Engineering Evaluation / Cost Analysis
Oriole Mine
Colville National Forest
Pend Oreille County, Washington

May 2007

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LIST OF ACRONYMS AND ABBREVIATIONS

95UCL	95th percentile upper confidence limit on the arithmetic mean
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
bcy	bank cubic yard
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CES	Cascade Earth Sciences
COI	Chemical of Interest
COPC	Chemicals of Potential Concern
COPEC	Chemical of Potential Ecological Concern
DGI	Data Gap Investigation
Ecology	Washington State Department of Ecology
EECA	Engineering Evaluation / Cost Analysis
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PRG	Preliminary Remediation Goal
RTE	Rare, Threatened, and Endangered
SI	Site Inspection
SOC	Species of Concern
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxicity Characteristic Leaching Procedure
USFS	U.S. Department of Agriculture, Forest Service

EXECUTIVE SUMMARY

Cascade Earth Sciences (CES) has prepared the following Engineering Evaluation / Cost Analysis (EECA) for completing a non-time-critical removal action related to metal contamination at the Oriole Mine (Site). The Site is an abandoned lead and zinc mine located in the Colville National Forest, approximately 1.5 miles northeast of Metaline, Washington. The EECA is being performed by the U.S. Department of Agriculture, Forest Service (USFS) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) cleanup authorities [42 USC 9604(a) and 7 CFR 2.60(m)] and Federal Executive Order 12580. This EECA has been prepared in accordance with the provisions of "National Oil and Hazardous Substances Pollution Contingency Plan," 40 CFR 300.415(b)(4)(i). The purpose of the EECA is to evaluate and determine risks to human health and the environment, and to select an alternative to minimize or eliminate the risks associated with the release of a hazardous substance into the environment or impact on public health and welfare as outlined in 40 CFR 300.415(b)(2)(i)-(viii).

Elevated concentrations of antimony, cadmium, copper, iron, lead, selenium, silver, and zinc are present in nearly all soil/wasterock samples collected from the Site. Several multi-metal (antimony, arsenic, cadmium, copper, lead, mercury, selenium, silver, thallium, and zinc) ecological hot spots are present in wasterock, most noticeably the ore stockpile. Hot spots are defined as areas where metal concentrations exceed risk-based criteria and background by a factor of 10 or more. It is likely that individual plants and invertebrates are adversely impacted within these localized areas. Wasterock is also a likely past and current source for contaminant transport to Linton Creek. Elevated cadmium, lead, and zinc attributable to the Site are present in sediment near the Site, and this impact is evident for approximately 1,200 feet downstream of the Site, based on stream sediment sample analyses. Elevated sediment concentration farther downstream may be attributable to other sources. Additional minor ecological hot spots are present in the adit seep for lead and Linton Creek sediment for zinc. Because 1) the wasterock metal concentrations exceed several state and federal soil criteria, 2) the minor exceedences of several of sediment and surface water criteria proximal to the Site, and 3) the identified ecological risks, a removal action should be completed to protect public health and the environment.

Metal concentrations in ore and wasterock are unlikely to impact overall terrestrial ecological receptor populations in the area because of the limited area of potential exposure and lost habitat. Surface water impact by barium, cadmium, copper, and zinc is limited to the adit seep. The seep does not discharge directly to Linton Creek, and there is no apparent impact to Linton Creek from the adit seep.

As part of the EECA, human health and ecological risk assessments were performed. Nineteen contaminants of interest were identified; only arsenic and lead were identified as contaminants of potential concern for human receptors. The risk assessment determined that there are no unacceptable human health impacts from lead in surface water and no unacceptable carcinogenic or non-carcinogenic health effects expected from exposure to arsenic in soil, wasterock, or sediment. Because there are no unacceptable human health risks at the Site, there was no human health hot spot analysis performed.

The goal of the removal action is to reduce to acceptable levels the risk to humans and the environment from mining related wasterock and stockpiled ore at the Site. The following three alternatives were evaluated and compared as potential removal actions and were evaluated individually and collectively against the three criteria (effectiveness, implementability, and cost) as outlined in EPA, 1993.

Alternative 1:	No Action
Alternative 2:	Onsite Consolidation of Ore and Wasterock
Alternative 3:	Excavation and Offsite Disposal of Ore and Wasterock

The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect the selection of a removal action can be identified. Based on the evaluation, Alternative 2 is considered the most appropriate and cost-effective alternative. The estimated total present worth cost for implementing the recommended removal action is $307,000, which includes addressing the data gaps, estimated at $15,000. This alternative protects human and ecological health by controlling contact and inhalation of particles, which is adequate for this location. Results of the SPLP analyses indicate that leaching from wasterock and ore to groundwater and Linton Creek is extremely low. Therefore, Alternative 2 will be adequately protective at a significantly lower cost than Alternative 3.

The recommended removal action does not directly address elevated metals in sediment; however, controlling the release of particulate metals from soil/waste material and adit/seep discharges will indirectly address the release of metals to surface water and subsequently sediments. Furthermore, inconsistent sediment analyses indicates probable sources other than the Site.

1.0 INTRODUCTION

Cascade Earth Sciences (CES) has prepared this Engineering Evaluation / Cost Analysis (EECA) Report for completing a non-time-critical removal action of metal contaminant material at the Oriole Mine (Site) near Metaline, Washington. The EECA is being performed by the U.S. Department of Agriculture, Forest Service (USFS) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup authorities [42 USC 9604(a) and 7 CFR 2.60(m)] and Federal Executive Order 12580. This EECA has been prepared in accordance with the provisions of "National Oil and Hazardous Substances Pollution Contingency Plan" (NCP), 40 CFR 300.415(b)(4)(i). The purpose of this EECA is to evaluate and determine risks to human health and the environment, and to select an alternative to minimize or eliminate the risks associated with the release of a hazardous substance into the environment or impact on public health and welfare as outlined in 40 CFR 300.415(b)(2)(i)-(viii).

This project has been prepared using the U.S. Environmental Protection Agency (EPA) *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA, 1993). Other relevant guidance includes:

- *Forest Service Guide to CERCLA* (USDA, 1996);
- *Field Operations Plan – Site Inspection of the Oriole Mine, Colville National Forest, Pend Oreille County, Washington* (CES, 2004); and
- *Site Inspection of the Oriole Mine, Colville National Forest, Pend Oreille County, Washington* (CES, 2005).

2.0 SITE CHARACTERIZATION

2.1 Site Description and Background

2.1.1 Site Location and Status

The Site is located in the Colville National Forest in Pend Oreille County, approximately 1.5 miles northwest of Metaline, Washington (Figure 1). According to the USGS 7.5 Minute Quadrangle Map - Metaline Falls (USGS, 1992), the Site location is as follows:

- Section 19, Township 39 North, Range 43 East of the Willamette Principal Meridian
- Latitude – 48° 51' 37"
- Longitude – 117° 24' 50"
- Elevation – 2,760 to 3,000 feet above mean seal level (amsl)

Access to the Site is from the City of Metaline and State Highway 20 by following Boundary Road to Oriole Road, then following Oriole Road (Forest Road 411) west on Linton Creek across the powerline clearing to Forest Road 2740. The remaining ¼-mile access to the Site on Forest Road 2740 is extremely rough and requires a 4-wheel drive vehicle. Approximately 2 acres are disturbed and the Site is inactive.

2.1.2 Site Physiography

The Site is situated near the base of the southeast flank of Linton Mountain. Linton Creek, a tributary of the Pend Oreille River, borders the Site on the southeast. Linton Creek originates approximately 1 mile upgradient from the Site where it flows east and adjacent to the Site, and eventually discharges to the Pend Oreille River approximately 1.5 miles downstream from the Site. The Site is primarily within a Douglas fir/trembling aspen forested community and immediately adjacent to a wetland/riparian community.

Figure 2 provides a general layout of the Site, including 2-foot contours and pertinent features. Topography of the Site is steep with a northwest to southeast slope of approximately 80% (Figure 1). Past mining activities have altered surface topography. The Colville National Forest surrounds the Site on all sides.

Three main adits are associated with the Site (Figure 2). The caved uppermost adit is likely the Discovery Adit. There are two exploration trenches and two short unnamed adits on contour with the Discovery Adit. The two main lower adits (referred to as Upper Adit and Lower Adit) were the primary production workings; the Lower Adit appears to be the primary haulage route. A 3-foot diameter corrugated metal culvert was observed at the Discovery Adit and the Lower Adit; all three main adits are blocked with bat gates. Several other trenches and a small unnamed adit are located on the south side of Linton Creek, which appear to be exploration workings. Small wasterock piles are associated with these workings. A dilapidated building, likely the former office or residence, is located 800 feet northeast of the Site on Forest Road 2740.

Wasterock pile 1 (WR1) is located adjacent to the Upper Adit and is 80 feet wide and 110 feet long, with an estimated volume of 4,400 bank cubic yards (bcy). Wasterock pile 2 (WR2) is located adjacent to the Lower Adit and is 150 feet wide and 100 feet long, with an estimated volume of 11,000 bcy. On the north side of WR2 is a short overgrown access road, which appears to be the haul road to the dilapidated log ore bin. Ore Pile 1 (OP1) consists of the log ore bin and wasterock and ore that was spilled during transport. It measures 35 feet wide by 75 feet long, with an estimated volume of 800 bcy (100 bcy of which is located inside the log ore bin). Located immediately northeast of OP1 is Ore Pile 2 (OP2), which is small and appears to be a mixture of ore and debris. The estimated volume of OP2 is 30 bcy. The total volume of wasterock and ore at the Site is estimated at 16,230 bcy.

Water discharges from the Lower Adit, flows over WR2, and eventually infiltrates into soil near the access road. During field investigations conducted by CES, there was no evidence of historical flow from the Upper Adit or any of the exploration workings. An Unnamed Creek discharges into Linton Creek 0.5 mile above the confluence with the Pend Oreille River. During field activities, portions of Linton Creek were not flowing while other portions appear to be perennial. The City of Metaline drinking water intake is located in the Unnamed Creek, immediately upstream of the confluence with Linton Creek.

2.1.3 Mining History

Little information is available regarding the operational history of the Site. However, *Inventory of Washington Minerals* (Huntting, 1956) and *Metal Mines of Washington* (Derkey et al., 1990) provide the following chronological listing of mine ownership:

- 1907 – Oriole Mining & Milling Co.
- 1911-1922 – Metaline Oriole Mining Co.
- 1922-1924 – Metaline Minerals Co.
- 1935 – Frank Schultz
- 1942 – W.L. Schultz
- 1953 – Arthur Betchart and E.O. Dressel, Jr.

The first recorded production of zinc in Washington was from the Site in 1911 (Huntting, 1956). There is recorded production for 1911, 1912, 1925, 1926, and 1953. However, production for each year is not reported in the referenced reports, but rather totaled as "*up to 2,000 tons up to 1942 with assays on smelter returns on a carload of picked ore: 42.1 oz/ton silver; 21.9% zinc; 15.3% lead, 1.12% copper*" (Huntting, 1956). Mr. Tony Belmonte, a local historian (Lentz, 2005), indicated that in the early 1950's a small ball mill and flotation cell bank were used at the Site for one season and five truck loads of concentrates were shipped. The tailings were reportedly deposited between the mill and Linton Creek.

However, during field investigation no evidence of tailings were observed, nor were any concrete foundation remains identified as typical crusher and ball mill pedestals.

2.1.4 Previous Removal Actions

No previous CERCLA or other regulatory removal actions have been conducted at the Site. Previous environmental regulatory activities related to the Site are documented in:

- *Preliminary Assessments and Site Investigations Report – Lower Pend Oreille River Mines and Mills, Pend Oreille County, Washington*. (EPA, 2002); and
- *Site Inspection of the Oriole Mine, Colville National Forest, Pend Oreille County, Washington* (CES, 2005).

2.1.5 Climate and Meteorology

The following climate data was compiled from the Metaline Falls, Washington monitoring station located approximately six miles northwest of the Site at an elevation of 1,100 feet amsl.

- Total average precipitation is approximately 28 inches per year.
- The average minimum temperature of approximately 17 degrees Fahrenheit occurs in January.
- The average maximum temperature of approximately 84 degrees Fahrenheit occurs in July.

The Site, which is located approximately 1,800 feet higher in elevation than Metaline Falls, receives more total precipitation and has lower minimum and maximum temperatures. The annual prevailing wind direction is to the south-southeast.

2.1.6 Geologic Setting

Regional geologic information presented in this section was obtained from Orr and Orr (2002). Site-specific geology was compiled from Bancroft (1911 and 1914), and Park and Cannon (1943), as well as a site-specific reconnaissance performed by a CES professional geologist.

2.1.6.1 Regional Geology

The Site is located in the Omineca-Intermontane physiographic province (Orr and Orr, 2002). Basement rocks of the region consist of the Proterozoic Belt Supergroup metasediments and the Late Proterozoic Windemere Group metasediments and metavolcanics. In the Metaline district, Early Cambrian Gypsy Quartzite conformably overlies the earlier formation. The Gypsy Quartzite grades upward into the Maitlen Phyllite. The Middle Cambrian to Early Ordovician Metaline Formation conformably overlies the Maitlen Phyllite and is subdivided into three units: bedded limestone, bedded dolomite and grey limestone. The Middle to Late Ordovician Ledbetter Slate conformably overlies the Metaline Formation. Silurian-Devonian argillites cap the Paleozoic sequence. Cretaceous quartz monzonite and granodiorite intrusive rocks cut the section throughout the Metaline district. Numerous Pleistocene glacial fluvial and lake deposits, as well as Quaternary alluvial deposits overlie the district.

