# FINAL
## SAMPLING AND ANALYSIS REPORT

# POORMAN / BALM CREEK MINE SITE
# BAKER COUNTY, OREGON

Prepared For:

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And

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## LIST OF ATTACHMENTS

## LIST OF ACRONYMS

| | |
|---|---|
| ACEC | Area of Critical Environmental Concern |
| A.D. | Anno Domini |
| AML | Abandoned Mine Lands |
| AMLIS | Abandoned Mine Lands Information System |
| amsl | Above mean sea level |
| BLM | Bureau of Land Management |
| cfs | Cubic feet per second |
| DQO | Data Quality Objective(s) |
| DWS | Domestic Water Supply |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EPA | Environmental Protection Agency |
| FSP | Field Sampling Plan |
| F | Fahrenheit |
| FWAL | Fresh Water Aquatic Life |
| GB | Gold Book |
| H | Hardness in mg/l as $CaCO_3$ |
| MDL | Method Detection Limit |
| µg/l | Micrograms per Liter |
| mg/l | Milligrams per Liter |
| ng/l | Nanograms per liter |
| NTAC | National Technical Advisory Committee |
| NRWQC | National Recommended Water Quality Criteria |
| NSTC | National Science and Technology Center |
| ODEQ | Oregon Department of Environmental Quality |
| OWQC | Oregon Water Quality Criteria |
| PCR | Primary Contact Recreation |
| PQL | Practical Quantitation Limit |
| QAPP | Quality Assurance Project Plan |
| QA/QC | Quality Assurance/Quality Control |
| RL | Reporting Limit |
| RPD | Relative Percent Difference |
| SAR | Sampling and Analysis Report |
| SOW | Statement of Work |
| SOC | Sum of Constituents |
| TAL | Target Analyte List |
| TDS | Total Dissolved Solids |
| USGS | United States Geological Survey |

# 1.0 INTRODUCTION

## 1.1 Authority, Purpose, and Scope

The U.S. Department of Interior, Bureau of Land Management (BLM) authorized Dynamac Corporation (Dynamac) to prepare a Sampling and Analysis Report (SAR) addressing surface water sample collection activities and assess potential impacts to the surface water migration pathway at the Poorman/Balm Creek Mine Site (BLM, 2002b). This SAR has been prepared in accordance with the BLM Statement of Work (SOW) issued to Dynamac under the terms of Contract 1422-N660-C98-3003, Task Order BLM-0F (105).

The general purpose of this directive was to collect, organize, and present surface water quality and hydrologic characteristics data to support federal cleanup obligations/decisions regarding mined tailings impacts to the Balm Creek and Slide Creek watersheds.

The general scope of work consisted of several SOW elements:

**Project Management**
Task 1: Project Management and Technical Coordination (Ongoing)

**Project Planning**
Task 2: Project Initiation and Field Sampling Plan and Quality Assurance Project Plan (FSP/QAPP) Preparation, Review, and Approval (Completed November 6, 2002)

**Field Investigation Activities**
Task 3: Surface Water Sample Collection (Completed November 13, 2002)
Task 4: Surface Water Sample Analysis (Completed December 4, 2002)

**Findings Reporting**
Task 5: Data Validation (Completed December 6, 2002)
Task 6: Data Reduction and Assessment (Completed December 13, 2002)
Task 7: Draft Sampling and Analysis Report Submittal (December 16, 2002)
Task 8: Draft Sampling and Analysis Report Review/Comment Period (Underway)
Task 9: Final Sampling and Analysis Report Submittal (December 31, 2002)

## 1.2 Objectives

Project objectives were based on the scope of work stated in Task Order BLM-0F (105), issued by BLM, and subsequent input from BLM. Tasks undertaken to accomplish project objectives are outlined in the ***Final Field Sampling Plan and Quality Assurance Project Plan (FSP/QAPP)***, dated November 6, 2002 (Dynamac, 2002a). The FSP/QAPP was prepared in accordance with the criteria established under the Department of Environmental Quality, Water Pollution, Division 41, State-Wide Water Quality Management Plan; Beneficial Uses, Policies, Standards, and Treatment Criteria for Oregon. The FSP/QAPP was also prepared in accordance with the U.S. Environmental Protection Agency (EPA) guidance documents: ***Compendium of ERT Surface Water and Sediment Sampling Procedures (EPA/540/P-91/005)***; and, ***Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA***

***QA/R-5***. The FSP/QAPP was reviewed and approved by BLM and Dynamac project managers prior to its implementation in the field.

**Section 2** of this SAR summarizes historical, physical, and applicable water quality criteria aspects of the Poorman/Balm Creek Mine Site. **Section 3** focuses on field investigation activities, sample analyses/results, and associated quality assurance/quality control (QA/QC) issues. A summary discussion is presented in **Section 4**.

It is important to point out that this SAR focuses on the salient aspects of the BLM SOW and is thus limited in scope and text to concerns associated solely with the surface water migration pathway. Other site environmental concerns, which include waste source characterization and containment, the ground water migration pathway, the soil exposure pathway, the air migration pathway, and human/environmental risk assessment are addressed within the framework of a technical report prepared by the BLM National Science & Technology Center (NSTC) entitled, ***Draft Engineering Evaluation/Cost Analysis, Poorman/Balm Creek Mine Site***, issued in August 2002. Site background and descriptive information, previous sampling results, and mapping presented in this SAR are the products of BLM's EE/CA efforts. Accordingly, BLM has authorized Dynamac to incorporate them into this SAR to avoid duplication of that effort. Users of this SAR are cautioned that the site information and data presented in the draft EE/CA, which are restated in this SAR, may be subject to future revision by the BLM NSTC (BLM, 2002a).

# 2.0 SITE DESCRIPTION

## 2.1 Site History and Features

Minerals were discovered at the Mother Lode (Poorman/Balm Creek) Mine in the 1900's. By 1920, the Mother Lode Gold Mines Company had produced $78,516 of gold and silver. In 1924, high grade copper ores were discovered and developed by the Oregon Copper Company. Flotation tailings were sent to a settling pond. No production occurred after 1938, although exploration continued until the 1970s. During the 1990s, the various claims were declared null and void (Dynamac, 2000).

The Balm Creek Mine was most commonly known as the Mother Lode Mine, which is actually a consolidation of the Mother Lode, Balm Creek, and Poorman workings. These sites were consolidated for the purposes of the EE/CA and collectively referred to as the Poorman/Balm Creek Mine Site. This designation has been continued in this FSP/QAPP for the purpose of consistency. It has been assigned the Abandoned Mine Lands Information System (AMLIS) number OR-035800002.

