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REFERENCE 13

Ecology & Environment Inc., March 21, 2006, *Black Butte Mine, Removal Assessment Report, TDD: 06-01-0005,* prepared for the U.S. Environmental Protection Agency, 134 pages.

REFERENCE 3

Black Butte Mine Site
Removal Assessment Report
Lane County, Oregon
TDD: 06-01-0005

Ecology and Environment, Inc.
Contract: EP-S7-06-02
March 21, 2006

Region 10

START-3

Superfund Technical Assessment and Response Team

Submitted To: Marc Callaghan, On-Scene Coordinator
United States Environmental Protection Agency, Region 10
811 SW Sixth Avenue
Portland, Oregon 97204

00001

BLACK BUTTE MINE
REMOVAL ASSESSMENT REPORT
LANE COUNTY, OREGON

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LIST OF ACRONYMS

Acronym	Abbreviation
BBM	Black Butte Mine
bgs	below ground surface
CSM	Conceptual Site Model
DQO	data quality objective
DUP	duplicate
E & E	Ecology and Environment, Inc.
EPA	United States Environmental Protection Agency
GPS	Global Positioning System
J	estimated quantity
Lumex	Lumex mercury analyzer
MASC	Maximum Allowable Soil Concentration
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
µg/g	micrograms per gram
µg/l	micrograms per liter
MS	matrix spike
NOAA	National Oceanic & Atmospheric Administration
NRWQC	National Recommended Water Quality Criteria
ODEQ	Oregon Department of Environmental Quality
OSU	Oregon State University
OSC	On-Scene Coordinator
PA	Preliminary Assessment
PEL	probable effects level
ppm	parts per million
PRG	Preliminary Remediation Goal
QA	quality assurance

LIST OF ACRONYMS (CONTINUED)

Acronym	Abbreviation
QC	quality control
RA	Removal Assessment
RPD	relative percent difference
SI	Site Inspection
SLV	Level II Screening Level Values
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
SquiRT	Screening Quick Reference Table
SSSP	site-specific sampling plan
START	Superfund Technical Assessment and Response Team
TAL	Target Analyte List
TEL	threshold effects level
TMDL	Total Maximum Daily Load
UJ	estimated quantity
USFWS	United States Fish and Wildlife Service
XRF	X-Ray Fluorescence Analyzer

1. INTRODUCTION

In May 2005, the United States Environmental Protection Agency (EPA), Region 10, Office of Environmental Cleanup, tasked Ecology and Environment, Inc. (E & E), under the Superfund Technical Assessment and Response Team (START)-2 contract No. 68-S0-01-01 to conduct a removal assessment (RA) at the Black Butte Mine site in Lane County, Oregon, under the Technical Direction Document No. 05-04-0005. The Oregon Department of Environmental Quality (ODEQ) requested the EPA conduct an RA at the Black Butte Mine site in July 2004 for this phase of work.

The Black Butte Mine (BBM) is a former mercury mine located in southern Lane County, Oregon. Brooks (1963) lists the BBM as Oregon's fourth largest producer of mercury. The BBM was identified in recent Total Maximum Daily Load (TMDL) investigations (ODEQ 2003) as a significant contributor of mercury to sediment and fish tissue in Cottage Grove Reservoir, located approximately six miles downstream of BBM. Cottage Grove Reservoir, and the main stem of the Willamette River, the nation's 13th largest watershed, are water quality limited for mercury, and the Oregon Department of Human Services has issued health advisories to limit consumption of fish harvested from the watershed due to elevated mercury concentrations in fish tissue. The Willamette River also is home to several threatened or endangered species.

2. SITE DESCRIPTION AND HISTORY

This section presents the BBM site location and description (Subsection 2.1); physical setting (Subsection 2.2) including topography, geology, and hydrology; operations and site ownership history (Subsection 2.3); and previous investigations (Subsection 2.4).

2.1 SITE LOCATION AND DESCRIPTION

The BBM is located in southern Lane County, in the Coast Fork Willamette River basin, approximately 10 miles south of Cottage Grove, Oregon off London Road (Figure 2-1). The BBM site is on the northwest flank of Black Butte. The legal description of the site location is Section 6, Township 23 South, Range 3 West, Willamette Meridian. Access to the site is restricted by a locked gate; however, a dirt road leading onto the site from London Road crosses private property (Pooler residence). Michael Pooler currently lives at the entrance to the site. Mr. Pooler was a former site worker at the BBM .

The primary features of the site include mine waste piles consisting of waste rock and mill tailings; a former mill structure containing a rotary kiln, mercury condenser, and ore storage/crushing equipment (New Furnace Area); another mill and furnace area (Old Ore Furnace); several old dilapidated buildings; a system of unimproved roads; and mine adits (Figure 2-2).

The Main Tailings Pile is a relatively flat area below the New Furnace Area and is flanked to the northeast by Dennis Creek. A mine access road leads from the Pooler's residence up to and over the Main Tailings Pile and continues up beyond the "404" Adit. Tailings in the Main Tailings Pile commonly consist of gravel-sized material with lesser amounts of fine- to sand-sized material. Tailings on the northeast edge of the tailings pile dip steeply to the northeast toward Dennis Creek (Appendix A, Photo 1-12). The former mill structure containing a rotary kiln is located in the New Furnace Area (Appendix A, Photo Numbers 1-9 through 1-11).

Remnants of a second waste pile exist to the northwest of the Old Ore Furnace. This area is flanked by Furnace Creek to the southwest. The Old Ore Furnace is shown in Appendix A, Photo Numbers 1-1 through 1-4. Materials in this area are finer grained than in the Main Tailings Pile. The "404" Adit is located upgradient of the Old Ore Furnace and New Furnace Area. Ore from the "404" Adit historically was transported to the Old Ore Furnace via a tramway. The Dennis Creek Adit is located upgradient of the New Furnace Area. Ore historically was transported from the Dennis Creek Adit to the

New Furnace Area via a railway (Figure 2-2). Seven adits have been identified in unpublished work completed by ODEQ. Four or more of these adits are located topographically upgradient of the "404" Adit.

2.2 PHYSICAL SETTING

This subsection describes the topography, geology, and hydrology at and near the BBM site.

2.2.1 Topography

The elevation of the BBM site is between approximately 1,080 and 2,420 feet above mean sea level. The site is characterized by steep slopes leading down from Black Butte to the surrounding creeks (Dennis Creek, Furnace Creek, and Garoutte Creek). The slopes become more gentle and the land surface is relatively flat in the Main Tailings Pile area. Waste rock/tailings in the Main Tailings Pile adjacent to Dennis Creek are very steep, at their angle of repose. Topographically downgradient of the Old Ore Furnace, tailings also show steep slopes down to Furnace Creek.

2.2.2 Geology

In southwestern Oregon, mercury mineralization, or the conversion of mercury to mercury ore, is scattered within a belt 20 to 25 miles wide extending from the vicinity of BBM in southern Lane County through Douglas and Jackson Counties, in the southern Coast Range, to the California border. The BBM and Bonanza mines are responsible for about one-half of Oregon's historic mercury production (Brooks 1963).

The BBM and surrounding vicinity is underlain by a sequence of hydrothermally altered mercury-bearing andesitic lavas, silicic ash tuff, and volcanic breccias belonging to the late Eocene-early Oligocene Fisher Formation (Tertiary). Locally, these deposits have been injected by sills, plugs, and feeder dikes of Pliocene, Miocene, and possibly Oligocene age basalt and andesite. The BBM is developed along a normal fault that is exposed on the summit of Black Butte and in the underground mine workings. The mercury ore deposit, which consists primarily of cinnabar, a mercury sulfide mineral, appears to have formed along this fault, thought to be the primary conduit for ascending hydrothermal solutions (Schuette 1938).

2.2.3 Hydrology

Dennis Creek and Furnace Creek are the main drainages in the BBM area. Smaller unnamed creeks drain into Dennis Creek from the area topographically upgradient of the Main Tailings Pile. Dennis Creek borders the northeast side of the mine area and flows westward into Garoutte Creek, approximately 0.25 miles downstream of BBM. The Main Tailings Pile fronts approximately 600 feet of Dennis Creek, and mine tailings are located within 30 feet of the creek bed.

Furnace Creek, an intermittent stream, borders the southwest side of the mine area. The creek also flows into Garoutte Creek. Furnace Creek is adjacent to the Old Ore Furnace Area. Waste rock/tailings are in contact with the creek.

Garoutte Creek flows northward approximately six miles to the Coast Fork Willamette River, which empties into Cottage Grove Reservoir, a reservoir used extensively for recreational activities including contact recreation (i.e. swimming, canoeing, and scuba diving) and fishing.

The aquifers in the vicinity of the mine are the Fisher Formation (bedrock aquifer) and the alluvial aquifer along Dennis Creek, Garoutte Creek, and the Coast Fork Willamette River. Depth to groundwater and hydraulic conductivity of these aquifers at the mine site are unknown. Well logs in the vicinity of the mine indicate that the shallowest depth to water-bearing strata in bedrock is 29 feet below ground surface (bgs). Local groundwater gradients are unknown but are likely toward the streams. The nearest spring is London Springs, located approximately four miles north of the site. Its source, use, and quality are unknown.

2.3 OPERATIONS AND SITE OWNERSHIP HISTORY

2.3.1 Operators

The BBM was first operated in the late 1890s. The mine operated intermittently through the late 1960s, with peak production occurring during the period from 1927 to 1943. Between the years 1900 and 1957, a total of 16,904 flasks of elemental mercury were produced at the mine (one flask equals 76 pounds).

Mercury-bearing ore was extracted from underground workings and transported to the surface via light rail cars. The primary ore mineral at the site was cinnabar, a mercuric sulfide. Minor amounts of metacinnabar (another form of mercuric sulfide) and elemental mercury also were present in the ore (Brooks 1971). Ore was crushed in preparation for processing. The crushed ore was roasted in a kiln to volatilize the mercury. The resulting mercury vapor then was condensed and liquid mercury was bottled for shipment. A flotation process, in which crushed ore is processed to concentrate the ore mineral(s)

prior to roasting, reportedly was used between 1916 and 1919 (Brooks 1971). Two ore processing areas have been identified as described above, the New Furnace Area and the Old Ore Furnace. The dates of operations of the different areas are not known.

Processed ore from the ore milling operations were deposited downhill, mainly toward the north, from the mill areas. Ore reportedly was re-processed in 1943 (Brooks 1971), apparently because the roasting process used prior to 1943 left appreciable quantities of mercury behind in the waste.

2.3.2 Site Ownership History

The BBM was discovered by S. P. Garoutte in 1890 and a 40-ton-per-day Scott-Hutner furnace was installed at the site. In 1897, the Quicksilver Mining Company took over the property until 1909, when the mine was closed due to depressed mercury prices. During that period of operation, the capacity of the furnace was increased and 15,000 feet of development work was completed (Brooks 1963).

In 1916, the BBM was reopened, under the management of Earl B. Crane, by a New York-based company. A flotation unit and a redesigned Scott furnace were used from 1916 until 1919, when declining mercury prices forced the shutdown of the mine (Brooks 1963).

The BBM was operated by the Quicksilver Syndicate from 1927 to 1942. Two rotary furnaces were installed increasing the mills' capacity to 150 tons per day. During this period, old furnace tailings were re-treated. The mine was closed again in 1943 (Brooks 1963).

In 1956 and 1957, the mine was leased by Mercury & Chemicals Corporation of New York. The uppermost levels of the mine (900 and 1,100 foot levels) were explored and developed during this time (Brooks 1963).

Since mine closure, waste rock/tailings have reportedly been removed from the Main Tailings Pile and used in road construction (Michael Pooler personal communication).

2.4 PREVIOUS INVESTIGATIONS

Prior to a Preliminary Assessment (PA) conducted by the ODEQ in 1996, under a cooperative agreement with EPA Region 10, no formal investigation has been identified at the BBM site. Several organizations, however, conducted previous sampling activities in the vicinity of the site. The following lists these earlier efforts, as well as the more formal investigations, that have occurred at or near the BBM site:

- **Oregon State University (OSU), Department of Fisheries and Wildlife (1990).** This study compared limited sediment and tissue samples from three Oregon reservoirs. Samples from

Cottage Grove Reservoir included tissue samples from five largemouth bass and several sediment samples. Muscle tissue from the oldest two fish showed mercury concentrations of 1.49 and 1.79 parts per million (ppm). These concentrations are above the U.S. Food and Drug Administrations (FDA) limit for human consumption of 1 ppm for commercially caught fish (OSU 1992). Mercury concentrations in sediment samples averaged 0.84 micrograms per gram (µg/g), dry weight.

- **U.S. Fish and Wildlife Service (USFWS) (1992).** The USFWS conducted tissue analysis on an addled egg from a bald eagle's nest. The addled egg was analyzed for trace elements, including mercury (2.9 µg/g, dry weight and 0.76 µg/g, wet weight). These concentrations are significantly higher than nationally reported mercury levels for bald eagle eggs.
- **U.S. Geological Survey (USGS) (1993).** The USGS conducted limited sediment and tissue analysis near BBM. Site related data were generated as part of a periodic state-wide sampling. Total mercury was detected in sediment samples collected from three locations in the vicinity of BBM: Dennis Creek (up to 2.5 part per million (ppm)), Coast Fork Willamette (up to 1.4 ppm), and Cottage Grove Reservoir (up to 0.50 ppm). Data from this work was not published.
- **Oregon State University (OSU) Department of Fisheries and Wildlife (1992 and 1994).** More extensive sediment sampling completed in 1992 detailed apparent elevated levels of methylmercury in fish tissue in Cottage Grove Reservoir. The tissue concentrations approached or exceeded the FDA limit for human consumption of 1 ppm for commercially caught fish (OSU 1992). In 1994, soil samples were collected near BBM and sediment samples were collected from Cottage Grove Reservoir and its tributaries. Results of surface soil sampling near the rotary kiln indicated the presence of mercury at concentrations of 350 milligrams per kilogram (mg/kg). Mercury also was detected in sediments in Dennis and Garoutte Creeks downstream of BBM with concentrations up to 267 mg/kg (OSU 1994). This data appeared to support the conclusion that elevated mercury levels in sediments can be traced to the Dennis Creek drainage, and may result from off-site transport of mercury from the BBM.
- **ODEQ Preliminary Assessment (1996).** The PA was conducted to identify potential public health and environmental threats related to the site. The scope of the investigation included a review of available file information, interviews, a target survey, and an on-site reconnaissance inspection. No new sampling was conducted for this assessment. Based on

the work conducted under this PA, ODEQ recommended a Site Inspection be carried out to more fully evaluate the threat associated with the mine and tailings pile.

- **Ecology and Environment, Inc. *for EPA Region 10* Site Inspection (SI) (1999).** The SI was conducted to: document a threat or potential threat to public health or the environment posed by the site; identify if a potential emergency situation exists that may require an immediate response; assess the eligibility of the site for National Priorities List inclusion; and document presence or absence of uncontained or uncontrolled hazardous substances on site. The scope of work and the findings of the SI are summarized below.
  - The SI involved the collection of samples from potential hazardous substance sources at the mine and from target areas potentially impacted through contaminant migration from on-site sources. Sources identified for the SI included mine tailings, the former mill/rotary kiln (referred to as the New Furnace Area), and the "404" Adit. A total of 52 samples (excluding Quality Control (QC) samples) were collected for the SI. Sample locations included multiple locations at the on-site sources, Dennis Creek, Garoutte Creek downstream of its confluence with Dennis Creek, and nearby springs and domestic wells used for drinking water. Samples were analyzed for target analyte list (TAL) inorganic elements at EPA's Manchester Laboratory. All of the sources for the SI contained at least one hazardous substance at significant concentrations.
  - Mercury, found in only one sample, and arsenic detected in seven samples, were the only contaminants detected at significant concentrations in the mine tailings. The former mill/rotary kiln (New Furnace Area) soils contain ten contaminants at significant concentrations, most notably mercury, which ranged in concentration from 91.9 mg/kg to 54,300 mg/kg, and arsenic which ranged in concentration from 114 mg/kg to 952 mg/kg.
  - Groundwater samples collected from nearby springs and domestic wells contained elevated concentrations of inorganic elements that also were detected at significant concentrations in the on-site sources. Arsenic was detected above the federal maximum contaminant level (MCL) for drinking water (0.050 milligrams per liter [mg/l]) at the time of the SI) in three of the domestic wells sampled for the SI. As of January 23, 2006, the MCL for arsenic in drinking water is 0.010 mg/l. A background groundwater sample was collected during the SI. Arsenic detected in the background sample is above the current MCL for drinking water. Mercury was not detected in either of the spring samples or any of the domestic well samples.
  - Although surface water sample results from Dennis Creek and Garoutte Creek did not strongly indicate a release of contaminants to the surface water column, the migration of contaminants from tailings to the creek was indicated by elevated concentrations of mercury in two sediment samples collected downstream of the "lower" tailings pile. However, elevated contaminant concentrations were not observed farther downstream in Garoutte Creek that could be attributed to releases from the mine sources.

- A surface water and sediment sample from the "404" Adit indicated that significant concentrations of several inorganic elements are present in both the surface water and sediment. Arsenic was not detected in either surface water or sediment; however, mercury was detected in sediment (11.5 mg/kg).

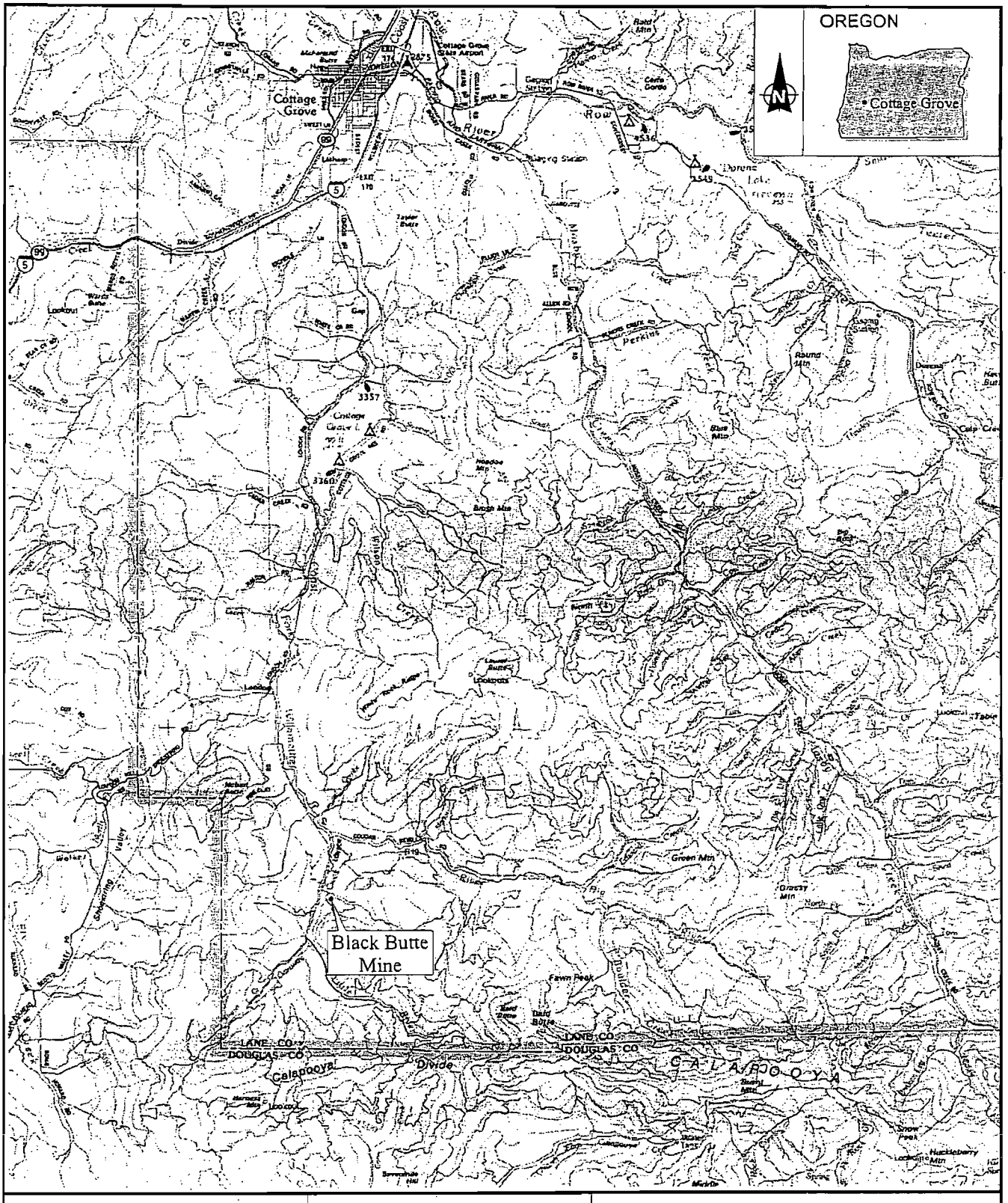
- **L.R. Curtis, Oregon State University (OSU)** ***for U.S. Army Corps of Engineers, Portland, Oregon.*** **Sources and Chronology of Mercury Contamination in Cottage Grove Reservoir (May 20, 2003).** The objective of this study was to assess a potential point source for mercury (BBM) and determine the distribution of mercury contamination in Cottage Grove Reservoir and its tributary streams. This study examined mercury contamination in soils of BBM (the suspected point source) and downgradient tributary stream and reservoir sediments. Reservoir sediment core stratigraphy samples, from sediment cores collected in 1995 and 2002, also were analyzed for mercury and assessed for how contaminant loading changed over time. Mercury distribution in tributary stream sediments and reservoir sediment core stratigraphy supports the conclusion that BBM is a point source of mercury contamination to the Cottage Grove Reservoir. Mercury concentrations in largemouth bass were found to exceed State and Federal Action Limits.

- **L.R. Curtis, Oregon State University** ***for ODEQ,*** **Reconnaissance Soil Sampling at the Black Butte Mine (August 9, 2004).** Ninety-nine composite surface soil samples were collected from an area forming a 1.5-mile radius circle centered on BBM. All 99 soil samples were analyzed for total mercury concentrations. In addition, sequential selective extraction analysis for mercury was conducted on ten of the soil samples. Results of the analysis for total mercury indicated that soils in the immediate vicinity of furnace areas were heavily contaminated with mercury. Total mercury in soils near the Old Ore Furnace ranged from 1,120 to 2,090 µg/g. Total mercury in soils near the New Furnace Area ranged from 41 to 727 µg/g. Results of the sequential selective extraction analysis were interpreted to indicate that most of the mercury in soil near the kilns was in the form of mercury sulfide (cinnabar). Some strong-complexed and organo-complexed forms of mercury also were present in these soils. Processed ore pile samples contained mostly strong-complexed and organo-complexed mercury and lower percentages of cinnabar. More mobile forms of mercury were interpreted to have leached from the processed ore materials prior to sampling.

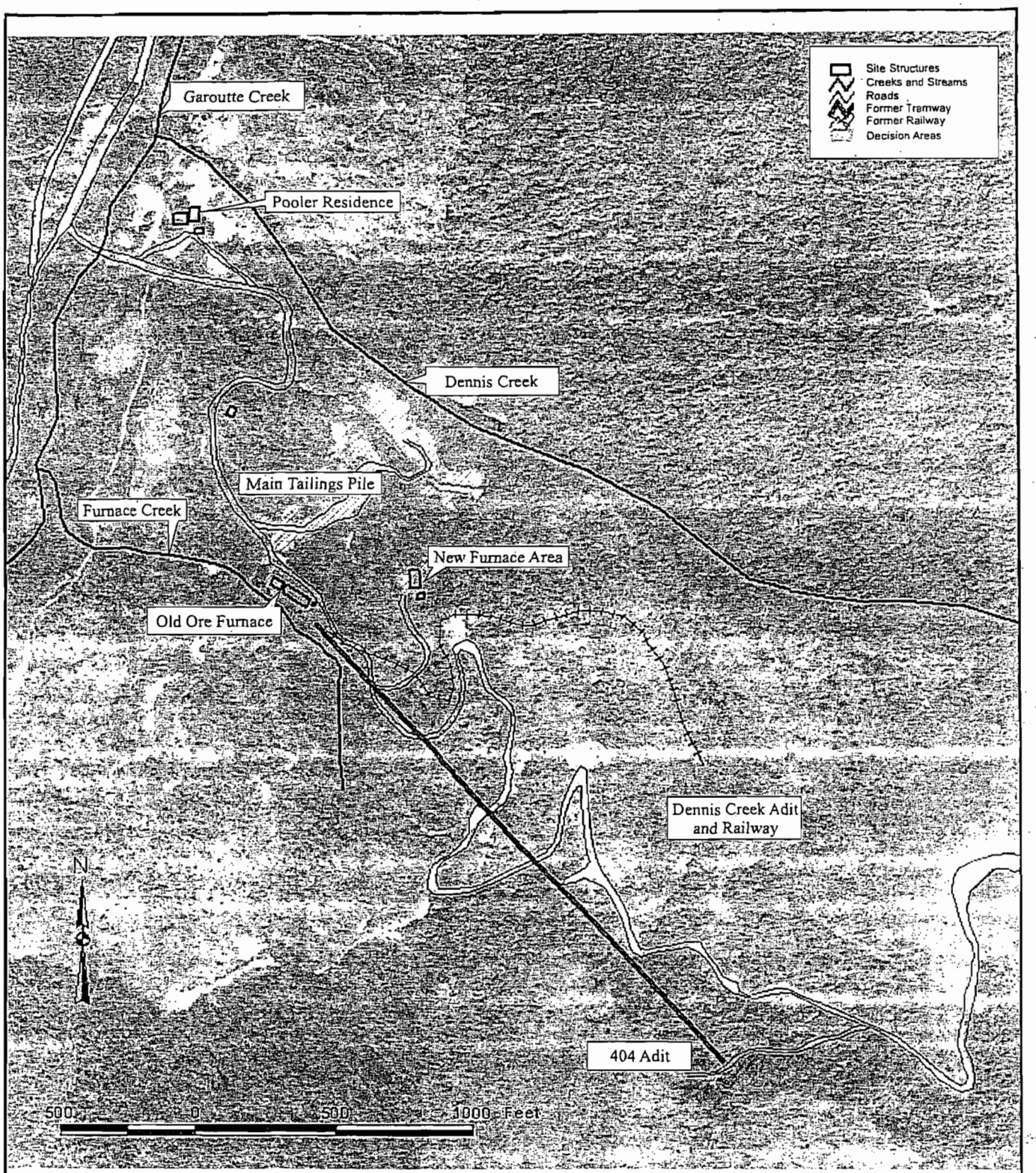
As a result of these investigations/observations, five main areas of contamination at the BBM site were identified for further investigation as part of this project (Figure 2-2):

- Main Tailings Pile;
- Old Ore Furnace Area;
- New Furnace Area;
- Other areas of potential contamination (including adits and associated waste rock, seeps); and
- Sediment and water in Furnace Creek, Dennis Creek, and Garoutte Creek.

