PRELIMINARY ASSESSMENT REPORT
Roba Westfall Mine Site
Malheur National Forest, Grant County, Oregon

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Principal Author and Investigator: *Douglas R. Wanta, R.P.G., Senior Geologist*

Reviewed By: *Kristine Uhlman, CGWP, CPG, Managing Geologist*
John Martin, R.P.G., Principal Geologist

Prepared For:
Mr. Charles H. Kurtz, Facilities Engineer
USDA Forest Service
Ochoco National Forest
P.O. Box 490/3160 NE 3rd Street
Prineville, Oregon 97754

Site Location:
Roba Westfall Mine
FS Road 641
Malheur National Forest
Grant County, Oregon

Prepared By:
Cascade Earth Sciences
7150 Supra Drive, SW
Albany, Oregon 97321

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EXECUTIVE SUMMARY

Cascade Earth Sciences was retained by the USDA, Forest Service, Malheur National Forest (MNF) to perform a Preliminary Assessment (PA) with limited sampling at the Roba Westfall Mine site (the Site). The Site is a historic mercury mining site in Grant County, Oregon (SW¼, SE¼ Section 6 of Township 16 south, Range 29 east, 44°12'37" latitude and 119°16'57" longitude). The site is easily accessible to the general public, although the area is used infrequently. The PA included limited sampling and analysis of several soil and waste rock samples from the Site and vicinity.

The objective of the PA at the Roba Westfall Mine was to collect sufficient information about the Site, and historical operations associated with the Site, for use by the Oregon Department of Environmental Quality (ODEQ) in completing a hazard ranking of the Site. The information was collected in general accordance with U.S. Environmental Protection Agency (EPA) *Comprehensive Environmental Response, Compensation, and Liability Act*[1] protocols and documentation requirements for preliminary site assessments involving hazardous substances.

Mercury was mined as cinnabar, a mercury sulfide (HgS) mineral. The ore was processed using a rotary retort, which was constructed in the early 1950s. The retort process involved crushing, heating, and vaporizing the ore and collecting the mercury from a condensation tube submerged in a water tank. According to records, total production was 12 flasks, or 912 pounds of mercury[2]. No production has occurred at this mine since 1953.

Surface water and groundwater are not present year round at the site, nor are groundwater wells or groundwater protection zones located near the site. Although there are a number of threatened, endangered, and sensitive species in the watershed, none exist at the mine site[3]. Due to the absence of fish in nearby Beaverdam Creek and the distance to Murderers Creek, impacts from the site to listed and proposed threatened and endangered species are not likely.

A Potential Hazardous Waste Site Preliminary Assessment Form for the Roba Westfall Mine is included (Appendix A) and the information pertinent to the form is summarized in Section 9.0 of this report, which outlines the important features of the site.

The limited sampling conducted at the site indicated that mercury and arsenic are the only metals in these samples that clearly exceed the relevant regulatory levels. The concentration of mercury in soil ranges from 1.0 to 5,500 mg/kg. Arsenic concentrations in soil and waste rock range from 3.1 to 94.5 mg/kg. The surface area of soil and waste material exceeding the EPA Region 9 Preliminary Remediation Goals (PRG) industrial level for mercury of 610 mg/kg is estimated at 21,856 ft^2. Although arsenic exceeds the PRG industrial level of 2.7 mg/kg in all areas sampled, the area exhibiting the highest concentration associated with the mill is estimated at 13,600 ft^2. Some areas considered representative of background conditions might contain high levels of mercury that are likely naturally occurring in the soil of the area. Probable pathways to human and ecological receptor exposure are inhalation of particulate matter in the air and contact with soil and waste material.

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[1]*Comprehensive Environmental Response, Compensation and Liability Act*, as amended.
[2]Brooks, H.C., 1963. Quicksilver in Oregon. Bulletin 55. Oregon Dept. of Geology and Mineral Industries.
[3]ODF&W, 2001. Personal Communication from Tim Underwagner to Doug Wanta, Cascade Earth Sciences. February 22, 2001.

Based on the record research, site reconnaissance, and limited sampling, CES recommends the following:

- Further investigation (especially at depths) is necessary to differentiate between process-related concentrations and naturally occurring background or ore related concentrations.

- Because most of the soil and waste at the site would be considered hazardous if removed from the Site during cleanup activities, as defined by the *Resource Compensation and Recovery Act of 1976*[4], remedies that involve leaving impacted soil and waste in place are recommended for further evaluation.

- Because the soil exposure pathway is complete and given the location and use of the Site, further assessment into site-specific cleanup levels is recommended.

- Because the air pathway is complete and given the location and use of the Site, further assessment into site-specific cleanup levels is recommended.

[4]*Resource Conservation and Recovery Act of 1978*, as amended.

1.0 INTRODUCTION

Cascade Earth Sciences (CES), was retained by the U.S. Forest Service (USFS), Malheur National Forest (MNF) on September 6, 2000 to perform a Preliminary Assessment (PA) with limited sampling of the Roba Westfall Mine (the Site or the Mine) in Grant County, Oregon. The Mine is a historic mercury mining site. Charlie Kurtz, P.E., of the Ochoco National Forest is coordinating the PA project. The investigation followed the U.S. Environmental Protection Agency (EPA) publication, *Guidance for Performing Preliminary Assessments Under CERCLA* (EPA, 1991). The PA included limited sampling and analysis of several soil and waste samples from the Site and vicinity.

This investigation was performed under USFS Contract Number 53-04HI-5-7740 and following the Work Plan developed by CES and approved by the USFS on October 20, 2000 (CES, 2000). The Work Plan was developed based on a preliminary site reconnaissance conducted by USFS personnel on August 5, 1996 and CES personnel on June 28, 2000.

2.0 OBJECTIVE AND SCOPE

The objective of the PA at the Roba Westfall Mine was to collect sufficient information to determine the “presence or absence” of human health and/or environmental hazards at the Site and to determine whether further environmental actions at the Site are warranted. This information, including historical operations associated with the Site, will be used by the Oregon Department of Environmental Quality (ODEQ) in completing a hazard ranking evaluation of the Site. The information was collected in general accordance with *Comprehensive Environmental Response Compensation and Liability Act* (CERCLA) protocols and documentation requirements for preliminary site assessments involving hazardous substances. This PA is not designed to determine the lateral and vertical extent or all locations and types of environmental hazards at the Site.

The scope of work for the project was based on the information requirements of the PA and the Work Plan (CES, 2000). Project activities were divided into a series of tasks associated with the PA and included the following:

- Preliminary Assessment
  - Conduct a historical site review to determine past site activities and processes that are potential sources of contamination
  - Review currently available regulatory agency records relating to the property and vicinity to identify documented releases of chemicals and determine past operating practices in handling hazardous substances and wastes related to site operations
- Site Reconnaissance and Sampling
  - Conduct a reconnaissance of the Site to identify potential areas of concern related to past practices or current conditions

- Identify and collect preliminary samples from potential areas of concern, and analyze samples for potential contaminants of concern

- Reporting:
  - Prepare a descriptive report of the findings of the preliminary assessment, reconnaissance and sampling activities

  - Complete a Potential Hazardous Waste Site Preliminary Assessment Form (Appendix A).

3.0 SITE DESCRIPTION

This section gives a specific description of the Site as well as a general description of the region; including location, climate, geology, and hydrogeology. Photographs of the Site are included in Appendix B and are referenced throughout the text.

3.1 Site Location and Description

The Roba Westfall Mine is located 1/3 mile north of the intersection of Forest Service roads (FS) 24 and FS 641 in the southwest ¼ of the southeast ¼ of Section 6, Township 16 south, Range 29 east of the Willamette Meridian (Figure 1). The Site is in Grant County approximately 17 air miles southwest of John Day, Oregon. To reach the Site, travel 17 miles south from John Day on U.S. Highway 395 to the intersection with FS 63. Turn right onto FS 63 and head west approximately 10 miles to the intersection with FS 24. Turn right onto a gravel road and head north approximately 6 miles (at 3 miles the road turns to the west) to the intersection of FS 24 and FS 641. Turn right onto FS 641 and drive north approximately 1/3 mile. The Mine is located uphill from the road to the east, and the mill is located downhill from the road to the west.

The Site encompasses an area of approximately 2.9 acres on National Forest System Land (NFSL) within the Malheur National Forest on the Bear Valley Ranger District. The Site is located at an approximate elevation of 5,260 feet above mean sea level. The site is moderately vegetated with large pines, brushes, and grasses.