The site consists of four sub-sites all located in the Balm Creek watershed (**Attachments 1 and 2**). General descriptions of the areas are as follows:

- Sub-sites A and B designate the Upper and Lower Poorman mine workings, respectively. Sub-site A (**Attachment 3**) consists of waste rock and a collapsed shaft, while Sub-site B (**Attachment 4**) consists of waste rock and a seeping adit. The adit, which is located along the right bank of Slide Creek, has collapsed. The waste rock pile contains a substantial amount of material, which has been placed into the riparian area and into the creek itself. At each of these sub-sites, Slide Creek is in contact with the waste rock material.
- Sub-site C (**Attachment 5**) is located on Balm Creek at the Balm Creek Mine. It consists of a shaft and headframe, a mill site foundation, waste rock, and a tailings pond located adjacent to Balm Creek. The Balm Creek Mine shaft discharges water to Balm Creek.
- The fourth sub-site (D) is a tailings pond located approximately 1,500 feet south of the confluence of Slide and Balm Creeks (**Attachment 6**). The tailings were placed in the riparian area of Balm Creek, diverting it toward the left bank. Furthermore, some of the flow from Balm Creek enters the upstream portion of the pond, thus impounding water. Additional waste material has been placed along the stream banks upstream of this pond. The material is composed of contaminated, fine-grained tailings (BLM, 2002a).

## 2.2 Site Location

The site, located at 44˚55'01"N, 117˚28'25"W, is situated in Baker County approximately 19.5 miles northeast of Baker City, Oregon, within Sections 31 and 32 of Township 7 South, Range 43 East (**Attachment 1**). Access to the site from Baker City can be gained by traveling east on Highway 86, then north on Keating Road toward the town of Keating. From Keating the site can be reached by traveling east on Keating Grange Lane for approximately four miles, taking a right onto Mother Lode Road. After traveling on Mother Lode Road for approximately 0.6 miles, the site is reached by taking the left fork onto a two-track road and traveling 2.5 miles (BLM, 2002a).

## 2.3 Site Topography

The Poorman/Balm Creek Mine Site is situated in the southern foothills of the Wallowa Mountains, in a remote canyon off of Red Ridge. The terrain can generally be described as rolling hills. Elevations at the site vary between 3,400 to 3,700 feet above mean sea level (amsl).

Native vegetation consists of spruce and deciduous riparian habitat in the drainages and shrub/steppe habitat on the ridges. Bunchgrasses, sagebrush, shrubs, and forbs are the dominant vegetation. It is estimated that approximately 10 acres have been impacted by the mining operations associated with the complex (BLM, 2002a).

## 2.4 Hydrologic Setting

### 2.4.1 Meteorology

The climate for Richland, Oregon (1948-2001), located approximately 18 air miles southeast of the site, was obtained from the Western Regional Climate Center website (wrcc.dri.edu). Both locations are subject to similar prevailing meteorological conditions. The annual average maximum temperature at the Richland weather station (# 357160) is 66.4°F, with July being the warmest month (92.7°F). The annual average minimum temperature is 35.3°F, with January being the coolest month (20.1°F). Annual average total precipitation is 11.89 inches, with January being the wettest month (1.45 inches) and July being the driest month (0.50 inches). Annual average snowfall is 15.1 inches.

### 2.4.2 Surface Water Pathway

Slide Creek and Balm Creek lie within the Powder Basin in eastern Oregon. The creeks are small, intermittent to perennial streams with summer flows of less than 5 cubic feet per second (cfs). The Balm Creek watershed is moderate in size, encompassing approximately 4,225 acres.

Upstream of the site, flow to Balm Creek is regulated by Balm Creek Reservoir. The reservoir, which has a maximum authorized discharge of 400 cfs, is located approximately six miles north of the site. The reservoir is privately-owned and located on land under US Forest Service jurisdiction. The reservoir is contained by a 65-foot high by 460-foot long earthen dam and has a normal storage capacity of 2,926 acre-feet. Since the Balm Creek flow is regulated, its potential for flooding is reduced, but not eliminated. The 100-year flood discharge is 207 cfs using regression equations for eastern Oregon (USGS, 1983). These two discharge rates were combined to estimate the width and elevation of the 100-year flood plain for the EE/CA (BLM, 2002a).

Below the mine complex, Balm Creek flows south approximately seven miles before joining the Powder River. Upstream of the confluence, an 11.7 mile segment of the Powder River between the Thief Valley Dam and the Highway 203 bridge is classified as a Scenic River (http://www.nps.gov/rivers/wsr-powder.html). Below the confluence, the Powder River flows east to the Snake River.

### 2.4.3 Water Quality Criteria

The process of comparing a water-chemistry data set with numerical water-quality criteria is complicated, especially when the constituents of interest are primarily metals. While most metals criteria apply to dissolved concentrations, some apply to total concentrations. Also, several of the criteria for metals are expressed as a function of hardness. The comparison involves numerical extrapolation and/or interpretation from somewhat limited and ambiguous regulatory guidelines promulgated by the governing State agency - Oregon Department of Environmental Quality (ODEQ). The direct comparison of ODEQ's Table 20 (Attachment 7), which contains their generic numerical criteria, has limited applicability for metals without supporting documentation. Thus, the following discussion of applicable surface water quality criteria is based on four primary sources:

1.) ODEQ's Table 20;
2.) EPA's National Recommended Water Quality Criteria, 11/02 (NRWQC, Attachment 8);
3.) EPA's Quality Criteria for Water 1986 (Gold Book); and
4.) Colorado's Basic Standards and Methodologies for Surface Water.

According to ODEQ's Table 14, the designated beneficial uses for Balm Creek and Slide Creek include everything except the generation of hydroelectric power. In cases where multiple uses are designated, the use with the most stringent water-quality criterion is used to determine compliance. The process of determining the appropriate criterion for each chemical constituent involved the following steps:

1.) Compute the hardness for each sample from calcium and magnesium concentrations;
2.) Determine the most stringent criterion;
3.) Determine if the criterion applies to the total or dissolved concentration;
4.) List or compute the criterion; and
5.) Document the sources used.

Hardness was computed by multiplying the sum of milliequivalents per liter of calcium and magnesium by 50 (Hem, 1989, p. 158), and the results are shown in Table 2.4.3-1.

$$\text{Hardness (mg/l as } CaCO_3) = [(\text{Dissolved Ca in mg/l})(0.0499) + (\text{Dissolved Mg in mg/l})(0.08229)]\ (50)$$

**Table 2.4.3-1: Water Hardness (mg/l as $CaCO_3$)**

| | C-SW-1* | C-SW-2* | C-SW-3* | C-SW-4* | C-SW-4R* | D-SW-2* |
|---|---|---|---|---|---|---|
| Hardness | 46.4 | 910.7 | 1024.8 | 115.8 | 120.4 | 109.2 |

* - 11/13/02 surface water sample identifier. Sample-specific detail is presented in Section 3.1.

Hardness varies over two orders of magnitude, yet the values listed in ODEQ's Table 20 are based on a hardness of 100 mg/l. Fortunately, the equations that ODEQ used in Table 20 are available in the Gold Book and in the NRWQC. Calculations for hardness-dependent metals criteria were run for hardness values of 50 mg/l and 1000 mg/l to supplement the Table 20 values for 100 mg/l.