The contaminants of concern are mercury and arsenic. The physical/chemical threats to the population at risk are exposure to soils at BBM and ingestion of fish containing mercury. Mercury has been detected in samples from the Main Waste/Tailings Pile, Old Ore Furnace, New Furnace Area, and in sediment from Furnace Creek and Dennis Creek.



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BLACK BUTTE MINE Lane County, Oregon	Figure 2-1 SITE LOCATION MAP		
	SOURCE: DeLorme, 1991, Scale 1:150,000	Date: 1-23-06	Drawn by: AES	10:START-3\06010005\fig 2-1



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BLACK BUTTE MINE Lane County, Oregon	Figure 2-2 SITE LAYOUT MAP		
	SOURCE: ODEQ	Date: 1-23-06	Drawn by: AES	10:START-3\06010005\fig 2-2

3. FIELD INVESTIGATION ACTIVITIES

A Site-Specific Sampling Plan (SSSP) was developed for the BBM RA prior to fieldwork (E & E 2005). The SSSP describes the sampling strategy, sampling methodology, and analytical procedures of the RA. The RA fieldwork was completed from September 6 through 11, 2005. A total of 47 surface and subsurface waste rock/tailings, sediment, and surface water samples (excluding quality control samples) were collected during the RA. All samples were collected following applicable Standard Operating Procedures (SOPs). SOPs are provided in an appendix to the SSSP for BBM.

This section summarizes field investigation activities including surface and subsurface waste rock/tailings sampling (subsection 3.1), sediment sampling (subsection 3.2), surface water sampling (subsection 3.3), field screening (subsection 3.4), and global positioning system survey (subsection 3.5). Photographic documentation is provided in Appendix A.

3.1 SURFACE AND SUBSURFACE WASTE ROCK/TAILINGS SAMPLING

Surface waste rock/tailings samples were collected from twelve sampling locations including: the Main Tailings Pile (MP01, MP02, MP03, MP04, MP08, MP09, MP10, and MP11), the Old Ore Furnace area (MP05, MP06, and MP07), and just downgradient of the New Furnace Area (MP12). Sample locations are shown on Figure 3-1.

Once surface samples were collected, boreholes were completed at the twelve sampling locations utilizing direct-push techniques to collect subsurface samples. Continuous cores were collected at each of the twelve locations using a Geoprobe equipped with a 4-foot long MacroCore soil sampler. Geologic logs were completed for all cores (Appendix B).

Each waste rock/tailings sample was screened for total mercury and total arsenic using an Innov-X Systems X-Ray Fluorescence (XRF) Analyzer and total mercury using a Lumex Mercury Analyzer (Lumex). Selected samples were submitted for fixed laboratory analysis by one or more of the following analyses:

- Total Target Analyte List (TAL) metals by EPA SW-846 7000 series methods (Severn Trent Laboratories - Seattle);
- Synthetic Precipitation Leaching Procedure (SPLP) mercury by EPA SW-846 Method 1312 and 6000 and 7000 series methods (Severn Trent Laboratories - Seattle);
- 5 - Step sequential selective extraction mercury analysis (Brooks Rand LLC); and
- Monomethylmercury by EPA Method 1630 (Brooks Rand LLC).

3.2 SEDIMENT SAMPLING

Sediment samples were collected from two locations on Garoutte Creek (CK01 and CK07), five locations on Dennis Creek (CK02 through CK06), and two locations on Furnace Creek (CK08 and CK09; Figure 3-1). Sediment samples were collected from the most downstream location to the most upstream locations within the three-creek drainage system in order to assure that sediment (and surface water) samples would not be contaminated by materials disturbed during sampling at an upstream location.

In addition to the stream sediment samples, one sediment sample was collected from the entrance to the "404" Adit (OA01). The "404" Adit is open, not secured, and has water pooled behind an earthen berm. The "404" Adit is shown in Photo Numbers 1-28 through 1-31 (Appendix A).

Each sediment sample was screened for total mercury using a Lumex with soil attachment. Selected samples were submitted for analysis by one or more of the following analyses:

- Total TAL metals by EPA SW-846 7000 series methods (Severn Trent Laboratories - Seattle);
- 5 - Step sequential selective extraction mercury analysis (Brooks Rand LLC); and
- Monomethylmercury by EPA Method 1630 (Brooks Rand LLC).

3.3 SURFACE WATER SAMPLING

Surface water grab samples were collected from each of the nine creek sample locations (CK01 through CK09; Figure 3-1). In addition, a surface water sample was collected from the entrance to the "404" Adit (OA01). Surface water samples were collected at each location prior to collection of co-located sediment samples. Following the collection of water samples, water-quality parameters were measured at each sampling location. Temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, and oxidation-reduction potential were measured directly in the stream or adit using a YSI-556 water-quality meter. Water quality parameters are presented in Table 3-1.

Each sample was screened for total mercury using a Lumex with water attachment. Selected samples were submitted for analysis by one or both of the following analyses:

- Total TAL metals by EPA SW-846 7000 series methods (Severn Trent Laboratories - Seattle) and
- Monomethylmercury by EPA Method 1630 (Brooks Rand LLC).

3.4 FIELD SCREENING

All samples were intended to be analyzed in the field using an XRF or a Lumex. However, samples could not be screened in the field because the XRF was not operational. Attempts made by START-2 to troubleshoot the XRF instrument in the field were unsuccessful. Because the XRF was not operational in the field, it was decided to conduct all field screening, including XRF and Lumex screening, at the START-2 warehouse located in Seattle, Washington after the completion of fieldwork.

Waste rock/tailings samples, sediment samples, and surface water samples were analyzed for total mercury using a Lumex equipped with a soil or water attachment, as appropriate. Field screening was performed by a START-2 chemist at the START-2 warehouse upon completion of field activities.

Field screening results from both XRF analysis and Lumex analyses were used to aid in the selection of samples submitted for fixed laboratory analysis.

3.5 GLOBAL POSITIONING SYSTEM

A Trimble global positioning system (GPS) was used in the field to survey RA sampling locations. The GPS was unable to provide coordinates at several creek sampling locations because dense tree coverage within the drainage valleys obscured satellite signal reception. At these locations, coordinates were collected at the nearest clearing.

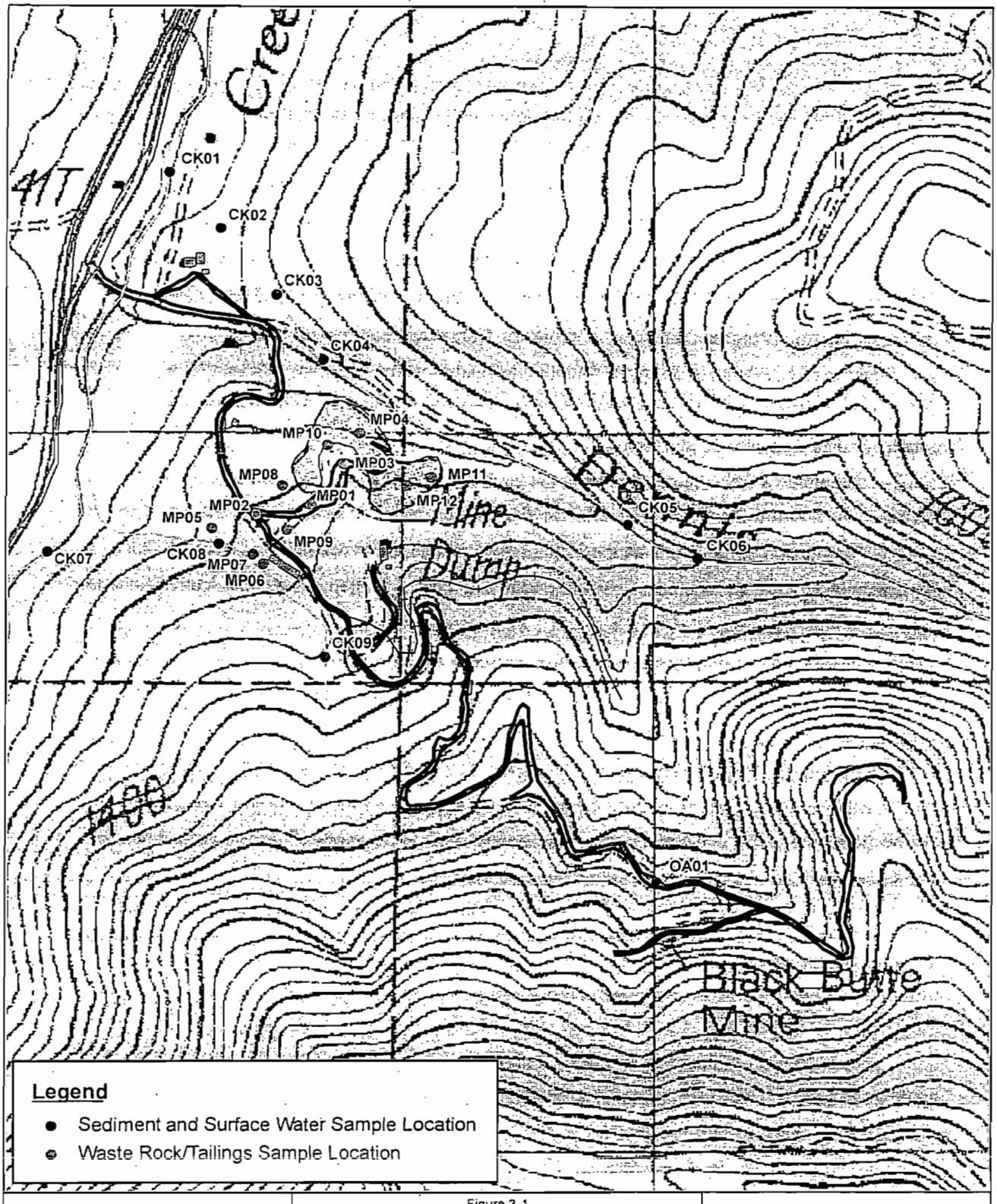
Table 3-1

WATER QUALITY PARAMETERS IN SURFACE WATER (CREEK AND ADIT) (YSI 556 MPS #A59664)
BLACK BUTTE MINE REMOVAL ASSESSMENT
LANE COUNTY, OREGON

Sample Number	Sample Location	Temperature in °C	Specific Conductance in mS/cm	Total Dissolved Solids in gm/L	Salinity	Dissolved Oxygen in %	Dissolved Oxygen in mg/L	pH	Oxidation Reduction Potential
CK01SW01	Garoutte Creek downstream of Dennis Creek	13.71	0.209	0.172	0.13	230.0	23.62	6.12	161.3
CK02SW02	Dennis Creek just above confluence with Garoutte Creek	13.28	0.317	0.265	0.20	171.3	17.91	7.18	133.3
CK03SW01	Dennis Creek below Old Mine Road	13.14	0.319	0.268	0.20	105.9	11.11	7.26	152.3
CK04SW01	Dennis Creek below Tailings	13.05	0.319	0.269	0.20	106.5	11.18	6.91	174.2
CK05SW01	Dennis Creek 35 feet downstream of drainage from Dennis Creek Adit Area	11.94	0.190	0.166	0.12	101.2	10.92	6.54	156.5
CK06SW01	Dennis Creek Background - 200 feet upgradient of confluence with drainage from Dennis Creek Adit Area	11.90	0.079	0.070	0.05	97.9	10.58	7.05	293.2
CK07SW01	Garoutte Creek upgradient of confluence with Furnace Creek	12.37	0.079	0.068	0.05	87.4	9.36	7.45	293.4
CK08SW01	Furnace Creek at base of Tailings	12.39	0.078	0.068	0.05	86.6	9.26	7.14	324.3
CK09SW01	Furnace Creek Background - Upgradient of Mine Activities	11.51	0.083	0.072	0.05	87.1	9.49	7.32	324.4
OA01SW01	404 - Adit	8.94	0.171	0.159	0.12	83.5	9.64	7.28	193.4

Key:

°C = degrees Centigrade
mS/cm =milliSiemens per centimeter
gm/L =grams per liter
% =percent
mg/L =milligrams per liter



0 125 250 500 750
Feet

Scale 1:7,500

ecology and environment, inc.
International Specialists in the Environment
Portland, Oregon

Figure 3-1

SAMPLE LOCATION MAP

BLACK BUTTE MINE

Lane County, Oregon

Job Id: 002233.0026.01IA	
Date: 12/20/2005	GIS Analyst: avh

Map Source Information: USGS Topographic Map. Harness Mountain, Oregon. Scale 1-24,000.

4. QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of sampling equipment, glassware, and reagents. Specific QC requirements for laboratory analyses are incorporated in the Contract Laboratory Program Statement of Work for Inorganic Analyses (EPA 2004b). These QC requirements or equivalent requirements found in the analytical method were followed for analytical work on the project. This section describes the QA/QC measures taken and provides an evaluation of the usability of data presented in this report.

All samples were collected following the guidance of the Site-Specific Sampling Plan (SSSP; E & E 2005). A START-2 chemist performed off-site field screening of selected TAL metals (XRF, by EPA SW-846 method 6200) and mercury (Lumex, by manufacturer's instructions). Analysis for monomethylmercury (EPA methods 1630 and 1631) and mercury 5-step sequential selective extraction analyses were performed by Brooks Rand, LLC, a commercial laboratory located in Seattle, Washington. Synthetic Precipitate Leaching Procedure (SPLP) mercury analysis (EPA SW-846 method and 7000 series methods) analyses were performed by STL-Seattle, a commercial laboratory located in Tacoma, Washington.

Field laboratory data were reviewed in accordance with the manufacturer's instructions and EPA SW-846 Method 6200. Data from the commercial laboratories were reviewed and validated by a START-2 chemist. Data validation memoranda are provided in Appendix C. Data qualifiers were applied as necessary according to the following guidance:

- EPA (1990) Guidance Document "Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan, and Data Validation Procedures" (EPA/540/G-90/004); and
- EPA (2004a) Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

In the absence of other QC guidance, method-specific QC limits also were utilized to apply qualifiers to the data. Correlation between the field analytical data sets was performed by a START-2 chemist and is discussed in subsection 4.5.

4.1 SATISFACTION OF DATA QUALITY OBJECTIVES

The following EPA (EPA 2000a) guidance document was used to establish data quality objectives (DQOs) for this project:

- Guidance for the Data Quality Objectives Process (EPA QA/G-4), EPA/600/R-96/055.

The EPA OSC determined that definitive data without error and bias determination would be used for the sampling and analyses conducted during the field activities. The data quality achieved during the field work produced sufficient data that met the DQOs stated in the SSSP (E & E 2005). A discussion of accomplished objectives is presented in the following subsections.

4.2 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

A QA sample (one rinsate blank) was collected for this project. Rinsate blank sample results are discussed in subsection 3.4.3. Trip blank samples are not required for inorganic analyses. QC samples included matrix spike (MS)/duplicate (DUP) samples for inorganic analyses at a rate of one MS/DUP per 20 samples per matrix per analysis.

4.3 PROJECT-SPECIFIC DATA QUALITY OBJECTIVES

The laboratory data were reviewed to ensure that DQOs for the project were met. The following describes the laboratory's ability to meet project DQOs for precision, accuracy, and completeness and the field team's ability to meet project DQOs for representativeness and comparability. The laboratory and the field team were able to meet DQOs for the project.

4.3.1 Precision

Precision measures the reproducibility of the sampling and analytical methodology. Laboratory and field precision is defined as the relative percent difference (RPD) between duplicate sample analyses. The laboratory duplicate samples or MS/MS duplicate samples measure the precision of the analytical method.

The RPD values were reviewed for all commercial laboratory samples. A total of 16 sample results (approximately 2.6 % of the data) were qualified as estimated quantities (J) based on duplicate outliers, therefore the DQO for precision of 85 % was met.

4.3.2 Accuracy

Accuracy measures the reproducibility of the sampling and analytical methodology. Laboratory accuracy is defined as the MS percent recoveries for all analyses. A total of 2 sample results (approximately 0.3 % of the data) were qualified as estimated quantities (J or UJ). The project DQO for accuracy of 85 % was met.

4.3.3 Completeness

Data completeness is defined as the percentage of usable data (usable data divided by the total possible data). All data were reviewed for usability. No sample results were rejected, therefore the project DQO for completeness of 90 % was met.

4.3.4 Representativeness

Data representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or environmental conditions. The number and selection of samples were determined in the field to account accurately for site variations and sample matrices. The DQO for representativeness of 85 % was met.

4.3.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Data produced for this site followed applicable field sampling techniques and specific analytical methodology. The DQO for comparability was met.

4.4 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL PARAMETERS

The laboratory data also were reviewed for holding times/temperature, laboratory blank samples, rinsate blank samples and serial dilution analyses. These QA/QC parameters are summarized below. In general, the laboratory and field QA/QC parameters were considered acceptable.

4.4.1 Holding Times/Temperature

All holding times and temperature limits were met except the temperature limits for monomethylmercury; all monomethylmercury results were qualified as estimated quantities (J or UJ).

4.4.2 Laboratory Blanks

All laboratory blanks met the frequency criteria. The following analyte was detected in laboratory blanks:

TAL Metals: Mercury.

No action was taken based on the mercury blank contamination as all sample results were greater than five times the absolute value of the mercury blank contamination.

4.4.3 Rinsate Blank

One rinsate blank was analyzed, meeting QC criteria of 1 per 20 samples collected with non-dedicated sampling equipment. No analytes were detected in the rinsate blank.

4.4.4 Serial Dilution

One serial dilution sample was analyzed per 20 samples per matrix, therefore meeting frequency criteria. All serial dilution results were within QC limits.

4.5 FIELD ANALYSIS

A START-2 chemist analyzed 27 soil samples for selected TAL metals using an Innov-X XRF instrument and 50 soil/sediment/waste rock/water samples for mercury using a Lumex mercury analyzer. The field results were used to determine the extent of contamination and to determine which samples to send for commercial laboratory analysis. Six soil/waste rock, two sediment and two water samples were submitted to a commercial laboratory for confirmation analysis. The field XRF results included 17 TAL metals (including arsenic and mercury); the laboratory confirmation analyses were only for total arsenic and mercury. A correlation between field and commercial laboratory results was not performed because the small number of data points would not yield a statistically significant data set; however, a correlation between the 23 samples analyzed for mercury using both field XRF and Lumex methods is included in Table 4-1. Adjusted values were created to allow for the correlation. Non-detect values were converted to one half of the detection limit and qualifiers and standard deviations were ignored to generate the adjusted values. Three of the twenty-six samples were excluded from the correlation process. The correlation between the data pairs associated with these three samples was poor, and the mercury concentrations in these samples were the highest in the sample set (mercury was greater than 350 mg/kg in at least one of the analyses). Therefore the poor correlations were skewing the correlation coefficient. When these results are included in the correlation data set, the correlation coefficient is -0.014, indicating

a negative correlation. However, when these three samples are excluded, the correlation coefficient is 0.868. This correlation indicates that the XRF and Lumex had good agreement for mercury results less than 350 mg/kg and poor agreement for results greater than 350 mg/kg. This interpretation of the results is consistent with the understanding that the Lumex is designed for low-concentration mercury samples so results in higher concentration mercury samples may not be as accurate.

According to EPA guidance, a minimum correlation coefficient of 0.700 is necessary to consider field analytical results acceptable when compared with laboratory confirmation results. For this project, mercury field laboratory results from the XRF instrument were compared with field laboratory results from the Lumex instrument. The correlation coefficient of 0.868 indicated an acceptable correlation between the two field analysis methods.

XRF, Lumex, and laboratory analytical data for waste rock/tailings are presented in Table 5-2. There is significant variation in concentrations detected in samples analyzed using these methods, particularly for relatively high concentrations and relatively low concentrations. This variation may be explained by the expected accuracy of the XRF instrument, the Lumex instrument, and the laboratory methods as well as by the nature of the distribution of mercury within the sample itself. The XRF results are more accurate for samples containing higher concentrations of mercury and other metals. The Lumex is designed to detect low concentrations of mercury and therefore produces analytical results that are more accurate for samples containing lower mercury concentrations. EPA guidance (EPA 2000b) has identified use of XRF as an appropriate field screening technology at abandoned mine sites. In this report, XRF data are the primary data used for interpretation of mercury and arsenic in waste rock/tailings.

Variations of concentrations of mercury within the matrices sampled and the samples themselves can also affect the detected concentration. Since the distribution of mercury within waste rock/tailings, soil, and/or sediment is heterogeneous, the distribution of mercury within the sample may somewhat vary. For metals analysis, samples are homogenized by the sampler to reduce the potential for heterogeneity within a sample. However, because only a small portion of the sample submitted to the laboratory is actually analyzed, minor concentration variation within the sample may occur.

TABLE 4-1

MERCURY XRF vs. LUMEX CORRELATION
BLACK BUTTE MINE SITE
LANE COUNTY, OREGON

Sample Number	XRF Mercury	Lumex Mercury
MP01SS04	34.91	30.7
MP01SS08	31.23	12.9
MP01SS12	31.36	39.3
MP01SS16	54.92	12.7
MP02SS04	22.72	16.8
MP03SS04	0.55	0.14
MP04SS04	18.14	0.95
MP04SS08	20.06	6.1
MP04SS12	19.97	3.1
MP04SS16	1.35	0.8
MP05SS08	80.96	45
MP07SS04	131.67	145
MP08SS04	19.12	6.5
MP09SS04	1.5	1.5
MP10SS04	18.23	0.89
MP10SS08B	14.42	4.6
MP10SS08A	19.79	5.2
MP11SS04	19.44	2.8
MP11SS08	43.25	0.95
MP11SS12	26.58	2.5
MP11SS16	42.01	2.4
MP11SS20	21.47	1.2
MP12SS04	1.78	8.8
Correlation	**0.866402743**	

Note: Non-detect results were changed to 1/2 the detection limit, the standard deviations from the XRF results were deleted, and J's, indicating estimated values, were removed.

5. SITE INVESTIGATION RESULTS

This section summarizes the site investigation results, including applicable or relevant and appropriate requirements (ARARs; Subsection 5.1), field screening and fixed laboratory results (Subsection 5.2), main tailings pile volume (Subsection 5.3). Tables presented in this section include analytical data from this RA as well as data from the SI (E & E 1999). The SI data is included because it is considered recent and relevant. The significance of the data is explained in Section 6.

5.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Field screening and fixed laboratory analytical results for samples collected during the RA field activities are summarized below. For the purposes of evaluating sample results, analytical results were compared to various benchmarks. Table 5-1 lists these benchmarks by media type and constituent. Analytical results also are presented in Tables 5-2 through 5-6. Mercury and arsenic concentrations in waste rock/tailings were compared to EPA Region 9 Preliminary Remediation Goals (PRGs) and ODEQ Maximum Allowable Soil Concentrations (MASCs) for both residential and industrial soils. Concentrations of mercury in sediment were compared to EPA Region 9 residential soil PRGs, National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SquiRT) threshold effects levels (TELs) and probable effects levels (PELs) for fresh water sediment (Buchman 1999), and ODEQ Level II Screening Level Values (SLVs) for soil. Concentrations of mercury in surface water were compared to EPA National Recommended Water Quality Criteria (NRWQC) and ODEQ Level II SLVs for fresh water. For the purpose of interpretation of sampling results, analytical data are compared to the most conservative criteria of those listed above and in Table 5-1.

Both industrial and residential soil EPA Region 9 PRGs and MASCs are presented in Table 5-1. BBM currently is owned by the Land and Timber Company and the property has been used for logging. Future use of this site may continue to be logging or may eventually become recreational. Because of the possibility of recreational use, the residential PRGs and MASCs are referenced for interpretation of analytical results. Although residential values are more conservative than industrial values, they are considered more appropriate to evaluate potential recreational use than industrial values.

5.2 FIELD SCREENING AND FIXED LABORATORY RESULTS

The following subsections describe analytical results for total metals, synthetic precipitation leaching procedure, monomethylmercury, and mercury sequential selective extraction.