2.1.6.2 Site-Specific Mining Geology

The following site-specific geology is summarized from Bancroft, (1914) and Park and Cannon (1943). The reader is directed to the full reports for more details. The country rock is fine to medium-grained grayish-blue dolomite of the Monk Formation, just below the base of the Gypsy Quartzite. The beds strike north 25° east and dip 30° to 45° northwest. The carbonate rocks have undergone intense hydrothermal alteration before, during, and after lead-zinc sulfide mineralization. Ore bodies are a series of elongate down-dip lenses along the fault plane and are connected by narrow quartz stringers (Park and

Cannon, 1943). The ore is apparently along a gouge-breccia seam that trends approximately north 65° west and dips 60° northeast.

According to Derkey et. al. (1990), three known adits were associated with the Site. They were driven in the northwest direction and are about 40 vertical feet apart. The Site includes total workings of about 1,600 feet of drifts and raises among the three adits. Commodities include lead, zinc, copper, silver, and gold. The primary minerals are sphalerite, galena, tetrahedrite, chalcopyrite, pyrite, malachite, azurite, smithsonite, cerussite, and bornite. Gangue is quartz, calcite, and dolomite.

2.1.7 Hydrogeology

The Site is located within the Linton Creek sub-watershed of the Pend Oreille River watershed. A review of the Washington State Department of Ecology (Ecology) Water Resources Department well log database indicates that more than 100 wells are located within a 4-mile radius of the Site. Only three of these wells were identified within 4 miles of the Site on the west side of the Pend Oreille River. Depths of completed wells range from 35 to 540 feet below ground surface (bgs). Static water levels in the wells were observed to be between 18 and 180 feet bgs. A review of the well logs indicates the shallow geology consists of sand and gravel and clay from the surface to depths of 16 to 135 feet bgs. These sediments likely originated from glacier deposits from the Pend Oreille Lobe. Bedrock below the glacial sediments consists of gray to black dolomite or limestone. Copies of the well logs reviewed are available in the USFS Project File. None of the wells were observed or sampled during Site Inspection (SI) or Data Gap Investigation (DGI) field activities.

During the SI and DGI field activities, groundwater emanated from the Lower Adit, flowed across WR2, and infiltrated into native soil near the access road. CES staff did not observe erosion channels that would indicate the adit drainage discharges directly into Linton Creek; the adit drainage appears to infiltrate into the shallow groundwater. The shallow groundwater in the vicinity of the Site likely flows in the unconsolidated sediments and daylights to surface water (Linton Creek) around and downgradient of the Site during gaining stream conditions.

2.1.8 Hydrology

Linton Creek borders the Site on the south. According to the USGS 7.5 minute quadrangle map (USGS, 1992) of the area, the Linton Creek watershed above the Site is approximately 480 acres or 0.75 square mile. In the vicinity of the Site, Linton Creek is a very small, first order stream (Armantrout. 1998). Linton Creek originates approximately 1 mile above the Site and flows through the Site eventually discharging to the Pend Oreille River approximately 1.5 miles downstream. During periods of low flow (i.e., summer), Linton Creek flows subsurface approximately 600 feet downstream from the Site (vicinity of the powerline corridor) until approximately 0.5 mile downstream from the Site. During the DGI completed in the spring of 2006, the entire reach of Linton Creek was flowing; however, the flow through the powerline corridor was a trickle. The disappearance and reappearance of flow may be a result of historical placer mining of the creek, which removed the fines thus allowing the surface water to infiltrate and flow underground. The hummocky appearance of the canyon bottom is indicative of placer mining, and local residents (personal communications, 2006), stated that placer mining did occur. An Unnamed Creek discharges into Linton Creek approximately 0.5 mile up from the confluence with the Pend Oreille River. The City of Metaline has a drinking water intake structure located in the Unnamed Creek, which does not draw from Linton Creek.

The flow rates in Linton Creek, the adit drainage, and the Unnamed Creek were measured on July 27 and 28, 2004, and again during the DGI on March 31, 2006. Flow rates in Linton Creek adjacent to the Site (LC-02; Figure 1) ranged from 0.2 cubic feet per second (cfs) in July 2004 to 1.8 cfs measured in March 2006. The flow rate of the Lower Adit drainage was 0.02 cfs in July 2004 and 0.14 cfs in March 2006. The flow rate in the Unnamed Creek, upstream of the City of Metaline drinking water structure, was 2.4 cfs during the SI and 1.7 cfs during the DGI. The flow rate of the Pend Oreille River measured at USGS Station

12396500, located approximately 6 miles upstream of Linton Creek (below Box Canyon) was measured at approximately 15,000 cfs in July 2004; however, March 2006 data were not unavailable at the time of this report.

2.1.9 Surrounding Land Use

2.1.9.1 Residential, Industrial, or Commercial

The Site is designated as industrial use for comparison with the EPA Region 9 Preliminary Remediation Goals (PRGs; EPA, 2004) and other regulatory standards. The immediate area around the Site is part of the Colville National Forest. There are an estimated 486 residents within a 4-mile radius. The nearest residence is located approximately 0.5 mile east of the Site (shown as "+" on Figure 1). During SI field activities, this residence had several outbuildings and a small lumber mill that did not appear to be in operation. The next closest residence is near the cemetery and drinking water tower (designated by a "†" and "WT," respectively on Figure 1), approximately 1 mile southeast of the Site.

2.1.9.2 Identification of Sensitive Populations and Targets

Sensitive populations are defined as receptors that are located within a target distance for a particular pathway. The target distances for the soil and air pathways are defined as the immediate area of the Site. There are no onsite workers or persons living within 200 feet of the Site. Public use of the Site and vicinity is most likely minimal, though public access records are not maintained**.** Access is currently not restricted by fencing, nor were any "No Trespassing" signs noted during the SI and DGI. In general, land uses in this area are limited to timber harvesting, firewood cutting, recreation (hiking, fishing, camping, hunting, etc.) and some minerals prospecting.

For the groundwater pathway, the target distance has been defined as 4 miles and example targets are drinking water wells, wellhead protection areas, etc. There are no known wellhead protection areas within 4 miles of the Site. Drinking water for rural residences is most likely supplied by wells. The Ecology Water Resources Department well log database lists more than 100 wells within a 4-mile radius of the Site. However, the vast majority of these wells are located east of the Pend Oreille River and, as such, are not considered targets because the Pend Oreille River is acting as a hydrologic barrier. Only three wells of these wells were identified on the west side of the Pend Oreille River. The closest well (Green well) is located approximately 0.5 mile east of the Site and appears to be associated with a residence; the two other wells are the Duncan and Bright wells. Both the Duncan and Bright wells are distant from Linton Creek, and very unlikely to be impacted by the Site. The static water level in the Green well is 18 feet bgs; Linton Creek in the vicinity of the Green well is approximately 60 feet lower in elevation than the static water level. Based on this, the well appears to be upgradient from Linton Creek (near the Green well) and cross-gradient to the Site. Therefore, it is highly unlikely that shallow groundwater from the Site would impact the Green well. Based on this, the groundwater pathway does not appear to be complete for both human and ecological receptors. Groundwater that discharges to surface water during gaining stream conditions is addressed in the surface water pathway discussion in the following paragraph.

For the surface water pathway, the target distance has been defined as 15 miles, and example targets are surface water intakes supplying drinking water, sensitive environments (i.e., wetlands), and aquatic organisms. As Linton Creek empties into the Pend Oreille River approximately 1.5 river miles downstream from the Site, only points above the confluence are considered targets because of the high flow rate and dilution of the Pend Oreille River when compared to Linton Creek. There are an estimated 486 residents within 4 miles of the Site (223 in Metaline Falls, 163 in Metaline, and ~100 rural). Drinking water for the town of Metaline, located on the west side of the Pend Oreille River, is supplied by a sand filter collection system on the Unnamed Creek that discharges to Linton Creek (Figure 1). Drinking water collected via a sand filter intake structure flows to a storage tank where it is chlorinated before distribution. CES did not

observe surface water uses of Linton Creek during the SI or EECA. However; surface water uses in or around the Site are likely limited to recreational purposes such as camping (washing dishes, cooking, etc).

2.1.10 Sensitive Ecosystems

2.1.10.1 Wetlands and Wildlife Breeding Areas

The National Wetlands Inventory, a division of the U.S. Fish and Wildlife Service, prepared maps outlining designated wetland areas. Wetlands were identified based on vegetation, visible hydrology, and geography in accordance with Classification of Wetlands and Deepwater Habitats of the United States. The following are considered "listed" on the National Wetlands Inventory map (USF&W, 1995).

- The headwaters of Linton Creek to approximately 1 mile downstream of the Site are designated as Riverine, Intermittent, Streambed, Seasonally Flooded (R4SBC).
- Approximately 1 mile downstream of the Site along Linton Creek to the confluence with the Pend Oreille River is classified as Riverine, Upper Perennial, Open Water/Unknown Bottom, Permanently Flooded (R3OWH).
- Areas located approximately ½ mile northeast of the Site are designated as Palustrine, Emergent, Persistent, Seasonally Flooded (PEM1C).
- Areas located south of Linton Creek near the confluence with the Pend Oreille River are identified as PEMC1 and Palustrine, Open Water/Unknown Bottom, Permanently Flooded (POWH).
- Areas to the north of the confluence of Linton Creek and the Pend Oreille River are classified as Palustrine, Unconsolidated Shore, Seasonally Flooded, Excavated (PUSCX), Palustrine Emergent, Persistent, Temporarily Flooded (PEM1AH), Lacustrine, Littoral, Unconsolidated Shore, Seasonally Flooded (L2USCH), and Lacustrine, Limnetic, Open Water/Unknown Bottom, Permanently Flooded (L1OWHH).

According to the US Army Corps of Engineers Technical Report Y-87-1 (Corps, 1987), "wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." A jurisdictional wetland delineation in accordance with the US Army Corps of Engineers standards has not been performed for the Site. As such, the exact boundaries and areas of potential wetlands were not defined. Based on field observations, other areas that exhibit some wetlands characteristics (i.e., plant types) are located adjacent to the Lower Adit and Linton Creek.

There are no known designated wildlife breeding areas in the vicinity of the Site.

2.1.10.2 Wild and Scenic Rivers

There are no wild and scenic rivers near the Site. The nearest is the Skagit River, to the west and across the Cascade Mountain Divide. Only two other wild and scenic rivers are identified in Washington State, the Klickitat and the White Salmon, both on the east side of the Cascade Mountains. Neither is in a drainage that would be affected by the Site.

2.1.10.3 Threatened and Endangered Species

A complete list of rare, threatened, and endangered (RTE) species, species of concern (SOC), federal and state candidate species, state sensitive species, and state monitored species for wildlife and plants observed or expected to be present at or near the Site is provided in Attachment B of Appendix A. The following federal and state RTE species and SOC were observed or have suitable habitat near the Site:

- Red-legged frogs and western toads are RTE species that may be found in the vicinity of the Site.
- Federal SOC westslope cutthroat trout, may be present in downstream portions of Linton Creek.
- Federal SOC and state candidate species Townsend's big-eared bats may be found in the underground working at the Site.
- State candidate (RTE) species for listing Pileated woodpeckers were observed at the Site.
- State priority species rainbow trout are present in the downstream portions of Linton Creek.

No fish were noted in Linton Creek. The culverts above and below LC-05R are likely barriers to upstream fish migration.

2.2 Data Gap Investigation

In March 2006, CES conducted a DGI to gather additional data and information related to the potential threat to human health and the environment not acquired during the SI conducted in 2004. Sampling locations and laboratory analyses are outlined in the Oriole Mine EECA Work Plan (CES, 2006). The primary purpose was to complete additional sampling. However, during the event, CES also discovered a small cabin that was clearly an old blacksmith structure with a small ducknest forge. This area is not related to mineral processing. Adjacent to the blacksmith structure, CES discovered a short adit (~25 feet). Although CES did not observe visible mineralization, a sample near the face contained elevated concentrations of cadmium, lead, and zinc, albeit in concentrations less than the larger wasterock piles. The following provides a brief summary of the DGI. Analytical results are included in Tables 1 through 3, and photographs are included in Appendix B.

2.2.1 Data Gap 1 – Background Surface Water and Sediment Samples

CES did not collect background surface water and sediment samples from Linton Creek during the 2004 SI because the creek bed was dry. Between March 31 and April 2, 2006, CES collected surface water and sediment samples from two new aquatic stations (stations) upstream from the Site in Linton Creek (stations LC-01 and LC-01A) in addition to all the previously established stations in Linton Creek, the Unnamed Creek, and the adit discharge. CES measured flow rates at each station and located both stations using a handheld GPS. Analytical results are included in Tables 1 and 2, and locations are shown on Figure 1.