The most stringent criterion for each metal, except aluminum, was determined from Table 20. The Oregon Administrative Rules [OAR-041-0765(2)(p)(B)] state that "levels of toxic substances shall not exceed the criteria listed in Table 20 which were based on criteria established by EPA and published in Quality Criteria for Water (1986), unless otherwise noted." An attempt was made to verify the criterion in Table 20 using the Gold Book or NRWQC. If a criterion could not be verified, a note was made that its origin is unknown. States are free to set more stringent criteria than EPA recommends, but ODEQ offers no clarifying rationale when their criteria differ from the recommended federal counterparts. ODEQ's criteria for beryllium and nickel could not be verified by another source.

An ODEQ criterion for aluminum could not be found, which represents a significant omission considering that Oregon is a state with important fishery resources. Aluminum can be very toxic to fish, particularly in mixing zones where colloidal aluminum may form from solution. For purposes of comparison, the aluminum criterion from the NRWQC are used.

For metals with both acute and chronic criteria, the chronic criterion was selected rather than the acute criterion. Since the samples were collected at base flow, the data should reflect chronic conditions that can persist over extended periods of time, rather than short duration acute events.

Criteria for aluminum, iron, selenium, and silver apply to total concentrations. The rest apply to dissolved concentrations. This determination was made using the Gold Book, NRWQC, and the Colorado water-quality criteria. The results of determining the most stringent criterion for each metal are shown in Table 2.4.3-2.

Complete calculations for chromium were not done because concentrations for all samples were below the reporting limit of 2.5 µg/l, and the lowest criterion is 120 µg/l for a hardness of 50 mg/l.

Lead is only dependent on hardness for hardness values less than 870 mg/l. The lead criterion for human health is 50 µg/l which corresponds to a hardness of 870 mg/l.

ODEQ's criterion for silver and selenium match the Gold Book numbers and the Gold Book states that they apply to total concentrations.

| Table 2.4.3-2: Most Stringent Criterion for Each Metal (µg/l Unless Otherwise Indicated) | | | |
|---|---|---|---|
| **Metal** | **Dissolved (D), Total (T), (Reference)** | **Hardness Dependent** | **Most Stringent Criterion (Reference)** |
| Aluminum | T (8) | N | 87 FWAL (8) |
| Antimony | D (CO) | N | 146 PCR (7, GB) |
| Arsenic | D (8, GB) | N | 2.2 ng/l PCR (7, GB) |
| Barium | D (CO, GB) | N | 1 mg/l PCR (7, 8), DWS (GB) |
| Beryllium | D (CO, GB) | N | 6.8 ng/l PCR (7) Origin unknown does not match GB |
| Cadmium | D (8, GB) | Y | 0.66 @ H = 50 FWAL<br>1.1 @ H = 100 (7)<br>2.0 @ H = 200<br>e^(0.7852(ln(H))-3.49) (GB) (This eq. is slightly different from eq. in 8) |
| Calcium | NA | NA | NA |
| Chromium | D (8, CO) | Y | No detects @ RL = 2.5, Criterion = 120 @ H = 50 FWAL (7, GB) |
| Cobalt | NA | NA | NA |
| Copper | D (8, GB) | Y | 6.5 @ H = 50 FWAL<br>12 @ H = 100 (7)<br>21 @ H = 200<br>e^(0.8545(ln(H))-1.465) (GB) (This eq. is slightly different from eq. in 8) |
| Iron | T (CO) | N | 0.3 mg/l PCR (7, 8), DWS (GB) |
| Lead | D (8, GB) | Y | 1.3 @ H = 50 FWAL<br>3.2 @ H = 100 (7)<br>7.7 @ H = 200<br>e^(1.273(ln(H))-4.705) (GB) (This eq. is slightly different from eq. in 8)<br>50 PCR (7, GB) (H = 870) |
| Magnesium | NA | NA | NA |
| Manganese | D (CO, GB) | N | 50 PCR (7, 8), DWS (GB) |
| Mercury | D (8, CO) | N | 0.012 FWAL (7, GB) |

| Table 2.4.3-2: Most Stringent Criterion for Each Metal (µg/l Unless Otherwise Indicated) | | | |
|---|---|---|---|
| Nickel | D (8, CO) | Y | 13.4 PCR (7) Origin unknown does not match anything else |
| Potassium | NA | NA | NA |
| Selenium | T (8, GB) | N | 10 PCR (7, GB) |
| Silver | T (GB), D (8) | Y | 0.12 FWAL (7, GB) |
| Sodium | NA | NA | NA |
| Thallium | D (CO) | N | 13 PCR (7, GB) |
| Vanadium | NA | NA | NA |
| Zinc | D (8) | Y | 67 @ H = 50 FWAL<br>120 @ H = 100 (7)<br>216 @ H = 200<br>e^(0.8473(ln(H))+0.884) (8) |

CO = Colorado Water Quality Standards
DWS = Domestic Water Supply
FWAL = Fresh Water Aquatic Life
GB = Gold Book
H = Hardness in mg/l as $CaCO_3$
PCR = Primary Contact Recreation
RL = Reporting Limit
7 = Attachment 7
8 = Attachment 8

Criteria for pH, temp., and TDS is at: http://www.deq.state.or.us/wq/wqrules/340Div41.pdf. The criterion for pH, as interpreted from guidelines stated on page 203, falls within a range of 6.5-9.0. The criterion for water temperature, as interpreted from guidelines stated on page 202, is 12.8 °C. The nearest applicable criterion for TDS, as interpreted from guidelines stated on page 205, applies to the mainstem Snake River (750 mg/l).

With respect to water-quality standards, the criterion as published and discussed in EPA's Quality Criteria for Water, 1986, is "20 mg/l or more as $CaCO_3$..." The discussion also states "alkalinity resulting from naturally occurring materials such as carbonate and bicarbonate is not considered a health hazard in drinking water supplies, per se, and naturally occurring maximum levels up to approximately 400 mg/l as $CaCO_3$ are not considered a problem to human health..."

Alkalinity is important for fish and other aquatic life in freshwater systems because it buffers pH changes that occur naturally as a result as a result of photosynthetic activity of chlorophyll-bearing vegetation. Components of alkalinity such as carbonate and bicarbonate will complex some toxic heavy metals and reduce their toxicity markedly. For these reasons, the National Technical Advisory Committee (NTAC, 1968) recommended a minimum alkalinity of 20 mg/l.

Given these recommended guidelines, and for the hazard assessment purposes of this study, a concentration of alkalinity less than 20 mg/l or exceeding 400 mg/l is considered potentially hazardous.

## 2.5 Results of Previous Surface Water Sampling Events

Two surface water sampling events have been completed in conjunction with the EE/CA site efforts **(Table 2.5-1)**. The objective of the sampling events was focused on identifying the distribution of contaminants in surface waters at the site, for both low-flow (9-22-00) and high flow (4-18-01) conditions (BLM, 2002a). The surface water samples were analyzed for selected metals (via EPA 200 Series Methods), major anions (i.e., nitrate, chloride, sulfate via EPA 300 Series Methods), alkalinity (i.e., acid-neutralizing capacity), cyanide, free cyanide, and selected physical parameters (i.e, pH and conductivity). **Table 2.5-1** shows the surface water analytical results corresponding to both EE/CA surface water sampling events (BLM, 2002a).