5.2.1 Total Metals (Mercury and Arsenic)

The following subsections describe analytical results for total mercury and total arsenic in waste rock/tailings, sediment, and surface water samples.

5.2.1.1 Waste Rock/Tailings

Waste rock/tailings samples were analyzed for total mercury and total arsenic. Results of total mercury and total arsenic analyses in waste rock/tailings samples including XRF, Lumex, and fixed laboratory results are presented in Table 5-2. Total mercury and total arsenic XRF results are presented in Figures 5-1a and 5-1b. For waste rock/tailings, the XRF results are the default values used in descriptions and discussions. However, if lower mercury concentrations are identified, then Lumex results are included in discussions since the Lumex is more accurate at lower mercury concentrations.

Total mercury in waste rock/tailings samples ranged in concentration from 1.13 to 2,416.48 mg/kg. Total mercury concentrations were compared to the EPA Region 9 PRG for residential soil of 23 mg/kg. Eleven of 27 waste rock/tailings samples exceeded the EPA Region 9 PRG for total mercury (using XRF data). All of the samples from boring MP01 (MP01SS04, MP01SS08, MP01SS12, MP01SS16, MP01SS20) exceeded the EPA Region 9 PRG for residential soil. The waste rock/tailings sample from the deepest sampling interval (16 to 20 feet bgs) in boring MP01, located near the center of the Main Tailings Pile, showed the highest total mercury concentration of 2,416.48 mg/kg. Samples collected from shallower intervals (0 to 4, 4 to 8, 8 to 12, 12 to 16 feet bgs) in boring MP01 resulted in total mercury concentrations two orders of magnitude lower than the concentration from the deepest sampling interval. This distribution of mercury may be explained by two factors: the deeper tailings are older and were not processed as efficiently as the younger, shallower tailings, thus resulting in higher residual mercury concentrations; and/or the shallower waste rock/tailings may have experienced more leaching of mercury than the tailings at the 16 to 20 foot depth interval. Both concepts fit within the Conceptual Site Model (CSM) described in the SSSP for BBM (E & E 2005). Waste rock/tailings are expected to be heterogeneous in terms of mineral and chemical composition, as well as grain-size distribution, based on changes in ore processing equipment and techniques and the nature of the ore extracted over the period of mine operations and the depositional history of mine waste rock/tailings.

Waste rock/tailings were deposited below the ore processing areas over the course of approximately seventy years of intermittent mining operations. Deeper waste rock/tailings were deposited first and are generally expected to be increasingly younger toward the surface. A subset of samples were analyzed for leaching potential; the results are described below in Section 5.2.2.

Waste rock/tailings samples from borings MP05 (MP05SS04 and MP05SS08) and MP07 (MP07SS04) exceeded the EPA Region 9 PRG for total mercury in residential soil. Borings MP05 and MP07 are located in the Old Ore Furnace area. Based on the proximity and downslope location of borings MP05 and MP07 with respect to the Old Ore Furnace, the waste rock/tailings in this area are interpreted to be the remnants of ore processed in the Old Ore Furnace. Processing of ore in the Old Ore Furnace is expected to have been less efficient and therefore waste rock/tailings can be expected to show higher concentrations of mercury. The re-processing of ore from this area, as described in Brooks (1971) and reported by Michael Pooler during field activities, further supports this concept. It is expected that the ore or waste rock/tailings would only be re-processed if a significant amount of mercury could still be recovered from them. The waste rock/tailings sample from the 0 to 4 feet, bgs in boring MP05 showed the second highest total mercury concentration of 1,180.6 mg/kg. This concentration of total mercury is one to two orders of magnitude higher than total mercury concentrations in waste rock/tailings samples from deeper intervals in MP05 (4 to 8 feet, bgs) and from locations closer to the Old Ore Furnace (MP07 and MP06). Waste rock/tailings in the area of MP05 are thicker than in MP07 and MP06 suggesting these tailings may have been overlooked during the reported re-processing.

Borings MP11 and MP12 are located downslope of the New Furnace Area. Only waste rock/tailings samples from boring MP11 (MP11SS08, MP11SS12, and MP11SS16) showed exceedances for total mercury with respect to the EPA Region 9 PRG for residential soil of 23 mg/kg. The samples from boring MP11 that exceeded the EPA Region 9 PRG are relatively close in concentration to the PRG. Sample analysis using an XRF tends to give more accurate readings for total mercury at higher concentrations. Waste rock/tailings samples were also analyzed using a Lumex. The Lumex gives more accurate results at lower concentrations of mercury. The results of analysis of the samples from MP11 using the Lumex showed even lower total mercury concentrations than those concentrations using the XRF. The total mercury concentrations detected using the Lumex in samples MP11SS08 (0.95 mg/kg), MP11SS12 (2.5 mg/kg), and MP11SS16 (2.4 mg/kg) are substantially lower than the EPA Region 9 PRG for residential soil (Table 5-2). Because the Lumex is designed for lower mercury concentrations, the total mercury concentrations detected in these samples using the Lumex may be more accurate than those using the XRF.

Total arsenic in waste rock/tailings ranged in concentration from 12.2 to 392.67 mg/kg. All 27 of field samples screened with the XRF exceeded the EPA Region 9 PRG for arsenic in residential soil of 0.39 mg/kg. The lowest concentration of arsenic (12.2 mg/kg), in sample MP12SS08, is two orders of magnitude higher than the EPA Region 9 PRG for residential soil. A lateral or vertical trend of total arsenic concentrations is not apparent in the sample results (Figure 5-1b). The high concentrations in all samples and the lack of a pattern in concentrations may indicate that background concentrations for arsenic could be high in this area. Because the site area is highly mineralized, higher background concentrations of arsenic or other metals are not unexpected.

Collecting a truly representative background surface sample of the waste rock/tailings pile was not possible because the waste rock/tailings consists of processed ore rather than natural soil. In this report, background surface and subsurface soil samples are used for comparison against the waste rock/tailings materials to show the difference in concentrations between natural conditions (background) and those impacted by mining activities (waste rock/tailings). Background surface and subsurface soil samples were collected during the Site Inspection (E & E 1999) from a forested location approximately 100 yards from London Road, approximately 0.5 miles west of the mine. These background samples were analyzed for total arsenic. Total arsenic concentration in the surface background sample was 68.5 mg/kg and in the subsurface background sample was 69.4 mg/kg. These arsenic concentrations can be used to represent local background concentrations. These concentrations fall within the range of concentrations detected in waste rock/tailings samples from this RA. If the resulting arsenic concentrations in waste rock/tailings are compared to a value of three times the background concentration, or approximately 210 mg/kg, only samples from borings MP01 and MP11 show exceedances.

5.2.1.2 Sediment

Sediment samples were analyzed for total mercury and results are presented in Table 5-3 and in Figure 5-2. Utilizing the XRF, total mercury ranged in concentration from 0.45 J mg/kg to 37.4 mg/kg in sediments. Total mercury concentrations in sediment samples were compared to the ODEQ Level II SLV for invertebrates (0.1 mg/kg), the lowest of the benchmarks used for comparison. Total mercury concentrations in all sediment samples collected during the RA exceeded the ODEQ Level II SLV for invertebrates. Total mercury concentrations in sediment samples CK06SD01 (7 mg/kg), CK07SD01 (0.45 J mg/kg), and CK09SD01 (1.7 mg/kg) represent background for Dennis Creek, Garoutte Creek, and Furnace Creek, respectively. Total mercury concentrations in these background sediment samples exceed

the ODEQ Level II SLV for invertebrates. The relatively high concentration of total mercury in background sediment samples may be expected because the area has a naturally high concentration of mercury-bearing minerals. The elevated mercury concentration from the Dennis Creek background sample may reflect the influence of mining activities further upslope of Dennis Creek Adit and "404" Adit or aerial deposition of mercury from inefficient recovery during early processing operations (OSU 2004).

Furnace Creek

The highest total mercury concentration (37.4 mg/kg) in sediment was detected in sample CK08SD01 and is one to two orders of magnitude higher than all other sediment samples collected for the assessment. The sample collected at location CK08 is also the only sample whose total mercury concentration exceeds the highest background concentration of 7 mg/kg (CK06SD01). Sediment sample CK08SD01 was collected from Furnace Creek where waste rock/tailings, downslope of the Old Ore Furnace, are in contact with Furnace Creek. The total mercury concentration in the sediment sample collected from Furnace Creek upgradient of mining activities (CK09SD01) was 1.7 mg/kg, significantly lower that in sample CK08SD01.

Dennis Creek

The next highest concentration of total mercury in sediment was 7 mg/kg in sample CK06SD01 from Dennis Creek, approximately 200 feet upgradient of its confluence with the drainage from the Dennis Creek Adit area. This location was thought to be upgradient of mining influence. Total mercury concentration in sediment sample CK02SD01 was 6.2 mg/kg. This sample was collected from Dennis Creek but near its confluence with Garoutte Creek, downgradient of mining influence. Three additional sediment samples (CK03SD01, CK04SD01, CK05SD01) were collected from Dennis Creek between CK02 and CK06. These samples were all collected from areas of the creek that are expected to be influenced by mining activities. Total mercury concentrations in these sediment samples ranged from 0.54 J mg/kg to 3.5 mg/kg.

Garoutte Creek

Two sediment samples were collected from Garoutte Creek (CK01SD01 and CK07SD01). Total mercury in sample CK01SD01 was 1.2 J mg/kg. This sample was collected from downgradient of Furnace Creek, Dennis Creek, and BBM. Sample CK07SD01 (0.45 J mg/kg) was collected from

Garoutte Creek upgradient of its confluence with Dennis Creek and Furnace Creek and upgradient of BBM.

"404" Adit

A single sediment sample (OA01SD01) was collected from near the portal of the "404" Adit. The total mercury concentration in OA01SD01 was 2.1 mg/kg. The total mercury concentration in the adit sediment sample is below that in the Dennis Creek background sediment sample but above ODEQ Level II SLV for invertebrates.

5.2.1.3 Surface Water

Results of total mercury analyses in surface water samples are presented in Table 5-4 and Figure 5-2. Total mercury was not detected in any of the surface water samples using the Lumex with the water analysis attachment. The detection limit for analysis using the Lumex was 1.4 microgram per liter (µg/L). Results of laboratory analysis indicate a total mercury concentration of 2.25 µg/L in surface water sample CK08SW01, where waste rock/tailings are in contact with Furnace Creek. The NRWQC - CMC for mercury is 1.4 µg/L and the NRWQC - CCC and ODEQ Level II SLV (aquatic) for mercury is 0.77 µg/L.

5.2.2 Synthetic Precipitation Leaching Procedure

The metal constituents that may be released by leaching from waste rock, tailings, and other mine waste can be identified by one of several leach tests. The EPA SPLP is widely regarded as the preferred technique for evaluating potential metals leaching of mine waste. Results of analysis of mercury in leachate produced from a waste rock/tailings samples MP01SS04, MP01SS20, MP05SS04, MP05SS08, MP07SS04, and MP12SS08 using SPLP are presented in Table 5-5. The reporting limit for analysis of mercury in leachate was 0.002 milligrams per liter (mg/L) and the method detection limit was 0.00044 mg/L. All leachate samples were non-detect for mercury except sample MP12SS08. Boring MP12 is located in the New Furnace Area just downslope of the New Furnace. The mercury leachate concentration for MP12 was 0.00149 mg/L, below the method reporting limit and well below the Oregon Leachate Reference Concentration of 0.2 mg/L. Also of note, the waste rock/tailings samples with the highest total mercury concentrations (MP01SS20 and MP05SS04) were included in the subset of samples analyzed using SPLP. Mercury was not detected in leachate produced by SPLP from either of these samples.

5.2.3 Monomethylmercury

In general, the potential environmental impacts of mercury from mercury mine waste depend on the mercury species as well as the total mercury concentrations present in the source materials and media present in impacted areas. The mercury species of greatest environmental concern is monomethylmercury, which is the most bioavailable form of mercury, and which can become concentrated through bioaccumulation in fish and fish-consuming biota.

Formation of monomethylmercury in aqueous environments (methylation) is enhanced by the presence of sulfate (SO_4^{2-}) and high concentrations of dissolved organic carbon in the presence of sulfate-reducing bacteria. Although methylation can occur in mine site sources and in mine drainage, the process occurs predominantly in wetlands and larger aquatic bodies downstream of the mine sources. (Rytuba 2002)

Select waste rock/tailings samples (MP01SS12, MP01SS20, MP05SS04, MP06SS04, and MP12SS08) and sediment samples (CK01SD01, CK08SD01, and OA01SD01) were submitted for analysis of monomethylmercury. Resultant monomethylmercury concentrations ranged from less than the detection limit of 0.000015 mg/kg to 0.0127 J mg/kg, and are presented in Table 5-6. Monomethylmercury concentrations were compared to the ODEQ Level II soil SLV for plants of 0.0002 mg/kg. Five (MP01SS12, MP05SS04, MP06SS04, CK01SD01, CK08SD01) of the eight samples analyzed had concentrations of monomethylmercury that exceeded the ODEQ Level II soil SLV for plants. The highest monomethylmercury concentration (0.0127 J mg/kg) was detected in the sediment sample from location CK08. This concentration is two orders of magnitude higher than the ODEQ Level II soil SLV for plants. Sample CK08 was collected from Furnace Creek where waste rock/tailings downslope of the Old Ore Furnace are in contact with Furnace Creek. The second highest monomethylmercury concentration (0.00134 J mg/kg) was detected in the waste rock/tailings sample MP05SS04 also located downslope of the Old Ore Furnace.

5.2.4 Mercury Sequential Selective Extraction

As discussed in the previous section, monomethylmercury is the most bioavailable form of mercury. Methylation of mercury and its uptake is a complicated process governed by several variables. Mercury speciation plays a large role in determining how much of the mercury released from mine sources may become available for methylation in downstream aquatic environments. For example, elemental mercury and ionic mercury are more readily methylated than several other forms of mercury

such as mercury sulfide (e.g., cinnabar). Speciation also dictates how much mercury is bioavailable for the direct ingestion exposure pathway, as well as influencing the mobility of mercury in the environment.

Extended X-ray adsorption fine structure spectroscopy studies of mercury mine wastes indicate that the mercury species metacinnabar (m-HgS), corderoite ($Hg_3S_2Cl_2$), schuetteite ($HgSO_4$-H_2O), and mercury chlorides are likely to form during the roasting of mercury ores. These minerals are more soluble compared to cinnabar under typical surface oxidizing conditions, and thus are likely to be disproportionately large contributors of mercury to the environment (Rytuba 2002). During roasting of cinnabar ore, the mercury is oxidized to mercury (II), with which inorganic and organic (e.g., monomethylmercury) compounds may readily form (Moore 2002).

A sequential selective extraction technique (Bloom et al. 2003) was employed to approximate relative proportions of water soluble, stomach acid (weak acid) soluble, organo-chelated, elemental mercury, and mercuric sulfide (sulfide-bound) forms of mercury in the BBM waste rock/tailings and sediment samples. Although this technique does not identify exact mineral or oxidation state, it does differentiate between and quantify groups of mercury species based upon solubility under various conditions. Each sequential extraction step dissolves a less soluble fraction. Mine site media that contain higher fractions of inorganic mercury in the first three fractions (water soluble, stomach acid soluble, and organo-chelated) are more readily methylated than those containing most of their mercury in the last two fractions (elemental mercury and mercuric sulfide; Bloom et al. 2003).

A summary of the selective extraction technique and typical species identified by each extraction step is provided below.

Extraction Step	Extractant	Fraction Description	Typical Species
1	De-ionized Water	Water Soluble	$HgCl_2$, $HgSO_4$ (salts)
2	pH 2 HCl/HOAc	Stomach Acid Soluble (weak acid)	HgO
3	1M KOH	Organo-chelated	CH_3Hg, Hg-humics, Hg_2Cl_2
4	12 M HNO_3	Elemental Mercury	Hg^0, Hg_2Cl_2
5	Aqua Regia (concentrated HCl and HNO3)	Mercuric sulfide (sulfide bound)	HgS, m-HgS, HgSe, HgAu

Key:

CH_3Hg	= Monomethylmercury	HgS	= Cinnabar
HCl	= Hydrochloric acid	HgSe	= Mercuric selenide
Hg	= Mercury	$HgSO_4$	= Mercuric sulfate
Hg^0	= Elemental mercury	HNO_3	= Nitric acid
HgAu	= Mercury-gold amalgam	HOAc	= Acetic acid

$HgCl_2$	= Mercuric chloride	KOH	= Potassium hydrochloride
Hg_2Cl_2	= Mercurous chloride	m-HgS	= Metacinnabar
HgO	= Mercuric oxide	M	= Molar

Eight waste rock/tailings and sediment samples (MP01SS12, MP01SS20, MP05SS04, MP06SS04, MP12SS08, CK01SD01, CK08SD01, and OA01SD01) were submitted for sequential selective extraction mercury analysis. Results are summarized in Table 5-6 and presented in Figure 5-3. Results indicate that between approximately 45.4% and 94.3% of the total mercury in waste rock/tailings samples and sediment samples can be characterized as 'elemental mercury' or 'mercury sulfide' fractions[1]. This indicates that between 45.4% and 94.3% of the total mercury in waste rock/tailings and sediment is in relatively insoluble forms and these forms of mercury are not readily methylated.

With the exception of waste rock/tailings sample MP06SS04, a much smaller percentage of total mercury, between approximately 0.06% and 14.9%, in waste rock/tailings samples and sediment samples exists in the comparatively soluble forms (water soluble and stomach acid soluble). The majority of total mercury in sample MP06SS04 is in the 'stomach acid soluble' or 'mercuric sulfide' forms indicating this area has mixed solubility and methylation potential results.

Between approximately 5.7% and 54.6% of total mercury in waste rock/tailings samples and sediment samples can be characterized as 'water soluble', 'stomach acid soluble', or 'organo-chelated'.

Results of sequential selective extraction indicate that the majority of total mercury in waste rock/tailings and sediment appears to be in the 'elemental mercury' or 'mercuric sulfide' fractions. Typical mercury species found in these fractions include elemental mercury, mercurous chloride, cinnabar, metacinnabar, mercuric selenide, and mercury - gold amalgam. These species can be characterized as relatively insoluble. Although 'elemental mercury' is more readily methylated than some other forms of mercury, it's solubility is important because it becomes available for methylation through various natural processes once it is dissolved in water.

5.3 MAIN TAILINGS PILE VOLUME

The Main Tailings Pile was estimated to contain approximately 300,000 cubic yards of material (ODEQ 1996). Twelve borings (MP01 through MP12) were completed during the RA and indicate this volume may be substantially smaller than these early estimates. Borings MP01, MP04, MP10, MP11, and MP12 are located on the northeastern side or Dennis Creek side of the Main Tailings Pile. Tailings

[1] Percentages were calculated by summing the concentration of elemental mercury and mercury sulfide; dividing that number by the sum of the concentration of the water soluble, stomach acid soluble, organo-chelated, elemental mercury, and mercuric sulfide; and multiplying the result by 100.

thickness in these borings range from 4.3 feet to over 20 feet in thickness. For the remainder of the borings, MP02, MP03, MP05, MP06, MP07, MP08, and MP09, either tailings were not encountered or tailings were less than 1 foot in thickness. Photo 1-6 in Appendix A shows the tailings/natural soil interface from boring MP06. This was typical of what was seen in borings in the Old Ore Furnace area.

Table 5-1

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
BLACK BUTTE MINE REMOVAL ASSESSMENT
LANE COUNTY, OREGON

Waste Rock/Tailings/Soil			Total Mercury	Total Arsenic
Environmental Protection Agency Region 9 PRGs	Residential Soil	mg/kg	23	0.39
Environmental Protection Agency Region 9 PRGs	Industrial Soil	mg/kg	310	1.6
Oregon DEQ Maximum Allowable Soil Concentrations	Residential Soil	mg/kg	80	0.4
Oregon DEQ Maximum Allowable Soil Concentrations	Industrial Soil	mg/kg	600	3

Sediment			Total Mercury
National Oceanic and Atmospheric Administration SQuiRT - TEL	Sediment	mg/kg	0.174
National Oceanic and Atmospheric Administration SQuiRT - PEL	Sediment	mg/kg	0.486
Oregon DEQ Level II Screening Level Values - Plants	Soil	mg/kg	0.3
Oregon DEQ Level II Screening Level Values - Invertebrates	Soil	mg/kg	0.1
Oregon DEQ Level II Screening Level Values - Birds	Soil	mg/kg	1.5
Oregon DEQ Level II Screening Level Values - Mammals	Soil	mg/kg	73

Surface Water			Total Mercury
EPA National Recommended Water Quality Criteria (Freshwater CMC)	Water	µg/L	1.4
EPA National Recommended Water Quality Criteria (Freshwater CCC)	Water	µg/L	0.77
Oregon DEQ Level II Screening Level Values - Aquatic	Water	µg/L	0.77
Oregon DEQ Level II Screening Level Values - Birds	Water	µg/L	3,300
Oregon DEQ Level II Screening Level Values - Mammals	Water	µg/L	10,000

Leachate			Mercury
Oregon DEQ Leachate Reference Concentration	Leachate	mg/L	0.2

Waste Rock/Tailings/Soil			Methylmercury
Environmental Protection Agency Region 9 PRGs	Residential Soil	mg/kg	6.1
Environmental Protection Agency Region 9 PRGs	Industrial Soil	mg/kg	62
Oregon DEQ Level II Screening Level Values - Plants	Soil	mg/kg	0.0002
Oregon DEQ Level II Screening Level Values - Invertebrates	Soil	mg/kg	--
Oregon DEQ Level II Screening Level Values - Birds	Soil	mg/kg	0.025
Oregon DEQ Level II Screening Level Values - Mammals	Soil	mg/kg	4

Key:
PRGs = Preliminary Remediation Goals
DEQ = Department of Environmental Quality.
mg/kg = milligrams per kilogram.
SQuiRT = Screening Quick Reference Tables.
PEL = probable effects level.
TEL = threshold effects level.
CMC = Criteria Maximum Concentration.
CCC = Criterion Continuous Concentration.
µg/L = micrograms per liter.