The area of the former mineshaft is located near the top of the high point in the area (Photo 1). The hillside is moderately forested with large pines, sagebrush and grass undergrowth. According to USFS information, the mineshaft was bulldozed in a number of years ago (USFS, 2001a). Soil and rocks from around the former mine shaft were used to fill in the opening. To the west of the mineshaft is an ore waste pile (Photo 2). Mounds of overburden rock and soil piles surround the area. Older workings as evidenced by bulldozed trenches below the mineshaft area are covered with vegetation (Figure 2). To the east of the former mine shaft, a former road connecting to FS 24 leads to the area (Figure 2). The road may have been used to move ore to the retort for processing.

The mill area is set on a leveled area of the hillside below the mine (Photo 3). Very little remains of the former rotary retort, and it is speculated that much of the equipment was moved from the Site to another mill in the vicinity. The remaining structures present on the Site are the cement foundation of the retort (Photo 4), exhaust hood assembly and stacks from the retort (Photo 5), and various planks of wood and metal roofing from the former building on the Site (Photos 6 and 7). Only the foundation is in the original location. Other remnants are scattered about the Site. A mill access road is present to the north of the Site (Photo 7). Photo 8 (USFS, 2001b), taken in the early 1970s, shows the former building and a second mill access road located to the south. A burnt ore pile was observed immediately to the southwest of the retort foundation (Photographs 3 and 9).

The Site is situated in the southernmost reach of the Beaverdam Creek. According to the USGS topographic map, Flagtail Mountain (USGS, 1990), springs and groundwater seeps appear to be the primary source for the surface water drainage features in the lower elevations of the watershed, although none are in the immediate vicinity of the mine and mill. The nearest body of water downslope from the Site on the USGS map is Beaverdam Creek located approximately ¼ mile northwest from the Site. No other surface water drainage or water storage features were observed at the Site.

3.2 Public Use of Site and Vicinity

Public use of the Site and vicinity is most likely minimal, although public access roads are maintained near the Site. Access is currently not restricted by either fencing or posted notifications. Public access is generally limited to recreational activities such as hunting, rock collecting or firewood cutting. Timber harvesting is not extensive in the immediate area though extensive roads provide access to the area.

3.3 Climate

No climatic data is available for the immediate Site, but the town nearest to the Site, Seneca, Oregon, receives approximately 13.2 inches of precipitation and 57.8 inches of snowfall annually, with approximately 70% of precipitation occurring between November and May (WRCC, 2000). Precipitation at the Site, which is located in the forested mountain terrain and at a higher elevation, is probably somewhat higher than for Seneca. The climate is characterized by cold winters with heavy snows, and hot, dry summers. Deep snowpack accumulates in the winter. The average annual air temperature in Seneca is 40°F with daily temperatures averaging 57°F for the summer months and 32°F for the winter months (WRCC, 2000).

3.4 Geology

The Site is situated within the Blue Mountain physiographic province in northeast Oregon. The providence is typified by mountains, ice-sculpted mountain peaks, deep canyons, and broad valleys to the east and wide uplifted plateaus to the west. The providence is a cluster of smaller ranges of various origins and relief (Orr, et al., 1992). The Site is near the continental suture with accreted clusters of land masses of Permian, Triassic, and Jurassic age rocks along the late Mesozoic shoreline, which once laid across eastern Washington and Idaho. Metamorphism, volcanic activity, and intrusions joined these exotic terranes to the North American continent. The geologic block terrane, which encompasses the Site, is known as the Izee Terrane, an assemblage of Upper Triassic age layered rocks from an ancient basin between an oceanic subduction trench and volcanic islands. Rocks grouped in this terrane are limestone, mudstone, silt, and sandstone deposited in distinct shallow marine environments. In many places the rocks occur as islands surrounded by Tertiary lavas and pyroclastics (Brooks, 1963). The pre-Tertiary and Tertiary rocks are warped by large broad folds and major faults are common. Intense folding and thrust events along with intrusions of Cretaceous granitic rocks resulting in metamorphism of marine sediments, greenstones, and basic intrusives has greatly complicated the geologic interpretation of the area (Brooks, 1963).

The mercury deposit at this site occurs in the pre-Tertiary graywackes and shales mapped as Upper Triassic age (Brooks, 1963). Bedding planes of the formations strike a few degrees east of north and dip 45^{o} to 65^{o} east. Rocks in this vicinity are cut by small faults and shear zones of diverse trend, although most lie along the bedding plane (Brooks, 1963). Cinnabar occurs as disseminations in narrow gouge-filled fractures and as thin films along fractures and bedding planes. The deposit in the area is aligned in a north-south direction for approximately 1,000 feet.

The mineshaft at the Roba Westfall Mine was sunk on one of the better showings and the majority of ore extracted was from above the 25-foot level. Below the 25-foot level the intensity of fracturing, oxidation, and cinnabar mineralization decreased (Brooks, 1963). A shaft at the 60-foot level was also worked, but was reported as almost barren of cinnabar. According to Mr. Roba, cinnabar can be found fairly consistently over a large area along the ridge with localized areas giving stronger showings (DOGAMI, 1952).

3.5 Surface Hydrology and Water Quality

An assessment of nearby bodies of water located immediately downslope from the Site was investigated. According to USGS Flagtail Mountain map, the southernmost intermittent reach of Beaverdam Creek comes to within ¼ mile west of the Site (Figure 1). During the site visit in the fall 2000, no surface water was present in the apparent intermittent creek. No channel or other surface water features were present indicating water transmission during wetter times of the year. Beaverdam Creek flows 2.7 miles to the northwest where it joins the South Fork Murderers Creek. Murderers Creek flows approximately 15 miles to the west where it joins the South Fork John Day River. The John Day River System eventually joins the Columbia River, which discharges to the Pacific Ocean.

North Fork Deer Creek (Figures 1 and 2), located approximately ¼ mile to the east is separated by a ridge from the mine. This creek could only be impacted by ore transportation activities from the mineshaft to the mill area via the former road in the area (Figure 1). North Fork Deer Creek eventually drains to the south where it joins Deer Creek, which flows another approximately 15 miles to the west where it joins the South Fork John Day River. As mentioned above, the John Day River system eventually joins the Columbia River, which discharges to the Pacific Ocean.

A National Wetland Inventory prepared by the U.S. Fish and Wildlife Service (USF&WS) identified the creek as palustrine (or marsh), scrub-shrub, and seasonally flooded (USF&WS, 1995). The creek was mapped as palustrine to within ½ mile downslope of the Mine site.

3.6 Hydrogeology

Little is known about the hydrogeology of the area. Based on observations, it appears that a thin veneer of soil is present over the bedrock of the area. Soil probably thickens in the draws and bases of the canyons. The nearest source of groundwater is likely found in the bedrock below the site. It is expected that the numerous fractures and faults in the bedrock are likely to be water bearing. According to historical records, groundwater was observed 35 feet below ground surface in the mineshaft collared in the bedrock (Brooks, 1963).

3.7 Local Water Use

Based on records with the Oregon Water Resources Department, no registered water wells are located within 1 mile of the Site. Furthermore, no permanent residences are located within 4 miles of the Site (USFS, 2001a). Beneficial water use of the area is likely to be solely to provide seasonal flow to Beaverdam Creek and recharge to the regional aquifer.

3.8 Endangered and Threatened Species

The USF&WS was contacted (USF&WS, 2001) and they indicated that the listed and proposed endangered and threatened species that may be found in this forest are the Canada Lynx, Bald Eagle, and Middle Columbia River Steelhead. The only candidate species, or species under review for listing, is the Columbia spotted frog. Several species are considered species of concern because they are of concern to the agency, but further information is needed before a determination is made on their status. Species of concern for mammals include the Pale western big-eared bat, Silver-haired bat, Pacific Fisher, Small-Footed Myotis (bat), Long-Eared Myotis (bat), Fringed Myotis (bat), Yuma Myotis (bat), and California Bighorn. Species of concern for birds include the Northern Goshawk, Olive-Sided Flycatcher, Willow Flycatcher, Yellow-Breasted Chat, Lewis' Woodpecker, Mountain Quail, and White-Headed Woodpecker. Species of concern for fish include the Pacific Lamprey and Interior Redband Trout. Species of concern for plants include Wallowa Ricegrass, Upward-Lobed Moonwort, Crenulate Grape-Fern, Twin-Spike Moonwort, Stalked Moonwart, Colonial Luina, Oregon Semaphore Grass, and Arrow-Leaf Thelypody. No protection is afforded candidate species or species of concern under the Endangered and Threatened Species Act.