**Table 2.5-1: EE/CA Surface Water Results, Poorman/Balm Creek Site, OR (mg/l)**

| | Balm Creek | Pond | Down-stream Site | Lower Poorman Adit | Decant Pipe | Head Frame | Above Upper Poorman | Upper Poorman Seep | D/S Lower Poorman | Main Site Puddle | Most Stringent Criterion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **9/22/0** | **9/22/00** | **9/22/00** | **9/22/00** | **4/18/01** | **4/18/01** | **4/18/01** | **4/18/01** | **4/18/01** | **4/18/01** | |
| Antimony | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | NC |
| Arsenic | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | NC |
| Cadmium | <0.000 | <0.0005 | <0.0005 | <0.0005 | 0.0083 | <0.0005 | <0.0005 | <0.005 | <0.005 | 0.013 | NC |
| Copper | <0.002 | 0.008 | 0.007 | <0.002 | 2.24 | 0.54 | 0.027 | <0.002 | 0.034 | 7.96 | NC |
| Lead | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | NC |
| Mercury | <0.000 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | NC |
| Nickel | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | NC |
| Selenium | <0.005 | <0.005 | <0.005 | <0.005 | **0.017** | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.010 |
| Silver | <0.001 | <0.001 | <0.001 | **0.004** | **0.001** | <0.001 | <0.001 | <0.001 | **0.004** | **0.003** | 0.00012 |
| Thallium | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | NC |
| Zinc | <0.005 | 0.009 | 0.008 | 0.023 | 1.4 | 0.366 | 0.005 | 0.077 | 0.034 | 2.28 | NC |
| Nitrate | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | |
| Alkalinity | 52.3 | 34.1 | 38.8 | **12.1** | NA | NA | NA | NA | NA | NA | 20 < Alkalinity < 400 |
| Chloride | <1 | <1 | <1 | 1 | NA | NA | NA | NA | NA | NA | |
| Conductivity | 57.6 | 151 | 76.8 | 1170 | NA | NA | NA | NA | NA | NA | |
| Cyanide-Free | <0.01 | <0.01 | <0.01 | <0.01 | NA | NA | NA | NA | NA | NA | |
| Cyanide-Total | <0.005 | <0.005 | <0.005 | <0.005 | NA | NA | NA | NA | NA | NA | 0.0052 |
| Sulfate | 1 | 54 | 7 | 700 | NA | NA | NA | NA | NA | NA | |
| pH | 7.8 | 7.2 | 7.7 | **5.7** | **6.2** | **6.1** | 7.2 | 7.3 | 7.1 | **3.34** | 6.5 < pH < 9 |

NC - Not Calculable.
NA - Not Analyzed.

It is problematic to interpret the EE/CA-derived data in terms of numerical criteria in that their respective hardness values are incalculable because calcium and magnesium analyses were not run. The silver exceedance for the 9/22/00 Lower Poorman Adit sample is so noted because it is a total concentration. All reported concentrations for the 4/18/01 sampling event are total concentrations, so the silver exceedances are so noted. In addition, the reported selenium concentration for the 4/18/01 Decant Pipe sample constitutes an exceedance. There are no other calculable metals exceedances associated with the 4/18/01 data set.

The sample collected from the Slide Creek spring, located upstream of Sub-site A, was found to carry a background loading of copper (0.027 mg/l). In Balm Creek, the seep water flowing from the Head Frame was found to carry a source loading of copper (0.54 mg/l) and zinc (0.366 mg/l). Surface water emanating from the seep flows approximately 100 yards before draining into Balm Creek and it is likely there is attenuation along this segment, as evidenced by the iron precipitates in the sediment.

All surface water pH results were within the OAR340-041-0765, 2, d, B range (6.5-9.0) with the exception of the Lower Poorman Adit (pH = 5.7), Decant Pipe (pH = 6.2), Head Frame (pH = 6.1), and Main Site Puddle (pH = 3.34). In addition, alkalinity at the Lower Poorman Adit (12.1 mg/l) did not meet the minimum standard, 20 mg/l, recommended by NTAC.

# 3.0 FIELD INVESTIGATION ACTIVITIES

Specific tasks undertaken to accomplish project objectives are described in the ***Final Field Sampling Plan and Quality Assurance Project Plan***, dated November 6, 2002. This project planning document was reviewed and approved by BLM and Dynamac project managers.

This sampling project followed protocols established by the EPA and BLM that are considered to be standard practice in the environmental industry. A fixed number of samples were collected at locations previously sampled during the EE/CA low flow and high flow events. These samples were collected using disposable equipment to minimize the need for decontamination. The samples were analyzed for selected parameters to provide a localized evaluation of the presence or absence of contaminants potentially impacting the surface water migration pathway. Surface water quality parameters (pH, conductivity, temperature) were measured in the field immediately following the collection of each sample. Each surface water sample was analyzed for 23 total and dissolved Target Analyte List (TAL) metals, total low-level mercury and silver, alkalinity, major anions (sulfate, chloride, fluoride), and total dissolved solids (TDS).

A priority of this sampling project was to assure that the sampling and QA/QC protocols discussed throughout the FSP/QAPP were rigidly followed. To achieve that goal, experienced BLM field personnel conducted the sampling. The locations of the sample collection points were recorded with a Global Positioning System (GPS) unit. All field sampling activities, the rationale for deviations from FSP/QAPP protocols, and sample events/locations were recorded in the field logbook. Important aspects of the field sampling effort which deviated from those proposed in the Final FSP/QAPP are described as follows (BLM, 2002c):

- The FSP/QAPP was designed to focus on surface water locations downgradient, at waste sources, and upgradient of each Sub-site. Dry, low-flow, and/or stagnant surface water body conditions corresponding to Slide Creek and the Sub-site D decant pipe rendered six of the proposed eleven surface water samples uncollectible.
- The FSP/QAPP called for the collection of a quality assurance/quality control (QA/QC) replicate (duplicate) sample, D-SW-1R, from the decant pipe to verify the integrity of the sampling data. There was no water flowing from the decant pipe and stagnant water was pooled below the decant pipe outfall. Thus, to conform with requisite sample QA/QC protocol, replicate sample C-SW-4R was collected from Balm Creek between Sub-site C and the confluence of Slide Creek and Balm Creek (**Attachment 5**).

