local recruitment, set up temporary lodging
Temporary Facilities & Utilities	1	LS	$1,000	$1,000	Trailers, signs, portable toilets, etc.
SUBTOTAL:				$9,000	
Site Personnel					
Site Superintendent	25	DAY	$950	$23,750	25 total work days
Operator 1	25	DAY	$800	$20,000	
Operator 2	25	DAY	$800	$20,000	
Operator 3 (truck driver)	25	DAY	$800	$20,000	
Labor 1	25	DAY	$600	$15,000	
Labor 2	25	DAY	$600	$15,000	
Site Engineer	25	DAY	$750	$18,750	
SUBTOTAL:				$132,500	
Equipment					
Long Arm CAT 225	25	DAY	$800	$20,000	
Loader John Deere 644	25	DAY	$750	$18,750	
10-yard dump truck 1	25	DAY	$500	$12,500	
SUBTOTAL:				$51,250	
Site Facilities					
Trailer, Connex & toilet	5	WEEK	$1,000	$5,000	
Road Improvement	1	LS	$13,000	$13,000	Includes improvement for off-site haul trucks
SUBTOTAL:				$18,000	
Materials and Supplies					
PPE (Level D)	25	DAY	$20	$500	
On site structural fill	5000	TON	$6	$30,000	Assumes minimal creek bank restoration
Erosion Mats	10000	SQFT	$0.75	$7,500	Price includes delivery
Planting Subcontractor	1	LS	$10,000	$10,000	Local subcontractor (within 100 miles)
Off Site Transport	10000	TON	$105.00	$1,050,000	To the nearest Class II Landfill (Up to 250 mi one-way Central Valley)
Class II Disposal	10000	Ton	$40.00	$400,000	Price includes delivery
SUBTOTAL:				$1,498,000	
SUBTOTAL:				$1,708,750	
Contingency			20%	$341,750	10% scope + 10% bid
SUBTOTAL:				$2,050,500	
Project Management			6%	$102,525	6% of Capital Costs
Engineering Design/Permitting		LS		$15,000	Minimal design (slope restoration design only)
Post-Construction Submittals		LS		$15,000	Including Disposal documentation
SUBTOTAL:				$132,525	
Prime Contractor Overhead			7%	$152,812	
Profit			10%	$218,303	
TOTAL CAPITAL COSTS:				**$2,554,139**	

OPERATION AND MAINTENANCE COSTS:

Field inspection	1	LS	$2,000	$2,000	
Minor Repair	1	LS	$1,000	$1,000	
SUBTOTAL O&M COSTS:				$3,000	
Project Management			5%	$150	
Contingency			20%	$630	10% scope and 10% bid
Prime Contractor Overhead			7%	$291	
Profit			10%	$378	
TOTAL ANNUAL O&M COSTS:				**$4,449**	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE
Capital Cost	0	$2,554,139	$2,554,139	1.000	$2,554,139
Annual O&M Cost	1-10	$44,485	$4,449	7.024	$31,246
		$2,598,624			$2,585,386

TOTAL PRESENT VALUE OF ALTERNATIVE NO. 4 **$2,585,386**