The Oregon Department of Fish & Wildlife (ODF&W) was contacted and they indicated that while there are Preble's shrew and goshawks in the vicinity, they are not of concern for the Site (ODF&W, 2001a). The shrew was recently delisted and the nearest documented goshawk nest is a mile away. Mid-Columbia steelhead, which is a threatened species, do run within North Fork Deer Creek (ODF&W, 2001a), which is located ¼ mile over a ridge from the Site. They also run within Murderers Creek (ODF&W, 2001b), which is a perennial stream located approximately 2.7 miles northwest of the Site. Impacts to this threatened species are unlikely due to the distance from the Site. No other endangered or threatened species are known to exist at the Mine.

A biological evaluation conducted by the USFS for a timber sale in the Deer Creek Watershed, which includes the vicinity of the Site, identified seven endangered and threatened species (USFS, 1999). The listed endangered species is the American Peregrine Falcon. Species considered threatened are the Northern Bald Eagle, Summer Run Steelhead, Fall Chinook Salmon, and Columbia River Basin Bull Trout. Sensitive species are the California Wolverine, Preble's Shrew, Townsend's Big-eared Bat, Spring Chinook Salmon, and Interior Redband Trout, Westslope Cutthroat Trout, Blue Mountain Caddisfly, Sierra Onion, Washington Monkey Flower, and Least Phacelia. Although there are a number of threatened and endangered species in the watershed, the ODF&W wildlife biologist stated that none exist at the Site (ODF&W, 2001a).

3.9 Sensitive Environments

The biological evaluation conducted for the Deer Creek Watershed indicated the Mid-Columbia River and Snake River as Evolutionary Significant Units (USFS, 1999). An Evolutionary Significant Unit (ESU) listing means the total geographic area in which the fish are listed. Surface water flow originating from the Site could reach a tributary of the Columbia River, but not tributaries of the Snake River. Because the Site is at distance from the nearest tributary to the Columbia River, impact to this sensitive environment is unlikely.

The ODF&W indicated that North Fork Deer Creek and Murderers Creek are designated critical habitats by the National Marine Fisheries Service, due to the threatened mid-Columbia steelhead (ODF&W, 2001a, 2001b). Any in-stream work on these creeks or potential impacts to water quality of these creeks would need to be addressed with the ODF&W. No other sensitive environments are known to exist near the Site.

4.0 MERCURY IN THE ENVIRONMENT

The following information is summarized from Steinnes (1990) unless specifically noted.

Mercury is among the most toxic elements to man and many higher animals, and all chemical compounds of mercury are toxic to humans. Depending on the geochemical conditions, mercury may occur in three different valency states (Hg^0, Hg_2^{2+}, and Hg^{2+}). Mercury salts show a high acute toxicity with a variety of symptoms and damages. Some organomercurials, particularly alkyl mercury compounds, are considered even more hazardous to humans because of their high chronic toxicity with respect to various, largely irreversible, defects of the nervous system.

Chloride concentration, sulfide concentration and pH are key parameters in determining the speciation found in soils. In addition to chemical reactions, transformation into methyl mercury may be mediated by microbial activity. Methyl mercury is the dominant toxic mercury species in the environment. Under naturally occurring conditions of pH and temperature in an aqueous environment, mercury in any form (organic or inorganic) has been shown to be readily converted into methyl mercury through a combination of microbially catalyzed and chemical equilibrium systems (EPA, 1976).

The primary fate of elemental mercury in the environment is thought to be adsorption onto the surfaces of particulate phases, followed by a settling into bed sediment. To a lesser degree, dissolved mercury is ingested by aquatic biota and transported by water movement. Hg^0 is also volatile, and high concentrations of Hg^0 are frequently observed in the air in the vicinity of mercury-bearing ores. Mercury is not generally available for plant uptake but will tend to accumulate in the roots.

Cinnabar is relatively resistant to the normal processes of oxidation and weathering and is extremely insoluble in water. Therefore, mercury enters the geochemical cycle from cinnabar mainly in the form of mechanically degraded particulate material. The release of mercury gas is a more important source of mercury in the geochemical cycle. Mercury is strongly fixed (adsorbed) in soils and its removal by leaching is not significant in most cases when the soil pH is greater than 4. The background concentration of mercury in surface soils in the western United States ranges from 0.01 to 4.6 mg/kg.

5.0 SITE HISTORY

5.1 Mercury Mining in Oregon

The following background information is summarized from Brooks (1963) unless specifically noted. This information is provided to help the reader understand typical mercury mining practices in the region.

5.1.1 Ore Distribution

Mercury ore (quicksilver) deposits are widely distributed in Oregon, but areas of high productivity are found in the southwest, southeast and north-central portions of the state. Cinnabar, the red mercuric sulfide (HgS), is the only mercury-bearing mineral of commercial significance in Oregon, though several other mercury-bearing minerals have been recognized in Oregon. Pure cinnabar contains 86% mercury and 14% sulfur. It can be identified by its vermilion red color, hardness (2.5), and high specific gravity (8.10). It crystallizes in hexagonal crystals; however, well-formed crystals of appreciable size are rare.

Mercury deposits are associated with ascending hydrothermal solutions related to subsurface magma bodies. The deposition of cinnabar is thought to take place in alkaline environments, such as Tertiary and Quaternary age volcanic rocks. Mercury-bearing minerals form near the surface, and most of the world's mercury has come from depths of less than 1,000 feet. Oregon's deposits conform to this. Some ore bodies have yielded little or no ore from depths greater than 100 feet. Mercury deposits are formed at lower temperatures and pressures than the majority of most other metals formed from residual magmatic solutions. This accounts for the small amount of metallic minerals other than cinnabar in mercury deposits.

Mercury is a silver-white, mobile, highly conductive, liquid metal at room temperature, solidifying to a malleable solid at -38.8°C, beginning to vaporize at 356.7°C, and boiling at 580°C. It has a specific gravity of 13.6 at 0°C and is slightly volatile at ordinary temperatures. Its solubility in water at 25°C is 0.28 µmole/liter. Mercury forms alloys (amalgams) with most metals except iron.

5.1.2 Mercury Production

Mercury production is measured by the number of flasks produced; each flask contains 76 pounds of mercury. Most of the mercury that enters the market is about 99.9% pure. The production of mercury from Oregon mines through 1970 was approximately 108,000 flasks (Brooks, 1971). Five mines in Douglas, Lane, Jefferson, and Malheur counties produced approximately 103,500 flasks. The five mines are the only mines within the state that produced more than 1,000 flasks. More than 60 other mines in the state have produced between 1 and 1,000 flasks.

Mercury was first discovered in Oregon about 1852 in Jackson County, but the first record of production was 50 flasks in 1882 from mines in Douglas County. Mercury production in Oregon reached its peak during the early 1940s. This peak and other smaller peaks that followed were all triggered by the demand for strategic metals during periods of war and conflict (Brooks, 1963). From 1936 through 1944, Oregon ranked second only to California in annual production. As of 1963, the reserves minable under the economic conditions have been virtually exhausted; however, should the economic climate become favorable, Oregon could produce substantial amounts of mercury.

5.1.3 Ore Extraction and Processing

Mines may be either open pit or subsurface mines. The relatively shallow nature of most cinnabar deposits lends itself to open pit mining.

The production of metallic mercury, the end product of cinnabar mining operations, is a relatively straightforward process that involves a series of steps beginning with the removal of ore from the mine and ending with the condensation of mercury vapors. The initial steps in ore processing include crushing and screening to optimize the size of the material and to increase recovery of mercury during retorting. Mercury ore was roasted at temperatures above the boiling point of mercury (580°C) in a retort (Figure 3) to transform the mercury into a vapor. Retorting is a batch process where the ore is heated indirectly in closed container that is intermittently charged and discharged manually. Oil, coal, gas, or wood may be used as fuel for retorts.

Retorts are generally small, comparatively inexpensive to install and manual intensive. Due to manual operation, costs to operate are higher compared to the more common rotary furnace. Retorts are used at small mines where the ore bodies are of high grade but the ore bodies are too small and widely distributed to supply feed economically for the continuous operation of a furnace, or where the quantity of ore available is considered too small to amortize the cost of constructing a furnace.

Retorts commonly consist of either cylindrical or D-shaped iron castings placed singly or in sets over a fire chamber. The entire assemblage is enclosed in firebrick or other masonry (Figure 3). Retorts can be one or two pipes for the D-shaped retorts to 12 or more pipes for the cylindrical or pipe retorts. The D-shaped pipes range from 20 to 24 inches across, 10 to 15 inches in height, and 6 to 12 feet long. Cylindrical pipes are usually 10 to 12 inches in diameter and 7 to 9 feet long. The condensing assemblage typically consists of a cast iron pipe, one end that is attached to the end of the retort and the other end terminating in a water tank used to collect mercury. The D-shaped cross-section is installed horizontally with the flat side down allowing for ease in inserting and removing rectangular pans in the retort. The cylindrical pipes are sloped at 30 to 45 degree angles to discharge burnt ore at the bottom. Figure 3 illustrates the general layout of a D type retort and pipe retort, although it should be recognized that there are many different variations to each.