## 3.1 Surface Water Sample Identification, Locations, and Rationale

The six surface water samples which were collected on 11/13/02, their respective locations, and the corresponding rationale for their collection are listed in **Table 3.1-1**.

| Table 3.1-1;  Surface Water Samples, 11/13/02, Poorman/Balm Creek Site, OR | | |
|---|---|---|
| **Sample ID** | **Location** | **Rationale** |
| C-SW-1 | Upper Balm Creek - Above Mine Works (**Attachment 5**) | Upgradient Water Quality Assessment, Balm Creek |
| C-SW-2 | Shaft - Headframe Discharge (**Attachment 5**) | Surface Water Pathway, Sub-site C Waste Source Impact Assessment |
| C-SW-3 | Balm Creek Shaft Discharge - Seep At Toe Of Waste Rock (**Attachment 5**) | Surface Water Pathway, Sub-site C Waste Source Impact Assessment |
| C-SW-4 | Lower Balm Creek - Between Sub-site C and Confluence of Slide Creek and Balm | Surface Water Pathway, Contaminant Attenuation Assessment, Sub-site C |
| C-SW-4R | Lower Balm Creek - Between Sub-site C and Confluence of Slide Creek and Balm | QA/QC Replicate (Duplicate) Sample of C-SW-4 |
| D-SW-2 | Lower Balm Creek - Below Lower Tailings Pond (**Attachment 6**) | Surface Water Pathway, Contaminant Attenuation Assessment, Sub-sites A, B, C, & D |

## 3.2 Surface Water Sampling Procedures

Surface water sampling procedures conformed with **Section 3.2** of the project FSP/QAPP. In summary, surface water parameters were measured and recorded using an industry-standard water quality checker, then individual sample fractions were collected using direct immersion methodology. The low-level total mercury sample fraction was collected following EPA Method 1669 sample collection methodology. Surface water sampling procedures conformed with all applicable project QA/QC requirements (Dynamac, 2002a).

## 3.3 Surface Water Sampling Analyses

The following EPA analytical methods were run on each sample by the first project laboratory, Accutest Laboratories Gulf Coast, Inc.:

- 200.7 - TAL Metals (Total & Dissolved)
- 310.1 - Alkalinity
- 300.0 - Sulfate
- 300.0 - Chloride
- 300.0 - Fluoride
- 160.1 - TDS.

Additional EPA analytical methods were run on each sample by the second project laboratory, ACZ Laboratories, Inc. (Dynamac, 2002a):

- 1631 B - Low-Level Total Mercury
- 200.8 - Low-Level Total Silver.

Discussion concerning laboratory-specific performance, data reliability, and data usability is presented in **Section 3.5** and **Attachment 9**.

### 3.4 Surface Water Sampling Results

Surface water sample results, organized according to Sub-site C and D) and numbering sequence, are tabulated (**Tables 3.4-1, 3.4-2, and 3.4-3**) and discussed as follows:

| Table 3.4-1; Total Metals Results, Poorman/Balm Creek Site, OR (µg/l) | | | | | | |
|---|---|---|---|---|---|---|
| | | C-SW-2 | C-SW-3 | C-SW-4 | C-SW-4R | D-SW-2 |
| Aluminum | 50.2 | 51.0 | <13 | 232 | 223 | 191 |
| Antimony | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Arsenic | <2.5 | <2.5 | <5.0 | <2.5 | <2.5 | <2.5 |
| Barium | 27.5 | 9.8 | 8.1 | 31.6 | 31.4 | 45.3 |
| Beryllium | <1.0 | <1.0 | <2.0 | <1.0 | <1.0 | <1.0 |
| Cadmium | <1.0 | 1.1 | <2.0 | <1.0 | <1.0 | <1.0 |
| Calcium | 10600 | 334000 | 316000 | 34000 | 34300 | 31000 |
| Chromium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Cobalt | <2.5 | 20.7 | 7.7 | <2.5 | <2.5 | <2.5 |
| Copper | <5.0 | 117 | <5.0 | 263 | 260 | 95.9 |
| Iron | 112 | 17200 | 728 | 182 | 172 | 669 |
| Lead | <2.5 | <2.5 | <5.0 | <2.5 | <2.5 | <2.5 |
| Magnesium | 3920 | 41700 | 41800 | 8290 | 8360 | 8700 |
| Manganese | 7.3 | 1530 | 744 | 166 | 164 | 139 |
| Mercury | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| Mercury (Low) | 0.0006 | 0.0003 | 0.0012 | 0.0011 | 0.0006 | 0.0011 |
| Nickel | <5.0 | <5.0 | <10 | <5.0 | <5.0 | <5.0 |
| Potassium | 1370 | 2570 | 2650 | 1630 | 1650 | 1750 |
| Selenium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Silver | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Silver (Low) | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 |
| Sodium | 6920 | 30300 | 30100 | 9880 | 9780 | 9740 |
| Thallium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Vanadium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Zinc | <7.5 | 884 | 532 | 74.7 | 75.0 | 93.0 |

| Table 3.4-2; Filtered Metals Results, Poorman/Balm Creek Site, OR (µg/l) | | | | | | |
|---|---|---|---|---|---|---|
| | C-SW-1 | C-SW-2 | C-SW-3 | C-SW-4 | C-SW-4R | D-SW-2 |
| Aluminum | <13 | <13 | <13 | 86.6 | 92.9 | 91.8 |
| Antimony | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Arsenic | <2.5 | <2.5 | 2.9 | <2.5 | <2.5 | <2.5 |
| Barium | 41.2 | 11.8 | 10.6 | 40.7 | 49.6 | 62.2 |
| Beryllium | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Cadmium | <1.0 | 1.1 | <1.0 | <1.0 | <1.0 | <1.0 |
| Calcium | 11900 | 302000 | 341000 | 33100 | 34400 | 29900 |
| Chromium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Cobalt | <2.5 | 21.5 | 7.8 | <2.5 | <2.5 | <2.5 |
| Copper | <5.0 | 10.9 | <5.0 | 176 | 185 | 64.0 |
| Iron | 59.2 | 6670 | <34 | 70.9 | 73.2 | 402 |
| Lead | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Magnesium | 4050 | 38200 | 42300 | 8080 | 8400 | 8420 |
| Manganese | 5.6 | 1540 | 785 | 161 | 166 | 138 |
| Mercury | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| Nickel | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Potassium | 1390 | 2430 | 2780 | 1600 | 1660 | 1730 |
| Selenium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Silver | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Sodium | 6970 | 30400 | 30800 | 9810 | 10100 | 9610 |
| Thallium | <2.5 | 2.7 | <2.5 | <2.5 | <2.5 | <2.5 |
| Vanadium | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Zinc | 12.8 | 832 | 489 | 75.2 | 76.9 | 90.2 |

| Table 3.4-3; Major Anions and Water Quality Results, Poorman/Balm Creek Site, OR (mg/l Unless Otherwise Indicated) | | | | | | |
|---|---|---|---|---|---|---|
| | **C-SW-1** | **C-SW-2** | **C-SW-3** | **C-SW-4** | **C-SW-4R** | **D-SW-2** |
| Alkalinity | 54.3 | 53.3 | 42.0 | 50.2 | 50.2 | 48.2 |
| Chloride | <20 | <20 | <20 | <20 | <20 | <20 |
| Fluoride | <0.20 | 0.48 | 0.43 | <0.20 | <0.20 | <0.20 |
| TDS | 90.0 | 1240 | 1250 | 202 | 206 | 188 |
| Sulfate | <20 | 794 | 781 | 85.4 | 85.4 | 82.0 |
| pH | 7.86 | 6.23 | 7.50 | 7.68 | 7.68 | 7.55 |
| Conductivity (mS/cm) | 115 | 1476 | 1453 | 293 | 293 | 281 |
| Temperature (°C) | 5.1 | 15.2 | 12 | 5.7 | 5.7 | 4 |