2.2.2 Data Gap 2 – Additional Soil Samples

CES collected three background soil samples for metals analysis during the July 2004 SI field activities. Three additional background soil samples were collected in April 2006 for improved statistical analyses. Figure 1 shows the sample locations, and Table 3 presents the analytical results.

2.3 Source, Nature, and Extent of Contamination

2.3.1 Surface Water Pathway

Surface water bodies at or near the Site that would be affected by the Site are identified in Section 2.1.8. During the 2004 SI, CES established four stations in Linton Creek to assess the impact of the Site on surface water and aquatic organisms. Because Linton Creek was dry above the Site during the SI, one station was established in the Unnamed Creek that discharges into Linton Creek to determine reference/background concentrations. During the 2006 DGI, CES established two new stations in Linton Creek upstream from the Site to determine background concentrations. In addition, CES collected two surface water samples from the Lower Adit discharge from the same locations as the 2004 SI. Surface water and stream sediment samples were collected at each station during periods of low flow (July 2004) and high flow (March 2006). Station locations are depicted on Figure 1 and results are tabulated in Tables 1 and 2.

2.3.1.1 Surface Water

Surface water samples were analyzed for both dissolved and total recoverable metals during the 2004 SI and total recoverable metals during the 2006 DGI. However, only total recoverable results are presented in this section because they represent the worst-case concentrations. Five metals (aluminum, arsenic, barium, iron, and lead) were detected in at least one sample from Linton Creek at concentrations that exceeded the lowest regulatory comparison standard and background/reference concentrations. Detections above background/reference concentrations and the lowest regulatory comparison standard are summarized as follows.

- Aluminum was detected in two samples: SW-05HF at 200 micrograms per liter [µg/L] and SW-04HF at 630 µg/L.
- Arsenic was detected at station LC-05 during both the low flow and high flow sampling events: SW-05 at 0.9 µg/L and SW-05HF at 0.8 µg/L, respectively. However, station LC-05 is located downstream from the confluence with the Unnamed Creek, which had the highest concentrations of arsenic detected during the SI and DGI. Therefore, the Unnamed Creek is likely the source of the elevated arsenic concentration at station LC-05.
- Barium was detected at every station in Linton Creek at concentrations equal to or slightly greater than the background concentrations.
- Iron was detected in two samples: SW-05HF at 240 µg/L and SW-04HF at 760 µg/L.
- Lead was detected in three samples: SW-05 at 1.1 µg/L, SW-05HF at 3.2 µg/L, and SW-04HF at 9.1 µg/L.
- Samples SW-04HF and SW-05HF had the highest concentrations of aluminum, iron, and lead. Upstream concentrations during the same events were far less than these concentrations. Therefore, it is possible that the elevated concentrations reported at these two stations might be associated with another source. Such potential sources include upstream culverts (which are known to contribute zinc) and the intermittent Unnamed Creek southwest of stations LC-04 and LC-05. An abandoned road follows the Unnamed Creek to the Bella May Mine. However, discharge from this mine appears to enter a different drainage. The elevated concentrations could be derived from erosion of mineralized strata that discharges to the Unnamed Creek or from contamination on the access road.

Five metals (barium, cadmium, copper, lead, and zinc) were detected in at least one sample from the Lower Adit discharge at concentrations that exceeded the lowest regulatory comparison standard and background concentrations of Linton Creek. Detections above background concentrations and the lowest regulatory comparison standard are summarized as follows.

- Barium concentrations ranged from 21 µg/L to 25 µg/L.
- Cadmium concentrations ranged from 0.8 µg/L to 1.2 µg/L.
- Copper concentrations ranged from 1.9 µg/L to 2.1 µg/L.
- Lead concentrations ranged from 1.0 µg/L to 8.2 µg/L.
- Zinc concentrations ranged from 80 µg/L to 120 µg/L.

Based on the information presented above, the adit discharge appears to be slightly impacted by metals; however, the adit discharge infiltrates into native soils downgradient of WR2 and does not discharge into Linton Creek. In addition, the adit discharge does not exceed drinking water or Washington Model Toxics Control Act (MTCA) Method A groundwater cleanup criteria and therefore is very unlikely to impact potential drinking water use downgradient from the Site. However, the adit discharge water concentrations are above background concentrations as defined by LC-01, 01A, and 02. Surface water in Linton Creek does not appear to be impacted by metals from Site wasterock/ore piles or the adit discharge.

2.3.1.2 Stream Sediment

The following is a summary of the findings; stream sediment concentrations are reported as total metals. Eight metals (antimony, arsenic, cadmium, lead, mercury, nickel, silver, and zinc) were detected in at least one sample from Linton Creek at concentrations that exceeded the lowest regulatory comparison standard and background concentrations. Detections above background concentrations and the lowest regulatory comparison standard are summarized as follows.

- Antimony was detected in four samples at three stations with concentrations ranging from 0.6 milligrams per kilogram (mg/kg) at SW-04 to 2.6 mg/kg at SW-03HF.
- Arsenic was detected at station LC-03 during both the low flow and high flow sampling event: SS-03 at 15.9 mg/kg and SS-03HF at 23.9 mg/kg, respectively.
- Cadmium was detected in five samples from three stations with concentrations ranging from 1.19 mg/kg (SS-04) to 3.09 mg/kg (SS-03HF).
- Lead was detected at all four downstream stations with concentrations ranging from 147 mg/kg (SS-04) to 1,880 mg/kg (SS-03). Station LC-03 had the highest detection for lead during both the low and high flow sampling events. The presence of elevated lead at LC-03 may be related to activity at the Oriole Mine such as tailings disposal. Lead detected at the farthest downstream station (LC-05) during the low flow sampling event at 1,130 mg/kg may be partially related to the sediment discharge from the Unnamed Drainage to the southwest or the Unnamed Creek to the north (lead concentration at 868 mg/kg). An abandoned road follows the Unnamed Drainage to the Bella May Mine. However, discharge from the Bella May Mine appears to enter a different drainage. Therefore, the elevated lead concentrations could be derived from erosion of mineralized strata that discharges to the Unnamed Drainage and Unnamed Creek, or from contamination on the access road.
- Mercury was detected in three samples from two stations (LC-03 and LC-04) with concentrations ranging from 0.21 mg/kg to 0.64 mg/kg, respectively.
- Nickel was only detected in two low flow samples, slightly above the background concentration of 26 mg/kg, ranging from 26.9 mg/kg to 28 mg/kg.
- Silver was detected in one sample: SS-02 at 2.01 mg/kg during the low flow sampling event, which was only slightly above the background concentration of 1.31 mg/kg measured during the high flow sampling event. No sample during the high flow sampling event was greater than the background concentration.
- Zinc was detected in seven samples from all four downstream stations with concentrations ranging from 162 mg/kg at SS-02 to 2,320 mg/kg at SS-03HF.

The highest concentrations of antimony (2.2 mg/kg), arsenic (23.9 mg/kg), cadmium (3.09 mg/kg), lead (1,880 mg/kg), and nickel (28 mg/kg), were detected directly downstream of the Site at station LC-03 in both low flow and high flow sampling events. At the two farthest downstream stations, most metal concentrations decreased to near background/reference concentrations. Based on this information, the Site appears to have partially impacted the sediment in Linton Creek at least upstream from the powerline corridor either by erosion from wasterock and/or transport of tailings from the reported flotation mill.

2.3.1.3 Surface Water Pathway Summary

Based on the data presented, the surface water pathway is complete due to elevated concentrations of metals in stream sediment samples. Sediment in Linton Creek appears to be impacted by the Site; numerous metals (antimony, arsenic, cadmium, lead, mercury, nickel, silver, and zinc) were detected in Linton Creek samples that exceeded several comparison criteria and the concentrations detected in the upstream background and reference stations. Wasterock and ore piles at the Site are the likely source of metals to Linton Creek sediment. Surface water in Linton Creek does not appear to be impacted by metals from the Site.

Rainbow trout (a state priority species) have been documented in the lower portions of Linton Creek (below LC-05) and there is the potential that the westslope cutthroat trout (federal species of concern) may be present; however, the fine-grained organic substrate and high gradient would make it unlikely that these fish use Linton Creek for spawning habitat. The benthic macroinvertebrate enumeration results suggest little or no difference in invertebrate populations between stations upstream, adjacent to, and downstream of the Site.

2.3.2 Groundwater Pathway

As outlined in Section 2.1.7, there are only three wells within 4 miles of the Site on the west side of the Pend Oreille River. The only known well that potentially could be impacted by the Site is located approximately 0.5 mile east of the Site and appears to be upgradient from Linton Creek (in the vicinity of the well) and cross-gradient to the Site. Thus, it is highly unlikely that shallow groundwater from the Site would impact the well. The adit drainage infiltrates into the shallow groundwater and likely discharges to Linton Creek during certain times of the year (i.e., when Linton Creek is gaining). Based on this, the groundwater pathway does not appear to be complete for both human and ecological receptors. Groundwater that discharges to surface water during gaining stream conditions is addressed in the surface water pathway discussion.

2.3.3 Air Pathway

The most likely air exposure pathway is inhalation of dust or particulate matter. However, most of the particulate matter in the air originates from the wasterock piles currently at the Site. Given this, and the remote location and limited use of the Site, the air pathway will be assessed under the soil pathway and no further assessment into Site-specific levels of compounds in the air is recommended.

2.3.4 Soil Pathway

A total of 6 background soil samples, 12 wasterock samples, 4 ore samples, 2 native soil samples beneath the wasterock, and 5 vegetation samples were collected and submitted for laboratory analysis. All sample locations are provided in Figure 2. CES used a small excavator to collect samples from various depths through WR1 and WR2 and from native soils beneath the piles. Locations of soils, wasterock, and tissue samples are shown on Figure 2. Analytical results for background soils and the 95th percentile upper confidence limit on the arithmetic mean (95UCL) are tabulated in Table 4; wasterock and ore results are in Table 5; toxicity characteristic leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP) results are in Table 6; and vegetation results are in Table 7.

2.3.4.1 Background Soil pH and Metal Results

Background soil pH ranged from 6.2 to 7.2 standard units (su), indicating slightly acidic to neutral soils. Concentrations of barium, cadmium, chromium, lead, mercury, selenium, vanadium, and zinc exceed the Oak Ridge National Laboratory PRGs (EPA, 2004) for soil ecological receptors. All background soils exceeded the EPA Region 9 Industrial PRG of 1.6 mg/kg (cancer endpoint) for arsenic. The concentration of cadmium exceeds the Washington MTCA Method A Industrial Soil Cleanup Levels for Human Receptors of 2.0 mg/kg.

2.3.4.2 Wasterock pH and Metal Results

Wasterock and ore samples paste pH ranged from 6.2 to 8.1 su, which indicates the wasterock varies from slightly acidic to slightly alkaline. Concentrations of 15 metals in wasterock and ore exceed both the average background soil concentration and the lowest regulatory comparison standard. Antimony, arsenic (V and total), cadmium, copper, lead, and zinc appear to be the primary metals of concern. Concentrations of antimony, arsenic, cadmium, and lead exceeded the EPA Region 9 Industrial PRGs (EPA, 2004).

Arsenic, cadmium, chromium, lead, and mercury concentrations exceeded the Washington Method A Industrial Soil Cleanup Levels. Aluminum, antimony, arsenic V, barium, cadmium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc were detected at concentrations that exceeded the lowest Washington Ecological Indicator Soil Concentrations, which exist for plants, soil biota, and wildlife receptors (Ecology 2006). Antimony, arsenic, cadmium, chromium, copper, and zinc concentrations exceeded the lowest EPA Ecological Soil Screening Levels, which were developed for plants, invertebrates, birds, and mammals (EPA, 2005). Oak Ridge National Laboratory soil PRGs were exceeded for the following metals: antimony, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc. With the exception of manganese, vanadium, and chromium (to a limited extent), most metals that exceeded criteria also exceeded 95UCL as indicated in Table 4.

2.3.4.3 Wasterock Acid Based Accounting and Sulfur Results

Eight wasterock samples were analyzed for static acid base accounting (ABA) using the Modified Sobek Method to evaluate the acid generating potential (AGP) and acid neutralization potential (ANP). The acid base potential (ABP) ranged from +2 to +965 t $CaCO_3$/Kt (ABP units are presented as tons of calcium carbonate needed to neutralize a kiloton of waste). The ABP is the result of the ANP minus the AGP; a negative ABP indicates that the AGP is greater than the ANP and thus, the material has the potential to produce acid rock drainage (ARD). Wasterock associated with the Site had an average ABP of +554 t $CaCO_3$/Kt. Material that exhibits ABP greater than +20 t $CaCO_3$/Kt is generally accepted as non-acid producing material whereas ABP less than -20 t $CaCO_3$/Kt is indicative of probable acid production ABPs between +20 and -20 t $CaCO_3$/Kt are uncertain and usually require kinetic testing such as humidity cells for more confident prediction (EPA, 1994). None of the wasterock samples showed ABPs less than -20 t $CaCO_3$/Kt and all but two samples exceeded +523 t $CaCO_3$/Kt.