Volatile gases released from the ore are passed to the condenser, through a pipe submerged in the water tank, scrubbed by the water, and then discharged to the atmosphere. Because oxygen is not used in the retort, lime is added to combine with the sulfur to form calcium sulfide and calcium sulfate, which liberate the mercury. The liquid mercury is then collected, filtered, and placed into flasks. Without lime application, the sulfur would attack the iron to form iron sulfide. One byproduct of this process was sulfuric acid. Calcines (burnt ore) were manually discharged to a burnt ore pile near the retort opening. Furnace dumps (or burnt ore piles) would have been associated with each mill location. Figure 3 illustrates the general layout of D type and cylinder type retorts. Typical retorts process 300 to 500 pounds of ore per tube every 12 hours. Cylindrical pipes have capacities of 200 to 300 pounds per tube in 12 hours.

A third variation used at several mines in central Oregon was the revolving retorts, commonly referred to as the Champion rotary retort. The rotary retort consists of an iron cylinder 8 feet long and about 30 inches in diameter, mounted on trunions and rotating within a masonry shell. The condenser pipe is connected to the retort by means of a stuffing box. Processing capacity is about 800 pounds every 6 hours. These rotary retorts shorten the roasting period and are therefore more economical in fuel consumption. They create dust however, and this can cause trouble in operation. An illustration of a rotary retort could not be found, although it is similar in design to the pipe retort pictured in Figure 3.

5.2 Mining at the Roba Westfall Mine

The information presented in this section is summarized from Brooks (1963) unless specifically noted. The Site (also known as Deer Creek Prospect) was first discovered in 1947 by Lawrence Roba of Canyon City, Oregon. Little or no work was done until 1951 when claims were staked. Most of the processing took place in the early 1950s. A retort was installed and ore processing began in 1951.

The main shaft is 125 feet deep with side drifts at 25, 60, and 120 feet. The rock in which the collar is installed is fractured and could be unstable. Before the shaft was filled in, groundwater stood in the shaft to within 35 feet of the collar. All of the ore processed from this mine was extracted above the 25-foot depth. Records from the mining operation indicate that it was difficult to separate the overburden material form the ore, and that the overall processing system lacked efficiency.

The ore was hoisted from the shaft and spilled down a steep surface to a 35-ton coarse ore bin. The ore was crushed and washed through a 2-ft x 6-ft trammel with 3/16-inch perforations. The screened material was diverted to settling vats. The ore was processed in a 30-inch by 8-foot, ½-ton, Champion-type rotary retort that was obtained from the Bear Creek Mine in Jefferson County, Oregon. Records by N.S. Wagner (DOGAMI, 1952) reported substantial efficiency problems resulting from the washing, screening, and retorting. Total production from the mine has been estimated at 9 flasks (684 lb) and up to a possible 12 flasks of mercury. No production has occurred since 1953. According to State Bureau of Land Management office electronic records, the last active claim was located in September 2, 1982 by Precious Minerals Unlimited.

6.0 ENVIRONMENTAL AGENCY RECORDS REVIEW

Recent EPA and ODEQ environmental lists were reviewed to help identify recognized environmental conditions in connection with the Site. For this review, primary records were obtained from Environmental Data Resources (EDR, 2000). The approximate minimum required search distance (MSD) for the Site vicinity is noted under each database listed below with target property (TP) representing the Site itself. The list date for each record is behind the name in parentheses. The EDR report and supporting documentation is included in Appendix C. A summary of the database information and regulatory records review is included in the following sections.

6.1.1 Federal Database Information

<u>NPL (current as of 6/13/00)</u> (MSD=1.0 mile)

The National Priorities List (NPL) is the EPA's database of uncontrolled or abandoned hazardous waste sites identified for priority remedial action under the Superfund Program (CERCLA – *Comprehensive Environmental Response, Compensation, and Liability Act*). To be included on the NPL, a site must either meet or surpass a predetermined Hazard Ranking System score, be chosen as a state's top-priority site, or meet all three of the following criteria: (1) the U.S. Department of Health and Human Services issues a health advisory recommending that people be removed from the site to avoid exposure; (2) the EPA determines that the site represents a significant threat; and (3) the EPA determines that remedial action is more cost-effective than removal action. Review of the NPL database did not reveal any hazardous waste sites within a 1.0-mile radius of the Site.

<u>Delisted NPL (current as of 6/13/00)</u> (MSD=1.0 mile)

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425(e), sites may be deleted from the NPL where no further response is appropriate. Review of the Delisted NPL List did not identify any facilities within a 1.0-mile radius of the Site.

<u>CERCLIS List (current as of 4/16/00)</u> (MSD=0.5 mile)

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list is a compilation by the EPA of sites that the EPA has investigated or is currently investigating for a release or threatened release of hazardous substances pursuant to the 1980 Superfund Act. The CERCLIS database did not list any release sites within a 0.5-mile radius of the Site.

CERC-NFRAP (current as of 4/16/00) (MSD=0.25 mile)

The Comprehensive Environmental Response, Compensation, and Liability Information System – No Further Remedial Action Planned (CERC-NFRAP) list is a compilation by the EPA of sites where no contamination was found, was removed quickly or was not serious enough to require Superfund Action or NPL consideration. Review of the database did not identify any facilities within a 0.25-mile radius of the Site.

CORRACTS Report (current as of 4/20/00) (MSD=1.0 mile)

The EPA's Corrective Action Report (CORRACTS) identifies hazardous waste handlers with RCRA corrective action activities. Review of the database did not reveal any CORRACTS facilities within a 1.0-mile radius of the Site.

RCRIS - TSD Facilities (current as of 6/21/00) (MSD=0.5 mile)

The EPA's Resource Conservation and Recovery Information System (RCRIS) provides selective information on sites that generate, transport, store, or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act of 1976 (RCRA). The TSD Facilities database is a compilation by EPA of reporting facilities that treat, store, or dispose of hazardous waste. Review of the database did not reveal any TSD facilities within a 0.5-mile radius of the Site.

ERNS Database (current as of 8/8/00) (MSD=TP)

The Emergency Response Notification System (ERNS) database contains more than 25,000-spill records and stores information on reported releases of oil and hazardous substances. The database is compiled from reports made to federal authorities, including the EPA, the U.S. Coast Guard, the National Response Center, and the Department of Transportation. A search of the database did not reveal any reported releases at the Site.

CONSENT (date of version not available) (MSD=1 mile)

The EPA's Superfund (CERCLA) Consent Decrees lists major legal settlements that establish responsibility and standards for cleanup at NPL sites. A search of the CONSENT database (no date listed) did not reveal any records within 1.0-mile of the Site.

ROD (current as of 1/31/99) (MSD=1.0 mile)

The Record of Decision (ROD) documents mandates a permanent remedy at an NPL site containing technical and health information to aid in the cleanup. A search of the ROD database did not reveal any record for facilities within 1.0-mile of the Site.

FINDS (current as of 10/13/99) (MSD=TP)

The Facility Index System (FINDS) is a cross-reference compilation of properties and facilities that the EPA has investigated, reviewed, or been made aware of in connection with its various regulatory programs. FINDS provides cursory facility information and references other sources/databases that contain more detailed information for that listing. A search of the FINDS database did not reveal any records for the Site.

HMIRS (current as of 6/30/99) (MSD=TP)

The Hazardous Materials Information Reporting System (HMIRS) contains hazardous material spill incidents reported to the Department of Transportation. A search of the HMIRS database did not reveal any records for the Site.

MLTS (current as of 4/23/00) (MSD=TP)

The Material Licensing Tracking System (MLTS) is maintained by the Nuclear Regulatory Commission (NRC) and contains a list of approximately 8,100 sites that posses or use radioactive materials that are subject to NRC licensing requirements. A search of the MLTS database did not reveal any records for the Site.

MINES (current as of 8/1/98) (MSD=1.0 mile)

The Mines Master Index File (MINES) identifies mines that were listed as active or open since 1971. Review of the MINES database did not identify any facilities within a 1.0-mile radius of the Site.