**Table 3.4-4** compares the 11/13/02 metals data to the most stringent applicable criteria. Exceedances are noted in bold. Since an aluminum criterion could not be found in the ODEQ standards, the aluminum exceedances shown in Table 4.0-3 refer to the NRWQC. For arsenic and beryllium, the most stringent criterion was below the reporting limit.

| Table 3.4-4: Comparison of 11/13/02 Metals Data to Most Stringent Criteria (µg/l Unless Otherwise Noted) | | | | | | |
|---|---|---|---|---|---|---|
| **Metal (Dissolved Unless Otherwise Noted)** | **Most Stringent Criterion** | **C-SW-1** | **C-SW-2** | **C–SW-3** | **C-SW-4** | **D-SW-2** |
| Aluminum (Total) | 87 FWAL | 50.2 | 51 | <13 | **232** | **191** |
| Antimony | 146 PCR | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Arsenic[1] | 2.2 ng/l PCR | <2.5 | <2.5 | **2.9** | <2.5 | <2.5 |
| Barium | 1 mg/l PCR, DWS | 41.2 | 11.8 | 10.6 | 40.7 | 62.2 |
| Beryllium[1] | 6.8 ng/l PCR | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Cadmium | 0.66 @ H = 50 FWAL<br>1.1 @ H = 100<br>6.9 @ H = 1,000 | <1.0 | 1.1 | <1.0 | <1.0 | <1.0 |
| Chromium | 120 @ H = 50 FWAL | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |

| Table 3.4-4: Comparison of 11/13/02 Metals Data to Most Stringent Criteria (µg/l Unless Otherwise Noted) | | | | | | |
|---|---|---|---|---|---|---|
| **Metal (Dissolved Unless Otherwise Noted)** | **Most Stringent Criterion** | **C-SW-1** | **C-SW-2** | **C–SW-3** | **C-SW-4** | **D-SW-2** |
| Copper | 6.5 @ H = 50 FWAL<br>12 @ H = 100<br>85 @ H = 1,000 | <5.0 | 10.9 | <5.0 | **176** | **64** |
| Iron (Total) | 300 PCR | 112 | **17200** | **728** | 182 | **669** |
| Lead | 1.3 @ H = 50 FWAL<br>3.2 @ H = 100<br>50 PCR H > 870 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Manganese | 50 PCR, DWS | 5.6 | **1540** | **785** | **161** | **138** |
| Mercury[2] | 0.012 FWAL | 0.0006 | 0.0003[3] | 0.0012 | 0.0011 | 0.0011 |
| Selenium (Total) | 10 PCR | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Silver (Total) | 0.12 FWAL | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Thallium | 13 PCR | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Zinc | 67 @ H = 50 FWAL<br>120 @ H = 100<br>843 @ H = 1,000 | 12.8 | 832 | 489 | 75.2 | 90.2 |

1. Criterion less than the reporting limit
2. The criterion is for dissolved but only total mercury was analyzed
3. MDL = 0.0002, PQL = 0.0005

**Table 3.4-5** compares the 11/13/02 data for constituents other than metals with their most stringent criterion. Again exceedances are noted in bold. Criteria for temperature and pH were found in the Oregon Administrative Rules at the cited location.

| Table 3.4-5: Comparison of 11/13/02 Non-Metals Data With Most Stringent Criteria (mg/l Unless Otherwise Indicated) | | | | | | |
|---|---|---|---|---|---|---|
| **Constituent** | **Most Stringent Criterion/Reference** | **C-SW-1** | **C-SW-2** | **C–SW-3** | **C-SW-4** | **D-SW-2** |
| Temperature °C | 12.8°C<br>(OAR340-041-0765, 2, b) | 5.1 | **15.2** | 12 | 5.7 | 4.0 |

| Table 3.4-5: Comparison of 11/13/02 Non-Metals Data With Most Stringent Criteria (mg/l Unless Otherwise Indicated) | | | | | | |
|---|---|---|---|---|---|---|
| **Constituent** | **Most Stringent Criterion/Reference** | **C-SW-1** | **C-SW-2** | **C–SW-3** | **C-SW-4** | **D-SW-2** |
| pH | 6.5-9.0 (OAR340-041-0765, 2, d, B) | 7.86 | **6.23** | 7.5 | 7.68 | 7.55 |
| Chloride | 230 FWAL (7, 8) | < 20 | < 20 | < 20 | < 20 | < 20 |
| Fluoride | 2 DWS (CO) | < 0.20 | 0.48 | 0.43 | < 0.20 | < 0.20 |
| Sulfate | 250 DWS (CO) | < 20 | **794** | **781** | 85.4 | 82.0 |
| TDS | 750 (OAR340-041-0765, 2, A, o) | 90.0 | **1240** | **1250** | 202 | 188 |

All surface water pH results are within the OAR340-041-0765, 2, d, B range (6.5-9.0) with the exception of the Shaft - Headframe Discharge, which is slightly acidic at 6.23. However, this is surfacing groundwater which appears to be buffered by the time it reaches Balm Creek (BLM, 2002d).

A hazard assessment concerning water temperature, as interpreted from OAR340-041-0765, 2, b guidelines stated on page 202, concludes that the surface water sample temperatures are acceptable. Samples collected at the Shaft - Headframe Discharge and the Balm Creek shaft discharge - seep at toe of waste rock are somewhat elevated, however, recharge at these locations is surfacing groundwater, and their temperatures (15.2 °C and 12 °C, respectively) are consistent with groundwater. The apparent temperature exceedance in the shaft water is of minimal practical concern for three reasons: 1) the intent of the criterion is to protect salmonid spawning areas and it is unlikely that salmonids have or will make their way up to the shaft to spawn; 2) the water temperature is below the criterion at the seep and in the stream; and, 3) the shaft water is primarily comprised of surfacing ground water, so a surface water temperature criterion has limited applicability. In any case, comparison of individual temperature measurements with a temperature criterion is not recommended because surface water temperature is largely dictated by daily meteorological conditions and fluctuations. The appropriate means for monitoring temperature compliance is by implementation of a continuous monitoring program (BLM, 2002d).

A hazard assessment concerning TDS, as interpreted from OAR340-041-0765, 2, A, o guidelines stated on page 205, concludes that though TDS discharges emanating from the Shaft - Headframe Discharge (1,240 mg/l) and the Balm Creek shaft discharge - seep at toe of waste rock (1,250 mg/l) exceed the nearest applicable mainstem Snake River criterion (750 mg/l), their in-stream distance from the mainstem Snake River precludes any discernable impact to it (BLM, 2002d).

For comparative purposes, the shaft (794 mg/l) and seep (781 mg/l) water exceed the Colorado sulfate criterion (250 mg/l) for drinking water supply (BLM, 2002d).

Sample-specific exceedances of the most stringent water quality criteria are summarized as follows:

Sample C-SW-1, Upper Balm Creek - Above Mine Works (**Attachment 5**)

- none of the 23 TAL metals, major anions, or general water parameters were found to meet or exceed the most stringent water quality criteria. Validated C-SW-1 sample results are tabulated and presented in **Attachment 9**.