Only wasterock samples OM-WR4-1 and OM-WR5-1 (ABAs = +3 and +2, respectively), from two small exploration workings (Figure 2), exhibited ABPs between 20 and -20 t $CaCO_3$/Kt. However, both these samples contained total sulfur concentrations below the method detection limit (MDL) of 0.01%. Such sulfur concentrations are too low for the material to generate acid (Price and Errington, 1995). Based on the above results, the wasterock and ore at the Site are not expected to generate ARD. This conclusion is supported by the adit drainage, which remains neutral after long-term exposure of fractured mine-rock surfaces to humidity (water) and oxygen, the key prerequisites for the production of ARD.

2.3.4.4 Wasterock Synthetic Precipitation Leaching Procedure and Toxicity Characteristic Leaching Procedure Results

Seven wasterock samples and one ore sample were submitted for SPLP and TCLP analyses for the eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). The cadmium TCLP limit (1.0 milligrams per liter [mg/L]) was exceeded in one sample (OP1-1 = 3.22 mg/L); and the lead TCLP limit (5.0 mg/L) was exceeded in two samples (OP1-1 = 39.2 mg/L and WR1-3 = 13.2 mg/L). None of the samples analyzed for SPLP exceeded any of the TCLP limits.

The TCLP analysis was developed to test the leaching of heavy metals from wastes deposited in municipal landfills. TCLP uses a weak organic acetic acid solvent commonly found in municipal landfills. Because organic acids are not normally present in waste material found at mines and other field sites, the SPLP was developed, which uses a weak non-organic-acid solvent (hydrochloric and sulfuric acids) more typical of mine-site conditions[1]. TCLP can give misleading results for leachable metals in mine wastes, especially for carbonate hosted lead occurrences in oxidizing (surface) environments like the

[1] The EPA recognizes that acetic acid used in TCLP is too "aggressive" for use on mine-related waste but was concerned that such sites could be used for municipal landfills in the future (EPA, 1998). This issue is not applicable to the Site because USFS regulations (36 CFR 251.54[e]) do not permit new municipal waste facilities on National Forest System (NFS) lands.

Site. Under these conditions lead from the primary lead ore mineral, galena (PbS_2), reacts to form lead carbonate and perhaps lead sulfate, neither of which are readily soluble. However, when acetic acid is present, the lead reacts to form lead acetate, a highly soluble and mobile compound that is readily leached. This phenomenon also occurs when lead is in the form of a primary lead carbonate mineral. Consequently, SPLP is considered the more appropriate analysis for determining the leachability of mine-related wasterock and other material.

2.3.4.5 Vegetation Metal Results

Five vegetation samples, collocated with background soil and wasterock samples, were collected around the Site (Figure 2). Laboratory results are presented in Table 6. Based on a review of the results, onsite vegetation does not appear to be impacted by activities associated with the Site; metals concentrations in background vegetation samples were equal to or above those detected in vegetation samples collected from WR1 and WR2.

2.3.4.6 Soil Pathway Summary

Metal concentrations in background soils are elevated; 11 metals are present at concentrations exceeding one or more comparison criteria. However, 17 metals were detected in wasterock and ore samples at concentrations exceeding both the average background soil concentration and one or more comparison criteria. In comparing wasterock and ore concentrations to 95UCL background soil concentrations, antimony, arsenic, cadmium, copper, lead, silver, and zinc are the primary metals of concern.

Analyses of ABAs for wasterock and ore samples indicates the Site does not have the potential to produce ARD. This is to be expected in carbonate hosted ore bodies such as this. One ore pile sample exceeded the Ecology TCLP limit for cadmium and lead, and one wasterock sample exceeded the TCLP limit for lead. None of the samples analyzed for SPLP exceeded any of the TCLP limits.

3.0 STREAMLINED RISK EVALUATION AND ASSESSMENT

3.1 Streamlined Human Health Risk Assessment

The Human Health Risk Assessment (HHRA) evaluated the potential for adverse health effects that could result from current or future human exposures to hazardous substances present at the Site. Chemicals of potential concern (COPCs) were selected by screening chemicals of interest (COIs) using approved human health risk-based screening procedures; exposure doses were then calculated for each COPC and receptor. The exposure doses were then compared to acceptable doses of the COPCs using approved screening numbers to determine the potential risk or hazard associated with the COPCs. The following are the primary elements of the HHRA.

- Hazard Identification and Selection of COPCs
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Summary of Human Health Risks

The following sections briefly summarize the estimated human health risks and hazards. A more detailed discussion of the HHRA is provided in Appendix A.

3.1.1 Potential Receptors and Exposure Pathways

Due to the remote nature and difficult access conditions, long-term risk associated with the Site is considered low. However, recreational receptors (e.g., hikers, hunters, and campers) still have the potential to access the Site and were selected as the most likely current and future receptor. Complete exposure pathways were evaluated for the recreational receptor and included:

- Inhalation of wasterock and ore particulates;
- Incidental ingestion of wasterock, ore, surface water, and sediment; and
- Dermal contact with wasterock, ore, surface water, and sediment.

Use of groundwater as potential drinking water was eliminated as a pathway of concern because the closest reported drinking water well is located approximately 0.5 mile cross-gradient from the Site and upgradient of Linton Creek. Fish consumption was also eliminated as a potential pathway of concern because the culverts above and below LC-05 are likely barriers to upstream fish migration therefore limiting habitat.

3.1.2 Hazard Identification and Selection of Chemicals of Potential Concern

The media of interest for human health included surface soil, wasterock, ore, surface water, and sediment. Maximum concentrations of the COIs in these media were compared to EPA Region 9 PRGs (EPA, 2004). Industrial PRGs were selected as the most appropriate screening criteria for soil, wasterock, ore, and sediment, and tap water PRGs represent a very conservative screen for surface water. The following table lists the results of the COPCs screening.

Chemicals of Potential Concern for the Human Health Exposure Media

COPCs	Surface Soil/ Wasterock	Surface Water	Sediment
Arsenic	X	X	X
Lead	X	X[1]	X

NOTES:
X = COPC at the Site.
[1] There is no PRG for lead in surface water.

3.1.3 Risk and Hazard Estimates for the Recreational Receptor

This section summarizes the results of the quantitative risk assessment. Calculations, assumptions, exposure point concentrations, and exposure inputs are available in Appendix A. Risks and hazards were calculated for both the central tendency exposure and reasonable maximum exposure. In general, the reasonable maximum exposure (RME) scenario is a conservative or worst-case estimate of potential exposure, while the central tendency exposure (CTE) scenario is typically more realistic and uses exposure factors that are more indicative of the average recreational user. The Hazard Quotient (HQ) is defined as a comparison of the estimated intake dose of a metal with the reference dose or concentration, expressed as a ratio. Hazard Quotients greater than 1.0 indicate the potential for adverse health effects because the intake exceeds the reference dose. The sum of all individual chemical-specific HQs is termed the Hazard Index (HI) and is calculated under each exposure pathway. Thus, an HI less than 1.0 is not anticipated to produce unacceptable human health effects. The excess cancer risk (ECR) is defined as the incidence of cancer over and above known background (one case for every three people). The standard of one in one million (1E-06) sets the allowable “excess” cancer cases at one more case in a population of one million people. The following sections provide a brief summary of the non-carcinogenic and carcinogenic risks.

3.1.3.1 Non-Carcinogenic Risk Results

Arsenic was identified as a non-carcinogenic COPC in soil, wasterock, ore, and sediment. A summary of the non-carcinogenic risks are presented in the following table and in Appendix A, Table 3-5. The HQs for the soil, wasterock, ore, surface water, and sediment exposure routes were all below the regulatory standard of 1.0. Therefore, no unacceptable non-carcinogenic health impacts are anticipated.

Summary of Non-Carcinogenic Risks

Exposure Route	Chemical of Potential Concern	Hazard Quotient	
		Central Tendency Exposure	Reasonable Maximum Exposure
Soil and Wasterock			
Ingestion	Arsenic	0.001	0.01
Dermal Contact	Arsenic	0.00008	0.004
Surface Water			
Ingestion	Arsenic	0.00004	0.0001
Dermal Contact	Arsenic	0.000001	0.000002
Sediment			
Ingestion	Arsenic	0.0001	0.0009
Dermal Contact	Arsenic	0.00002	0.0004
	Hazard Index	**0.002**	**0.02**

3.1.3.2 Carcinogenic Risk Results

Arsenic was identified as the only carcinogenic COPC at the Site. Carcinogenic risks are summarized in the following table and in Appendix A, Table 3-6. The ECR for the CTE and RME receptors did not exceed Ecology's regulatory standard of 1E-06.

Summary of Carcinogenic Risks

Exposure Route	Chemical of Potential Concern	Excess Cancer Risk	
		Central Tendency Exposure	Reasonable Maximum Exposure
Soil and Wasterock			
Ingestion	Arsenic	5E-08	8E-07
Dermal Contact	Arsenic	5E-09	6E-07
Inhalation of Particles	Arsenic	9E-08	1E-08
Surface Water			
Ingestion	Arsenic	2E-08	5E-08
Dermal Contact	Arsenic	9E-10	7E-08
Sediment			
Ingestion	Arsenic	8E-09	3E-08
Dermal Contact	Arsenic	6E-11	6E-10
	Sum of Excess Cancer Risk	**9E-08**	**2E-06**

3.1.3.3 Lead Risk Results for Soil, Wasterock, and Sediment

Meaningful ingestion and inhalation critical toxicity values have not been developed for lead. Many of the non-carcinogenic effects associated with lead may not exhibit a threshold, especially in young children. In

lieu of a reference dose or slope factor, the EPA has developed two models that correlate dose with blood lead levels. The results of the lead screening for soil, wasterock, and sediment are summarized in the following table; additional information on lead exposure and risk calculations is provided in Appendix A.

Summary of Human Health Risks Due to Lead in Soil, Wasterock, and Sediment

EPC (mg/kg)		Intake (mg/kg/day)		Predicted Intake (mg/day)		Provisional Intake Value (mg/day)
Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure	
Soil						
19,500	42,900	0.00000001	0.00000004	0.0002	0.002	0.075
Sediment						
658	1,090	0.000000005	0.00000002	0.000004	0.00002	0.075
			Total Intake	**0.0002**	**0.002**	**0.075**

3.1.3.4 Lead Risk Results for Surface Water

Lead was identified as a COPC in surface water because no PRG was available for screening. As outlined above, ingestion critical toxicity values have not been developed for lead. The maximum total recoverable concentration of lead found in surface water at the Site was 0.0009 mg/L. The federal action level for lead in drinking water is 0.015 mg/L. Since the maximum concentration of lead did not exceed the federal action level for drinking water standards, no unacceptable risk is anticipated from lead in surface water.

3.1.4 Summary of Human Health Risks

Of the 19 COIs identified at the Site, only arsenic and lead were identified as COPCs. Based on current and future land use, individuals who might come in contact with Site-related contaminants through recreational activities (e.g., hunting, hiking, and camping) were identified as the only potential receptors.

The risk assessment determined that there were no unacceptable carcinogenic or non-carcinogenic health effects expected from exposure to arsenic in soil, wasterock, ore, surface water, or sediment. Therefore, no unacceptable human health risks are anticipated due to recreational exposure to arsenic. The maximum concentration of lead found in surface water (0.0009 mg/L) did not exceed the federal action level for lead in drinking water (0.015 mg/L). Based on this, no unacceptable human health impacts from lead in surface water are expected.

3.2 Streamlined Ecological Risk Assessment

The goal of the ecological risk assessment (ERA) is to determine whether there is an unacceptable ecological risk associated with the Site. This report, which is presented in Appendix A, consists of:

- Problem Formulation
- Risk-Based Screening
- Risk Characterization
- Uncertainty Analysis
- Summary of Ecological Risk

An ecological survey was conducted as part of a previously completed SI (CES, 2005). The SI report documented ecological features and conditions at and near the Site. An ecology terrestrial ecological exclusion assessment was completed based on this survey and is provided in Appendix A. Based on the

terrestrial ecological exclusion assessment, an exclusion from further terrestrial ecological evaluation is not acceptable. Based on Ecology guidance (2001), a site-specific terrestrial ERA is warranted. Ecology does not provide specific guidance for an ERA of water or freshwater sediment. Therefore, methods appropriate for Ecology (2001) and the EPA (1997, 1999) were implemented to assess the potential for risks to be posed by Site-related COIs in soil (terrestrial receptors), surface water (aquatic receptors), and sediment (benthic receptors).

The problem formulation, risk assessment data, ecological risk-based screening, risk characterization, uncertainty analysis, conclusions, and recommendations are included in Appendix A. The problem formulation determines the scope of the ERA and culminates in a conceptual ecological exposure model and assessment endpoints. The assessment endpoints tie the risk assessment results to risk management decisions and present the focus of the remainder of the ERA. The analytical data used for the ERA are briefly described, and a risk-based screening is conducted, comparing the site data to ecological risk-based screening concentrations. The results of the risk-based screening are discussed along with the uncertainties inherent in the ERA process and, finally, conclusions and recommendations are provided regarding the potential for ecological risks to be posed by Site-related contaminants and whether further investigation or remediation is warranted for the protection of ecological receptors.