Table 5-2

TOTAL MERCURY AND ARSENIC IN WASTE ROCK/TAILINGS SAMPLES
FROM REMOVAL ASSESSMENT AND SITE INSPECTION
BLACK BUTTE MINE
LANE COUNTY, OREGON

Sample Number	Sample Location/Identification (depth)	Units	Total Mercury				Total Arsenic		
			XRF	+/-	Lumex	Fixed Laboratory	XRF	+/-	Fixed Laboratory
Environmental Protection Agency Region 9 PRGs		mg/kg	23				0.39		
Removal Assessment (September 2005)									
MP01SS04	Main Tailings Pile/Borehole 1 (0 - 4 ft bgs)	mg/kg	34.91	5.64	30.7	--	137.25	5.14	--
MP01SS08	Main Tailings Pile/Borehole 1 (4 - 8 ft bgs)	mg/kg	31.23	5.26	12.9	--	272.95	6.79	--
MP01SS12	Main Tailings Pile/Borehole 1 (8 - 12 ft bgs)	mg/kg	31.36	5.21	39.3	7.35	135.42	4.92	197
MP01SS16	Main Tailings Pile/Borehole 1 (12 - 16 ft bgs)	mg/kg	54.92	6.22	12.7	--	148.84	5.16	--
MP01SS20	Main Tailings Pile/Borehole 1 (16 - 20 ft bgs)	mg/kg	2,416.48	43.79	1.7	0.808	173.52	6.31	34.6
MP02SS04	Main Tailings Pile/Borehole 2 (0 - 4 ft bgs)	mg/kg	22.72	4.94	16.8	--	63.82	3.9	--
MP02SS08	Main Tailings Pile/Borehole 2 (4 - 8 ft bgs)	mg/kg	N/A	N/A	0.75 J	--	N/A	N/A	--
MP03SS04	Main Tailings Pile/Borehole 3 (0 - 4 ft bgs)	mg/kg	1.13	5.32	0.14 J	--	75.13	5.19	--
MP04SS04	Main Tailings Pile/Borehole 4 (0 - 4 ft bgs)	mg/kg	18.14	6.6	0.95 J	--	170.07	7.69	--
MP04SS08	Main Tailings Pile/Borehole 4 (4 - 8 ft bgs)	mg/kg	20.06	4.7	6.1	--	178.08	5.45	--
MP04SS12	Main Tailings Pile/Borehole 4 (8 - 12 ft bgs)	mg/kg	19.97	5.67	3.1	--	157.06	6.06	--
MP04SS16	Main Tailings Pile/Borehole 4 (12 - 16 ft bgs)	mg/kg	2.68	3.51	0.8 J	--	20.66	2.65	--
MP05SS04	Old Furnace Area/Borehole 5 (0 - 4 ft bgs)	mg/kg	1,180.6	26.85	68.6	17.7	131.2	5.33	118
MP05SS08	Old Furnace Area/Borehole 5 (4 - 8 ft bgs)	mg/kg	80.96	7.95	45	--	65.25	4.37	--
MP06SS04	Old Furnace Area/Borehole 6 (0 - 4 ft bgs)	mg/kg	16.1	4.15	386	--	70.32	3.53	--
MP07SS04	Old Furnace Area/Borehole 7 (0 - 4 ft bgs)	mg/kg	131.67	8.7	145	3.83	47.53	3.59	17.7
MP08SS04	Main Tailings Pile/Borehole 8 (0 - 4 ft bgs)	mg/kg	19.12	4.57	6.5	--	149.86	5.01	--
MP09SS04	Main Tailings Pile/Borehole 9 (0 - 4 ft bgs)	mg/kg	2.99	3.99	1.5	5.42	37.87	3.13	35.3
MP10SS04	Main Tailings Pile/Borehole 10 (0 - 4 ft bgs)	mg/kg	18.23	4.74	0.89 J	--	139.5	5.08	--
MP10SS08B	Main Tailings Pile/Borehole 10 (4 - 8 ft bgs)	mg/kg	14.42	4.46	4.6	--	23.29	2.65	--

Table 5-2

TOTAL MERCURY AND ARSENIC IN WASTE ROCK/TAILINGS SAMPLES
FROM REMOVAL ASSESSMENT AND SITE INSPECTION
BLACK BUTTE MINE
LANE COUNTY, OREGON

Sample Number	Sample Location/Identification (depth)	Units	Total Mercury				Total Arsenic		
			XRF	+/-	Lumex	Fixed Laboratory	XRF	+/-	Fixed Laboratory
Environmental Protection Agency Region 9 PRGs		mg/kg	23				0.39		
MP10SS08A	Main Tailings Pile/Borehole 10 (4 - 8 ft bgs)	mg/kg	19.79	6.6	5.2	--	116.67	6.51	--
MP11SS04	Main Tailings Pile/Borehole 11 (0 - 4 ft bgs)	mg/kg	19.44	4.64	2.8	--	100.39	4.37	--
MP11SS08	Main Tailings Pile/Borehole 11 (4 - 8 ft bgs)	mg/kg	43.25	5.86	0.95 J	--	213.14	6.22	--
MP11SS12	Main Tailings Pile/Borehole 11 (8 - 12 ft bgs)	mg/kg	26.58	5.44	2.5	--	392.67	8.69	--
MP11SS16	Main Tailings Pile/Borehole 11 (12 - 16 ft bgs)	mg/kg	42.01	5.89	2.4	--	263.91	6.97	--
MP11SS20	Main Tailings Pile/Borehole 11 (16 - 20 ft bgs)	mg/kg	21.47	5.01	1.2 J	--	151.56	5.2	--
MP12SS04	New Furnace Area/Borehole 12 (0 - 4 ft bgs)	mg/kg	1.78	3.23	8.8	--	29.5	2.62	--
MP12SS08	New Furnace Area/Borehole 12 (4 - 8 ft bgs)	mg/kg	9.34	4	N/A	0.952	12.2	2.59	7.33

Table 5-2

TOTAL MERCURY AND ARSENIC IN WASTE ROCK/TAILINGS SAMPLES
FROM REMOVAL ASSESSMENT AND SITE INSPECTION
BLACK BUTTE MINE
LANE COUNTY, OREGON

Sample Number	Sample Location/Identification (depth)	Units	Total Mercury				Total Arsenic		
			XRF	+/-	Lumex	Fixed Laboratory	XRF	+/-	Fixed Laboratory
Environmental Protection Agency Region 9 PRGs		mg/kg	23				0.39		
Site Inspection (September 1998)									
98BBBG01SS	Background Surface (0 - 2 in bgs)	mg/kg	15.2	--	--	--	68.5	--	--
98BBBG01SB	Background Subsurface (20 - 24 in bgs)	mg/kg	11.1 J K	--	--	--	69.4	--	--
98BBMT01SS	Upper Tailings - East Surface (0 - 2 in bgs)	mg/kg	0.383	--	--	--	52	--	--
98BBMT01SB	Upper Tailings - East Subsurface (20 - 26 in bgs)	mg/kg	0.11	--	--	--	56.7	--	--
98BBMT02SS	Upper Tailings - West Surface (0 - 2 in bgs)	mg/kg	11.8	--	--	--	52.9	--	--
98BBMT02SB	Upper Tailings - West Subsurface (16 - 20 in bgs)	mg/kg	**148**	--	--	--	**239**	--	--
98BBMT03SS	Lower Tailings - West Surface (0 - 2 in bgs)	mg/kg	2.62	--	--	--	**269**	--	--
98BBMT03SB	Lower Tailings - West Subsurface (16 - 20 in bgs)	mg/kg	5.44	--	--	--	**356**	--	--
98BBMT04SS	Lower Tailings - Northwest Surface (0 - 2 in bgs)	mg/kg	3.44	--	--	--	**348**	--	--
98BBMT04SB	Lower Tailings - Northwest Subsurface (20 - 26 in bgs)	mg/kg	3.66	--	--	--	**338**	--	--
98BBMT05SS	Lower Tailings - Center Surface (0 - 2 in bgs)	mg/kg	5.99	--	--	--	**109**	--	--
98BBMT05SB	Lower Tailings - Center Subsurface (14 - 20 in bgs)	mg/kg	2.04	--	--	--	**143**	--	--
98BBMT06SS	Lower Tailings - East Surface (0 - 2 in bgs)	mg/kg	1.12	--	--	--	**382**	--	--
98BBMT06SB	Lower Tailings - East Subsurface (12 - 18 in bgs)	mg/kg	1.18	--	--	--	**330**	--	--
98BBMK01SS	New Furnace - Outside Mill East Door (0 - 2 in bgs)	mg/kg	**2,550**	--	--	--	**270**	--	--
98BBMK01SB	New Furnace - Outside Mill East Door (10 - 16 in bgs)	mg/kg	**397**	--	--	--	**173**	--	--
98BBMK02SS	New Furnace - Inside Mill Near Feeder (0 - 2 in bgs)	mg/kg	**1,800**	--	--	--	**145**	--	--
98BBMK02SB	New Furnace - Mill Trap Door (1 - 7 in bgs)	mg/kg	**237**	--	--	--	**102**	--	--
98BBMK03SS	New Furnace - Outside Mill West Door (0 - 2 in bgs)	mg/kg	**2,390**	--	--	--	**153**	--	--
98BBMK03SB	New Furnace - Outside Mill Northeast Side (12-18 in bgs)	mg/kg	**91.9**	--	--	--	**132**	--	--
98BBMK04SS	New Furnace - East Side Foundation (0 - 2 in bgs)	mg/kg	**54,300**	--	--	--	**952**	--	--
98BBMK04SB	New Furnace - Outside Mill Northwest Side (12-18 in bgs)	mg/kg	**264**	--	--	--	**135**	--	--
98BBMK05SS	New Furnace - Outside Mill Northeast Side (0-2 in bgs)	mg/kg	**359**	--	--	--	**183**	--	--
98BBMK06SS	New Furnace - Outside Mill Northwest Side (0-2 in bgs)	mg/kg	**174**	--	--	--	**114**	--	--

Key:

XRF = X-ray Fluorescence.
+/- = confidence interval around XRF result.
PRGs = Preliminary Remediation Goals.
-- = no data.
ft = feet.
in = inches.
bgs = below ground surface.
mg/kg = milligrams per kilogram.
Bold = exceeds benchmark.

00044

Table 5-3

TOTAL MERCURY IN SEDIMENT (CREEKS AND ADIT) SAMPLES FROM REMOVAL ASSESSMENT AND SITE INSPECTION
BLACK BUTTE MINE
LANE COUNTY, OREGON

Sample Number	Sample Location	Matrix	Units	Total Mercury	
				XRF	Fixed Laboratory
	Oregon DEQ Level II Screening Level Values - Invertebrates	Soil	mg/kg	0.1	
	Removal Assessment (September 2005)				
CK01SD01	Garoutte Creek downstream of Dennis Creek	Sediment	mg/kg	**1.2 J**	--
CK02SD01	Dennis Creek just above confluence with Garoutte Creek	Sediment	mg/kg	**6.2**	--
CK03SD01	Dennis Creek below Old Mine Road	Sediment	mg/kg	**0.54 J**	--
CK04SD01	Dennis Creek at base of Tailings	Sediment	mg/kg	**0.9 J**	--
CK05SD01	Dennis Creek 35 feet downstream of drainage from Dennis Creek Adit Area	Sediment	mg/kg	**3.5**	--
CK06SD01	Dennis Creek Background - 200 feet upgradient of confluence with drainage from Dennis Creek Adit Area	Sediment	mg/kg	**7**	0.435
CK07SD01	Garoutte Creek upgradient of confluence with Furnace Creek	Sediment	mg/kg	**0.45 J**	--
CK08SD01	Furnace Creek at base of Tailings	Sediment	mg/kg	**37.4**	79
CK09SD01	Furnace Creek Background	Sediment	mg/kg	**1.7**	--
OA01SD01	"404" Adit	Sediment	mg/kg	**2.1**	--
	Site Inspection (September 1998)				
98BBDC05SD	Dennis Creek Background	Sediment	mg/kg	**0.978 J H**	--
98BBDC04SD	Dennis Creek Tributary	Sediment	mg/kg	**1.22 J H**	--
98BBDC03SD	Dennis Creek below Tailings	Sediment	mg/kg	**48 J H**	--
98BBDC02SD	Dennis Creek below Mine Road	Sediment	mg/kg	**5.61 J H**	--
98BBDC01SD	Dennis Creek at Mouth	Sediment	mg/kg	**3.85 J H**	--
98BBGC02SD	Garoutte Creek Background	Sediment	mg/kg	**0.932 J H**	--
98BBGC01SD	Garoutte Creek below Dennis Creek	Sediment	mg/kg	**0.978 J H**	--
98BBDC05SD	"404" Adit	Sediment	mg/kg	**11.5 J H**	--

Key:

DEQ = Department of Environmental Quality.

mg/kg =milligrams per kilogram.

-- = no data

J = The analyte was positively identified. The result is estimated because the concentration is below the Sample Quantitation Limit.

H = High bias.

Bold = exceeds benchmark

Table 5-4

TOTAL MERCURY IN SURFACE WATER (CREEKS AND ADIT) SAMPLES
FROM REMOVAL ASSESSMENT AND SITE INSPECTION
BLACK BUTTE MINE
LANE COUNTY, OREGON

Sample Number	Sample Location	Matrix	Units	Total Mercury	
				Lumex	Fixed Laboratory
EPA National Recommended Water Quality Criteria (Freshwater.CCC)		Water	µg/L	0.77	
Oregon DEQ Level II Screening Level Values - Aquatic		Water	µg/L	0.77	
Removal Assessment (September 2005)					
CK01SW01	Garoutte Creek downstream of Dennis Creek	Water	µg/L	1.4 U	--
CK02SW02	Dennis Creek just above confluence with Garoutte Creek	Water	µg/L	1.4 U	--
CK03SW01	Dennis Creek below Old Mine Road	Water	µg/L	1.4 U	--
CK04SW01	Dennis Creek below Tailings	Water	µg/L	1.4 U	--
CK05SW01	Dennis Creek 35 feet downstream of drainage from Dennis Creek Adit Area	Water	µg/L	1.4 U	--
CK06SW01	Dennis Creek Background - 200 feet upgradient of confluence with drainage from Dennis Creek Adit Area	Water	µg/L	1.4 U	0.073
CK07SW01	Garoutte Creek upgradient of confluence with Furnace Creek	Water	µg/L	1.4 U	--
CK08SW01	Furnace Creek at base of Tailings	Water	µg/L	1.4 U	**2.25**
CK09SW01	Furnace Creek Background	Water	µg/L	1.4 U	--
OA01SW01	"404" Adit	Water	µg/L	1.4 U	--
Site Inspection (September 1998)					
98BBDC05SW	Dennis Creek Background	Water	µg/L	0.2 U	--
98BBDC04SW	Dennis Creek Tributary	Water	µg/L	0.2 U	--
98BBDC03SW	Dennis Creek below Tailings	Water	µg/L	0.2 U	--
98BBDC02SW	Dennis Creek below Mine Road	Water	µg/L	0.2 U	--
98BBDC01SW	Dennis Creek at Mouth	Water	µg/L	0.2 U	--
98BBGC02SW	Garoutte Creek Background	Water	µg/L	0.2 U	--
98BBGC01SW	Garoutte Creek below Dennis Creek	Water	µg/L	0.2 U	--
98BBDC05SW	"404" Adit	Water	µg/L	U	--

Key:

EPA = U.S. Environmental Protection Agency.
DEQ = Department of Environmental Quality.
CCC = Criterion Continuous Concentration.
µg/L = micrograms per liter.
U = The analyte was not detected at or above the listed detection limit.
Bold = exceeds benchmark

Table 5-5

MERCURY IN LEACHATE FROM WASTE ROCK/TAILINGS
SYNTHETIC PRECIPITATION LEACHING PROCEDURE
BLACK BUTTE MINE REMOVAL ASSESSMENT
LANE COUNTY, OREGON

Sample Number	Sample Location/Identification (depth)	Matrix	Units	Mercury
	Oregon Leachate Reference Concentration		mg/L	0.2
MP01SS04	Main Tailings Pile/Borehole 1 (0 - 4 ft bgs)	Waste Rock/Tailings	mg/L	0.002 U
MP01SS20	Main Tailings Pile/Borehole 1 (16 - 20 ft bgs)	Waste Rock/Tailings	mg/L	0.002 U
MP05SS04	Old Furnace Area/Borehole 5 (0 - 4 ft bgs)	Waste Rock/Tailings	mg/L	0.002 U
MP05SS08	Old Furnace Area/Borehole 5 (4 - 8 ft bgs)	Waste Rock/Tailings	mg/L	0.002 U
MP07SS04	Old Furnace Area/Borehole 7 (0 - 4 ft bgs)	Waste Rock/Tailings	mg/L	0.002 U
MP12SS08	New Furnace Area/Borehole 12 (4 - 8 ft bgs)	Waste Rock/Tailings	mg/L	0.00149

Key:

RL = reporting limit
MDL = method detection limit
ft = feet.
bgs = below ground surface.
mg/L = milligrams per liter.
U = Result below the method detection limit (MDL) and therefore analyte was not detected.
Bold = **exceeds benchmark**

Table 5-6

TOTAL, MONOMETHYL, AND SELECTIVE SEQUENTIAL EXTRACTION MERCURY RESULTS IN WASTE ROCK/TAILINGS AND SEDIMENT
BLACK BUTTE MINE REMOVAL ASSESSMENT
LANE COUNTY, OREGON

Sample Number	Sample Location/Identification (depth)	Matrix	Mercury (in mg/kg, dry weight)							% Solids
			Total	Monomethyl	Selective Sequential Extraction					
					Water Soluble	Stomach Acid Soluble	Organo - Chelated	Elemental Mercury	Mercuric Sulfide	
Oregon Level II Screening Level Values - Plants		Soil	0.3	0.0002	--	--	--	--	--	--
Oregon Level II Screening Level Values - Invertebrates		Soil	0.1	--	--	--	--	--	--	--
MP01SS12	Main Tailings Pile/Borehole 1 (8 - 12 ft bgs)	Waste Rock/Tailings	**9.64 J**	**0.0002 J**	0.258	0.274	0.0179	6.3	2.820	90.15
MP01SS20	Main Tailings Pile/Borehole 1 (16 - 20 ft bgs)	Waste Rock/Tailings	**1.13**	0.000015 J	0.00144	0.00548 J	0.364	0.628	0.0806	65.92
MP05SS04	Old Furnace Area/Borehole 5 (0 - 4 ft bgs)	Waste Rock/Tailings	**1,190**	**0.00134 J**	27.8	177	389	659	122	77.44
MP06SS04	Old Furnace Area/Borehole 6 (0 - 4 ft bgs)	Waste Rock/Tailings	**431 J**	**0.000319 J**	5.61 J	256 J	30.5 J	113 J	254 J	82.37
MP12SS08	New Furnace Area/Borehole 12 (4 - 8 ft bgs)	Waste Rock/Tailings	**1.25**	0.000018 J	0.0722	0.00381 J	0.435	0.396	0.029 J	84.53
CK01SD01	Garoutte Creek downstream of Dennis Creek	Sediment	**5.36 J**	**0.000731 J**	0.0516 J	0.00172 J	0.134 J	0.211 J	0.431 J	73.85
CK08SD01	Furnace Creek at base of Tailings	Sediment	**225**	**0.0127 J**	5.49	30.9	0.292	135	128	63.44
OA01SD01	404 - Adit	Sediment	**10.90**	0.000015 J	0.135	0.970	0.0269	5.710	2.210	66.52

Key:

mg/kg = milligrams per kilogram.

-- = no benchmark.

J = Estimated value.

U = Result below the method detection limit (MDL) and therefore analyte was not detected. Results reported at MDL.

Bold = exceeds benchmark

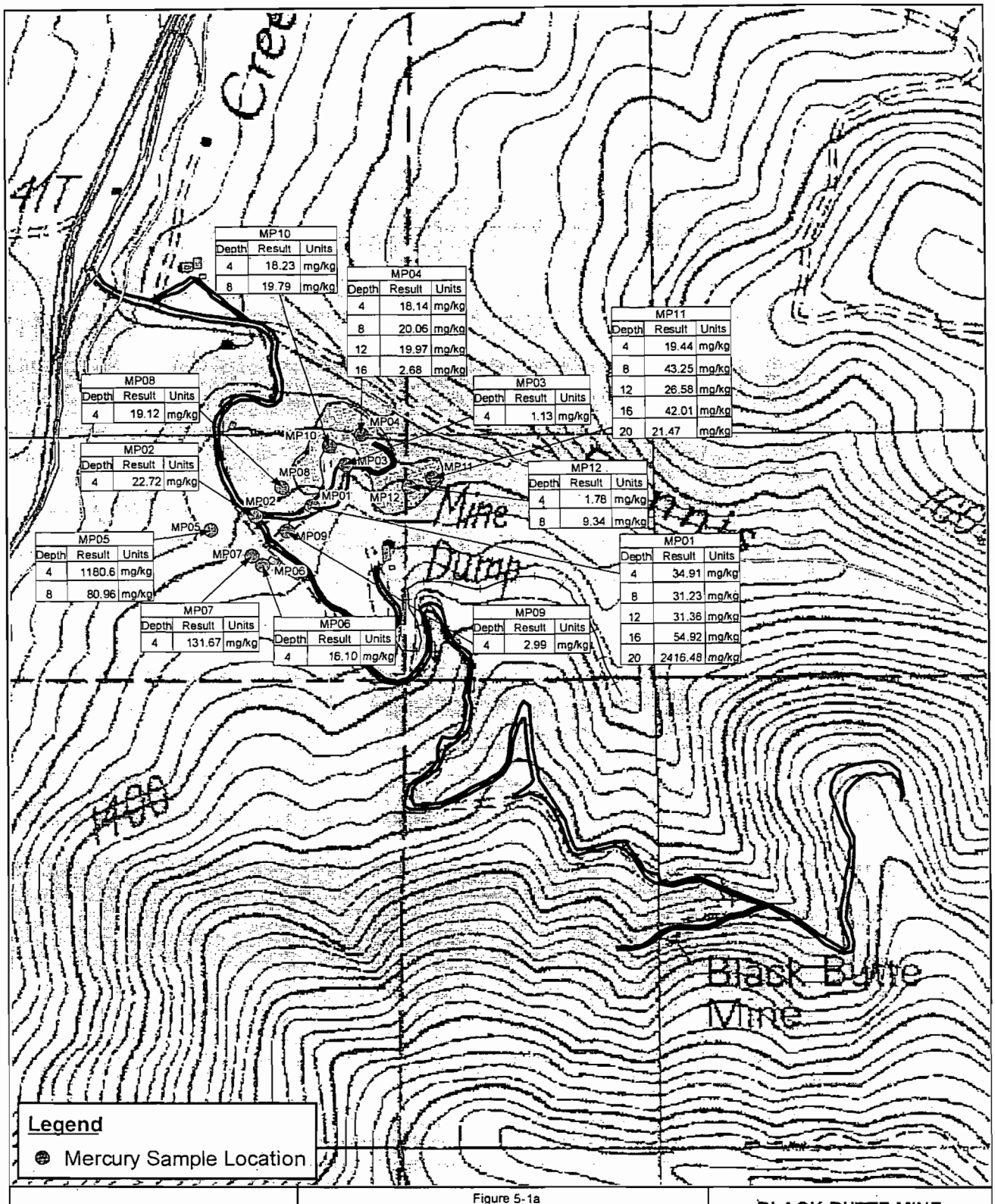


Figure 5-1a

WASTE ROCK/TAILINGS SAMPLE LOCATION MAP AND TOTAL MERCURY RESULTS

BLACK BUTTE MINE

Lane County, Oregon

Job Id: 002233.0026.01IA	
Date: 1/20/06	GIS Analyst: avh

Map Source Information: USGS Topographic Map. Harness Mountain, Oregon. Scale 1-24,000.

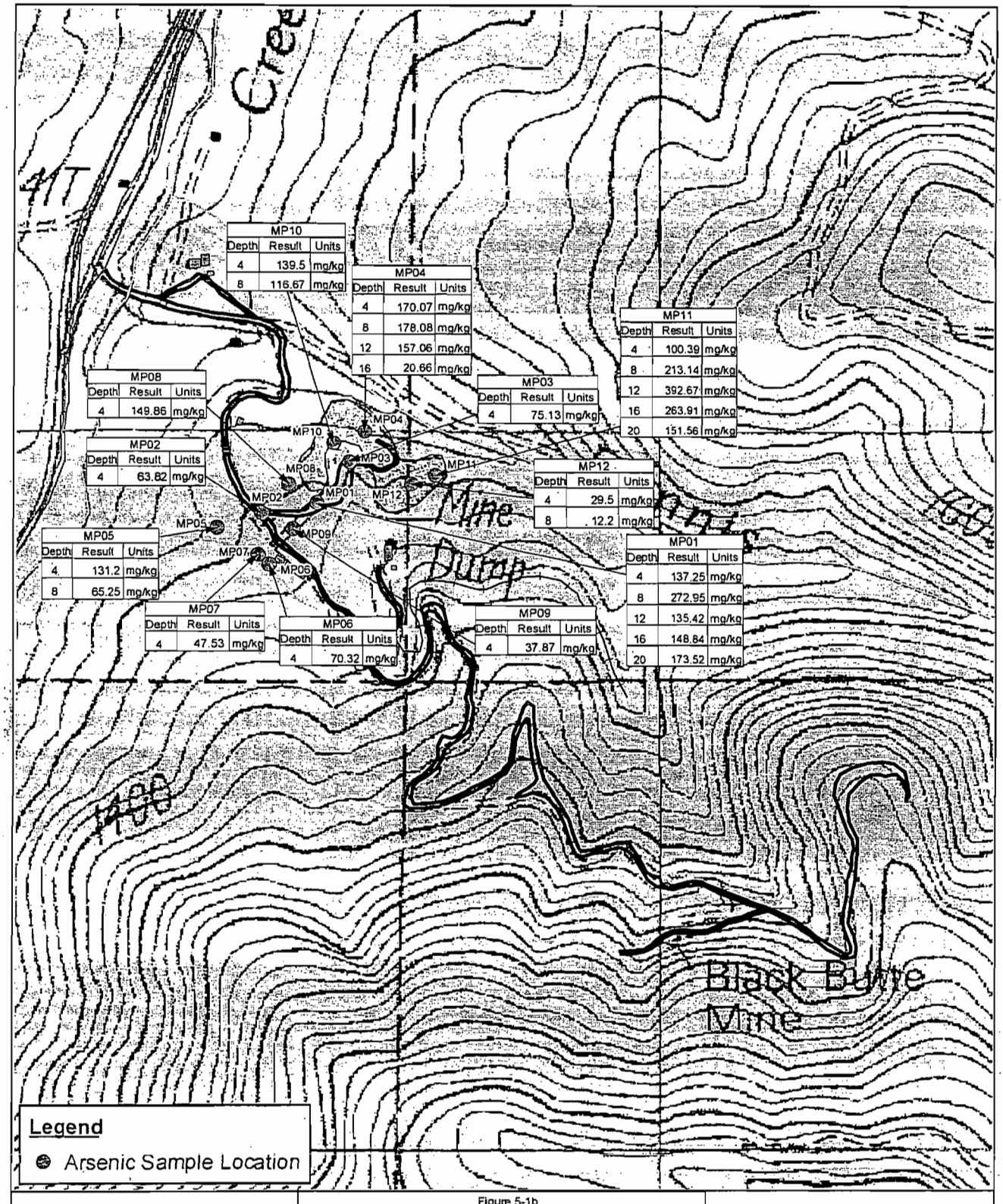


Figure 5-1b

WASTE ROCK/TAILINGS SAMPLE LOCATION MAP AND TOTAL ARSENIC RESULTS

BLACK BUTTE MINE

Lane County, Oregon

Job Id: 002233.0026.01IA

Date: 1/20/06

GIS Analyst: avh

Map Source Information: USGS Topographic Map. Harness Mountain, Oregon. Scale 1-24,000.

ecology and environment, inc.
International Specialists in the Environment
Portland, Oregon

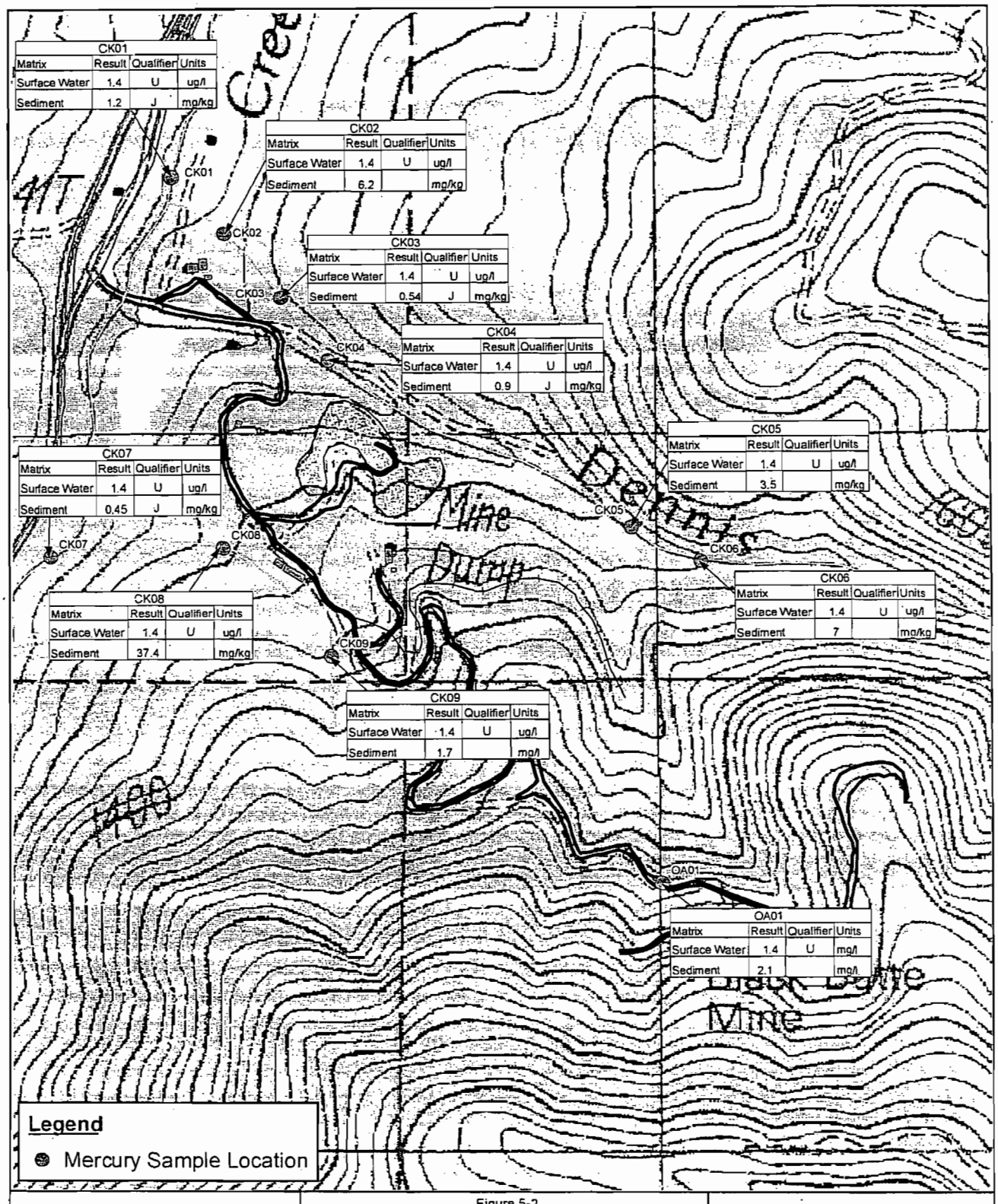


Figure 5-2

SURFACE WATER AND SEDIMENT SAMPLE LOCATION MAP WITH TOTAL MERCURY RESULTS

BLACK BUTTE MINE

Lane County, Oregon

Job Id: 002233.0026.01IA

Date: 1/20/06

GIS Analyst: avh

Map Source Information: USGS Topographic Map. Harness Mountain, Oregon. Scale 1-24,000.