NPL Liens Database (current as of 10/15/91) (MSD=TP)

The National Priorities List (NPL) Liens database is a compilation of liens filed by the EPA against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. A search of the NPL Liens database did not reveal any records for the Site.

PADS (current as of 1/1/00) (MSD=TP)

The PCB Activity Database System (PADS) identifies generators, transporters, commercial storers and/or brokers and disposers of polychlorinated biphenyl's (PCB's) who are required to notify the EPA of such activities. A search of the PADS database did not reveal any records for the Site.

RAATS (current as of 4/17/95) (MSD=TP)

The RCRA Administrative Actions Tracking System (RAATS) tracks and records RCRA Section 3008 Compliance Orders and Orders on Consent for the Office of Waste Programs Enforcement (EPA). A search of the RAATS database did not reveal any records for the Site.

TRIS (current as of 12/31/97) (MSD=TP)

The Toxic Chemical Release Inventory System (TRIS) identifies facilities that release toxic chemicals to the air, water and land in reportable quantities under the Superfund Amendment and Reauthorization Act, Title III Section 313. A search of the TRIS database did not reveal any records for the Site.

TSCA List (current as of 12/31/98) (MSD=TP)

The Toxic Substance Control Act (TSCA) list identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory. It includes data on production volume of these substances by plant site. A search of the TSCA database did not reveal any records for the Site.

6.1.2 State Database Information

ECSI System (current as of 8/16/00) (MSD=1.0 mile)

The Environmental Cleanup Site Information System (ECSI) records information about sites in Oregon that may be of environmental interest. The database is maintained by the DEQ and contains sites considered to be actually or potentially contaminated and presenting a possible threat to human health and the environment. These sites are generally listed by the state to warn the public or as a part of an investigation and cleanup program managed by the state. The ECSI list did not identify any facilities within a 1.0-mile radius of the Site.

Solid Waste Facilities List (current as of 7/1/00) (MSD=0.5 mile)

The Solid Waste Facilities List typically contains an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA subtitle D Section 4004 criteria for solid waste landfills or disposal sites. Review of the solid waste facility database did not identify any facilities within a 0.5-mile radius of the Site.

LUST List (current as of 3/20/00) (MSD=0.5 mile)

The Leaking Underground Storage Tank (LUST) list is a collection of known or suspected releases of petroleum products from underground storage tanks. The LUST database did not identify any facilities within a 0.5-mile radius of the Site.

Registered Underground Storage Tank List (current as of 6/1/00) (MSD=0.25 mile)

The Registered Underground Storage Tank (UST) list is a compilation of underground storage tanks registered with the DEQ. The UST database did not identify any facilities within a 0.25-mile radius of the Site.

Spills (current as of 5/31/00) (MSD=TP)

The DEQ maintains a database of reported spill sites that includes facilities with a confirmed release that the DEQ has determined to require further investigation, removal, remedial action, or related long-term environmental or institutional controls. Again, the spill database provides detailed release characteristics and is organized based on the cleanup status. Review of the spill database did not identify any facilities in the vicinity of the Site.

CRL (current as of 6/21/00) (MSD=1.0 mile)

The Confirmed Release List (CRL) is a compilation maintained by the DEQ of ECSI facilities with confirmed releases. The CRL provides detailed information of confirmed release characteristics and is organized based on the status of the cleanup. Review of the CRL database did not identify any facilities located within a 1.0-mile radius of the Site.

VCS Program (current as of 8/2/00) (MSD=0.5 mile)

The DEQ maintains a database of facilities that have entered into the state sponsored voluntary cleanup program (VCS) for the remediation of confirmed spill sites. A review of the VCS database did not identify any facilities within 0.5-mile of the Site.

Hazmat Incident Listing (current as of 3/27/00) (MSD=TP)

The Hazmat Incident Listing is a comprehensive inventory of all hazmat responses reported to the Oregon Office of State Fire Marshal. The listing did not identify any entries within the vicinity of the Site.

HSIS (current as of 3/27/00) (MSD=TP)

The State Fire Marshal's Office list of companies in Oregon submitting the Hazardous Substance Information Survey (HSIS) and either reporting or not reporting hazardous substances. A review of the HSIS database did not reveal any facility names in the vicinity of the Site.

6.1.3 Unmappable Facilities

Unmappable facilities are facilities that present some level of environmental risk that cannot be geocoded but can be located by zip code or city name. The EDR report identified the following seven unmappable facilities for the area:

Orphan Site	**Location**
• Dry Creek Oil Spill	10S/33E/S24
• Anderson's Chevron Diesel Spill	Hwy 26 Milepost 182.5
• Crane Prairie Work Center	Crane Prairie – Malheur National Forest
• Valley Sanitation	Section 20 Township 13S Range 31E
• Retherford's	Section 21 Township 13S Range 31E
• Canyon City	Section 36 Township 13S Range 31E
• Seneca Landfill	P.O. Box 208 97873

Based on a cursory review of County maps and discussions with the USFS, none of the facilities appear to be in the vicinity of the Site.

6.1.4 Additional Regulatory Inquiries

Former Manufactured Gas (Coal Gas) Sites (date of version not available) (MSD=1.0 mile)

EDR maintains a proprietary database for coal gas sites. Review of the database did not identify any facilities within a 1.0-mile radius of the Site.

7.0 SITE RECONNAISSANCE

The purpose of the site reconnaissance was threefold. First, it was conducted to determine whether or not a release of a hazardous substance(s) to the environment is occurring or has occurred at the Site. Second, it was to make a preliminary determination whether or not the Site poses an imminent or substantial threat to human health and the environment. Third, the site reconnaissance was performed to provide sufficient information so that the ODEQ can perform a preliminary scoring of the Site using the hazard ranking system (HRS) criteria.

The reconnaissance included a complete walkover of the mine and processing facility at the Roba Westfall Mine. It also included a limited amount of sampling at several areas of potential concern. The sampling was not intended to characterize both the vertical and horizontal extent of contamination at the Site.

7.1 Mine Site Reconnaissance

On October 24 and 25, 2000, CES performed a reconnaissance of the Mine, including the mine shaft area and the ore processing area (Figure 2). CES also walked through the forest surrounding the Site for evidence of waste disposal or other mining activities. The following observations were recorded during that visit.

The area of the former mineshaft is located near the top of the high point in the area (Photo 1). The hillside is moderately forested with large pines, sagebrush and grass undergrowth. According to USFS information, the mineshaft was bulldozed in a number of years ago (USFS, 2001a). Soil and rocks from around the former mine shaft were used to fill in the opening. To the west of the mineshaft is an ore waste pile (Photo 2). Mounds of overburden rock and soil piles surround the area. Older workings as evidenced by bulldozed trenches below the mineshaft area are covered with vegetation (Figure 2). To the east of the former mine shaft, a former road connecting to FS 24 leads to the area (Figure 2). The road may have been used to move ore to the retort for processing.

The mill area is set on a leveled area of the hillside (Photo 3). Very little remains of the former rotary retort, and it is reported that much of the equipment was moved from the Site to another mill in the vicinity. The remaining structures present on the site are the cement foundation to the retort (Photo 4), exhaust hood assembly and stacks from the retort (Photo 5), and various planks of wood and metal roofing from the former building on the site (Photos 6 and 7). Only the foundation is in the original location. Other remnants are scatter about the site. A mill access road is present to the north of the site (Photo 7). Photo 8 (USFS, 2001b), taken in the early 1970s, shows the former building and a second mill access road located to the south. No evidence remains of the washing trammel and crusher, which were located near the base of the ore waste pile mentioned in early records of the site (see Section 5.2 above). A burnt ore pile was observed immediately to the southwest of the retort foundation (Photographs 3 and 9).

No surface water was observed within ¼ mile of the Site. There was no evidence of a water well at the Site. Except for the clearing where the retort was situated, the area surrounding the former mill is moderately forested with pines and sparse undergrowth (Photos 10 and 11).

8.0 SAMPLE COLLECTION AND ANALYSIS

As part of the PA, a total of 12 soil and waste samples were collected and analyzed to further evaluate the potential for impact to the Site. The samples collected for this project were grab samples from several potential areas of concern. The samples were collected and analyzed according to the protocols established in the Work Plan prepared by CES and submitted to the Forest Service on October 13, 2000.

8.1 Methods and Protocols

8.1.1 Sample Collection

Initially, sampling activities began with a reconnaissance to verify that planned sample locations were appropriate and accessible. Based on the reconnaissance, the following modifications were made to the sampling locations:

- Sample RW-S1, which was to be collected beneath the area presumed to be the dust collector and condenser tray, was not collected from this area because this equipment is not used for this type of mill. Instead, a soil sample was collected immediately north of the foundation (Photo 12) where the likely spot for the water tank used for mercury collection would have been located.