3.2.1 Ecological Risk-Based Screening

Ecological risk-based screening begins with the list of COIs shown in Appendix A. Exposure point concentrations are then determined for each COI in each potential exposure medium and compared to selected ecological risk-based screening concentrations with consideration of bioaccumulation potential and exposures to multiple contaminants and multiple media. Risk ratios greater than one indicate a potential risk; COIs for which potential ecological risks are indicated become the contaminants of potential ecological concern (COPECs). The results of the risk-based screening are provided in Appendix A, Tables 4-2 through 4-5. The COPECs identified for the Site are outlined in the following table.

Selected Contaminants of Potential Ecological Concern

COPEC	Surface Soil/ Wasterock	Surface Water	Sediment
Aluminum	X	X	X[1]
Antimony		X[1]	
Arsenic III	X[2]		
Arsenic V	X[2]		X
Arsenic, total	X	X[2]	X
Barium		X	X[1]
Beryllium		X[1]	X[1]
Cadmium	X	X[2]	X
Chromium VI		X[2]	
Cobalt			X[1]
Copper	X		
Iron	X	X[1]	X[1]
Lead	X	X	X
Manganese	X		
Mercury	X		X
Selenium	X		X
Silver	X	X[1]	
Thallium	X	X[1]	X[1]
Vanadium			X[1]
Zinc	X	X	X

NOTES: X = COPEC at the Site.
[1] Selected as a COPEC solely because an ecological risk-based screening concentrations was not available.
[2] Selected as a COPEC due solely to a potential for bioaccumulation.

3.2.2 Ecological Hot Spots

A hot spot in soil is generically defined as an area where the contamination is "highly concentrated," highly mobile, or cannot be reliably contained. For this ERA, hot spot levels corresponded to COPEC concentrations that exceed both ecological risk-based screening concentrations and background concentrations by a factor of 10 or more. As outlined in the following table, most of the ecological hot spots are located in soil/wasterock, with only a few hot spots in surface water and sediment.

Ecological Hot Spot Concentrations and Location

COPEC	Hot Spot Concentration	Hot Spot Locations (Figure 2)
Soil/Wasterock (mg/kg)		
Antimony	50	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3; OM-WR3-1
Total Arsenic	180	OM-WR1-3
Cadmium	40	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3; OM-WR3-1
Copper	500	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3; OM-WR3-1
Lead	1,070	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3; OM-WR3-1
Mercury	1	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3
Selenium	4.3	OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3
Silver	20	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3; OM-WR3-1
Thallium	10	OM-WR1-3
Zinc	4,500	OM-OP1-2; OM-OP2-1; OM-OP3-1; OM-WR1-3; OM-WR2-3; OM-WR3-1
Surface Water (mg/L; Total Concentrations)		
Lead	0.0066	OM-AS-02; LC-SW-04(HF)
Sediment (mg/kg)		
Zinc	883	LC-SS-03; LC-SS-04; LC-SS-03(HF); LC-SS-04(HF)

3.2.3 Ecological Risk Assessment Summary

Elevated concentrations of some COPECs are present in nearly all of the soil/wasterock samples collected from the Site, and it is likely that individual plants and invertebrates are adversely impacted within these localized areas. Given the highest risk ratios and most widespread distribution in soil/wasterock, antimony, cadmium, copper, iron, lead, selenium, silver, and zinc have the most potential for causing ecological impacts. Overall, terrestrial ecological receptor populations are unlikely to be significantly impacted because of the limited area of potential exposure. In addition, the habitat lost due to any effects on plants is also unlikely to result in significant effects to upper trophic level species due to the large amount of relatively undisturbed habitat available surrounding the Site.

Given the proximity to Linton Creek, wasterock is likely a past and current source for contaminant transport to Linton Creek. The surface water risk-based screening suggested that the adit seep and samples LC-SW-04 and LC-SW-05 may have elevated total concentrations of some metals. The lack of elevated total metal concentrations at stations adjacent to and immediately downstream from the mine indicates the tributary of Linton Creek entering from the southwest approximately 0.5 mile below the mine may have elevated metals concentrations. Dissolved metals concentrations suggest that only a slight potential exists for impacts to aquatic life in surface water at sample LC-SW-02, adjacent to the Site.

Cadmium, lead, and zinc present the highest potential for ecological risk in sediment. The consistency of slightly to moderately elevated concentrations of COPECs in sediments at samples LC-SS-02, LC-SS-03, and LC-SS-04, suggests the Site may be impacting the sediment of Linton Creek.

Excluding individual plants and invertebrates exposed to Site-related COPECs in soil/wasterock and surface water, significant ecological impacts are not expected at the Site. However, Linton Creek sediments appear to be partially impacted by the Site as indicated by elevated concentrations of several

metals (cadmium, lead and zinc) in downstream stations. In addition, numerous ecological hot spots are present in wasterock, and several ecological hot spots are present in surface water and sediment.

4.0 SITE CLEANUP CRITERIA

4.1 Applicable or Relevant and Appropriate Requirements

Federal, state, and local applicable or relevant and appropriate requirements (ARARs) are used to (1) evaluate the extent of cleanup needed at the Site, (2) scope and develop removal action alternatives, and (3) guide the implementation and operation of the preferred alternative. The NCP (40 CFR 300.415(j)) establishes that removal action shall "to the extent practicable, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal or state environmental facility siting laws." To determine whether compliance with ARARs is practicable, two factors are specified in 40 CFR 300.415(j): urgency and scope of the removal action. The scope of the removal action is often directed at minimizing and mitigating potential hazard rather than eliminating the hazard. Therefore, even though a particular standard may be an ARAR for a particular medium, it may be outside the scope of the immediate problem. For example, removal of a contaminant source may improve groundwater or surface water quality without meeting water quality criteria, thus not meeting the ARAR, can be an acceptable action.

The ARARs are grouped as federal or state of Washington ARARs; no specific local ARARs were identified (Appendix C). They are identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR, and whether the ARAR is applicable, or relevant and appropriate. Administrative requirements are not ARARs and thus do not apply to actions conducted entirely onsite. Administrative requirements are those that involve consultation, issuance of permits, documentation, reporting, record keeping, and enforcement. The CERCLA program has its own set of administrative procedures, which outlines the proper implementation of CERCLA. In accordance with Section 121(e) of CERCLA, no permits are required for the removal action.

ARARs are chemical, location, or action specific.

- Chemical-specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals that may be found in or discharged to the ambient environment.
- Location-specific requirements are restrictions placed on the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location specific ARARs relate to the geographical or physical positions of sites rather than to the nature of contaminants at sites.
- Action-specific requirements are usually technology based or activity based requirements or limitations on actions taken with respect to hazardous substances, pollutants, or contaminants. A given cleanup activity will trigger an action specific requirement. Such requirements do not themselves determine the cleanup alternative but define how to perform chosen cleanup methods.

4.2 ARAR-Based Preliminary Remediation Goals

ARAR-based Preliminary Remediation Goals are not applicable because site-specific human and ecological risk assessments were completed.

4.3 Risk-Based Preliminary Remediation Goals

The risk assessment determined that there are no unacceptable human health hazards from lead in surface water and no unacceptable carcinogenic or non-carcinogenic health effects expected from exposure to arsenic in soil, wasterock, or sediment. There appears to be no unacceptable risk from exposure to arsenic

in surface water under CTE or average conditions. While the risk assessment demonstrated that there is a potential for unacceptable risk from exposure to arsenic in surface water under RME or maximally exposed conditions, this risk is attributable to detection limits that exceeded the human health criteria. The potential risk calculated is uncertain and upwardly biased because of these detection limits. Based on these considerations, unacceptable human health risks are not anticipated from exposure to contaminants on site under a recreational scenario and therefore, risk-based PRGs for human receptors were not developed.

As outlined in the ecological risk assessment, the ecological risk-based screening concentrations used in the assessment would be overprotective of ecological receptors. Furthermore, population level effects could only occur for ecological species if the receptors were to forage predominantly at the Site. Considering localized and small exposure areas, this is unlikely. In addition, the habitat lost due to any effects on plants is also unlikely to result in significant effects to upper trophic level species due to the large amount of relatively undisturbed habitats available surrounding the Site. Based on this, risk-based PRGs for ecological receptors were not developed.

4.4 Regulation-Based Remedial Goals

Most mine waste in the United States is exempt from certain federal regulations through 40 CFR261.4(b)(7), known as the Bevill Amendment. Remedial and removal actions focused on mining waste in the State of Washington State are regulated by Chapter 173-340 Washington Administrative Code (WAC), which does not recognize the Bevill Amendment exemptions. As is indicated in Section 3.0, the primary risk is ecological and related to potential for ingestion and inhalation. There is no unacceptable human health risk for ingestion and inhalation, but some risk is present. There is no apparent uptake of metals, as is discussed in Section 2.3.4.5. Therefore, a simply soil cover is adequate to isolate wasterock from contact with human and ecological receptors.

A second potential impact is leaching of metals from wasterock, which could then infiltrate to groundwater and possibly be transported to surface water. This potential is evaluated in WAC Chapter 173-340-747(7) wherein Ecology recommends assessing the leachability of material by either the TCLP or SPLP. If leachate analyses for cadmium, lead, and zinc are less than 10 times the groundwater cleanup criteria in 173-340-720 WAC, the material leachate is considered protective of groundwater. For analyses of chromium, copper, mercury, nickel, and selenium, if the leachate concentration is equal to or less than groundwater cleanup criteria, the material leachate is considered protective of groundwater. The adjusted groundwater criteria are outlined below:

Arsenic =	5 μg/L	Cadmium =	50 μg/L
Chromium =	50 μg/L	Copper =	No MTCA Method A Standard
Lead =	150 μg/L	Mercury =	2 μg/L
Nickel =	No MTCA Method A Standard	Selenium =	No MTCA Method A Standard
Zinc =	No MTCA Method A Standard		

As stated in WAC Chapter 173-340-747(7)(b)(i), SPLP is the preferred method under non-acidic (pH>6) soil conditions in the absence of wood waste, municipal landfill waste, and low-sulfur mining wastes. This is the case with the wasterock and ore present at the Site, no municipal waste is present or would be permitted at the Site; wood waste materials are limited and would be removed during cleanup; and wasterock pH is neutral, is not expected to produce ARD, and contains low sulfide sulfur (Table 4). Therefore, SPLP results are applicable. In WR1 and WR2, cadmium, chromium, lead, and mercury SPLP leachate analyses are below the adjusted criteria. The SPLP detection limit for arsenic is higher than the above-listed criterion; however, the overall arsenic concentrations are generally low. In OP1, cadmium and lead SPLP leachate concentrations exceed the adjusted criteria listed above. SPLP leachate was not analyzed for copper, nickel, selenium, or zinc, but concentrations of these metals were relatively low in comparison to similar metal mines. Surface water analyses from LC-03, located slightly downstream

from the Site, do not indicate a water quality impact to Linton Creek from wasterock and ore at the Site. As outlined in Section 2.3, elevated metal concentrations in surface water at LC-04 and LC-05 appear to be impacted by sources other than the Site.

Furthermore, the applicability of TCLP as method to evaluate leachability of mining waste as discussed in Section 2.3.4.4 is also questioned by several scientific organizations, including EPA (EPA, 1998). Because acetic acid does not occur in metal waste monofills, the procedure is inapplicable.

5.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

5.1 Removal Action Justification

The NCP states that an appropriate removal action may be conducted when a threat to human health or welfare or the environment is identified. The removal action is undertaken to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or the threat of a release at a site. Section 300.415(b)(2) of the NCP outlines eight factors to be considered when determining the appropriateness of a removal action. The applicable factors are outlined below and provide justification for completing the removal action.

1. "High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate."
   - Surficial wasterock and ore is contaminated with metals at the Site. The wasterock piles are situated adjacent to Linton Creek and minor erosion of wasterock and ore into Linton Creek has likely occurred over the years. The risk assessment determined that there were no unacceptable carcinogenic or non-carcinogenic health effects expected from exposure to metals in soil, wasterock, or ore. However, ecological receptors could be at risk from exposure to surficial metal contamination through ingestion and inhalation.

2. "Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released."
   - Sediments in Linton Creek near the Site are elevated compared to background and reference concentrations. These elevated concentrations are likely related to high precipitation events during the spring months that transport metals via erosion from the wasterock and ore piles to Linton Creek.

3. "Other situations or factors that may pose threats to public health or welfare of the United States or the environment."
   - The Site is located in the Colville National Forest, approximately 1.5 miles from the City of Metaline and Highway 20, along unmaintained Forest Road 2740 and is accessible to the public. Frequent visitation to the Site is evident from off road and four wheel drive tracks, sawdust from firewood collection, and footprints. This activity is clear evidence of potential risk to exposure, although there is little sign of visits to the more inaccessible exploration workings.

4. "Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants."
   Complete exposure pathways to ecological (aquatic and terrestrial) receptors have been documented during the risk assessment from exposure to wasterock, ore, soil, and sediment. In addition, numerous ecological hot spots are present in wasterock, and several ecological hot spots are present in surface water and sediment.