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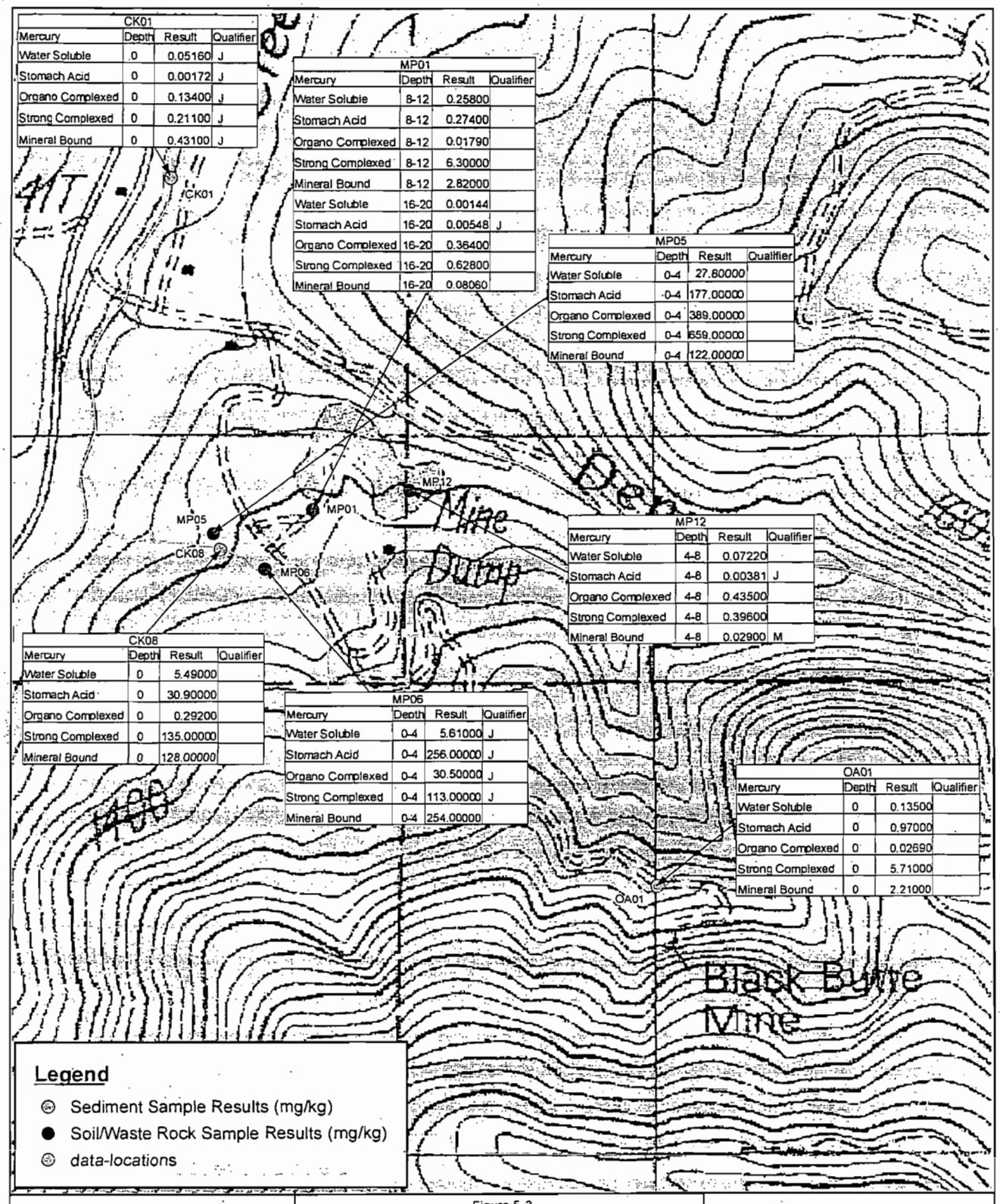
International Specialists in the Environment
Portland, Oregon



CK01			
Mercury	Depth	Result	Qualifier
Water Soluble	0	0.05160	J
Stomach Acid	0	0.00172	J
Organo Complexed	0	0.13400	J
Strong Complexed	0	0.21100	J
Mineral Bound	0	0.43100	J

MP01			
Mercury	Depth	Result	Qualifier
Water Soluble	8-12	0.25800	
Stomach Acid	8-12	0.27400	
Organo Complexed	8-12	0.01790	
Strong Complexed	8-12	6.30000	
Mineral Bound	8-12	2.82000	
Water Soluble	16-20	0.00144	
Stomach Acid	16-20	0.00548	J
Organo Complexed	16-20	0.36400	
Strong Complexed	16-20	0.62800	
Mineral Bound	16-20	0.08060	

MP05			
Mercury	Depth	Result	Qualifier
Water Soluble	0-4	27.80000	
Stomach Acid	0-4	177.00000	
Organo Complexed	0-4	389.00000	
Strong Complexed	0-4	659.00000	
Mineral Bound	0-4	122.00000	

MP12			
Mercury	Depth	Result	Qualifier
Water Soluble	4-8	0.07220	
Stomach Acid	4-8	0.00381	J
Organo Complexed	4-8	0.43500	
Strong Complexed	4-8	0.39600	
Mineral Bound	4-8	0.02900	M

CK08			
Mercury	Depth	Result	Qualifier
Water Soluble	0	5.49000	
Stomach Acid	0	30.90000	
Organo Complexed	0	0.29200	
Strong Complexed	0	135.00000	
Mineral Bound	0	128.00000	

MP06			
Mercury	Depth	Result	Qualifier
Water Soluble	0-4	5.61000	J
Stomach Acid	0-4	256.00000	J
Organo Complexed	0-4	30.50000	J
Strong Complexed	0-4	113.00000	J
Mineral Bound	0-4	254.00000	

OA01			
Mercury	Depth	Result	Qualifier
Water Soluble	0	0.13500	
Stomach Acid	0	0.97000	
Organo Complexed	0	0.02690	
Strong Complexed	0	5.71000	
Mineral Bound	0	2.21000	

Figure 5-3

WASTE ROCK/TAILINGS SAMPLE LOCATION MAP WITH SEQUENTIAL SELECTIVE EXTRACTION RESULTS FOR MERCURY

BLACK BUTTE MINE

Lane County, Oregon

Job Id: 002233.0026.01A

Date: 1/19/06

GIS Analyst: avh

Map Source Information: USGS Topographic Map. Harness Mountain, Oregon. Scale 1-24,000.

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Portland, Oregon

6. REMOVAL ASSESSMENT

This section is organized into the five decision areas identified in the SSSP (E & E 2005): Main Tailings Pile (Subsection 6.1); Old Ore Furnace (Subsection 6.2); New Furnace Area (Subsection 6.3); Other Areas of Potential Contamination (Subsection 6.4); and Furnace Creek, Dennis Creek, and Garoutte Creek (Subsection 6.5). Assessment of each decision area is based on the results of sampling and field activities for this RA and on the results of the Site Inspection conducted in 1998 for EPA Region 10 (E & E 1999). Analytical results from the Site Inspection were included in Tables 5-2 through 5-4 along with results from the RA.

Based on the non-detections to low concentration of total mercury in leachate produced using SPLP and on the low solubility of the predominant mercury species indicated by sequential selective extraction, the main mechanism for the transportation of mercury in the environment at BBM appears to be mechanical (ie. erosion).

6.1 MAIN TAILINGS PILE

Eight borings (MP01, MP02, MP03, MP04, MP08, MP09, MP10, and MP11) were completed in the main waste rock/tailings pile as part of the RA and six locations were sampled as part of the Site Inspection. Only samples from borings MP01 and MP11 exceeded the EPA Region 9 PRG for residential soil. However, the highest detection of total mercury (2,416.48 mg/kg in sample MP01SS20) was from a depth of 16 to 20 feet bgs and was located in the approximate middle of the Main Waste Rock/Tailings Pile. Although the total mercury concentration exceeds the EPA Region 9 PRG for mercury in residential soil by two orders of magnitude, results of SPLP analysis for mercury in sample MP01SS20 indicate that leaching is likely not occurring or is occurring at a very low level. Sequential selective extraction of mercury also indicates that the mercury present in this area is not highly soluble.

In addition, a substantial quantity of waste rock/tailings were removed and used in highway construction (Michael Pooler, personal communication). In Photo 1-12 of Appendix A, the push-probe rig is located in an area where a significant quantity of waste rock/tailings have apparently been removed. The ridge along the left side of the photo is a remnant of a much larger pile of waste rock/tailings whose

surface apparently once extended over the area where the push-probe rig is located. Photo 1-17 in Appendix A shows the north-northeast edge of the main waste rock/tailings pile. The waste rock/tailings follow the steep angle shown on the right of the photo down toward Dennis Creek. The waste rock/tailings along this side of the pile are unstable and subject to erosion and undercutting by unnamed drainages that are tributary to Dennis Creek.

Stabilization of waste rock/tailings in the area of the Main Tailings Pile is recommended to reduce the likelihood that materials will continue to erode into Dennis Creek.

6.2 OLD ORE FURNACE

The Old Ore Furnace is shown in Photos 1-1 through 1-4 in Appendix A. Three borings (MP05, MP06, and MP07) were completed in tailings thought to have originated from processing in the Old Ore Furnace. These tailings are located downslope of the Old Ore Furnace. Total mercury concentrations in all but one sample exceeded the EPA Region 9 PRG for residential soil; however, only a thin layer of waste rock/tailings covers the majority of this area, apparently because tailings were removed. The presence of only a thin veneer to tailings/waste rock in this area is indicated in the boring logs for MP05, MP06, and MP07 (Appendix C) and shown in Photo 1-6 in Appendix A. Photo 1-6 shows the waste rock/tailings - soil interface at the top of the 0 to 4 foot core from MP06. The waste rock/tailings layer at this location was approximately 0.3 feet thick. This is an area where waste rock/tailings are believed to have been removed for reprocessing through the New Furnace.

Of the total mercury concentrations in waste rock/tailings samples from the Old Ore Furnace area (from locations MP05, MP06, and MP07), only the sample from MP06 did not exceed the EPA Region 9 PRG for residential soil. The highest concentration of total mercury in the Old Ore Furnace area was in the sample from 0 to 4 feet bgs in MP05 (1,180.6 mg/kg). This total mercury concentration is two orders of magnitude higher than the EPA Region 9 PRG and the second highest concentration detected in all samples collected. Results of SPLP analysis for mercury in MP05SS04 and MP05SS08 indicate that leaching is likely not occurring or is occurring at a very low level. Sequential selective extraction mercury analysis of sample MP05SS04 also suggests that the majority of mercury present in this area may be characterized as 'elemental mercury' or 'mercuric sulfide' indicating that it is not highly soluble and not readily methylated. MP05 is located in a thicker part of the waste rock/tailings pile from the Old Ore Furnace and is adjacent to Furnace Creek. The highest concentration of total mercury in sediment from Furnace Creek (37.4 mg/kg at location CK08) is also from this area where waste rock/tailings are in contact with the creek. This concentration exceeds the total mercury concentration in the background

sample from Furnace Creek. Sediment sample CK08 also was analyzed for monomethylmercury. The monomethylmercury concentrations in waste rock/tailings sample MP05 from 0 to 4 feet bgs (0.00134 J mg/kg) and in the sediment sample from location CK08 (0.0127 J mg/kg) exceed the ODEQ Level II soil SLV for plants of 0.0002 mg/kg. Sequential selective extraction of mercury suggests that the mercury present in this area is not highly soluble. Sequential selective extraction also indicates that the majority of mercury at this location may be characterized as 'elemental mercury' or 'mercuric sulfide'. The main mechanism for mercury transport is likely by mechanical processes.

In the Old Ore Furnace area, the waste rock/tailings should be removed from the stream. In the Old Ore Furnace area, removal of soils in the immediate area of the furnace structure is recommended.

6.3 NEW FURNACE AREA

Six surface soil samples and four subsurface soil samples were collected from the New Furnace Area as part of the Site Inspection (E & E 1999). The New Furnace Area was inaccessible to the Geoprobe rig, therefore, borings were not completed in this area and results of the Site Inspection were used. Results are summarized in Table 5-2 and presented in Figure 6-2, Appendix D. Total mercury concentrations ranged from 91.9 to 54,300 mg/kg in the New Furnace Area. Concentrations of total mercury in all samples exceed the EPA Region 9 PRG for residential soil of 23 mg/kg. The high concentrations of mercury in the immediate area of the mill structure and furnace are likely the result of localized spillage of elemental mercury during processing activities.

During the removal assessment, boring MP12 was completed in waste rock/tailings just downslope of the New Furnace Area. Total mercury concentrations in waste rock/tailings samples from MP12 were below the EPA Region 9 PRG for residential soil. The low concentrations of total mercury in samples from MP12 may be attributable to higher efficiency of the "New Furnace". Mercury was detected in the SPLP leachate from the waste rock/tailings sample collected from MP12 from 4 to 8 feet, bgs at a low concentration of 0.00149 mg/L. In addition, sequential selective extraction analysis for mercury suggests that the mercury present in the waste rock/tailings in this area is not highly soluble.

In the New Furnace Area, removal of soils in the immediate area of the mill structure is recommended. A removal action is not recommended for the waste rock/tailings just downslope of the New Furnace Area.

6.4 OTHER AREAS OF POTENTIAL CONTAMINATION

The other areas of potential contamination that were focused on during the RA are the Dennis Creek Adit and the "404" Adit. The Dennis Creek Adit did not have water flowing from the adit at the time of sampling. Based on a lack of indicators of drainage and the topography, it appeared that the Dennis Creek Adit remains dry during the wet season as well, and therefore, the Dennis Creek Adit does not appear to present an imminent or substantial risk to human health or the environment.

Sediment and surface water samples were collected from the "404" Adit. Total mercury was not detected in the surface water sample and the concentration of total mercury in the sediment sample (2.1 mg/kg) exceeded the ODEQ Level II soil SLV for invertebrates but did not exceed Dennis Creek background concentration. The monomethylmercury concentration in the sediment from the "404" Adit also was well below the ODEQ Level II soil SLV for plants. Results of sequential selective extraction for mercury suggest that the mercury present in the sediment is not highly soluble and over 88% of the mercury in the sediment may be characterized as 'elemental mercury' or 'mercuric sulfide' fractions and are, thus, not readily bioavailable.

A removal action is not recommended for either the Dennis Creek Adit or the "404" Adit.

6.5 FURNACE CREEK, DENNIS CREEK, AND GAROUTTE CREEK

All of the nine sediment samples collected for the RA, including the background samples, exceeded ODEQ Level II soil SLV for invertebrates for mercury. Background concentrations are interpreted to be higher than the selected criteria. Elevated background concentrations are natural and can be expected in a mineralized area such as the area surrounding BBM. Interpretation and recommendations are thus based on how mercury concentrations in downstream sediments compare to background sediment concentrations. Total mercury in the sediment sample from CK08 is the only concentration that substantially exceeds background. As described above, CK08 was collected from Furnace Creek, and is also the area where tailings downslope of the Old Ore Furnace are in contact with the creek. This sample also was analyzed for monomethylmercury. The resultant monomethylmercury concentration in CK08 sediment (0.0127 J mg/kg) exceeds the ODEQ Level II soil SLV for plants. Sequential selective extraction mercury analysis suggests that the mercury present in this area is likely not highly soluble. Sequential selective extraction results also indicate that over 77% of the total mercury at this location can be characterized as 'elemental mercury' or 'mercuric sulfide' fractions and thus not readily bioavailable.

Removal of tailings from Furnace Creek in the Old Ore Furnace area is recommended.

7. SUMMARY AND CONCLUSIONS

The BBM has been identified as a significant contributor of mercury to sediment and fish tissue in Cottage Grove Reservoir. Previous investigations reduced the areas of concern at BBM to five areas: Main Tailings Pile; Old Ore Furnace Area; New Furnace Area; Other Areas of Potential Contamination (Dennis Creek and "404" Adits); and Dennis Creek, Furnace Creek, and Garoutte Creek.

START-2 conducted an RA at the BBM site. Twelve direct-push borings were completed and waste rock/tailings samples were collected from the Main Tailings Pile, the Old Ore Furnace Area, and the New Furnace Area. All samples were field screened for total mercury and arsenic using an XRF and for total mercury using a Lumex. In addition, a subset of samples was submitted to a fixed laboratory for confirmation analysis of total mercury and arsenic. A subset of samples was submitted for SPLP analysis for mercury. Eight samples also were analyzed for monomethylmercury and sequential selective extraction of mercury.

Results of RA sampling were compared to various benchmarks. For the purpose of interpretation of sampling results, analytical data were compared to the most conservative criteria.

Both the RA sampling results and the sampling results of the 1998 Site Inspection were reviewed by decision area to evaluate the need for removal actions. Removal actions are recommended for the Main Tailings Pile, the Old Ore Furnace Area, the New Furnace Area, and Furnace Creek. START-2 recommends stabilization of waste rock/tailings along the north-northeast edge of the Main Tailings Pile to minimize future erosion of tailings that could eventually reach Dennis Creek and to prevent use of the tailings for construction projects. START-2 recommends removal of the tailings in the immediate area of Old Ore Furnace to minimize potential future erosion of waste rock/tailings into Furnace Creek; removal of waste rock/tailings from Furnace Creek to minimize movement of contaminated sediment further downstream; and removal of soils in the immediate area around the New Furnace to minimize potential direct contact exposure.

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APPENDIX A

PHOTOGRAPHIC DOCUMENTATION

Photo 1-1 Old Ore Furnace from tailings area.

Direction: Southwest

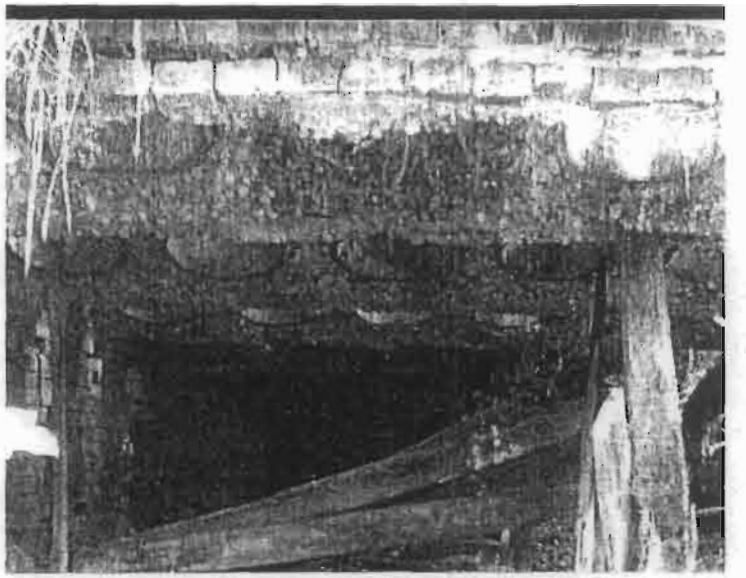

Photo 1-2 Old Ore Furnace detail showing ceramic pipes in ceiling.

Direction: Southwest

Photo 1-3 Old Ore Furnace detail.

Direction: Southwest

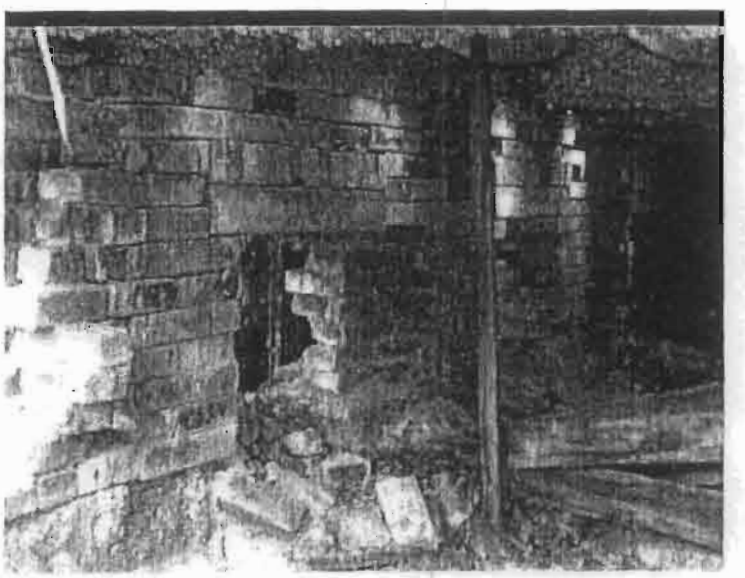

Photo 1-4 Old Ore Furnace detail.

Direction: Southwest

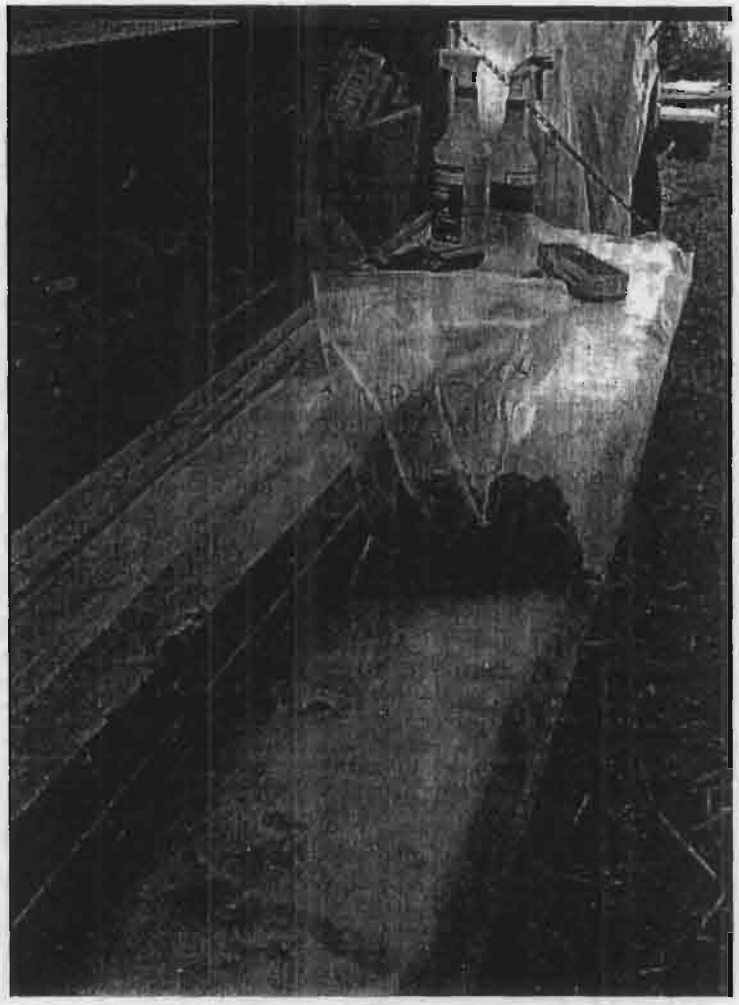

Photo 1-5 Soil/Tailings sample MP06SS04, boring MP06, 1-4 feet bgs.