- Sample RW-S2, which was to be collected from the native soil below the presumed location of the crushed ore hopper, was not collected from this area because based on the layout of the Site, it could not be determined where and if crushing occurred. Therefore, a soil sample was collected 30 feet north of the retort to determine the lateral extent of impacts in the retort area (Photo 12). Information on ore crushing as discussed in Section 5.2 was not discovered until after the Site reconnaissance.

- Sample RW-WS3, which was to be collected from the area presumed to be the conveyer/crushing system, was actually collected from waste material 20 feet north of the foundation (Photo 12). Based on the layout of the Site, it could not be determined if and where crushing occurred. Therefore, a sample was collected from waste material approximately 20 feet north of the foundation to define the lateral extent of impacts in the retort area. Information about washing and crushing as discussed in Section 5.2 was not discovered until after the Site reconnaissance.

All sampling equipment, including trowels, augers, and buckets, was washed between samples with fresh water, laboratory grade soap, a dilute nitric acid rinse, and a final rinse with distilled water. Samples were placed in laboratory cleaned glass jars, properly labeled and placed in a cooler chilled to 4°C, custody sealed, and shipped overnight under chain-of-custody to ACZ Laboratories, Inc. in Steamboat Springs, Colorado.

Field notes are included in Appendix D and photographs in Appendix B. Sample locations are shown on Figure 4.

8.1.2 Sample Analysis

All of the samples were shipped on October 26, 2000 to ACZ Laboratories, Inc. for analysis according to Tier II analysis and reporting protocols. The samples were received at the laboratory on October 27, 2000. The complete analytical report, including the QA/QC results, is included in Appendix E.

All of the samples were analyzed for 13 metals on the EPA Priority Pollutant List by EPA method 6000/7000 series. This method gives the total concentration of each metal in the sample. In addition, each of the samples was analyzed for saturated paste pH and percent solids.

8.2 Results and Discussion

The following sections discuss relevant regulatory goals and results from the limited sampling conducted at the Site. Discussion of results includes those samples collected by the USFS in August 1996 (USFS, 1996) for greater understanding of the extent and degree of contaminant impacts known at the Site.

The relevant regulatory criteria discussed in the following section is for soil and waste material. Waste material is defined as waste ore, burnt ore, crushed rock, mill equipment, and timber used for the mill structures. The term “waste” is not a label for hazardous waste. A discussion of whether the soil or waste material is considered hazardous waste is included in Section 8.2.1.

8.2.1 Relevant Regulatory Criteria

Applicable or Relevant and Appropriate Requirements (ARARS) have not been established for the Site and were beyond the scope of this project. However, the EPA preliminary remediation goals can serve as a guide for evaluating the analytical results of the samples collected from the Site.

Risk-based standards set by EPA Region 9 are referred to as the Preliminary Remediation Goals (PRGs). These are risk-based concentrations for the Superfund/RCRA programs, derived from standardized equations combining exposure information assumptions with EPA toxicity data. They are considered by the EPA to be protective for humans (including sensitive groups), over a lifetime. However, PRGs are not always applicable to a particular site and do not address non-human endpoints such as ecological impacts. PRGs are commonly used for site screening and as initial cleanup goals or as tools for identifying initial cleanup goals at a site, and calculated levels based on residential and industrial scenarios. Industrial PRG standards are shown in Table 1. To apply the industrial standards, a site must meet the following three criteria:

1. The site is planned and zoned for industrial use;

2. Uses of the property and uses of properties within 100 meters of the contaminated area are industrial uses or are other uses where the Department concurs that the exposure is limited and thus does not warrant application of the residential standard; and

3. Appropriate institutional controls (e.g. deed restrictions, restrictive covenants, environmental hazard notices, etc.) will be in force.

An industrial standard for the Roba Westfall Mine is appropriate until a more site-specific risk assessment is performed. The Site could be occupied under the Mining Law given the proper USFS approval (36 CFR 228, Subpart A). However, residential occupation is considered unlikely. The industrial soil cleanup levels are based on a daily exposure of 8 hours per day, 5 days per week. This Site is not currently occupied on a regular basis and may not be occupied for extensive periods. Therefore, the risk of long-term exposure to contaminants at the Site is low.

Another set of standards that could apply to any waste generated at the Site is the Hazardous Waste Rules. Waste material on the Site, such as the burnt ore, could be a hazardous waste as defined under the *Resource Conservation and Recovery Act of 1976* (RCRA). Soil excavated from the Site may also be considered a hazardous waste if it exceeds the RCRA standards. However, the waste was generated pre-RCRA (1976) and is not subject to RCRA and its exemptions. During a cleanup, the soil is not a hazardous waste until such time that it is relocated or otherwise reclassified as a hazardous waste. As it currently exists on the Site, it is not defined as a waste.

8.2.1.1 Total Metals

Results of samples collected from the Site indicated that most of the 13 priority pollutant metals analyzed were present at the Site in concentrations indicative of native soils or at elevated concentrations typical of a mine site. Antimony and beryllium were almost absent in concentrations above the laboratory method detection limit. As would be expected for a mercury mine and mill, mercury was present in all of the samples collected and indicated the widest range of concentrations from 1.0 to 5,500 mg/kg (Table 1). Arsenic, thallium, and selenium were also quite variable. All other metals fell within a fairly limited range and were generally near the range for the corresponding metal analyzed in the background samples.

8.2.1.2 Arsenic

Arsenic was detected in all of the samples collected from the Site. Concentrations ranged from 3.1 to 94.5 mg/kg, with background soil samples between a concentration range of 3.3 to 13.6 mg/kg. All samples were above the PRG industrial standard for arsenic of 2.7 mg/kg. However, excluding the sample collected from the burnt ore area (94.5 mg/kg), all of the other samples are within or near the background range for the site (Table 1).

The higher concentrations of arsenic in the burnt ore are likely a metal of an associate mineral of the cinnabar ore body. The most common of the arsenic minerals is arsenopyrite (FeAsS), which is found associated with many types of mineral deposits, especially those including sulfide mineralization (Alloway, 1990).

Concentrations of arsenic in background samples are likely due to weathering of the local geology of the area. Background levels in soils reported in the engineering evaluation of the Mother Lode Mine site had values as high as 10.7, 12.5, 16.9, and 29.2 mg/kg with a geometric mean of 4.4 mg/kg for 16 values (CES, 1997). Arsenic concentrations in soil across the state of Oregon can vary from 1.1 to 12 mg/kg, and average 5.1 mg/kg (DEQ, 1996). Within the United States, arsenic can range from 1 to 40 mg/kg with most being in the lower half of this range (Alloway, 1990). Mean values for finer grained argillaceous and metamorphic argillaceous rocks, which are the dominant rocks of the area, average 10 to 15 mg/kg (Alloway, 1990). The very high concentrations of arsenic (over 90 mg/kg) found in the burnt ore are probably due to the enrichment processes associated with milling the ore

8.2.1.3 Mercury

Mercury was detected in all the samples collected from the Site with concentrations ranging from 1.0 to 5,500 mg/kg (Table 1). The highest concentrations detected from non-background samples were found in the ore waste pile near the mineshaft (5,500 mg/kg), soil 6 feet south (2,140 mg/kg) and 6 feet north (910 mg/kg) of the retort, and the burnt ore (625 to 886 mg/kg). All of these areas exceeded the PRG industrial standard of 610 mg/kg. Low concentrations of mercury were indicated in the soil on the hillside north of the mill (54.1 mg/kg), soil downslope of the burnt ore tailings (54 mg/kg), soil 30 feet north of the retort (17 mg/kg), and waste material inside the retort foundation (4.1 mg/kg).

Background samples indicated a very wide range from 1 mg/kg to 3,600 mg/kg. The sample at 3,600 mg/kg was collected from an undisturbed vegetated area on the hillside south, upslope, and between the ore waste pile and the mill area (Figure 4). The elevated background sample is from an area with a stand of trees exceeding the age of the mining activities of the area. In addition, it is across a trough at a higher elevation than the base of the ore waste pile. Based on this, the elevated mercury concentration is likely from the occurrence of the cinnabar ore body, which traces in a north-south direction for nearly 1,000 feet across the local ridge (Brooks, 1963). The cinnabar occurrences have been discovered in this area by panning and test pitting (Brooks, 1963), indicating that the ore is near the surface. As discussed in Section 3.4, Mr. Roba reported that cinnabar is found fairly consistently over a large area along the ridge. This location may be one of those enriched areas.