5. "Actual or potential contamination of drinking water supplies or sensitive ecosystems."
   - Drinking water supplies (e.g., groundwater and surface water) and sensitive ecosystems (e.g., Linton Creek and adjacent wetlands) were identified within four miles of the Site. Drinking water supplies, both surface water and groundwater, do not appear to be impacted by the Site. There is no indication of contaminant leaching or mobilization from the Site using the SPLP tests. However, sediment in Linton Creek near the Site appears to be slightly impacted by erosion from the Site. Downstream sediment metal distributions are not consistent with a Site source and are more indicative of multiples non-Site sources.

5.2 Goals and Objective of the Removal Action

The goal of the removal action for the Site is to significantly reduce levels of risk to humans and the environment as defined by ARARs following evaluation of applicable removal action alternatives. The goal does not include cleanup of naturally occurring (undisturbed by historic human activities) metal-enriched soil, rocks, or groundwater.

The objectives for the removal action are as follows:

- Reduce ecological risk by controlling exposure to metals in wasterock and discharge at the Site;
- Reduce ecological risk by controlling and reducing the migration of metals to Linton Creek from wasterock runoff and adit discharge at the Site that could reach Linton Creek during extreme events; and
- Retain significant historical evidence of mining activities to the extent possible while meeting health and safety concerns.

5.3 Removal Action Schedule

The removal action process should be completed in a period of 18 to 24 months. This period includes allotment for assessing data gaps, design of the recommended removal action, review by the client and appropriate regulatory bodies, public comment, preparation of bid documents, completion of the removal action, and completion of the removal action report.

6.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section describes the selection of a removal action using a four-step process:

- Identify technologies and processes potentially applicable to the Site;
- Screen technologies and processes to eliminate ineffective or unfeasible technologies;
- Develop removal action alternatives using combinations of technologies that pass the screening process; and
- Evaluate the alternatives according to criteria described in Section 6.2.

6.1 Identification and Screening of Removal Action Options and Alternatives

The purpose of identifying and screening technology types and processes is to eliminate those technologies and process options that are unfeasible and/or do not meet ARARs. General removal actions are refined into technology types and process options. The technology and process options are screened for removal action on impacted soil/waste material at the Site. Although many treatment technologies and process options have been evaluated for mine/mill solid waste, most of these are not considered feasible. These technologies involve a variety of techniques related to physical/chemical processes. At present, most of these technologies would require extensive treatability studies or are cost prohibitive and thus not

considered appropriate. Therefore, the screening process has evaluated a limited number of treatment technologies. Table 7 summarizes the results of the screening process for developing removal action alternatives.

6.1.1 Identification and Description of Alternatives for Further Evaluation

Conceptual removal alternatives were developed from the technologies that passed the screening process. Key design features are estimates only and provided for comparison purposes. The material quantities and flow rates provided in this section are estimates only and should be more accurately quantified during the final design and construction. Using the retained process options, the following alternatives have been developed for detailed analysis:

- Alternative 1: No Action
- Alternative 2: Onsite Consolidation of Ore and Wasterock
- Alternative 3: Excavation and Offsite Disposal of Ore and Wasterock

Special care will be taken to avoid the introduction of noxious weeds during the removal action. Specifically the contractor will work with the USFS to select a borrow topsoil source that has minimal weeds, all straw/hay used (i.e., for mulch and silt fence) will be certified "weed free," and all off-road vehicles will be washed and inspected prior to entering and leaving the Site.

There are several small wasterock piles and exploration workings illustrated on Figure 2. CES believes that the workings, which are labeled "EXPLORATION WORKINGS" in Figure 2 present little potential for human health or ecological risk. The workings south of Linton Creek, represented by WR4-1 and WR5-1, contain only 300 and 500 bcy of soil/wasterock, respectively, and their metal concentrations in general do not significantly exceed the 95UCL. The small workings on the north hillside, which are represented by WR3-1 exhibit several metals that exceed criteria as well as the 95UCL. However, the volumes are only 20, 25, and 100 bcy, and accessibility is difficult. Further, reclamation of these small areas may impact both to a greater extent than no action because of the amount of soil exposure required for equipment access roads in often steep terrain. The adit near the Blacksmith Shop did not exhibit metal concentrations in excess of both criteria and the 95UCL. CES recommends no action at these small areas.

6.1.1.1 Alternative 1: No Action

No removal action would be completed to control contaminant migration or reduce the toxicity or volume. This alternative is used as baseline against which other removal options can be compared as suggested by the NCP.

6.1.1.2 Common Items for Alternatives 2 and 3

Several items are common and optional to Alternatives 2 and 3, and will be discussed and outlined in this section. Evaluation of these common items against the evaluation criteria is included in the overall evaluation of each of the alternatives. A summary of the common items are outlined in the following:

- **Diversion of Adit Drainage.** The drainage from the Lower Adit will be captured near the portal in a small sump and diverted to an infiltration system. The infiltration system will consist of either a basin filled with washed coarse gravel or a drain field, located as far from Linton Creek as feasible. The selection will be made as part of the data gap evaluation. Soil sorption will remove the limited amounts of dissolved metals anticipated or identified in the effluent. Depending on the location of the infiltration system, either a diversion ditch or buried pipeline will be used to convey the discharge water. This will be evaluated as part of the data gap evaluation.

- **Building Material, Equipment, and Debris Demolition / Disposal.** All metal, wood, equipment, and other miscellaneous nuisance debris that pose a potential physical or chemical hazard to Site users will be removed. To the extent possible, concrete foundations will be left intact. CES estimates that 10 tons of material will be disposed offsite at the Chemwaste Facility near Arlington, Oregon. Note: CES assumes that much of the wood debris will fail TCLP because of association with ore material. However, this will be assessed during the EECA data gap evaluation.

- **Road Construction and Decommissioning.** The access road from the powerline corridor to the Site is not passable to haul trucks needed for removal action. The road will be upgraded to a 12-foot width by grading and gravel topping where necessary. During removal action activities, the road will be maintained and left open using signs/flagging. Upon completion of the removal action activities, the road and any staging areas constructed during the removal action will be decommissioned and large boulders will be placed to limit unauthorized vehicle access. Decommissioning will consist of recontouring the road for proper drainage, ripping to 6 inches, seeding, and mulching. CES estimates a total of 1,300 lineal feet of road plus 0.5 acre of staging area to be decommissioned.

6.1.1.3 Alternative 2: Onsite Consolidation of Ore and Wasterock

This alternative consists of the common items of Section 6.1.1.2 plus consolidation of the ore from the collapsed ore bin with the lower wasterock pile followed by reclamation of the two large wasterock piles. The ore in the collapsed bin and adjacent small spillage piles failed the TCLP limit for several metals, but did not fail the same criteria using the SPLP. CES estimates that 130 bcy of this material will be consolidated onsite at the lower wasterock pile (WR2). This material will be consolidated with the wasterock. The two large wasterock piles (WR1 and WR2) and excess spillage material from the haulage route (OP-1) will be recontoured and revegetated onsite. The total volume of material to be recontoured is estimated at 16,230 bcy (Figure 2), including the ore material. The road between WP-1 and WP-2 will be minimally improved for equipment access.

Wasterock and spillage material will be graded within the existing footprint as closely as possible, but may extend outside the footprint to blend in with surrounding topography. The exact layout and slopes of all areas will be determined in the design phase; the goal will be to reduce the consolidation areas to less than 33% slope. The Upper and Lower Adits will be protected from hillside slough with steel sets to maintain accessibility for wildlife use and mine inspection and maintenance, and to mitigate any physical hazards associated with the adits. Existing bat gates will remain intact.

The SPLP analyses (Table 5) and surface water analyses (Table 1) suggest that significant metal leaching does not appear to be occurring in the waste material at the Site. Therefore, a water-balance or impervious cover is not warranted to prevent leaching to groundwater, and a simply soil cover (1 foot) should be adequate to isolate wasterock from contact with human and ecological receptors. This will be further assessed during the data gap evaluation and design. Based on this, the graded areas will be covered with one foot of cover soil (~ 2,300 cy) to control ecological exposure to the hot spots identified during the ERA and to promote revegetation. The cover soil will be placed in two lifts, one 6-inch equipment-compacted lift and one 6-inch loose lift. If warranted by data gap evaluation analyses, an engineered soil or impermeable cover will be designed using an appropriate infiltration model such as HELP, HYDRUS, EPACML, or CHEMFLO.

Visual observations and a Niton dual source XRF will be used to delineate the extent of the excavations; confirmation samples will be collected and sent to the laboratory to document the removal. All disturbed areas (~3 acres) will be graded and revegetated. Revegetation will consist of fertilizing, seeding, and mulching. A certified, weed free straw mulch would be applied to control erosion during plant establishment. The seed mix will be selected following consultation with the USFS. Storm water and

snowmelt runon will be controlled on the upgradient side of all construction by establishing runon control ditches or berms (~950 lineal feet) that channel the water around the revegetated areas to infiltration basins.

6.1.1.4 Alternative 3: Excavation and Offsite Disposal of Ore and Wasterock

This alternative consists of the common items of Section 6.1.1.2. In addition, the two large wasterock piles (WR1 and WR2), material within the ore bin (OR-2), and the excess spillage material from the haulage route (OP-1) would be excavated and transported to the Chemwaste Facility near Arlington, Oregon for disposal. The road between WP-1 and WP-2 would need to be improved for equipment and truck access. Visual observations and a Niton dual source XRF would be used to delineate the extent of the excavations; confirmation samples would be collected and sent to the laboratory to document the removal. The exact layout and slopes of all areas would be determined in the design phase. All areas will be recontoured for vegetating and erosion control. The Upper and Lower Adits will be protected from hillside slough with steel sets to maintain accessibility and to mitigate any physical hazards associated with the adits. Existing bat gates will remain intact.

All disturbed areas (~3 acres) will be graded and revegetated. Revegetation will consist of fertilizing, seeding, and mulching. A certified, weed free straw mulch would be applied to control erosion during plant establishment. The seed mix will be selected following consultation with the USFS. Storm water and snowmelt runon will be controlled on the upgradient side of all construction by establishing runon control ditches or berms (~950 lineal feet) that channel the water around the revegetated areas to infiltration basins.

6.2 Analysis of Selected Removal Action Alternatives

As required by the CERCLA guidance (EPA, 1993) and the NCP (40 CFR 300.415), removal action alternatives retained after the initial evaluation and screening have been evaluated individually against the following three criteria (effectiveness, implementability, and cost) and listed subcriteria (Table 8).

- **Effectiveness**
  - Compliance with removal action goals and objectives
  - Overall protection of human health and the environment
  - Compliance with ARARs
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness

- **Implementability**
  - Administrative feasibility
  - Technical feasibility
  - Availability of services and materials
  - State and community acceptance

- **Cost**
  - Direct capital costs
  - Indirect capital costs
  - Annual maintenance and inspection costs

6.2.1 Cost Estimates

Evaluation of costs consists of developing conservative, order-of-magnitude estimates based on the description of work items developed for each removal action alternative. These costs do not necessarily represent those that may be incurred during construction of the alternative, because many design details are preliminary at this stage. However, a similar set of assumptions is used for all the alternatives, so that the *relative* difference in cost between alternatives is represented. Appendix D provides detailed cost estimates with the capital, indirect, operation and maintenance costs, as well as the 10-year net present value of each of the alternatives. The costs are presented below from least to most expensive:

Alternative	Estimated Cost (Net Present Value)
Alternative 1	$0
Alternative 2	$307,000
Alternative 3	$3,837,000

6.3 Identification of Data Gaps

This section outlines the data gap identified during the preparation of the EECA. The identified data gap was not significant enough to warrant stopping the EECA process in order to investigate. The following data gap should be completed and evaluated as part of the removal design.

- **Additional Ore Material Characterization.** Prior to removal and/or alteration of the ore material, CES recommends collecting additional samples for SPLP to more accurately determine the volume of material to be consolidated in WR2 or transported offsite. The estimated cost is $5,000.
- **Identification of Capping Materials.** In order to construct engineered caps/covers for wasterock piles, the nearest sources of these materials must be determined and the materials characterized. The estimated cost is $10,000.

7.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Each of the retained alternatives evaluated in Section 6 was compared to identify a preferred alternative. The effectiveness of the retained alternatives was evaluated in terms of what advantages each alternative has in each of the evaluation criteria outlined in Table 9. Based on the information presented in Table 9, Alternative 2 – Onsite Consolidation of Ore and Wasterock (along with all the common items) is considered the most appropriate and cost-effective alternative because of the following:

- Reduces risk to human and ecological receptors by isolating hot spots;
- Consolidates ore material into WR2; and
- Provides a reduction in the mobility of containments.

8.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the conclusions of the detailed analysis and comparative analysis of alternatives, Alternative 2 – Onsite Consolidation of Ore and Wasterock is the preferred alternative for the Site. The total estimated cost to implement the recommended removal action is $307,000, which includes the data gap estimated at $15,000. The five factors outlined under Section 3.1 as justification for completing a removal action are further assessed below with the preferred alternative.

- **"High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate."**
  - Migration of hazardous substances and exposure to ecological hot spots are controlled by isolation of the ore material and recontouring and revegetation of the wasterock piles.