Direction: North

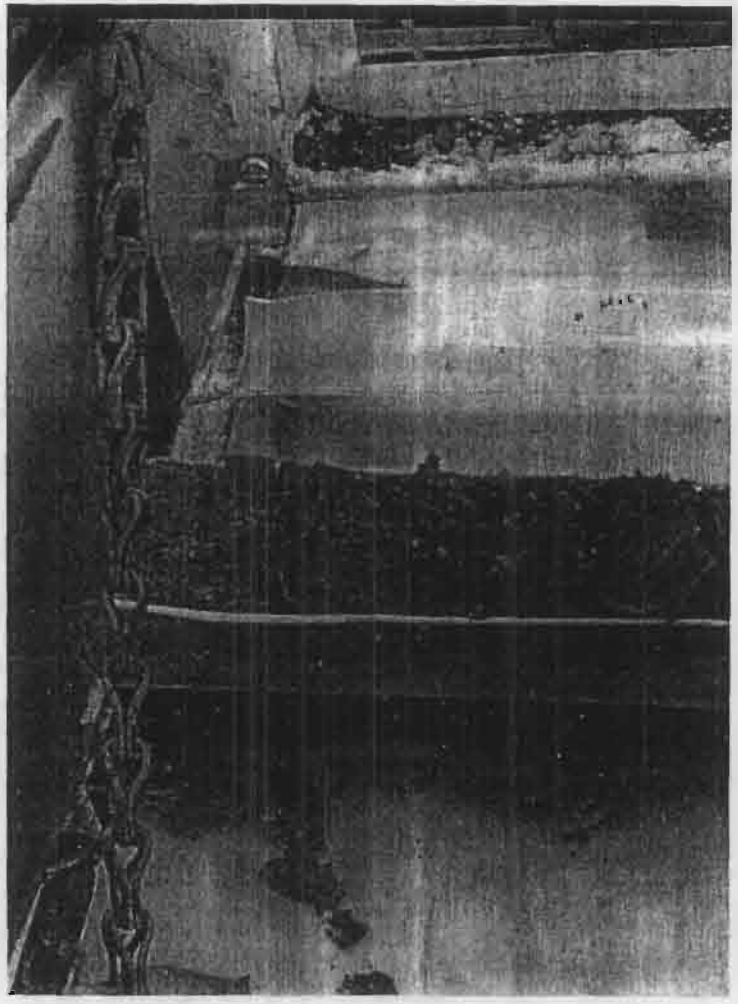

Photo 1-6 Fine tailings/natural soil interface, MP06, 1-4 feet bgs.

Direction: North

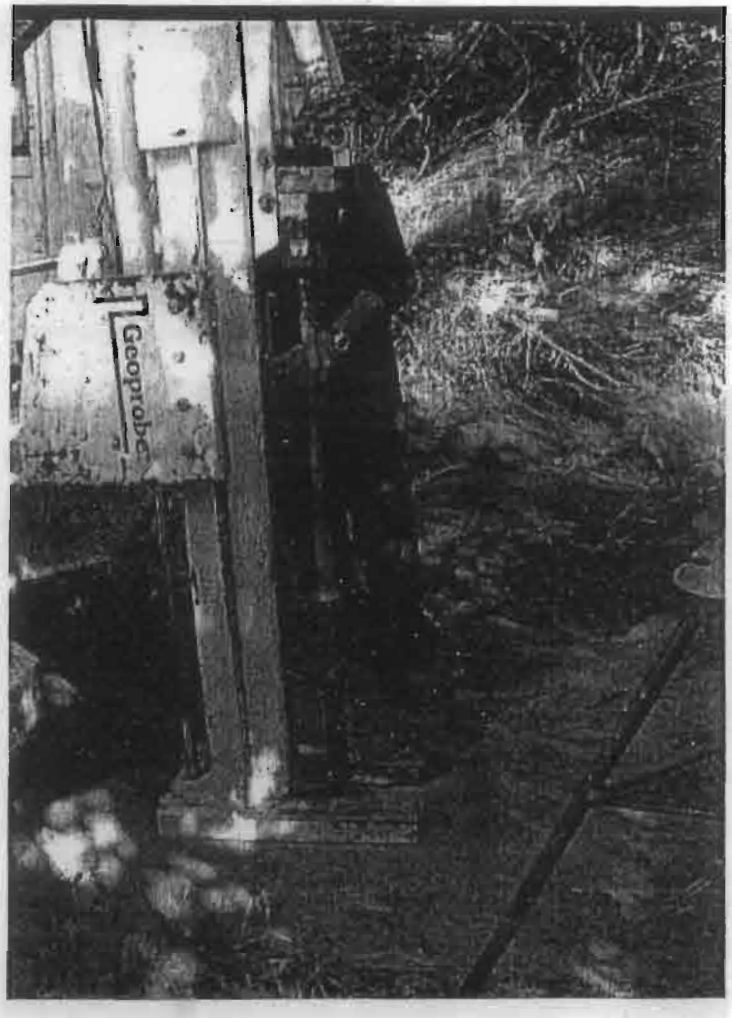

Photo 1-7 Probing MP07.

Direction: Southwest

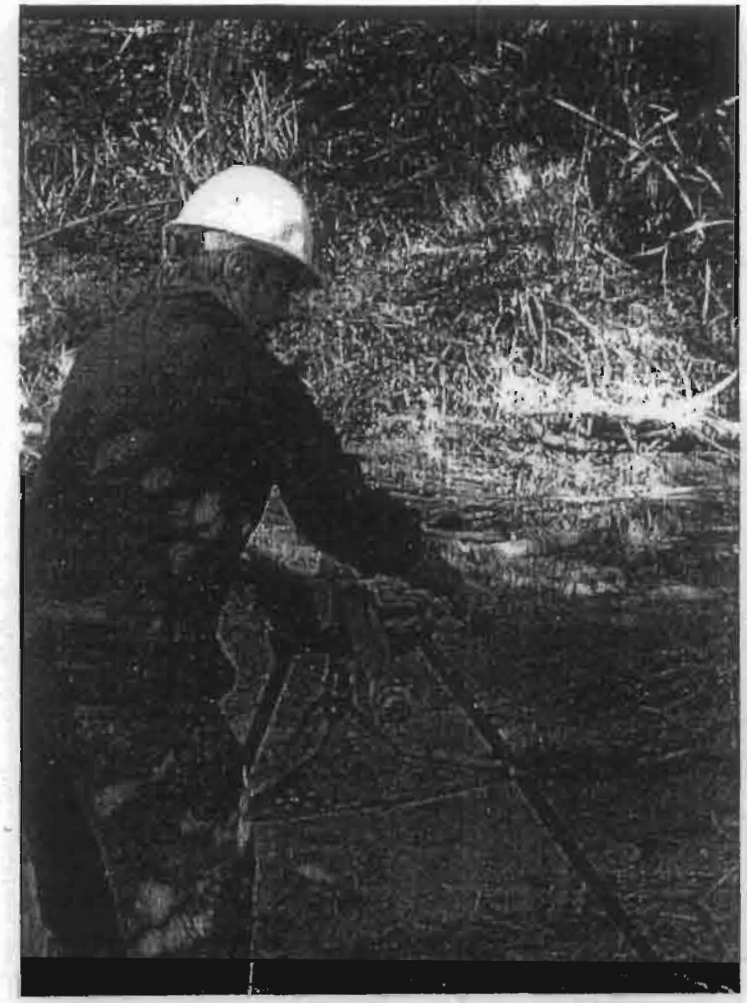

Photo 1-8 Collecting split-spoon sample, MP07.

Direction: Southwest

Photo 1-9 New Furnace Area, Hopper.

Direction: *Southeast*

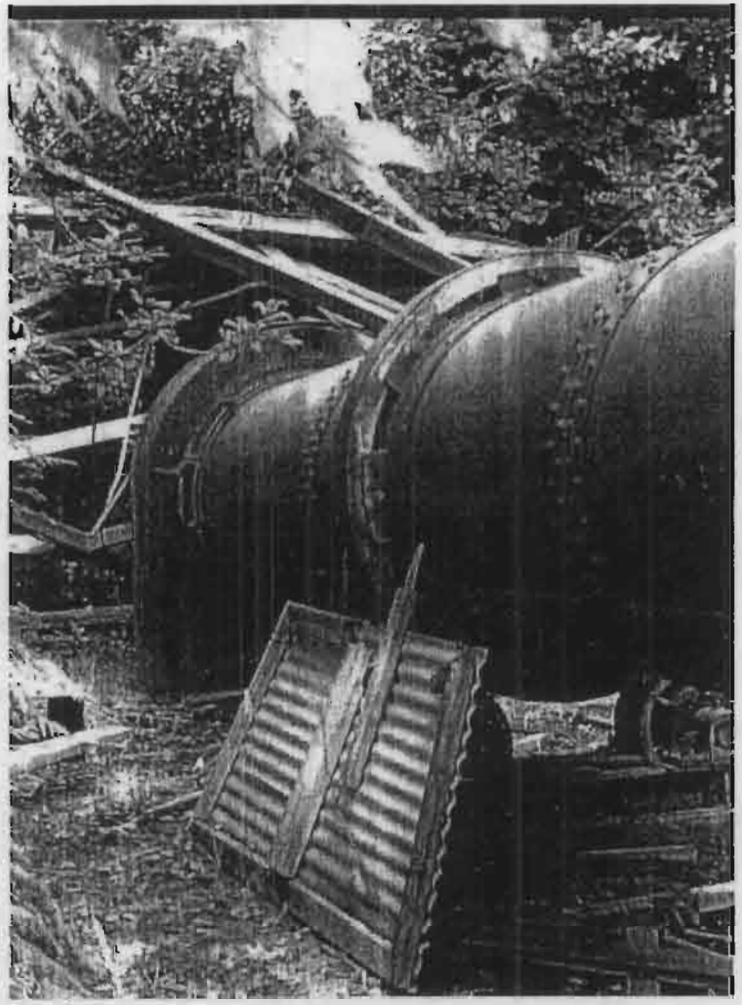

Photo 1-10 New Furnace Area, Rotary Kiln.

Direction: *North*

Photo 1-9 New Furnace Area, Hopper.

Direction: Southeast

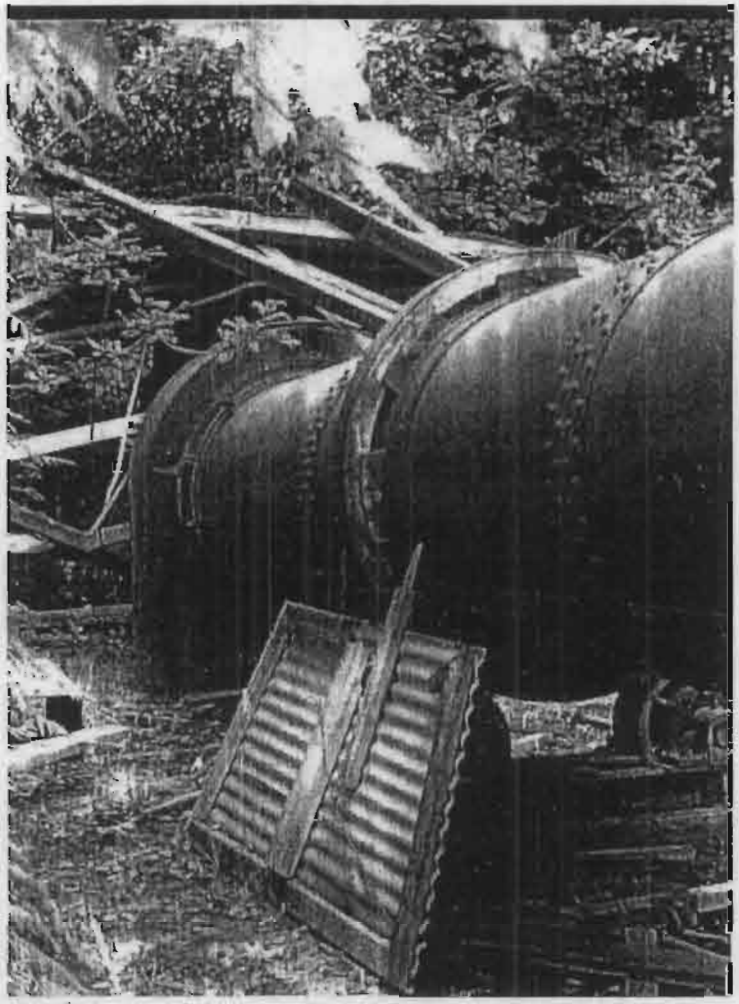

Photo 1-10 New Furnace Area, Rotary Kiln.

Direction: North

Photo 1-11 New Furnace Area, Hopper, Rotary Kiln, and Dust Collector.

Direction: South

Photo 1-12 MP11, tailings ridge drops off to Dennis Creek.

Direction: Southeast

Photo 1-13 MP11, tailings, note rig on area of previous tailings removal.

Direction: Southeast

Photo 1-14 Northernmost edge of tailings ridge.

Direction: Northwest

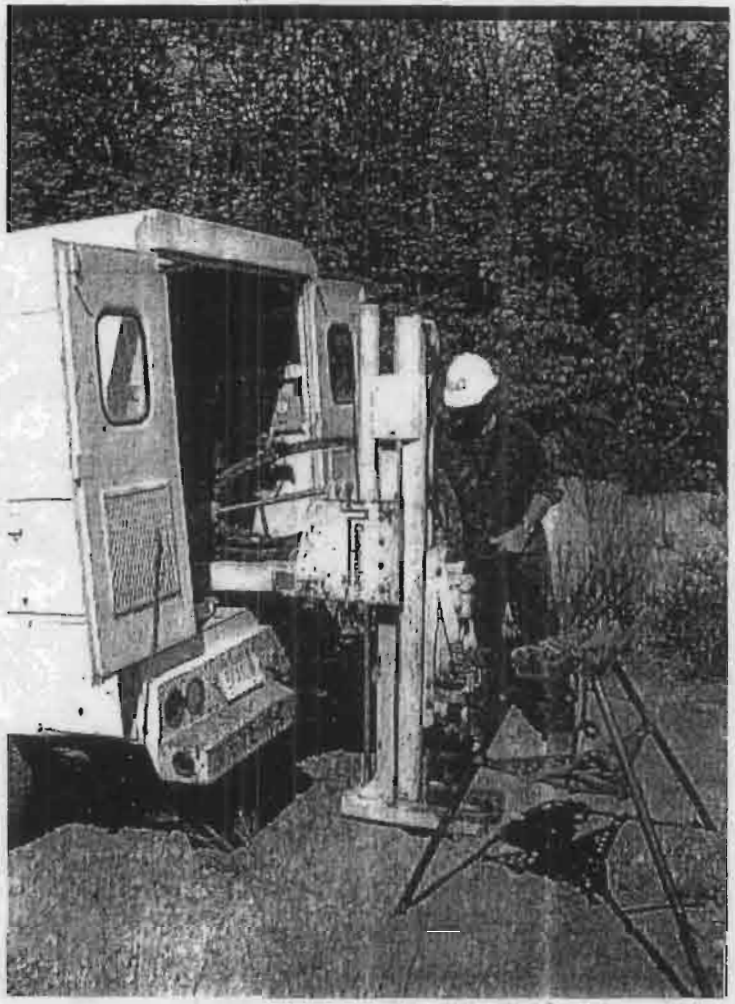

Photo 1-15 Boring MP-11.

Direction: Northeast

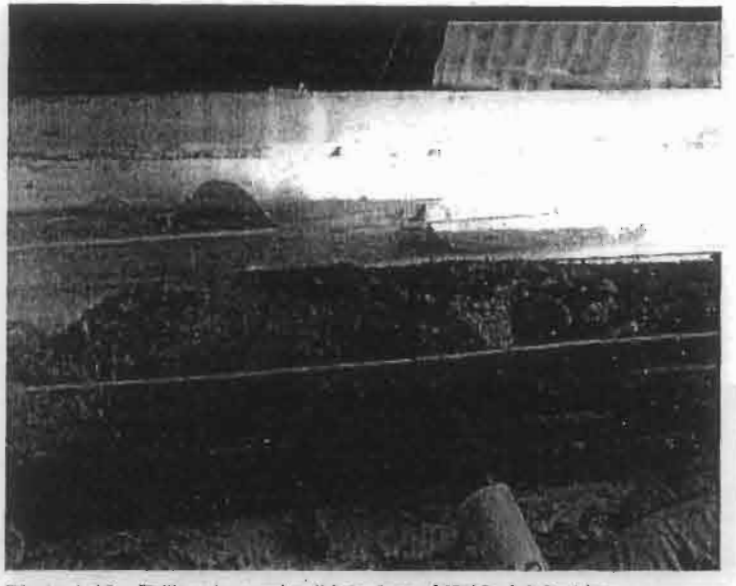

Photo 1-16 Tailings/natural soil interface, MP12, 4-8 feet bgs.

Direction: Southeast

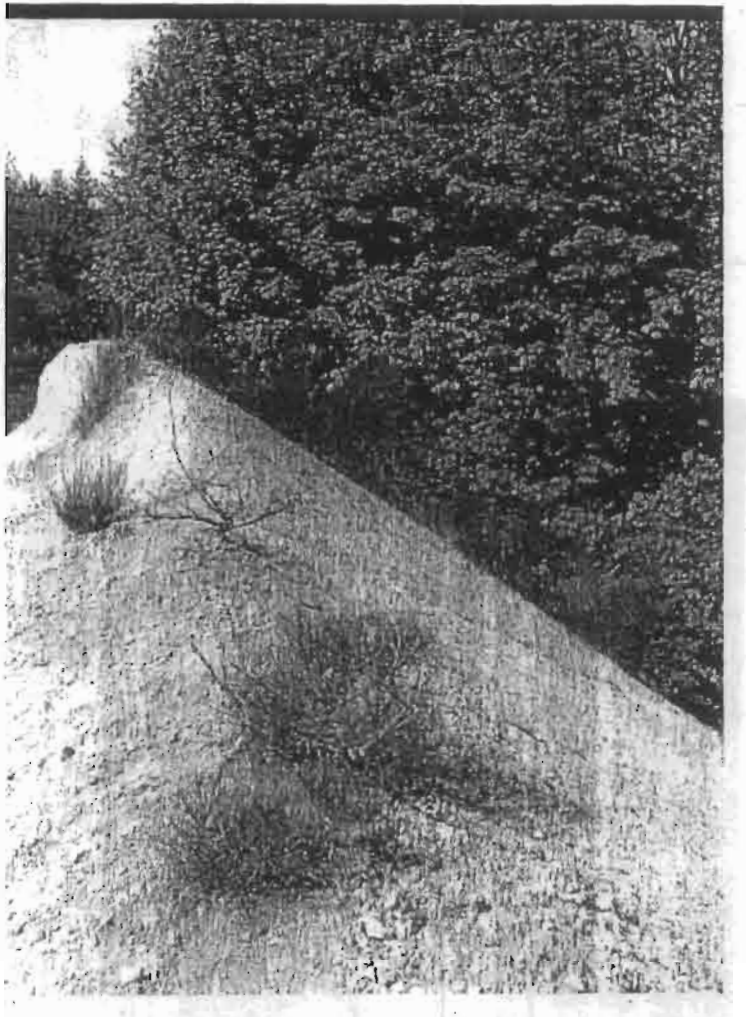

Photo 1-17 Tailings showing angle of repose leading to Dennis Creek.

Direction: Southeast

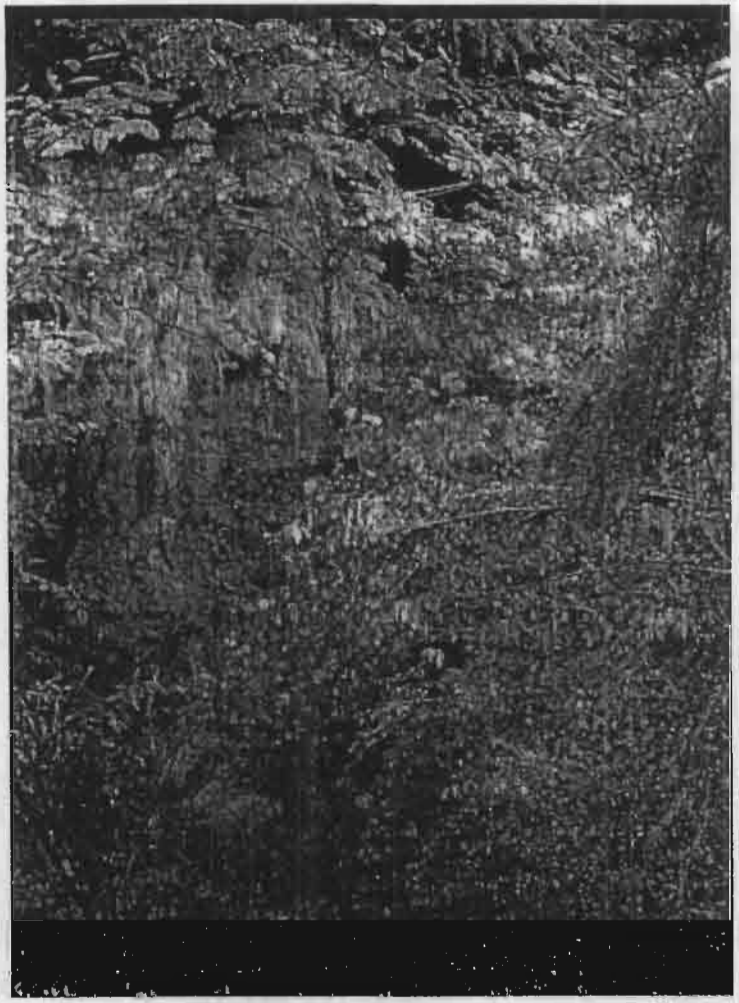

Photo 1-18 Dennis Creek Adit.

Direction: South

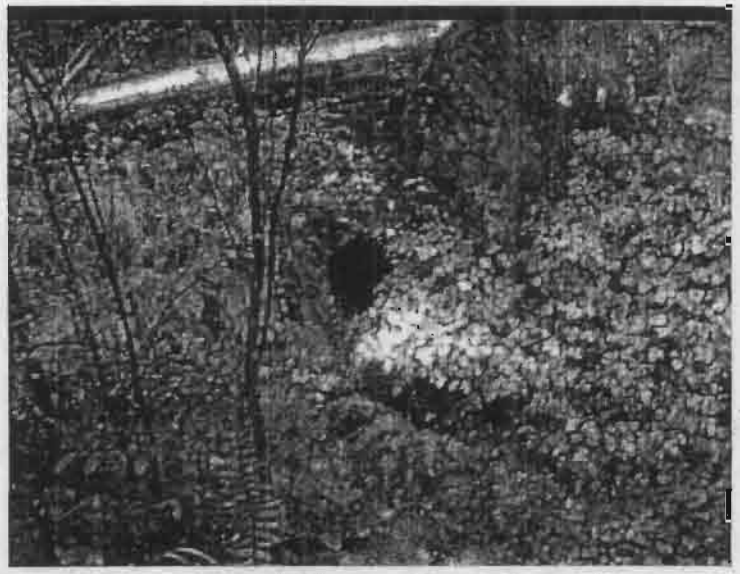

Photo 1-19 Unnamed adit at location of Dennis Creek Adit.

Direction: West

Photo 1-20 Dennis Creek Adit.

Direction: South

Photo 1-21 Entrance to Dennis Creek Adit.