Although a TCLP analysis test was not conducted on these samples, total constituent analysis can be used to determine whether a material may be considered hazardous (EPA, 2001). Given that the material is 100% solid, the total result can simply be divided by 20 to convert the total results into the maximum leachable concentration. Using this calculation, maximum leachable mercury concentrations for samples collected from the Site range from 0.05 to 275 mg/l. The TCLP standard for mercury is 0.2 mg/l, or, any total concentration that exceeds 4 mg/kg could qualify the material as a characteristic hazardous waste if removed from the Site as a remediation waste subject to RCRA cleanup rules.

Based on the soil sampling and Site reconnaissance, the surface area of disturbed soil at the ore waste pile and retort area (includes burnt ore pile) exceeding the PRG industrial level of 610 mg/kg is estimated at 21,856 ft^2. The estimated surface area is based on the limited sampling conducted, knowledge of the operation and layout of the mill, and judgement about how metal and ore impacted soil may have been distributed across the area. The surface area of soil with elevated mercury concentrations on the south hillside, which does not appear to be influenced by site activities, could not be determined without further assessment and is assumed to be an outcrop of the ore body.

The concentrations of the total metals in all the samples along with the applicable regulatory standards are summarized in Table 1.

8.2.2 Saturated Paste pH

A saturated paste pH analysis measures the pH of the soil water or leachate extract from a soil sample. Saturated paste pH is used to determine the acidity/alkalinity of the soil. If the soil becomes too acidic, below approximately pH 6.0, metals that are in the soil may become soluble and leach into the groundwater.

Saturated paste pH ranged from 5.7 to 7.3 standard units (std. units). The samples collected from the soil and waste were nearly the same at 6.3 and 6.2. Soil and waste were less acidic (6.3 std. units) on average compared to the samples collected from background locations (6.1 std. units). Saturated paste pH values for collected samples are summarized in Table 1.

Because mercury-laden soil and waste material are not highly acidic, the potential for leaching metals to groundwater is low.

8.2.3 Percent Solids

The percent solid analysis indicated that solids accounted for the majority of the weight of the sample ranging from 83.3 to 91.3%. Little difference was noted on water content between soil and waste. Percent solid values for collected samples are summarized in Table 1.

9.0 PRELIMINARY ASSESSMENT

A Potential Hazardous Waste Site Preliminary Assessment Form for the Roba Westfall Mine is included in Appendix A. The information pertinent to the PA form is summarized in this section.

9.1 General Information

The site is known as the Roba Westfall Mine site. In the past it has been called the Deer Creek Prospect. It is located in the Malheur National Forest in Grant County Oregon on FS 641 approximately 1/3 mile north of the junction of Forest Service roads FS 24 and FS 641. The site coordinates are 44°12'37" latitude and 119°16'57" longitude. The approximate size of the Site is 2.9 acres or 125,000 ft^2.

9.2 Site and Waste Characteristics

The predominant land uses of the area are forests, fields and mining. The area is rural and the distance to the nearest dwelling is approximately 4 miles. Mercury was mined and processed at the Site between 1950 and 1953. The owners of the operation are no longer present and the Site has been inactive since mining ceased.

Mine waste and mine-contaminated media are present at the Site and accessible to the general public. The burnt ore pile, ore waste pile, contaminated soil and equipment appear to be the sources of contamination at the Site. Metal contamination, particularly mercury is the concern for this Site. Determination of the full nature and extent of contaminants present at the Site is beyond the scope of a Preliminary Assessment.

9.3 Groundwater Pathway

According to the water well record database maintained by the Oregon Water Resources Department, no water wells exist within 4 miles of the Site. Also, as noted in Section 9.2, no dwellings are located closer than 4 miles to the Site. Therefore the possibility of non-registered water wells located near the Site is very low. Based on this information, it can be assumed that groundwater is not used for drinking within 4 miles of the Site. For these same reasons, it is assumed that a designated wellhead program area is not located within 4 miles of the Site.

It is possible that groundwater may exist in the colluvial material above the bedrock, which thickens in the draws and bases of the canyons. However, given that the Site is near a ridge top and can be quite dry during the long, warmer summer and early fall months, shallow groundwater is not likely to be present year-round. It is likely that groundwater, if present, is likely to be greater than 10 feet below ground surface in the bedrock below. Given the highly insoluble nature of mercury, soil pHs primarily above 6.0, and intermittent groundwater, transport by groundwater for all practical purposes is unlikely and considered an incomplete pathway.

9.4 Surface Water Pathway

Perennial surface water does not occur near the Site. The nearest perennial surface water body, Murderers Creek, is approximately 2.7 miles downslope to the northwest via intermittent Beaverdam Creek. Murderers Creek eventually drains to the South Fork John Day River at approximately 15 miles to the west. No evidence of surface water runoff (i.e. staining or distressed vegetation) was present below the Site. Since no evidence of surface water runoff was observed, surface water is presumed not to be a complete pathway.

9.5 Soil Exposure Pathways

Soil and waste material containing concentrations of mercury and arsenic above the listed PRG levels have been identified on the Site. However, there are currently no residents or workers on the Site.

The Roba Westfall Mine would qualify for the industrial standards if appropriate institutional controls were in force. The industrial soil cleanup levels are based on a daily exposure of 8 hours per day, 5 days per week. This Site is not currently occupied on a regular basis and may never be occupied for extensive periods. Therefore, the risk of long-term exposure to contaminants at the Site is low. However, because mercury impacted soil and waste is at the surface where humans and ecological receptors could be exposed, the soil exposure pathway is complete. Given the location and use of the Site, further assessment into site-specific levels is recommended.

9.6 Air Exposure Pathways

Mercury was likely released to the air during processing as vapors and as dust and particulate matter. Currently, the most likely air pathway is due to inhalation of particulate matter. As with soil exposure, this pathway is complete because mercury impacted soil and waste material is at the surface where humans and ecological receptors could be exposed through particulate matter. Given the location and use of the Site, further assessment into site-specific levels is recommended.

10.0 QUALITY ASSURANCE AND QUALITY CONTROL

Standards were maintained during sampling and analysis to ensure that data generated for the assessment meet data quality objectives outlined in *Data Quality Objectives for Remedial Response Activities, Development Process* (EPA, 1987). All laboratory and field data met EPA Level II Quality Assurance/Quality Control (QA/QC) standards. The following sections detail QA/QC.

10.1 Field QA/QC

10.1.1 Accuracy

Accuracy is a measure of the closeness of the measured value to the "true value." It is a function of techniques and procedures that minimize sampling and analytical error. The accuracy in the field was maintained by field personnel by following the sampling procedures outlined in the Work Plan (CES, 2000). Duplicate samples were collected as required by the Work Plan.

Many of the metals analyzed in the original and duplicate samples indicated values that were more than 10% apart (Table 2). Large variation in concentrations within soil samples is expected due to the nature of the ore body and how the material has been mixed and spreading mining operations. The metal indicating the largest difference was mercury, which also proved to be quite variable across the Site (Table 1). Arsenic and nickel also indicated a large percent difference, which can be variable across mine sites. The accuracy of values for metals not normally associated with the ore body, such as beryllium, zinc, copper and chromium, were as expected. Most of the other differences exceeding 10% were due to the range of small values just over the method reporting limit. A summary of QA/QC is shown in Table 2.

No concerns with the accuracy of the sampling and analytical procedures were identified; therefore, no corrective actions were deemed necessary.

10.1.2 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average values.

A field duplicate sample was collected for each medium sampled (waste material and soil). The sample was split from another predetermined sample as indicated in the Work Plan (CES, 2000). This split sample was submitted as a blind split sample using a false sample number. The true identity of the blind split sample was recorded on field note sheets.

Each sample was labeled using an indelible marker with the following information:

- Project Number
- Unique Sample Identification
- Sample Location
- Sample Depth (if applicable)
- Sampling Date and Time
- Name(s) of Individual(s) Collecting Samples.

No problems were encountered for field precision; therefore, no corrective actions were deemed necessary.

10.1.3 Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid measurements.

To ensure completeness, all samples were duplicates (i.e., two samples were obtained for each designated sampling location). In complying with precision requirements, one duplicate sample for each medium sampled for analysis was randomly designated as a blind field duplicate. If the blind duplicate were damaged or tampered with, the duplicate from another location was designated as a blind field duplicate.

All necessary samples were collected in the field, received by the laboratory, and analyzed by the laboratory. No other problems with field completeness were encountered. Corrective actions were not necessary and therefore none were taken.