- **"Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released."**
  - By isolation of the ore material and onsite containment of the wasterock piles, migration of metals into Linton Creek during periods of high rainfall runoff and snowmelt events will be reduced.

- **"Other situations or factors that may pose threats to public health or welfare of the United States or the environment."**
  - Accessibility will be limited to foot access only by road blockage, and access to underground workings remains restricted by bat gates.

- **"Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants."**
  - The exposure to human and ecological receptors is eliminated or reduced by isolation of ore material and onsite containment and revegetation of the wasterock piles. This reduces impact to both receptors by direct contact and reduces magnification of contaminants up the food chain by minimizing concentrations of contaminants in burrowing insects and plants that form the lower parts of the food chain.

- **"Actual or potential contamination of drinking water supplies or sensitive ecosystems."**
  - No drinking water supplies are impacted under current conditions, and risk to sensitive ecosystems is minimized by isolation of the ore material and onsite containment and revegetation of the wasterock piles to control erosion to Linton Creek.

USFS Disclaimer: This abandoned mine/mill site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the USDA Forest Service. The Forest Service has conducted a PRP search relating to this site and has been unable to identify any current claimants or viable PRPs at this time. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 Mining Law. Therefore, USDA Forest Service believes that this site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this site should be included on EPA's CERCLIS database. Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Sites Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the EPA Regional Docket Coordinator consult with the Forest Service and EPA Headquarters before making a determination to include this site on the Federal Agency Hazardous Waste Compliance Docket.

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Table 1. Surface Water Analytical Results
Oriole Mine EECA, Colville National Forest, Washington

Sample I.D.	Sample Date	Aluminum, TR*	Aluminum, Diss.	Antimony, TR	Antimony, Diss.	Arsenic III, TR	Arsenic V, TR	Arsenic Total, TR	Arsenic Total, Diss.	Barium, TR*	Barium, Diss.*	Beryllium, TR	Beryllium, Diss.	Cadmium, TR	Cadmium, Diss.	Calcium, TR	Calcium, Diss.	Chromium III, TR	Chromium VI, TR	Chromium, TR	Chromium, Diss.	Cobalt, TR	Cobalt, Diss.	Copper, TR	Copper, Diss.	Iron, TR*+
		Results in µg/L																								
OM-AS-01	7/27/2004	30 B	NA	1.6	NA	< 0.007	0.5 B	**0.5 B**	NA	**21**	NA	< *2*	NA	**1.1**	NA	20,000	NA	ND	**10**	< 10	NA	< 10	NA	**1.9 B**	NA	30 B
OM-AS-02	7/27/2004	50 B	NA	1.7	NA	< 0.007	0.5 B	**0.5 B**	NA	**28**	NA	< *2*	NA	**1.2**	NA	19,800	NA	<10	ND	< 10	NA	< 10	NA	**2.1 B**	NA	80
LC-SW-02	7/28/2004	< 30	< 30	< 0.20	< 2	< 0.007	< 0.5	< ***0.5***	< ***5***	**11**	**11**	< *2*	< *2*	< 0.1	< ***1***	8,400	8,700	ND	**10**	< 10	< 10	< 10	< 10	< ***0.5***	**17 B**	10 B
LC-SW-03	7/28/2004	< 30	< 30	< 0.20	< 0.4	< 0.007	< 0.5	< ***0.5***	< ***1***	**12**	**13**	< *2*	< *2*	< 0.1	< ***0.2***	8,000	8,200	ND	**10**	< 10	< 10	< 10	< 10	< ***0.5***	**4 B**	< 10
LC-SW-04	7/28/2004	30 B	< 30	< 0.20	< 0.4	0.014 B	0.486 B	**0.5 B**	< ***1***	**12**	**12**	< *2*	< *2*	< 0.1	< ***0.2***	20,600	20,400	<10	ND	< 10	< 10	< 10	< 10	< ***0.5***	< ***1***	60
LC-SW-05	7/27/2004	< 30	< 30	< 0.20	< 1	0.024 B	0.876 B	**0.9 B**	< ***3***	**12**	**14**	< *2*	< *2*	< 0.1	< ***0.5***	24,500	25,100	<10	ND	< 10	< 10	< 10	< 10	< ***0.5***	< ***3***	40 B
UD-SW-01	7/28/2004	< 30	< 30	< 0.20	< 0.4	0.036	1.064	**1.1 B**	**1 B**	**14**	**14**	< *2*	< *2*	< 0.1	< ***0.2***	27,300	27,800	<10	ND	< 10	< 10	< 10	< 10	< ***0.5***	**1 B**	20 B
DATA GAP																										
OM-AS-06 (HF)	3/31/2006	30 B	NA	1.7 B	NA	NA	NA	**0.6** B	NA	**25**	NA	< *2*	NA	**0.9**	NA	27,000	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	< 20
OM-AS-07 (HF)	3/31/2006	< 30	NA	1.7 B	NA	NA	NA	**0.6** B	NA	**25**	NA	< *2*	NA	**0.8**	NA	26,500	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	< 20
LC-SW-01 (HF)	3/31/2006	40 B	NA	< 0.40	NA	NA	NA	< ***0.5***	NA	**7** B	NA	< *2*	NA	< 0.1	NA	1,100	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	< 20
LC-SW-01A (HF)	3/31/2006	40 B	NA	< 0.40	NA	NA	NA	< ***0.5***	NA	**8** B	NA	< *2*	NA	< 0.1	NA	3,900	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	< 20
LC-SW-02 (HF)	3/31/2006	30 B	NA	< 0.40	NA	NA	NA	< ***0.5***	NA	**7** B	NA	< *2*	NA	< 0.1	NA	4,300	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	< 20
LC-SW-03 (HF)	3/31/2006	< 30	NA	< 0.40	NA	NA	NA	< ***0.5***	NA	**8** B	NA	< *2*	NA	< 0.1	NA	5,300	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	< 20
LC-SW-04 (HF)	3/31/2006	**630**	NA	< 0.40	NA	NA	NA	< ***0.5***	NA	**19**	NA	< *2*	NA	< 0.1	NA	19,800	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	**760**
LC-SW-05 (HF)	3/31/2006	**200**	NA	< 0.40	NA	NA	NA	**0.8** B	NA	**15**	NA	< *2*	NA	< 0.1	NA	22,600	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	**240**
UD-SW-01 (HF)	3/31/2006	50 B	NA	< 0.40	NA	NA	NA	**1.0 B**	NA	**14**	NA	< *2*	NA	< 0.1	NA	25,500	NA	NA	NA	< 10	NA	< 10	NA	< 10	NA	60
Standards, corrected for hardness where applicable (used 61 mg/L average for surface water samples, excluding portal seeps)																										
Washington - Aquatic Life [1]		NS	NS	NS	NS	NS	NS	*190*	190	NS	NS	NS	NS	*0.77*	0.71	NS	NS	*137.8*	*10*	NS	NS	NS	NS	7.7	7.4	NS
Washington - Human Health [2]		NS	NS	14	*14*	NS	NS	0.018	*0.018*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Washington Drinking Water Criteria [3]		NS	NS	6	*6*	NS	NS	10	*10*	2,000	*2,000*	4	*4*	5	*5*	NS	NS	NS	NS	100	*100*	NS	NS	1,300	*1,300*	300
EPA - Aquatic Life [4]		87	87	NS	NS	NS	NS	150	*150*	NS	NS	NS	NS	0.19	*0.17*	NS	NS	57.4	11	NS	NS	NS	NS	6.1	5.9	1,000
EPA - Human Health [5]		NS	NS	5.6	NS	NS	NS	*0.14*	0.14	1,000	NS	NS	NS	5	NS	NS	NS	NS	NS	100	NS	NS	NS	1,300	NS	300
ORNL - Surface Water PRGs [6]		87	87	30	30	190	3.1	NS	NS	4	4	0.66	0.66	0.15	0.15	116,000	116,000	44	2	NS	NS	23	NS	0.2	0.23	158

Sample I.D.	Sample Date	Lead, TR	Lead, Diss.	Magnesium, TR	Magnesium, Diss.	Manganese, TR*+	Manganese, Diss.*+	Mercury, TR	Nickel, TR	Nickel, Diss.	Potassium, TR	Potassium, Diss.	Selenium, TR	Selenium, Diss.	Silver, TR*	Silver, Diss.*	Sodium, TR	Sodium, Diss.	Thallium, TR	Thallium, Diss.	Vanadium, TR	Vanadium, Diss.	Zinc, TR*	Zinc, Diss.*+
		Results in µg/L																						
OM-AS-01	7/27/2004	**4.8**	NA	10,200	NA	8 B	NA	0.00366	< 10	NA	600 B	NA	< ***1***	NA	0.07 B	NA	1,100	NA	< 0.1	NA	< 5	NA	**110**	NA
OM-AS-02	7/27/2004	**8.2**	NA	10,000	NA	11 B	NA	0.0051	< 10	NA	500 B	NA	< ***1***	NA	0.07 B	NA	1,100	NA	< 0.1	NA	< 5	NA	**120**	NA
LC-SW-02	7/28/2004	< 0.5	< **10**	4,300	4,400	< 5	< 5	0.000275	< 10	< 10	400 B	400 B	< ***10***	< ***1***	< 0.05	< **0.5**	800 B	800 B	< 0.1	< 0.5	< 5	< 5	< 10	< 10
LC-SW-03	7/28/2004	< 0.1	< 0.3 B	4,000	4,100	< 5	< 5	0.00016 B	< 10	< 10	< 300	500 B	< ***1***	< ***2***	< 0.05	< 0.1	700 B	700 B	< 0.1	< 0.1	< 5	< 5	10 B	20 B
LC-SW-04	7/28/2004	0.3 B	< 0.2	8,500	8,500	< 5	< 5	0.000335	< 10	< 10	500 B	600 B	< ***1***	< ***2***	< 0.05	< 0.1	1,100	1,100	< 0.1	0.1 B	< 5	< 5	< 10	10 B
LC-SW-05	7/27/2004	**1.1**	**0.8 B**	9,000	9,300	6 B	< 5	0.000412	< 10	< 10	500 B	700 B	< ***1***	< ***5***	< 0.05	< 0.3	1,100	1,100	< 0.1	**1.8**	5	< 5	< 10	< 10
UD-SW-01	7/28/2004	< 0.1	< 0.2	9,700	9,900	< 5	< 5	0.000511	< 10	< 10	800 B	800 B	< ***1***	< ***2***	< 0.05	< 0.1	1,200	1,200	< 0.1	0.2 B	< 5	< 5	< 10	< 10
DATA GAP																								
OM-AS-06 (HF)	3/31/2006	**2.5**	NA	14,300	NA	< 5	NA	< 0.2	< 10	NA	800 B	NA	0.2 B	NA	< 0.05	NA	1,100	NA	< 0.1	NA	< 5	NA	**90**	NA
OM-AS-07 (HF)	3/31/2006	**1.0**	NA	14,100	NA	< 5	NA	< 0.2	< 10	NA	800 B	NA	0.2 B	NA	< 0.05	NA	1,100	NA	0.3 B	NA	< 5	NA	**80**	NA
LC-SW-01 (HF)	3/31/2006	< 0.1	NA	400 B	NA	< 5	NA	< 0.2	< 10	NA	300 B	NA	< *0.1*	NA	< 0.05	NA	500 B	NA	< 0.1	NA	< 5	NA	< 10	NA
LC-SW-01A (HF)	3/31/2006	< 0.1	NA	2,000	NA	< 5	NA	< 0.2	< 10	NA	400 B	NA	< *0.1*	NA	< 0.05	NA	600 B	NA	< 0.1	NA	< 5	NA	< 10	NA
LC-SW-02 (HF)	3/31/2006	< 0.1	NA	2,200	NA	< 5	NA	< 0.2	< 10	NA	400 B	NA	< *0.1*	NA	< 0.05	NA	600 B	NA	< 0.1	NA	< 5	NA	< 10	NA
LC-SW-03 (HF)	3/31/2006	0.1 B	NA	2,700	NA	< 5	NA	< 0.2	< 10	NA	400 B	NA	< *0.1*	NA	< 0.05	NA	600 B	NA	< 0.1	NA	< 5	NA	< 10	NA
LC-SW-04 (HF)	3/31/2006	**9.1**	NA	8,600	NA	21 B	NA	< 0.2	< 10	NA	800 B	NA	0.1 B	NA	< 0.05	NA	1,200	NA	< 0.1	NA	< 5	NA	30 B	NA
LC-SW-05 (HF)	3/31/2006	**3.2**	NA	8,600	NA	12 B	NA	< 0.2	< 10	NA	900 B	NA	0.2 B	NA	< 0.05	NA	1,100	NA	< 0.1	NA	< 5	NA	< 10	NA
UD-SW-01 (HF)	3/31/2006	0.1 B	NA	9,200	NA	16 B	NA	< 0.2	< 10	NA	900 B	NA	0.3 B	NA	< 0.05	NA	1,200	NA	0.1 B	NA	< 5	NA	< 10	NA
Standards, corrected for hardness where applicable (used 61 mg/L average for surface water samples, excluding portal seeps)																								
Washington - Aquatic Life [1]		*1.7*	1.46	NS	NS	NS	NS	0.012	*167.4*	166.9	NS	NS	5	5	NS	NS	NS	NS	NS	NS	NS	NS	*69.56*	68.59
Washington - Human Health [2]		NS	NS	NS	NS	NS	NS	0.14	610	*610*	NS	NS	170	*170*	NS	NS	NS	NS	1.7	*1.7*	NS	NS	NS	NS
Washington Drinking Water Criteria [3]		15	*15*	NS	NS	50	*50*	2	100	*100*	NS	NS	50	*50*	100	*100*	20,000	*20,000*	2	*2*	NS	NS	50,000	*50,000*
EPA - Aquatic Life [4]		1.7	*1.46*	NS	120	NS	NS	0.91	34.3	*34.2*	NS	NS	5	5	NS	NS	NS	NS	NS	NS	NS	NS	78.6	*77.5*
EPA - Human Health [5]		15	NS	NS	NS	50	NS	2	610	NS	NS	NS	50	NS	100	NS	NS	NS	1.7	NS	NS	NS	NS	NS
ORNL - Surface Water PRGs [6]		0.66	0.66	82,000	82,000	120	120	0.23	160	160	53,000	53,000	0.39	0.39	0.36	0.36	680,000	680,000	9	9	20	20	30	30