Direction: South

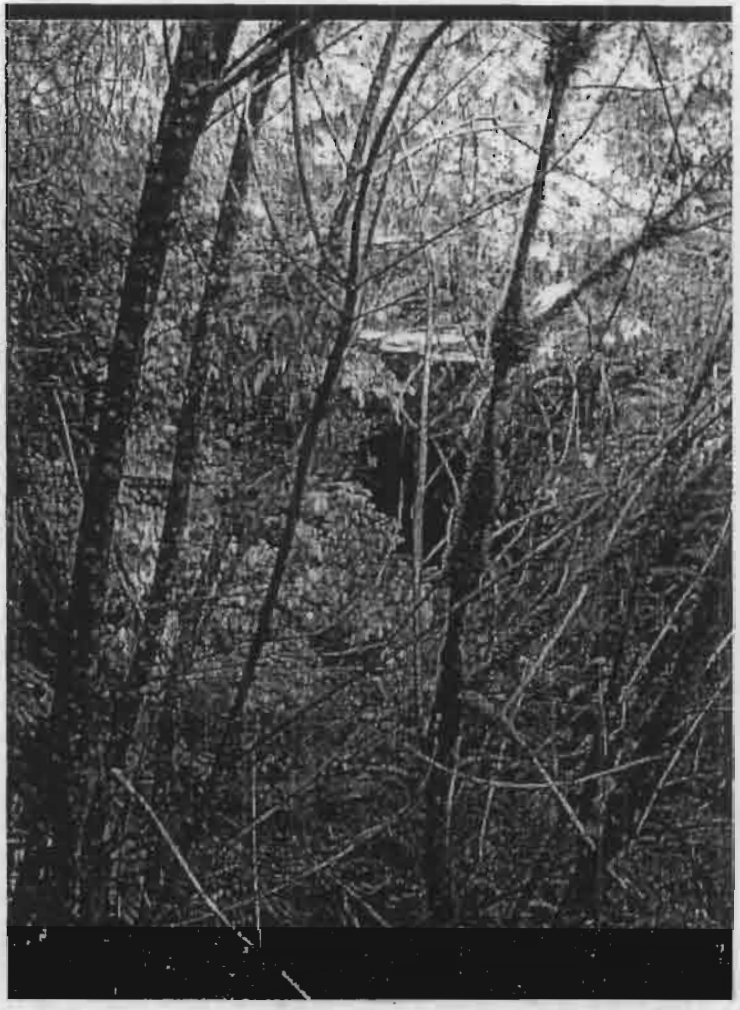

Photo 1-22 Dennis Creek Adit.

Direction: West

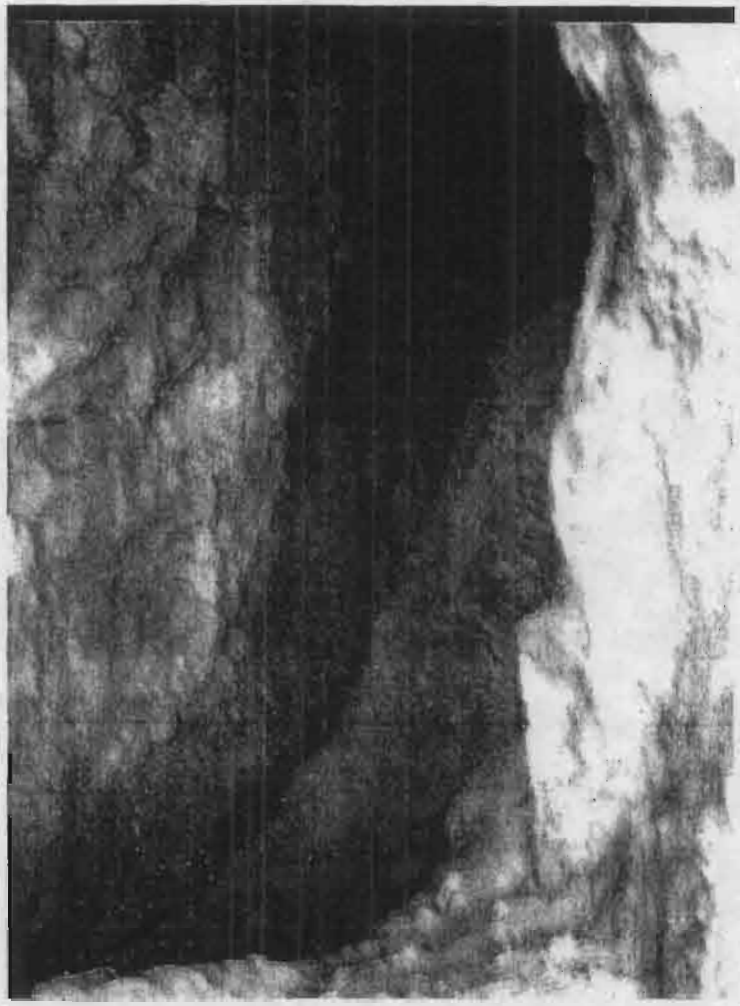

Photo 1-23 Dennis Creek Adit.

Direction: South

Photo 1-24 Looking into Dennis Creek Adit.

Direction: South

Photo 1-25 Dennis Creek Adit.

Direction: South

Photo 1-26 Dennis Creek Adit.

Direction: South

Photo 1-27 Dennis Creek Adit.

Direction: West

Photo 1-28 Measuring water parameters, 404 Adit.

Direction: Southwest

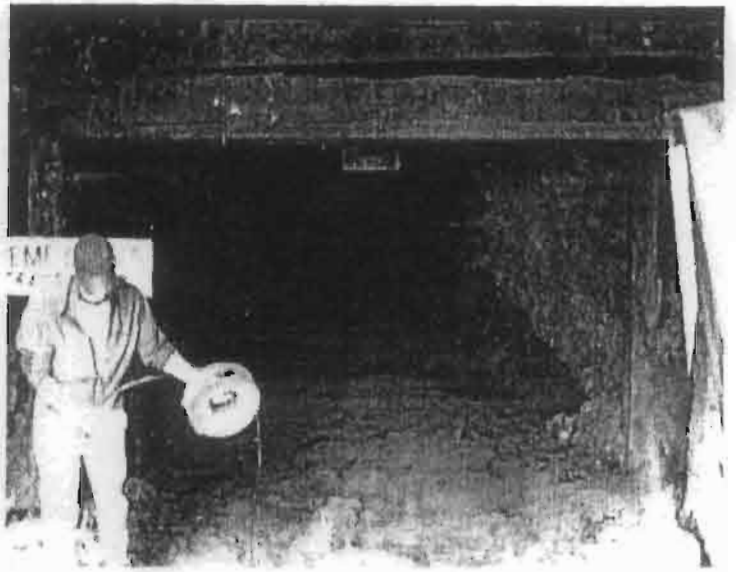

Photo 1-29 Measuring water parameters, 404 Adit.

Direction: Southwest

Photo 1-30 Sediment sample collection, 404 Adit.

Direction: Southwest

Photo 1-31 Sediment sample collection, 404 Adit.

Direction: *Southwest*

APPENDIX B

GEOLOGICAL LOGS FOR BORING

DRILLING LOG OF BORING NO. MP01

DATE DRILLED: 9/7/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
						This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
			Top of Ground Surface (GS) Elevation			
1	FILL		Tailings - Fines to coarse material to 1.5", well graded; Overall color reddish brown to brownish red with some individual large clasts white to yellow (Fe Hydroxide staining) as well as red brown; Dry.	1313	MP01SS04	Calcines
2						
3						
4						
5						
6				1325	MP01SS08	
7						
8			8.0			
9	FILL		Tailings - as above except 6 inch interval of brown, finer-grained material, slightly moist.			
10						

START BBM BORING LOG BBM2005.GPJ E&E PORTLAND.GDT 1/20/06

ecology and environment, inc.
333 SW Fifth Avenue
Suite 608
Portland, OR 97204
Phone: 503-248-5600 Fax: 503-248-5577

*** DRAFT ***

00076

DRILLING LOG OF BORING NO. MP01

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
11	FILL		Tailings - as above except 6 inch interval of brown, finer-grained material, slightly moist. *(continued)*	1330	MP01SS12	Soft, easy driving
12			12.0			
13	FILL		Tailings - as above (0 to 4 feet) but with less fine-grained material and more coarse material (0.25 to 1.5 inches), coarse material included some purple-colored clasts in addtion to white, red-brown, and yellow clasts. Less moisture noted than 8 to 12 ft due to coarser material. Brown, moist clay/silt in shoe.	1345	MP01SS16	Easy driving
16			16.0			
17	ML		Native Soil - Silt - clay mixture; Brown, with black organic chunks and layers to 0.25 inches; Moist.	1355	MP01SS20	
20			20.0			Total depth 20 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.

START BBM BORING LOG BBM2005.GPJ E&E PORTLAND.GDT 1/20/06

ecology and environment, inc.
333 SW Fifth Avenue
Suite 608
Portland, OR 97204
Phone: 503-248-5600 Fax 503-248-5577

DRILLING LOG OF BORING NO. MP02

DATE DRILLED: 9/7/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
						This log is part of the report prepared for the named project and *should be read together with that report for complete* interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
			Top of Ground Surface (GS) Elevation			
	FILL		Tailings - Mostly rock fragments to 1.5 inches with lesser sand and fines; Overall color brownish red, clasts white and red.			
0.7						
	ML		Native Soil - Silt - clay mixture; Brown; Moist.	1505	MP02SS04	
4.0						Total depth 4 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.

1 2 3 4 5 6 7 8 9 10

START BBM BORING LOG BBM2005.GPJ E&E PORTLAND.GDT 1/20/06

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00078

DRILLING LOG OF BORING NO. MP03

DATE DRILLED: 9/7/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
0	FILL		Tailings (or possibly imported material - road bed material) - Reddish to purple brown rock (rock to 1.5 inches) and fines; Moist.			
0.8						
1	ML		Native Soil - Silt with minor sand; Yellowish brown, localized grey mottling and reddish streaks; Moist.	1530	MP03SS04	
2						
3						
4						Total depth 4 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.
4.0						
5						
6						
7						
8						
9						
10						

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00079

DRILLING LOG OF BORING NO. MP04

DATE DRILLED: 9/7/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
1						
2	FILL		Tailings - Mostly gravel-size clasts to 1 inch, some to 1.5 inch, with 30% sand and fines; Overall color reddish brown, individual clasts white with purplish red, some minor yellowish brown; Dry.	1605	MP04SS04	
3						
4			4.0			
5			Tailings - Fines to gravel to 1 inch, approximately 40% sand and fines; Overall color brownish red, individual clasts white, purplish red; Dry.			
6	FILL			1615	MP04SS08	
7						
8			8.0			
9	FILL		Tailings - Mostly gravel to 1.5 inches, with lesser (approximately 30%) sand and fines. Color as above, Slightly moist. Dark brown clay in shoe.			
10						

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00080

DRILLING LOG OF BORING NO. MP04

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
11	FILL		Tailings - Mostly gravel to 1.5 inches, with lesser (approximately 30%) sand and fines. Color as above, Slightly moist. Dark brown clay in shoe. *(continued)*	1645	MP04SS12	
12.0						
13	CL		Native Soil - Clay with some silt; Dark grayish brown grading down to dark brown; Fine disseminated organic material as well as local chunks of partially decayed plant matter; Moist.	1655	MP04SS16	
16.0						Total depth 16 feet BGS. Borehole abandoned by backfilling with dry 3/8" bentonite chips to surface.
16						
17						
18						
19						
20						
21						
22						
23						

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DRILLING LOG OF BORING NO. MP05

DATE DRILLED: 9/8/2005
LOGGED BY: M. Longline
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at *this location with the passage of time. The data presented* is a simplification of actual conditions encountered.
1–4	ML		Native soil - Tailings appear at surface (see comment section), Clay silt with local rock fragments, Yellowish brown; Hard, compact; Dry.	1440	MP05SS04	Tailings evident on the surface at this location, possibly moved into place by the *front end loader this morning during* clearing operations. However, no tailings present in subsurface. Scotch broom, an otherwise useful indicator of recently vegetated tailings, misleading here.
5–8				1450	MP05SS08	
8			8.0			Total depth 8 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.
9–10						

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00082

DRILLING LOG OF BORING NO. MP06

DATE DRILLED: 9/8/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
0	FILL		0.3 Fill - Silt; Grayish Purple; Dry			
1			Native Soil - silt - clay mixture with minor local rock fragments, Rusty brown; Dry.			
2	ML			1530	MP06SS04	
3						
4			4.0			Total depth 4 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.
5						
6						
7						
8						
9						
10						

START BBM BORING LOG BBM2005.GPJ E&E PORTLAND.GDT 1/20/06

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DRILLING LOG OF BORING NO. MP07

DATE DRILLED: 9/8/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
0	ML		Native Soil - Silt; Grayish purple.			
0.5	CL		Native Soil - Silty clay; Brown			
1.2	ML		Native Soil - Silt - clay mixture; Mottled gray - rusty brown	1655	MP07SS04	
4.0						Total depth 4 feet BGS; Abandoned by backfilling to surface with 3/8 inch bentonite chips.

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*** DRAFT ***

00084

DRILLING LOG OF BORING NO. MP08

DATE DRILLED: 9/9/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
	ML		Soil, apparently transported to drilling location during brush clearing.			
0.5	FILL		Tailings - Mixture of rock fragments to 1 inch, sand and fines; Reddish brown, individual rock fragments mostly white.			Only tailings material sampled.
1.0	ML		Native Soil - Silt clay mixture with minor localized dark grey volcanic rock fragments to 0.75 inch, and minor partially decayed plant matter	0925	MP08SS04	
4.0						*Total depth 4 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.*

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DRILLING LOG OF BORING NO. MP09

DATE DRILLED: 9/9/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS): Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
1	ML		Native Soil - Silt clay mixture with volcanic rock fragments to 1.5 inch or more; Brown to yellowish brown; Slightly moist.	0955	MP09SS04	
2						
3						
4			4.0			Total depth 4 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.
5						
6						
7						
8						
9						
10						

START BBM BORING LOG BBM2005.GPJ E&E PORTLAND.GDT 1/20/06

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DRILLING LOG OF BORING NO. MP10

DATE DRILLED: 9/9/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.011A

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
1–10	FILL		Tailings - Rock fragments, silt and sand, approximately 40% sand and finer; Brownish red, rock fragments mostly white; Dry.	1035	MP10SS04	
4.8						
5–8	ML		Native Soil - Silt-clay mixture with mine rock fragments and black organic matter, chunks to 0.25 inch; Brown; Slightly moist.	1045	MP10SS08	
8.0						Total depth 8 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.

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00087

DRILLING LOG OF BORING NO. MP11

DATE DRILLED: 9/9/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
1–3	FILL		Tailings - Fines, sand, and rock fragments to 1 inch; gravel is approximately 50% of volume; - Overall color reddish brown, individual rock fragments mostly white, some with red streaks and blebs (likely cinnabar); Dry.	1135	MP11SS04	
4.0						
4–7	FILL		Tailings - Rock fragments with lesser sand and fines; gravel is approximately 70% of volume; Overall color brownish red, rock fragments white with red spots and red; Dry.	1150	MP11SS08	
8.0						
8–10	FILL		Tailings - As above but with approximately 60% rock fragments			

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00088

DRILLING LOG OF BORING NO. MP11

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
11			Tailings - As above but with approximately 60% rock fragments *(continued)*	1155	MP11SS12	
12						
13						
14				1205	MP11SS16	
15	FILL					
16						
17						
18				1215	MP11SS20	
19						
20			20.0			Total depth 20 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.
21						
22						
23						

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DRILLING LOG OF BORING NO. MP12

DATE DRILLED: 9/9/2005
LOGGED BY: M. Longtine
CHECKED BY: E. Lynch
DRILLING CONTRACTOR: E&E/START
DRILLED BY: A. Jensen
DRILLING METHOD: GEOPROBE DIRECT PUSH

VERTICAL DATUM:
LOCATION: BLACK BUTTE MINE

PROJECT: Black Butte Mine
TDD #: 05-04-0005
PROJECT LOCATION: Cottage Grove, Oregon

EPA PROJ MGR: M. Callaghan
START-2 PROJ MGR: E. Lynch
E & E PROJ #: 001281.0478.01IA

ELEVATION / DEPTH (feet)	USCS	GRAPHIC LOG	SOIL DESCRIPTION	SAMPLE COLLECTION TIME	SAMPLE ID	COMMENTS
			Top of Ground Surface (GS) Elevation			This log is part of the report prepared for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.
1–4	FILL		Tailings - Approximately 25% rock fragments with sand and fines; Overall color grayish purple; Dry.	1335	MP12SS04	
4.3						
5–8	ML		Native Soil - Silt - clay mixture with sand and minor rock fragments to 0.5 inch, Brown; Partially decayed plant matter; Moist.	1345	MP12SS08	
8.0						Total depth 8 feet BGS. Abandoned by backfilling to surface with 3/8 inch bentonite chips.
9–10						

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APPENDIX C
DATA VALIDATION MEMORANDA

ecology and environment, inc.
International Specialists in the Environment
2101 Fourth Avenue, Suite 1900, Seattle, WA 98121
Tel: (206) 624-9537, Fax: (206) 621-9832

MEMORANDUM

DATE: November 30, 2005

TO: Erin Lynch, Project Manager, E & E, Portland, Oregon

FROM: Mark Woodke, START-Chemist, E & E, Seattle, Washington MW

SUBJ: **Inorganic Data Quality Assurance Review, Black Butte Mine Site, Cottage Grove, Oregon**

REF: TDD: 05-04-0005 PAN: 001281.0478.01IA

The data quality assurance review of 10 soil and 3 water samples collected from the Black Butte Mine site located near Cottage Grove, Oregon, has been completed. Arsenic and mercury analyses (EPA SW-846 methods 6010, 7470 and 7471) and synthetic precipitate leaching procedure (SPLP) arsenic and mercury analyses (EPA SW-846 methods 1312 and 7470) were performed by STL-Seattle, Tacoma, Washington.

The samples were numbered:

Soil	CK06SD01	CK08SD01	MP01SS04	MP01SS12
	MP01SS20	MP05SS04	MP05SS08	MP07SS04
	MP09SS04	MP12SS08		
Water	CK06SW01	CK08SW01	Geoprobe Rinsate	

Data Qualifications:

1. **Sample Holding Times: Acceptable.**

All liquid samples were preserved to a pH < 2. The samples were maintained at 4°C (± 2°C). The samples were collected between September 7 and 10, 2005, and were analyzed by October 12, 2005, therefore meeting QC criteria of less than 6 months between collection, extraction, and analysis (28 days for mercury).

2. **Initial and Continuing Calibration: Acceptable.**

A minimum of one calibration standard and a blank were analyzed at the beginning of the ICP analysis sequence and after every 10 samples. No results were greater than 110% of the highest calibration standard. All ICP recoveries were within the QC limits of 90% to 110%. All AA recoveries were within QC limits of 80% to 120%. The AA correlation coefficient was > 0.995.

3. **Blanks: Acceptable.**

A preparation blank was analyzed for each 20 samples or per matrix per concentration level. Blanks were analyzed after each Initial or Continuing Calibration Verification. No elements were detected in any applicable calibration and/or preparation blanks that resulted in data qualifications.

4. **ICP Interference Check Sample: Acceptable.**

An Interference Check Sample (ICS) was analyzed at the beginning and end of each sequence or at least twice every 8 hours, whichever was more frequent. All ICS (solution AB) results were within QC limits of 80% - 120% recovery

5. **Precision and Bias Determination: Not Performed.**

Samples necessary to determine precision and bias were not provided to the laboratory. All results were flagged "PND" (Precision Not Determined) and "RND" (Recovery Not Determined), although the flags do not appear on the data sheets.

6. **Performance Evaluation Sample Analysis: Not Provided.**

Performance evaluation samples were not provided to the laboratory.

7. **ICP Serial Dilution: Acceptable.**

A serial dilution analysis was performed per matrix per concentration or per sample delivery group, whichever was more frequent. All serial dilution results were within QC limits.

8. **Matrix Spike Analysis: Acceptable.**

A matrix spike analysis was performed per SDG or per matrix per concentration level, whichever was more frequent. Spike and spike duplicate recoveries were within the QC limits.

9. **Duplicate Analysis: Acceptable.**

A laboratory duplicate analysis was performed per SDG or per matrix per concentration level, whichever was more frequent. All duplicate results were within QC limits.

10. **Laboratory Control Sample Analysis: Acceptable.**

A Laboratory Control Sample (LCS) was analyzed per SDG per matrix. All LCS results were within the established control limits.

11. **Overall Assessment of Data for Use**

The overall usefulness of the data is based on the criteria outlined in the OSWER Guidance Document "Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan, and Data Validation Procedures" (EPA/540/G-90/004), the analytical methods, and, when applicable, the Office of Emergency and Remedial Response Publication "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review". Based upon the information provided, the data are acceptable for use with the above stated data qualifications.

Data Qualifiers and Definitions

J - The associated numerical value is an estimated quantity because the reported concentrations were less than the sample detection limits but greater than the instrument detection limits or because quality control criteria limits were not met.

U - The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK06SD01
Lab ID:	130188-01
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	69.13

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	57.8	7.04	1.32	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK06SD01
Lab ID:	130188-01
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1
% Solids	69.13

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	0.435	0.0234	0.00515	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK08SD01
Lab ID:	130188-03
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	69.02

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	72.6	7.09	1.33	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK08SD01
Lab ID:	130188-03
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	200
% Solids	69.02

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	79	5.25	1.15	

10-12-2005

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP01SS12
Lab ID:	130188-06
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	88.69

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	197	5.09	0.957	

11-30-05

00098

00017

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP01SS12
Lab ID:	130188-06
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	20
% Solids	88.69

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	7.35	0.4	0.0881	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP01SS20
Lab ID:	130188-07
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	64.78

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	34.6	6.38	1.2	

MW139-05

00100

61000

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP01SS20
Lab ID:	130188-07
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1
% Solids	64.78

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	0.808	0.0281	0.00618	

MW 11-3005

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP05SS04
Lab ID:	130188-08
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	75.99

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	118	6.21	1.17	

MW 11/30/05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP05SS04
Lab ID:	130188-08
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	20
% Solids	75.99

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	17.7	0.464	0.102	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP07SS04
Lab ID:	130188-10
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	74.86

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	17.7	5.74	1.08	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP07SS04
Lab ID:	130188-10
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	10
% Solids	74.86

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	3.83	0.222	0.0488	

MW 11-2005

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP09SS04
Lab ID:	130188-11
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	79.72

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	35.3	5.76	1.08	

00106

MW 11-30-05

00025

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP09SS04
Lab ID:	130188-11
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	10
% Solids	79.72

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	5.42	0.226	0.0498	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP12SS08
Lab ID:	130188-12
Date Received:	9/30/05
Date Prepared:	10/12/05
Date Analyzed:	10/12/05
Dilution Factor	1
% Solids	81.12

Metals by ICP - USEPA Method 6010

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Arsenic	7.33	6.1	1.15	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP12SS08
Lab ID:	130188-12
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1
% Solids	81.12

Mercury by CVAA - USEPA Method 7471

Sample results are on a dry weight basis.

Analyte	Result (mg/kg)	RL	MDL	Flags
Mercury	0.952	0.0216	0.00476	

10/13/2005

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK06SW01
Lab ID:	130188-02
Date Received:	9/30/05
Date Prepared:	10/11/05
Date Analyzed:	10/12/05
Dilution Factor	1

Metals by ICP - USEPA Method 6010

Analyte	Result (mg/L)	RL	MDL	Flags
Arsenic	ND	0.05 U	0.0094	

10/12/2005

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK06SW01
Lab ID:	130188-02
Date Received:	9/30/2005
Date Prepared:	10/11/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	0.000073 J	0.0002	0.000044	~~J B1~~ MW

MW 11-30-05

00111

00102

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK08SW01
Lab ID:	130188-04
Date Received:	9/30/05
Date Prepared:	10/11/05
Date Analyzed:	10/12/05
Dilution Factor	1

Metals by ICP - USEPA Method 6010

Analyte	Result (mg/L)	RL	MDL	Flags
Arsenic	ND	0.05 U	0.0094	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	CK08SW01
Lab ID:	130188-04
Date Received:	9/30/2005
Date Prepared:	10/11/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	0.00225	0.0002	0.000044	~~B2~~ MU

10/12/2005

00113

00104

STL Seattle

Client Name	Ecology & Environment
Client ID:	GEOPROBE-RINSATE
Lab ID:	130188-13
Date Received:	9/30/05
Date Prepared:	10/11/05
Date Analyzed:	10/12/05
Dilution Factor	1

Metals by ICP - USEPA Method 6010

Analyte	Result (mg/L)	RL	MDL	Flags
Arsenic	ND	0.05 U	0.0094	

11-30-05

00114

00105

STL Seattle

Client Name	Ecology & Environment
Client ID:	GEOPROBE RINSATE
Lab ID:	130188-13
Date Received:	9/30/2005
Date Prepared:	10/11/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL		MDL	Flags
Mercury	ND	0.0002	U	0.000044	

10/13/05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP01SS04
Lab ID:	130188-05
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

SPLP Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	ND	0.002	0.00044	

00116

MW 11-30-05

00164

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP01SS20
Lab ID:	130188-07
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

SPLP Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	ND	0.002 U	0.00044	

10/13/05

00117

00165

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP05SS04
Lab ID:	130188-08
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

SPLP Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	ND	0.002 U	0.00044	

00118

10-30-05

00166

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP05SS08
Lab ID:	130188-09
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

SPLP Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	ND	0.002 U	0.00044	

MW 11-30-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP07SS04
Lab ID:	130188-10
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

SPLP Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	ND	0.002	0.00044	

11-32-05

STL Seattle

Client Name	Ecology & Environment
Client ID:	MP12SS08
Lab ID:	130188-12
Date Received:	9/30/2005
Date Prepared:	10/12/2005
Date Analyzed:	10/12/2005
Dilution Factor	1

SPLP Mercury by CVAA - USEPA Method 7470

Analyte	Result (mg/L)	RL	MDL	Flags
Mercury	0.00149 J	0.002	0.00044	

11-30-05

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MEMORANDUM

DATE: November 14, 2005

TO: Erin Lynch, Project Manager, E & E, Portland, Oregon

FROM: Mark Woodke, START-Chemist, E & E, Seattle, Washington MW

SUBJ: **Inorganic Data Quality Assurance Review, Black Butte Mine Site, Cottage Grove, Oregon**

REF: TDD: 05-04-0005 PAN: 001281.0478.01IA

The data quality assurance review of 5 soil and 3 sediment samples collected from the Black Butte Mine site located near Cottage Grove, Oregon, has been completed. Mercury analysis, including total mercury (EPA method 1631), monomethyl mercury (draft EPA method 1630), and 5-step sequential extraction mercury (water soluble, stomach acid, organo complexed, strong complexed, and mineral bound), was performed by Brooks Rand, LLC, Seattle, Washington.