Sample C-SW-2, Shaft - Headframe Discharge (**Attachment 5**)

- pH (6.23) fell short of the most stringent water quality criterion range ($6.5 < pH < 9.0$);
- sulfate (794 mg/l) exceeded the most stringent water quality criterion (250 mg/l) by a factor of 3.2;
- water temperature (15.2 °C) exceeded the most stringent water quality criterion (12.8 °C) by a factor of 1.2;
- iron (17,200 µg/l) exceeded the most stringent water quality criterion (300 µg/l) by a factor of 57.3;
- manganese (1,540 µg/l) exceeded the most stringent water quality criterion (50 µg/l) by a factor of 30.8;
- none of the other 21 TAL metals were found to meet or exceed the most stringent water quality criteria. Validated C-SW-2 sample results are tabulated and presented in **Attachment 9**.

Sample C-SW-3, Balm Creek Shaft Discharge - Seep at Toe of Waste Rock (**Attachment 5**)

- sulfate (781 mg/l) exceeded the most stringent water quality criterion (250 mg/l) by a factor of 3.1;
- arsenic (2.9 µg/l) exceeded the most stringent water quality criterion (2.2 ng/l) by a factor of 1318;
- iron (728 µg/l) exceeded the most stringent water quality criterion (300 µg/l) by a factor of 2.4;
- manganese (785 µg/l) exceeded the most stringent water quality criterion (50 µg/l) by a factor of 25.5;
- none of the other 20 TAL metals were found to meet or exceed the most stringent water quality criteria. Validated C-SW-3 sample results are tabulated and presented in **Attachment 9**.

Sample C-SW-4, Lower Balm Creek Between Sub-site C and the confluence of Slide Creek and Balm Creek (**Attachment 5**)

- aluminum (232 µg/l) exceeded the most stringent water quality criterion (87 µg/l) by a factor of 2.7;
- copper (176 µg/l) exceeded the most stringent water quality criterion (12 µg/l) by a factor of 14.7;
- manganese (161 µg/l) exceeded the most stringent water quality criterion (50 µg/l) by a factor of 3.2;
- none of the 20 TAL metals, major anions, or general water parameters were found to meet or exceed the most stringent water quality criteria. Validated C-SW-4 sample results are tabulated and presented in **Attachment 9**.

Sample C-SW-4R, Same Location as C-SW-4 (**Attachment 5**)

- aluminum (223 µg/l) exceeded the most stringent water quality criterion (87 µg/l) by a factor of 2.6;
- copper (185 µg/l) exceeded the most stringent water quality criterion (12 µg/l) by a factor of 15.4;
- manganese (164 µg/l) exceeded the most stringent water quality criterion (50 µg/l) by a factor of 3.3;
- none of the 20 TAL metals, major anions, or general water parameters were found to meet or exceed the most stringent water quality criteria. Laboratory results corresponding to C-SW-4R were consistent with C-SW-4 (**Section 3.5**). Validated C-SW-4R sample results are tabulated and presented in **Attachment 9**.

Sample D-SW-2, Lower Balm Creek Below the Lower Tailings Pond (**Attachment 6**)

- aluminum (191 µg/l) exceeded the most stringent water quality criterion (87 µg/l) by a factor of 2.2;
- copper (64 µg/l) exceeded the most stringent water quality criterion (12 µg/l) by a factor of 5.3;
- iron (669 µg/l) exceeded the most stringent water quality criterion (300 µg/l) by a factor of 2.2;
- manganese (138 µg/l) exceeded the most stringent water quality criterion (50 µg/l) by a factor of 2.8;
- none of the 20 TAL metals, major anions, or general water parameters were found to meet or exceed the most stringent water quality criteria. Validated D-SW-2 sample results are tabulated and presented in **Attachment 9**.

## 3.5 Quality Assurance/Quality Control (QA/QC) Sampling and Analyses

The FSP/QAPP called for the collection of a quality assurance/quality control (QA/QC) replicate (duplicate) sample, D-SW-1R, from the decant pipe to verify the integrity of the sampling data. There was no water flowing from the decant pipe and stagnant water was pooled below the outfall. Thus, field duplicate sample C-SW-4R was collected from Balm Creek between Sub-site C and the confluence of Slide Creek and Balm Creek (**Attachment 5**). The field replicate (duplicate) sample, submitted to evaluate sampling and analytical reproducibility, was analyzed for the same analytical fractions as specified for C-SW-4. All corresponding relative percent differences (RPDs) between each sample data set were within standard quality control limits (0-35%) and laboratory precision and overall sample matrix homogeneity was determined to be satisfactory (Dynamac, 2002b). Validated duplicate sample results are tabulated and presented in **Attachment 9**.

Two blank samples accompanied the low-level total mercury bottles from the laboratory to the field, for the duration of the sampling event, and from the field back to the laboratory. Low-level mercury analysis of each blank is a requirement of EPA Method 1631 B. Mercury was detected in these samples at 0.0002 µg/l. The results for low level mercury in samples C-SW-4R, C-SW-1, and C-SW-2 were qualified (B qualifier) indicating that the result was not significantly greater than that observed in the associated blanks (Dynamac, 2002b). Validated blank sample results are tabulated and presented in **Attachment 9**.

Data qualifications are minor and do not significantly detract from the overall validity, reliability, and defensibility of the laboratory analytical reporting and project data quality objectives (DQOs) were achieved. Dynamac has prepared a Data Validation Memorandum, dated December 6, 2002, which is presented as **Attachment 9** (Dynamac, 2002b).

Additional sample QA/QC assessment concerning charge balance, total minus dissolved concentrations, and TDS versus sum of constituents (SOC) is presented in **Table 3.5-1**:

**Table 3.5-1: Sample Charge Balance and Total Minus Dissolved Concentrations**

| Sample | Charge Balance | Total - Dissolved < 0 But > Reporting Limit | Comments |
|---|---|---|---|
| C-SW-1 | 7.66% | Ba, Ca, Mg | Satisfactory |
| C-SW-2 | 5.52% | Mn, Tl | Satisfactory |
| C-SW-3 | 9.53% | As, Ba, Ca, Mg, Mn, Na | Should Have Been Rerun |
| C-SW-4 | 0.14% | Ba | Satisfactory |
| C-SW-4R | 2.00% | Ba, Na | Results Consistent With C-SW-4 |
| D-SW-2 | -1.02% | Ba | Satisfactory |

The charge balances are considered acceptable with the possible exception of C-SW-3, though this outlier may be attributable to the high reporting limit (20 mg/l) for chlorine and sulfate, rather than a true imbalance. Column 3 shows the analytes for which the dissolved value exceeds the total value by more than the reporting limit. Again, results associated with six C-SW-3 metals are problematic. Given the charge balance and the number of dissolved > total, this sample should have been automatically rerun (BLM, 2002d).

**Table 3.5-2** compares laboratory TDS against the sum of constituents (SOC). Sample C-SW-1 rendered the lowest TDS:SOC ratio and the second highest charge balance. A positive charge balance difference is indicative of a shortage of anions. Most likely there is sulfate present at a concentration less than the laboratory reporting limit (20 mg/l), and if the true sulfate concentration were factored in, then both the charge balance and SOC results would be improved (BLM, 2002d).