10.1.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration of distribution of the chemical compounds in the matrix sampled. The sampling plan design, standard operating procedures, sampling techniques, and sample handling protocols (e.g., storage, preservation, and transportation) have been developed to ensure the collection of representative samples. Representativeness of the data from samples collected as part of this investigation was provided by the sampling methods outlined in the Work Plan (CES, 2000).

All specified sampling protocols were followed. No problems were encountered in obtaining representative samples during the investigation conducted at the Site. Corrective actions were not necessary and therefore none were taken.

10.1.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Sampling protocols and QA/QC procedures ensured the newly developed data was comparable to earlier sampling activities at the Site. Standard reporting units ensured comparability with previous studies mg/kg (ppm) was used for all soil and waste samples.

Data collected in the field such as depths, heights, and distances were verified for correct and consistent units. No problems were identified in units of measure of data collected from the field. Corrective actions were not necessary and therefore none were taken.

10.2 Laboratory QA/QC

The laboratory followed requirements for analysis and reporting under the EPA Level II protocols (EPA, 1987), including, laboratory blanks, laboratory duplicates, matrix spikes and matrix spike duplicates. All samples were analyzed within the holding times specified for the individual analytical procedure. All values between the minimum detection level (MDL) and the practical quantitation limit (PQL) were noted on the laboratory analytical reports. Analytical reports were reviewed to determine that all spikes, duplicates and lab blanks were within acceptable limits. Based on the review the following concerns were identified.

- Matrix spikes for antimony and some of the matrix spikes for arsenic, cadmium, and thallium were out of control limits. All of the corresponding analytical spikes were within control limits. Therefore, many of these values are reported as estimated due to matrix interference. The laboratory could not determine the cause of the matrix interference, although a typical explanation could be high concentrations of other metals in the sample, such as mercury.

- Laboratory control samples were reported as out of control limits for silver. These values were also estimated. The laboratory could not determine the cause of control samples being out of limits, although a typical explanation could be high concentrations of other metals in the sample, such as mercury.

- Many of the MDLs and PQLs were raised to levels above those listed in the Work Plan due to high concentrations of a particular metal in the sample. Upon further examination, none of the affected MDLs and PQLs were raised to levels above the relevant regulatory limits (refer to Section 8.2.1).

No problems were encountered for any of the other analyses performed.

11.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the foregoing assessment, CES has developed the following conclusions.

1. According to the water well record database maintained by the Oregon Water Resource Department, no water wells exist within 4 miles of the Site. Also, no dwellings are located closer than 4 miles to the Site. Based on this, groundwater is assumed not to be used for drinking within the vicinity of the Site. Beneficial water use of the area is likely to be solely to provide flow to Beaverdam Creek and recharge the regional aquifer.

2. In the summer and fall 2000, no surface water was present (even intermittent) near the Site. North Fork Deer Creek, located over the ridge top approximately ¼ mile to the east, could only be impacted by past ore movement activities on a former access road. No other surface water or springs were noted near the Site.

3. Based on Site observations, it is possible that groundwater may exist in the colluvial material above the bedrock, which thickens in the draws and bases of the canyons. However, given that the Site is near a ridge top and the Site can be quite dry during long the warmer summer and early fall months, shallow groundwater is not likely to be present year-round beneath the Site.

4. Review of federal, state, and other records did not identify any recognized environmental conditions within the specified search distances from the Site.

5. Although there are a number of threatened, endangered, and sensitive species in the watershed, the ODF&W wildlife biologist states that none exist at the mine site (ODF&W, 2001). In addition, due to the absence of fish in Beaverdam Creek and the distance from the Site to Murderers Creek, impacts to listed and proposed threatened and endangered species are not likely.

6. The ODF&W indicated that Murderers Creek is designated a critical habitat by the National Marine Fisheries Service, due to the threatened mid-Columbia steelhead. The biological evaluation conducted for the Deer Creek Watershed indicated that the Mid-Columbia River as an Evolutionary Significant Unit. Because the mine site is at distance from the nearest tributary (Beaverdam Creek) to the listed river, impact to this sensitive environment is unlikely.

7. Arsenic was detected in all of the samples (including background samples) collected from the Site. Concentrations ranged from 3.1 to 94.5 mg/kg, above the listed PRG industrial standards (2.7 mg/kg). However, if the sample collected from the burnt ore is excluded, the arsenic

concentrations are within or near the levels indicated in the background samples. The source for the arsenic in the burnt ore is likely a metal of an associate mineral of the cinnabar ore body. The lower concentrations of arsenic in the samples collected may be naturally occurring and derived from weathering of the local geology of the area.

8. Mercury was detected in all the samples collected from the Site. Concentrations of mercury ranged from 1.0 mg/kg in soils to 5,500 mg/kg in the ore waste pile. Several sample locations exceed the PRG industrial standard. 9The highest concentrations of mercury were identified near the mineshaft and mill area with levels exceeding the industrial PRG standard of 610 mg/kg. Specific areas are those associated with mill processing and the ore body outcrop.

9. The background sample (RW-S4) collected from the south hillside indicated high concentrations of mercury at 3,600 mg/kg. This mercury is due to the occurrence of cinnabar along the ridge of the area. *Quicksilver in Oregon* (Brooks, 1963) reports that the cinnabar deposit is aligned in a north-south direction for approximately 1,000 feet across the ridge, which would be near where the sample was collected. Furthermore, Mr. Roba reported that cinnabar can be found fairly consistently over a large area along the ridge, with localized areas giving stronger showings (DOGAMI, 1952).

10. Based on the soil sampling and Site reconnaissance, the surface area of soil, burnt ore, and waste ore exceeding the PRG industrial level of 610 mg/kg is estimated at 21,856 ft^2.

11. Because metal contaminated soil and waste rock material are not highly acidic, the potential for leaching metals to groundwater is low.

12. Mercury was likely released to the air in the past during processing as vapors and particulate matter. Currently, the most likely air pathway may be due to inhalation of dust and soil particulate matter.

13. Mercury and arsenic have completed exposure pathways for soil and waste at the site.

CES recommends the following:

1. To satisfy OAR 340-122-045(2)(e) (DEQ, 1997), the vertical and horizontal extent of elevated mercury contamination sources should be conducted. Further investigation (especially at depths) is recommended to differentiate between process-related concentrations and naturally occurring background or ore body concentrations.

2. Any remedy for the Site should consider that soil or waste rock with elevated mercury and arsenic concentrations that is removed from the Site would likely be considered a characteristic hazardous waste as defined under RCRA. Remedies, which involve leaving impacted soil and waste in place, are recommended for further evaluation.

3. Given the highly insoluble nature of mercury, soil and waste pHs primarily above 6.0, and intermittent, shallow groundwater, transport by groundwater for all practical purposes is

unlikely and considered an incomplete pathway. Further investigation into the groundwater pathway is not recommended.

4. No evidence was found that would suggest that intermittent flow of surface water has transported contaminants from the site, indicating that surface water is not a likely complete pathway. Further investigation into the surface water pathway is not recommended.

5. Although the mine waste and soil is present at the Site and is accessible to the general public, this Site is not currently occupied on a regular basis and may not be occupied for extensive periods. Therefore, the risk of long-term exposure to contaminants at the Site is low. However, the soil exposure pathway is nonetheless complete and, given the location and use of the Site, further assessment into site-specific risk levels is recommended.

6. Currently, the most likely air pathway is due to inhalation of particulate matter. As with soil exposure, this pathway is complete and, given the location and use of the Site, further assessment into site-specific risk levels is recommended.

12.0 LIMITATIONS

The data presented in this report is intended only for the purpose, location, and project indicated. The conclusions presented in this report are based on the assumption that Site conditions do not change from those observed during our investigation and as described in this report. This report is not a definitive study of the nature and extent of contamination and should not be interpreted as such. This report was prepared for the Malheur National Forest, and is accurate to the best of CES' knowledge and belief. This report is based, in part, on unverified information supplied to CES by third-party sources. While efforts have been made to substantiate this third party information, CES cannot guarantee its completeness or accuracy. CES staff participating in this PA are engineers and scientists, not attorneys. Therefore, it must be clear to all parties that this report does not offer any legal opinion, representation, or interpretation of environmental laws, rules, regulations, or policies of federal, state, or local government agencies.

CASCADE EARTH SCIENCES

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Douglas R. Wanta, R.P.G.
Senior Geologist

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TABLES

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APPENDICES

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Appendix B.	**Photo Documentation**
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Appendix A.

Potential Hazardous Waste Site Preliminary Assessment Form

Appendix B.

Photo Documentation

Appendix C.

EDR Report

Appendix D.

Field Notes

Appendix E.

Laboratory Reports