The samples were numbered:

CK01SD01	CK08SD01	MP01SS12	MP01SS20
MP05SS04	MP06SS04	MP12SS08	OA01SD01

Data Qualifications:

1. **Sample Holding Times: Satisfactory.**

The samples were maintained at 4°C (± 2°C), within all QC limits except for methyl mercury; all methyl mercury results were qualified as estimated quantities (J or UJ). The samples were collected between September 7 and 10, 2005, were prepared by October 3 and 11, 2005, and were analyzed on October 11 (organo complexed and water soluble), October 12 (stomach acid), October 13 (monomethyl and strong complexed), October 14 (mineral bound), and October 19 (total mercury), therefore meeting QC holding time criteria.

2. **Initial and Continuing Calibration: Acceptable.**

All initial calibration correlation coefficients were > 0.995. No results were greater than 110% of the highest calibration standard. All continuing calibration recoveries were within QC limit.

3. **Blanks: Acceptable.**

A preparation blank was analyzed for each 20 samples or per matrix per concentration level. Blanks were analyzed at the appropriate frequency. All sample results were corrected for blank contamination per the methods.

4. Precision and Bias Determination: Not Performed.

Samples necessary to determine precision and bias were not provided to the laboratory. All results were flagged "PND" (Precision Not Determined) and "RND" (Recovery Not Determined), although the flags do not appear on the data sheets.

5. Performance Evaluation Sample Analysis: Not Provided.

Performance evaluation samples were not provided to the laboratory.

6. Matrix Spike Analysis: Satisfactory.

A matrix spike analysis was performed per SDG or per matrix per concentration level, whichever was more frequent. Spike and spike duplicate recoveries were within the QC limits except where not applicable due to the type of analysis performed. The bias results for the 5-step extraction combined analyses were within QC limits except for sample CK01SD01 (low) and MP06SS04 (high). Sample results associated with the low recovery outlier were qualified as estimated quantities (J or UJ). Positive sample results associated with the high recovery outlier were qualified as estimated quantities (J).

9. Duplicate Analysis: Satisfactory.

A laboratory duplicate analysis was performed per SDG or per matrix per concentration level, whichever was more frequent. All duplicate results were within QC limits except sample MP01SS12 (total mercury), MP12SS08 (stomach acid), and MP12SS08 (mineral bound). Associated sample results were qualified as estimated quantities (J or UJ).

10. Certified Reference Material (CRM) Analysis: Acceptable.

A CRM sample was analyzed per SDG per matrix. All CRM results were within the established control limits.

11. Overall Assessment of Data for Use

The overall usefulness of the data is based on the criteria outlined in the OSWER Guidance Document "Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan, and Data Validation Procedures" (EPA/540/G-90/004), the analytical methods, and, when applicable, the Office of Emergency and Remedial Response Publication "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review". Based upon the information provided, the data are acceptable for use with the above stated data qualifications.

Data Qualifiers and Definitions

J - The associated numerical value is an estimated quantity because the reported concentrations were less than the sample detection limits but greater than the instrument detection limits or because quality control criteria limits were not met.

U - The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

UJ - The material was analyzed for, but not detected. The reported detection limit is estimated because quality control criteria were not met.

Reported by
Brooks Rand LLC
Contact: Amar Gill
3958 6th Avenue NW
Seattle, WA 98107
Tel: 206-632-6206 *Fax: 206-632-6017*

Summary of Results for
Ecology & Environment
Contact: Erin Lynch
333 SW 5th Ave
Portland OR 97204
Tel: 503-248-5600

Lab Project # EEI012
Lab Tracking # 05BR1474

Client Ref # 001281.0478
Quote EEI012b

Hg

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/17/2005	10/19/2005	05-0780-1	5,360 J	ng/g (dry)	~~MPM~~
CK08SD01	05BR1474 - 2	10/17/2005	10/19/2005	05-0780-1	225,000	ng/g (dry)	
MP01SS12	05BR1474 - 3	10/17/2005	10/19/2005	05-0780-1	9,640 J	ng/g (dry)	~~MPM~~
MP01SS20	05BR1474 - 4	10/17/2005	10/19/2005	05-0780-1	1,130	ng/g (dry)	
MP05SSO4	05BR1474 - 5	10/17/2005	10/19/2005	05-0780-1	1,190,000	ng/g (dry)	
MO06SS04	05BR1474 - 6	10/17/2005	10/19/2005	05-0780-1	431,000 J	ng/g (dry)	~~MPM~~
MP12SS08	05BR1474 - 7	10/17/2005	10/19/2005	05-0780-1	1,250	ng/g (dry)	
OA01SD01	05BR1474 - 8	10/17/2005	10/19/2005	05-0780-1	10,900	ng/g (dry)	

MW 11-14-05

Thursday, November 03, 2005

Project Manager

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Lab Project # EEI012
Lab Tracking # 05BR1474

Client Ref # 001281.0478
Quote EEI012b

Hg(Monomethyl)

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/10/2005	10/13/2005	05-0782a	0.731 J	ng/g (dry)	~~H,M~~
CK08SD01	05BR1474 - 2	10/10/2005	10/13/2005	05-0782a	12.7 J	ng/g (dry)	~~H,M~~
MP01SS12	05BR1474 - 3	10/10/2005	10/13/2005	05-0782a	0.200 J	ng/g (dry)	~~H,M~~
MP01SS20	05BR1474 - 4	10/10/2005	10/13/2005	05-0782a	0.015 UJ	ng/g (dry)	~~H,U,M~~
MP05SSO4	05BR1474 - 5	10/10/2005	10/13/2005	05-0782a	1.34 J	ng/g (dry)	~~H,M~~
MO06SS04	05BR1474 - 6	10/10/2005	10/13/2005	05-0782a	0.318 J	ng/g (dry)	~~H,M~~
MP12SS08	05BR1474 - 7	10/10/2005	10/13/2005	05-0782a	0.018 J	ng/g (dry)	~~B,H,M~~
OA01SD01	05BR1474 - 8	10/10/2005	10/13/2005	05-0782a	0.015 UJ	ng/g (dry)	~~H,U,M~~

MW 11-4-05

Thursday, November 03, 2005

Project Manager

00125

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Summary of Results for
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Portland OR 97204
Tel: 503-248-5600

Lab Project # EEI012
Lab Tracking # 05BR1474

Client Ref # 001281.0478
Quote EEI012b

Hg(Water Soluble)

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/3/2005	10/11/2005	05-0774	51.6 J	ng/g (dry)	~~MW~~
CK08SD01	05BR1474 - 2	10/3/2005	10/11/2005	05-0774	5,490	ng/g (dry)	
MP01SS12	05BR1474 - 3	10/3/2005	10/11/2005	05-0774	258	ng/g (dry)	
MP01SS20	05BR1474 - 4	10/3/2005	10/11/2005	05-0774	1.44	ng/g (dry)	
MP05SSO4	05BR1474 - 5	10/3/2005	10/11/2005	05-0774	27,800	ng/g (dry)	
MO06SS04	05BR1474 - 6	10/3/2005	10/11/2005	05-0774	5,610 J	ng/g (dry)	~~MW~~
MP12SS08	05BR1474 - 7	10/3/2005	10/11/2005	05-0774	72.2	ng/g (dry)	
OA01SD01	05BR1474 - 8	10/3/2005	10/11/2005	05-0774	135	ng/g (dry)	

MW 11-4-05

Thursday, November 03, 2005

Project Manager

00126

Reported by
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Summary of Results for
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Portland OR 97204
Tel: 503-248-5600

Lab Project # EEI012
Lab Tracking # 05BR1474

Client Ref # 001281.0478
Quote EEI012b

Hg(Stomach Acid)

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/5/2005	10/12/2005	05-0772	1.72 J	ng/g (dry)	
CK08SD01	05BR1474 - 2	10/5/2005	10/12/2005	05-0772	30,900	ng/g (dry)	
MP01SS12	05BR1474 - 3	10/5/2005	10/12/2005	05-0772	274	ng/g (dry)	
MP01SS20	05BR1474 - 4	10/5/2005	10/12/2005	05-0772	5.48 J	ng/g (dry)	
MP05SSO4	05BR1474 - 5	10/5/2005	10/12/2005	05-0772	177,000	ng/g (dry)	
MO06SS04	05BR1474 - 6	10/5/2005	10/12/2005	05-0772	256,000 J	ng/g (dry)	
MP12SS08	05BR1474 - 7	10/5/2005	10/12/2005	05-0772	3.81 J	ng/g (dry)	
OA01SD01	05BR1474 - 8	10/5/2005	10/12/2005	05-0772	970	ng/g (dry)	

MW 11/14/05

Thursday, November 03, 2005

Project Manager

00127

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Tel: 503-248-5600

Lab Project # EEI012
Lab Tracking # 05BR1474

Client Ref # 001281.0478
Quote EEI012b

Hg(Organo Complexed)

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/6/2005	10/11/2005	05-0771	134 J	ng/g (dry)	~~MW~~
CK08SD01	05BR1474 - 2	10/6/2005	10/11/2005	05-0771	292	ng/g (dry)	
MP01SS12	05BR1474 - 3	10/6/2005	10/11/2005	05-0771	17.9	ng/g (dry)	
MP01SS20	05BR1474 - 4	10/6/2005	10/11/2005	05-0771	364	ng/g (dry)	
MP05SS04	05BR1474 - 5	10/6/2005	10/11/2005	05-0771	389,000	ng/g (dry)	
MO06SS04	05BR1474 - 6	10/6/2005	10/11/2005	05-0771	30,500 J	ng/g (dry)	~~MW~~
MP12SS08	05BR1474 - 7	10/6/2005	10/11/2005	05-0771	435	ng/g (dry)	
OA01SD01	05BR1474 - 8	10/6/2005	10/11/2005	05-0771	26.9	ng/g (dry)	

MW 11/4/05

Thursday, November 03, 2005

Project Manager

00128

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Contact: Erin Lynch
333 SW 5th Ave
Portland OR 97204
Tel: 503-248-5600

Lab Project # EEI012
Lab Tracking # 05BR1474

Client Ref # 001281.0478
Quote EEI012b

Hg(Strong Complexed)

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/7/2005	10/13/2005	05-0773	211 J	ng/g (dry)	MW
CK08SD01	05BR1474 - 2	10/7/2005	10/13/2005	05-0773	135,000	ng/g (dry)	
MP01SS12	05BR1474 - 3	10/7/2005	10/13/2005	05-0773	6,300	ng/g (dry)	
MP01SS20	05BR1474 - 4	10/7/2005	10/13/2005	05-0773	628	ng/g (dry)	
MP05SSO4	05BR1474 - 5	10/7/2005	10/13/2005	05-0773	659,000	ng/g (dry)	
MO06SS04	05BR1474 - 6	10/7/2005	10/13/2005	05-0773	113,000 J	ng/g (dry)	MW
MP12SS08	05BR1474 - 7	10/7/2005	10/13/2005	05-0773	396	ng/g (dry)	
OA01SD01	05BR1474 - 8	10/7/2005	10/13/2005	05-0773	5,710	ng/g (dry)	

MW 11-14-05

Thursday, November 03, 2005

Project Manager

00129

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Lab Project # EEJ012
Lab Tracking # 05BR1474
Client Ref # 001281.0478
Quote EEI012b

Hg(Mineral Bound)

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
CK01SD01	05BR1474 - 1	10/11/2005	10/14/2005	05-0770	431 J	ng/g (dry)	
CK08SD01	05BR1474 - 2	10/11/2005	10/14/2005	05-0770	128,000	ng/g (dry)	
MP01SS12	05BR1474 - 3	10/11/2005	10/14/2005	05-0770	2,820	ng/g (dry)	
MP01SS20	05BR1474 - 4	10/11/2005	10/14/2005	05-0770	80.6	ng/g (dry)	
MP05SSO4	05BR1474 - 5	10/11/2005	10/14/2005	05-0770	122,000	ng/g (dry)	
MO06SS04	05BR1474 - 6	10/11/2005	10/14/2005	05-0770	254,000 J	ng/g (dry)	
MP12SS08	05BR1474 - 7	10/11/2005	10/14/2005	05-0770	29.0 J	ng/g (dry)	
OA01SD01	05BR1474 - 8	10/11/2005	10/14/2005	05-0770	2,210	ng/g (dry)	

MW 11-14-05

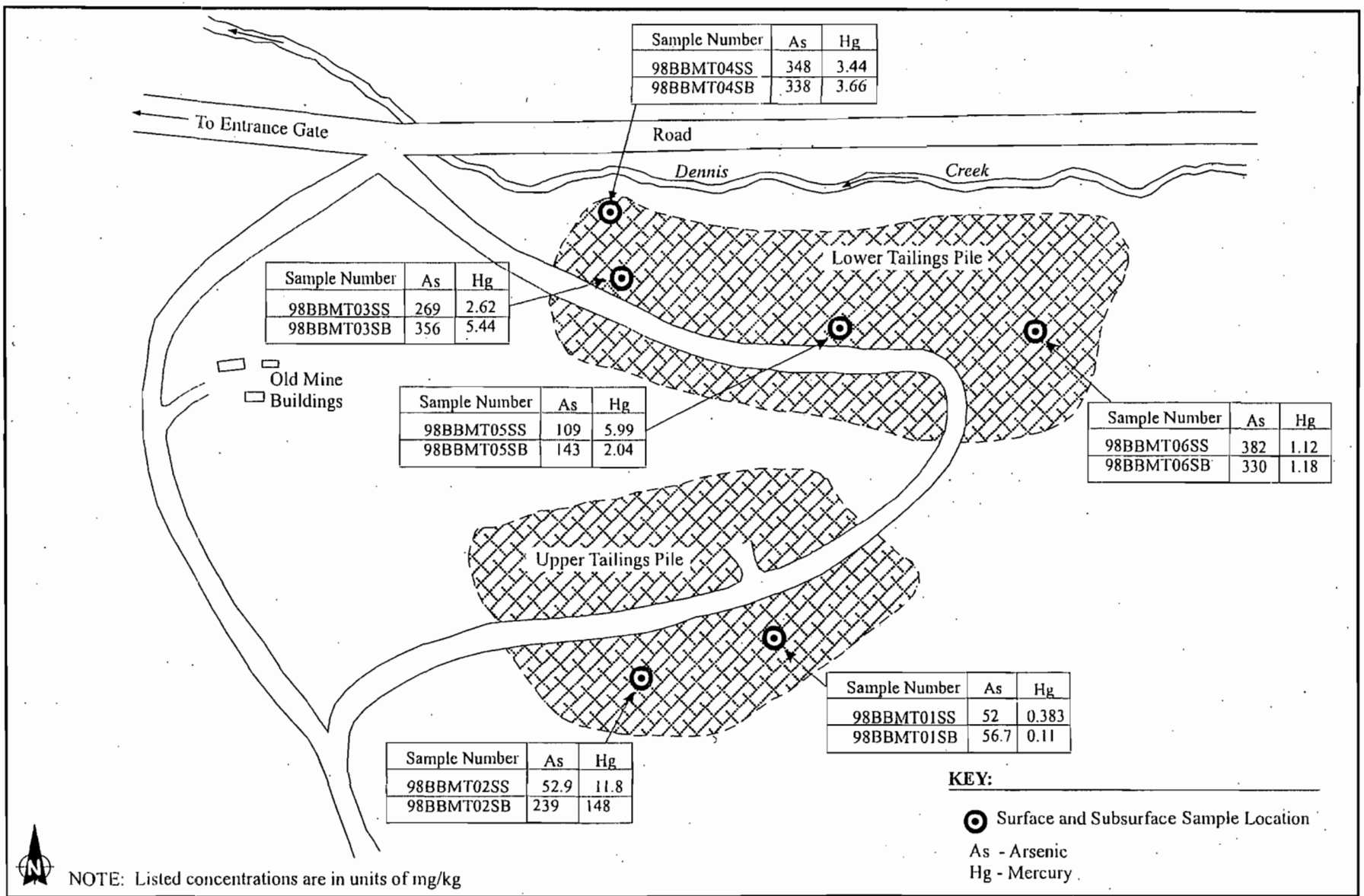
Thursday, November 03, 2005

Project Manager

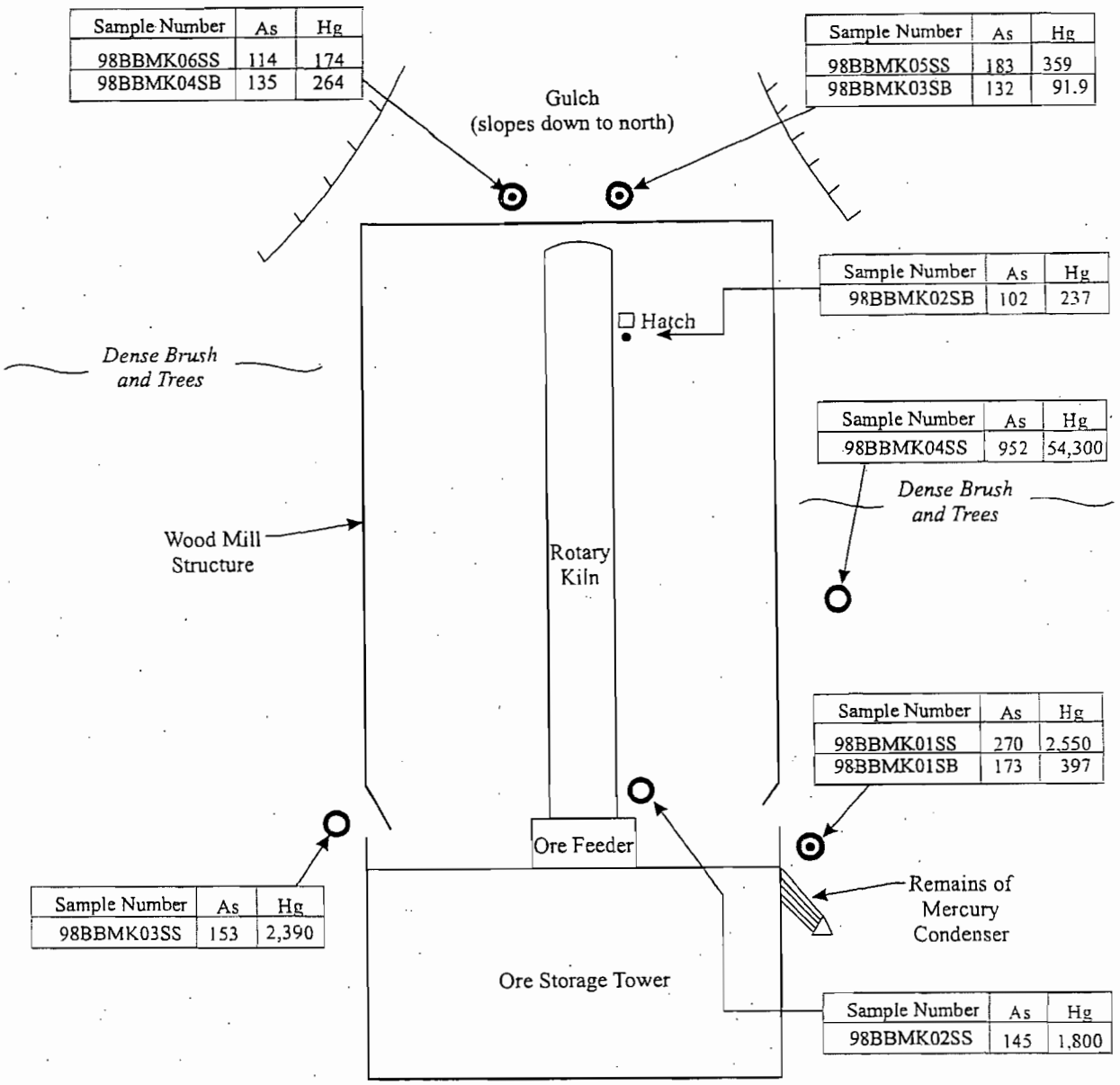
00130

APPENDIX D

FIGURES 6-1 THROUGH 6-3, SITE INSPECTION REPORT (E & E 1999)



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BLACK BUTTE MINE Lane County, Oregon	Figure 6-1 TAILINGS PILES SAMPLE LOCATION MAP	
	0 75 150 Approximate Scale in Feet	Date: 1/23/06	Drawn by: AES	10:START-3\060 10005\fig 6-1



KEY:

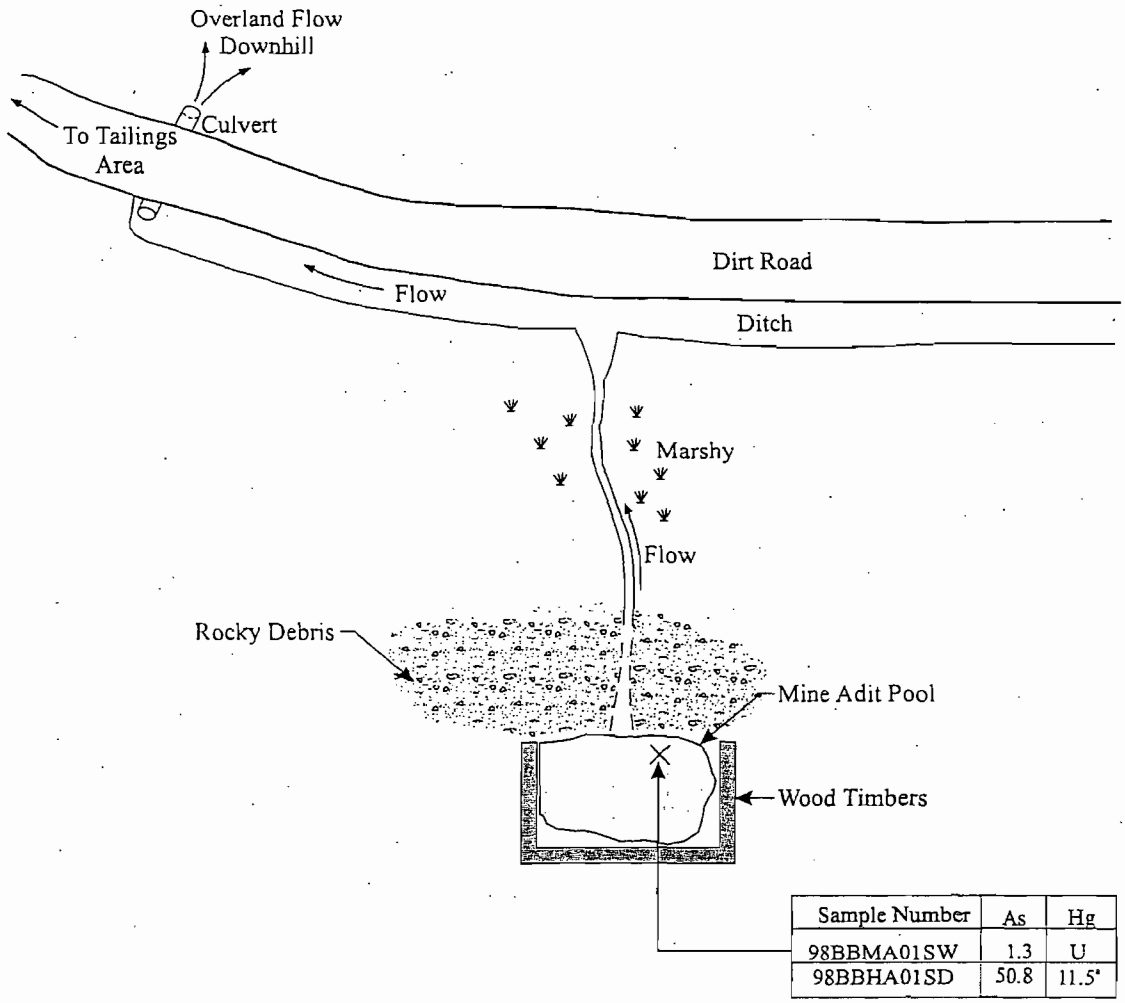
- Surface Soil Sample Location
- Surface and Subsurface Sample Location
- Subsurface Sample Location

As Arsenic

Hg Mercury

NOTE: Listed concentrations are in units of mg/kg

ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BLACK BUTTE MINE Lane County, Oregon	Figure 6-2 FORMER MILL/ROTARY KILN SAMPLE LOCATION MAP	
	0 5 10 Approximate Scale in Feet	Date: 1-23-06	Drawn by: AES	10:START-3\06010005\fig 6-2



Sample Number	As	Hg
98BBMA01SW	1.3	U
98BBHA01SD	50.8	11.5*

KEY:

× Location of Samples 98BBMA01SW and 98BBMA01SD
As - Arsenic
Hg - Mercury
U - Analyte undetected
* - Adjusted concentration

NOTE: Listed concentrations are in units of mg/kg (sediment) and µg/L (water).

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International Specialists in the Environment.
Seattle, Washington

BLACK BUTTE MINE
Lane County, Oregon

Figure 6-3
MINE ADIT
SAMPLE LOCATION MAP

Not to Scale

Date: 1-23-06 | Drawn by: AES | 10:START-3\06010005\fig 6-3