**Table 3.5-2: Total Dissolved Solids (TDS) Versus Sum of Constituents (SOC)**

| Sample ID | TDS | SOC | TDS:SOC |
|---|---|---|---|
| C-SW-1 | 90 | 57.0 | 0.63 |
| C-SW-2 | 1240 | 1209 | 0.98 |
| C-SW-3 | 1250 | 1225 | 0.98 |
| C-SW-4 | 202 | 169 | 0.84 |
| C-SW-4R | 206 | 171 | 0.83 |
| D-SW-2 | 188 | 161 | 0.86 |

# 4.0 DISCUSSION

## 4.1 Source and Background Loading

The shaft is a major source of calcium and sulfate, and to a lesser extent, sodium and magnesium. Concentrations of calcium and sulfate decrease slightly between the shaft and the seep, and then decrease markedly between the seep and Balm Creek above Slide Creek. Concentrations of sodium and magnesium stay about the same between the Shaft and the seep, then decrease between the seep and Balm Creek above Slide Creek. The concentration of potassium remains fairly constant with just a small increase for the shaft and seep samples. Alkalinity values are about the same for all samples. Concentrations of cations and anions change very little between Balm Creek above Slide Creek, and Lower Balm Creek below the Lower Tailings Pond. Fluorine was detected in the shaft and seep samples. No chlorine was reported, but the reporting limit for chlorine is 20 mg/l, so chlorine may be present at concentrations less than 20 mg/l.

The shaft also is a major source of iron, manganese, and zinc. The concentrations of total and dissolved iron fall quickly between the shaft and the seep and then begin to level out. Considerable iron staining was noted upstream of where the seep sample was taken. Concentrations of manganese and zinc fall less rapidly between the shaft and Balm Creek above Slide Creek. Concentrations of barium, iron, magnesium, potassium, and zinc increase between Balm Creek above Slide Creek and the downstream sampling station, while concentrations of manganese decrease slightly in this reach.

Aluminum concentrations in the shaft water were no different than in the upstream water. Apparently there is a source of aluminum and copper between the seep and Balm Creek above Slide Creek that results in the elevated concentrations of aluminum and copper in Balm Creek above the Slide Creek sample location. This turned out to be a fortuitous location for the replicate sample, which verified the aluminum and copper concentrations. The aluminum concentrations persist to the next station downstream, but the copper concentrations decrease.

Dissolved arsenic was only detected in the seep sample at a concentration close to the reporting limit. Mercury (total) was detected in concentrations over twice the PQL in the seep discharge and in the two samples downstream of the seep. In contrast to the previous EE/CA data sets, silver (total) was not detected in any of the 11/13/02 samples.

## 4.2 Relative Characteristics of Hazardous Substances

The toxicity of arsenic and manganese is very high and the persistence in aquatic ecosystems of each inorganic substance is high. The food chain bioaccumulation capacity and environmental bioaccumulation capacity of copper and manganese are very high. The ecotoxicity of silver is very high. The relative toxicity, persistence, food chain and environmental bioaccumulation, and ecotoxicity of those inorganic substances which meet or exceed the most stringent water quality criteria are listed in **Table 4.2-1**.

| Table 4.2-1; Relative Characteristics of Hazardous Substances (Inorganics) | | | | | |
|---|---|---|---|---|---|
| **Inorganic Substance** | **Toxicity** | **Persistence*** | **Bioaccumulation**** | | **Ecotoxicity**** |
| | | | **Food Chain** | **Environmental** | |
| Aluminum | NA | High | Very Low | Very Low | NA |
| Arsenic | Very High | High | Low | Low | Low |
| Copper | NA | High | Very High | Very High | Moderate |
| Iron | NA | High | Very Low | Very Low | Low |
| Manganese | Very High | High | Very High | Very High | NA |
| Silver | Moderate | High | Low | Low | Very High |
| Selenium | Moderate | High | High | High | Moderate |
| Zinc | Low | High | Moderate | Moderate | Low |

Source: EPA, 1996
* - River
** - Fresh Water
NA - Not Available

Downstream of the site is the Balm Creek Area of Critical Environmental Concern (ACEC). This BLM area is designated to protect and maintain natural riparian ecological systems for research and educational purposes. According to the Oregon Department of Fish and Wildlife Aquatic Inventory Project conducted in 1996, Redband trout (*Oncorhynchus mykiss* ssp.), a BLM-sensitive species, has been found in Balm Creek upstream and downstream of the Mother Lode, Balm Creek, and Poorman workings (BLM, 2002a).

## 4.3 Summary

The shaft is a major source for calcium, sulfate, iron, manganese, and zinc. Most of the iron disappears probably through precipitation by the time the flow reaches the seep. Concentrations of manganese and zinc decline almost linearly from the shaft to the Balm Creek above Slide Creek sampling location. A combination of precipitation and dilution is the most likely cause, with precipitation being more important between the shaft and the seep, and dilution being dominant in Balm Creek. The ODEQ criterion for total iron is exceeded in the shaft discharge, the seep, and the furthest downstream sampling location. The criterion for manganese is exceeded in the shaft discharge, the seep, and both of the downstream sampling locations. The seep is contributing mercury that persists downstream but the concentrations do not exceed the criterion. The most interesting development is the heretofore unknown, but apparently contributing source(s) of aluminum and copper between the seep and Balm Creek above Slide Creek. Concentrations of copper exceed the ODEQ criterion at the Balm Creek above Slide

Creek sampling location and the downstream sampling location, and concentrations of aluminum exceed the EPA recommended criterion at the same two sampling locations. Also, the increase in barium, iron, magnesium, potassium, and zinc between Balm Creek above Slide Creek and the downstream sampling location may indicate a subsurface contribution from Slide Creek. More focused investigations may be required to identify these unknown sources (BLM, 2002d).

Mitigation of waste source discharge to surface water is necessary to protect the trout species and its habitat. Additional seasonal surface water sample data should be compiled and evaluated to supplement the existing EE/CA analytical database, facilitate the selection of appropriate remedial alternatives, and support federal cleanup obligations/decisions regarding mined tailings impacts to the Balm Creek and Slide Creek watersheds.

# 5.0 REFERENCES

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## ATTACHMENT 1

## POORMAN / BALM CREEK MINE SITE, COVER SHEET

## ATTACHMENT 2

## POORMAN / BALM CREEK AML, PROJECT SITE PLAN

**ATTACHMENT 3**

**UPPER POORMAN MINE - SUB-SITE A, PLAN VIEW**

**ATTACHMENT 4**

**LOWER POORMAN MINE - SUB-SITE B, PLAN VIEW**

**ATTACHMENT 5**

**BALM CREEK SHAFT MINE - SUB-SITE C, HEAD FRAME / PLAN VIEW**

## ATTACHMENT 6

## LOWER HOLDING POND SITE - SUB-SITE D, PLAN VIEW

**ATTACHMENT 7**

**OREGON WATER QUALITY CRITERIA - POWDER BASIN**

# ATTACHMENT 8

# NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

## ATTACHMENT 9

## DATA VALIDATION MEMO AND TABLES, POORMAN/BALM CREEK