Sample I.D.	Sample Date	Flow Rate	Temperature (Field)	pH (Field)*	pH (Lab)*	Turbidity*	Conductivity (Field)	Conductivity @ 25C (Lab)	Dissolved Oxygen (Field)*	Oxygen Reduction Potential (Field)	Hardness as $CaCO_3$, TR*	Field TDS*	Residue, Filterable (TDS) @180*	Residue, Non-Filterable (TSS) @105° C*	Sulfate+
		cfs	°C	su	su	NTU	µS/cm	µS/cm	mg/L	mV	mg/L				
OM-AS-01	7/27/2004	0.02	9.52	8.05	6.4	80	43	163	12.02	110	92	110	100	< 5	< 10
OM-AS-02	7/27/2004	0.015	10.64	8.38	7.2	150	21	167	12.35	120	91	130	110	6 B	< 10
LC-SW-02	7/28/2004	0.2	7.52	7.20	7.1	121	66	80	9.30	186	39	43	50	< 5	< 10
LC-SW-03	7/28/2004	0.5	8.99	7.46	7.5	20.2	62	73	9.82	171	36	41	40	< 5	< 10
LC-SW-04	7/28/2004	0.8	7.64	7.76	7.9	22.8	138	200	9.71	176	106	90	120	< 5	< 10
LC-SW-05	7/27/2004	2.5	9.40	7.62	7.8	80.9	159	189	10.28	185	98	103	110	< 5	< 10
UD-SW-01	7/28/2004	2.4	8.40	7.74	7.9	14.2	170	200	10.0	194	106	111	120	< 5	< 10
DATA GAP															
OM-AS-06 (HF)	3/31/2006	0.14	5.90	7.84	8.2	NM	221	231	8.5	91.6	126	NA	130	NA	< 10
OM-AS-07 (HF)	3/31/2006	0.07	5.70	8.13	8.2	NM	228	234	9.3	71.8	124	NA	130	NA	< 10
LC-SW-01 (HF)	3/31/2006	0.02	2.60	7.12	6.9	NM	4	12	10.0	189.3	4	NA	20	NA	< 10
LC-SW-01A (HF)	3/31/2006	1.9	3.20	7.12	7.5	NM	26	38	10.1	137.2	18	NA	30	NA	< 10
LC-SW-02 (HF)	3/31/2006	1.8	3.10	7.12	7.5	NM	29	41	10.0	156.8	20	NA	40	NA	< 10
LC-SW-03 (HF)	3/31/2006	3.0	3.30	7.12	7.7	NM	41	49	10.3	148.2	24	NA	30	NA	< 10
LC-SW-04 (HF)	3/31/2006	1.13	3.90	7.57	8.1	NM	150	149	9.7	116.1	85	NA	100	NA	< 10
LC-SW-05 (HF)	3/31/2006	3.5	4.30	7.87	8.2	NM	169	169	11.3	125.1	92	NA	100	NA	< 10
UD-SW-01 (HF)	3/31/2006	1.7	4.60	7.09	8.2	NM	184	181	9.20	130.3	102	NA	120	NA	< 10
Standards															
Washington - Aquatic Life [1]		NS	12	6.5-8.5	6.5-8.5	5>Bkg	NS	NS	9.5	NS	NS	NS	NS	NS	NS
Washington - Human Health [2]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Washington Drinking Water Criteria [3]		NS	NS	6.5-8.5	6.5-8.5	NS	700	700	NS	NS	NS	500	500	NS	250
EPA - Aquatic Life [4]		NS	9-19	6.5-9	6.5-9	NS	NS	NS	9.5	NS	NS	NS	NS	NS	NS
EPA - Human Health [5]		NS	NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NOTES:

All analyses except Arsenic III & Mercury were conducted by ACZ Laboratories, Inc., Steamboat Springs, CO per EPA Method 200 series.
Arsenic III and mercury anlyses were conducted by Brooks Rand, Seattle, WA per EAP Methods 1631 & 1632, respectively.
Arsenic V was calculated from difference between Arsenic, TR and Arsenic III.
Chromium VI was determied in the field.
Chromium III was calculated from difference between Chromium, TR and Chromium VI.
µg/L = micrograms per liter
mg/L = milligrams per liter
su = standard units
µS/cm = micro siemans per centimeter
cfs = cubic feet per second
mV = micro volts
°C = degrees celcius
NM = Not Measured
NA = Not analyzed
B = analyte detected between MDL and practical quantification limit (PQL)
Bolded values indicate that the value exceeds one or more standard.
Italic values indicate that the MDL exceeds the lowest standard.
ND = Not Detected
HF = High-Flow sampling event
TR = Total Recoverable
* = Non-Priority Pollutant under NTR
+ = Secondary Drinking Water Criteria

STANDARD NOTES:

1 - State of Washington Aquatic Life criteria (WAC 173-201A), underline - corrected for hardness, *italics* - expressed as dissolved
3 - State of Washington drinking water criteria (WAC 246-290), underline - action level or level of concern,*italics* - expressed as Total Recoverable
4 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002), underline - corrected for hardness, *italics* - expressed as dissolved
5 - EPA recommended ambient water quality criteria for protection of human consumption of water and fish (EPA, 2002 NTR), *italics* - expressed as dissolved
6 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)
NS = No Standard

Table 2. Sediment Analytical Results
Oriole Mine EECA, Colville National Forest, Washington

Sample ID	Sample Date	Aluminum, Total	Antimony, Total	Arsenic III, Inorganic	Arsenic V, Inorganic	Arsenic - Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total
		mg/kg																								
LC-SS-02	7/28/2004	11,550	**1.2**	< 0.103	5.1	5.2	114.0	0.6 B	**1.56**	4,510	18	14	26.9	17,100	**290**	4,250	1,530	0.09 B	**26.9**	670	0.90 B	**2.01**	60 B	0.17	16.8	**162**
LC-SS-03	7/28/2004	7,170	**2.2**	< 0.038	15.3	**15.3**	63.7	0.8 B	**2.26**	1,950	19	13	21.2	86,300	**1,880**	2,440	2,570	**0.21**	**28**	310	0.50 B	0.30 B	< 60	0.95	23.0	**1,880**
LC-SS-04	7/28/2004	9,910	**0.6**	0.124 B	8.7	**8.8**	46.9	0.3 B	**1.19**	6,420	20	10	13.5	33,600	**147**	6,850	524	**0.64**	**19.7**	640	< 0.50	0.19	60 B	0.10	23.4	**1,970**
LC-SS-05	7/27/2004	7,460	0.4 B	0.057 B	5.4	5.5	46.7	0.2 B	0.56	7,350	16	5 B	9.6	18,000	**1,130**	5,970	497	< 0.04	17.0	630	< 0.50	< 0.30	110	0.18	24.6	**265**
UD-SS-01	7/28/2004	7,280	0.3 B	0.124 B	4.7	4.8	47.3	< 0.2	0.37	3,760	17	5 B	9.3	16,400	**868**	4,840	434	< 0.40	14.1	610	< 0.50	0.10 B	150	0.12	30.4	108
DATA GAP																										
LC-SS-01A (HF)	3/31/2006	11,700	0.4 B	NA	NA	**9.9**	122.0	0.7 B	**0.85**	2,040	15	13	20.0	16,900	**20.5**	3,450	1,270	< 0.05	**26.0**	1,010	0.34	1.31	50 B	0.11 B	20.6	107
LC-SS-02 (HF)	3/31/2006	8,430	0.2 B	NA	NA	3.7	65.9	0.4 B	**0.64**	1,470	16	9	9.0	15,400	**35.8**	4,150	975	< 0.05	**18.0**	560	0.17 B	0.09 B	< 30	0.17 B	13.8	94
LC-SS-03 (HF)	3/31/2006	8,540	**2.6**	NA	NA	**23.9**	57.7	0.8 B	**3.09**	1,510	16	12	21.0	96,300	**1,100**	3,050	1,370	**0.25**	**26.0**	360	0.40	< 0.30	< 30	0.63	21.8	**2,320**
LC-SS-04 (HF)	3/31/2006	16,500	0.2 B	NA	NA	**7.1**	138.0	0.5 B	**2.25**	7,930	32	13	32.0	23,900	**449**	7,980	683	0.13 B	**24.0**	1,950	0.72	0.30 B	270	0.23 B	53.7	**1,120**
LC-SS-05 (HF)	3/31/2006	9,900	< 0.2	NA	NA	**6.7**	73.0	0.3 B	**0.81**	12,300	18	8	15.0	17,400	**234**	8,800	499	0.04 B	15.0	1,090	0.38	0.14	170	0.15 B	34.4	**326**
UD-SS-01 (HF)	3/31/2006	9,170	< 0.2	NA	NA	5.7	65.7	0.3 B	0.17 B	4,240	19	6	11.0	15,900	6.15	5,200	576	< 0.05	12.0	860	0.18 B	0.08 B	220	0.15 B	40.2	50
Standards																										
WA - Freshwater (under development) [1]		NS	0.6	NS	NS	51	NS	NS	1	NS	100	NS	830	NS	430	NS	NS	0.75	70	NS	NS	2.5	NS	NS	NS	160
WA - Marine [2]		NS	NS	NS	NS	57	NS	NS	5.1	NS	260	NS	390	NS	450	NS	NS	0.41	NS	NS	NS	6.1	NS	NS	NS	410
EPA - Freshwater TEL [3]		NS	NS	NS	NS	5.9	NS	NS	0.596	NS	37	NS	35.7	NS	35	NS	NS	0.174	18	NS	NS	NS	NS	NS	NS	123.1
EPA - Freshwater PEL [4]		NS	NS	NS	NS	17	NS	NS	3.53	NS	90	NS	197	NS	91.3	NS	NS	0.486	35.9	NS	NS	NS	NS	NS	NS	315
ORNL - Freshwater [5]		NS	NS	NS	NS	42	NS	NS	4.2	NS	159	NS	77.7	NS	110	NS	NS	0.7	38.5	NS	NS	1.8	NS	NS	NS	270

Sample ID	Sample Date	Total Organic Carbon	Size Fraction by Hydrometer			Solids (ACZ)	Solids (BR)	Texture Classification	Clay Analysis (XRD)			
			Clay	Sand	silt				Smectite	Illite	Kaolinite	Chlorite
		%							%			
LC-SS-02	7/28/2004	7.5	10.0	65.0	25.0	46.9	29.1	SL	7	72	1*	20
LC-SS-03	7/28/2004	2.5	5.0	78.8	16.3	77.2	79.1	LS	NA	NA	NA	NA
LC-SS-04	7/28/2004	1.2	2.5 B	81.3	16.3	81.6	79.3	LS	NA	NA	NA	NA
LC-SS-05	7/27/2004	1.0	2.5 B	88.8	8.8	83.2	84.3	S	8	65	1*	26
UD-SS-01	7/28/2004	1.0	1.3 B	91.3	7.5	81.1	77.6	S	2	63	1*	34
DATA GAP												
LC-SS-01A (HF)	3/31/2006	NA	22.5	78.8	0.0	75.7	NA	NA	NA	NA	NA	NA
LC-SS-02 (HF)	3/31/2006	NA	15.0	87.5	0.0	80.3	NA	NA	NA	NA	NA	NA
LC-SS-03 (HF)	3/31/2006	NA	20.0	81.3	0.0	75.9	NA	NA	NA	NA	NA	NA
LC-SS-04 (HF)	3/31/2006	NA	87.5	13.8	0.0	64.3	NA	NA	NA	NA	NA	NA
LC-SS-05 (HF)	3/31/2006	NA	22.5	81.3	0.0	83.7	NA	NA	NA	NA	NA	NA
LC-SS-06 (HF)	3/31/2006	NA	20.0	81.3	0.0	78.4	NA	NA	NA	NA	NA	NA
UD-SS-01 (HF)	3/31/2006	NA	5.0	97.5	0.0	82.2	NA	NA	NA	NA	NA	NA

NOTES:

Analysis (except As III) was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO, per EPA Method 6010/7000 series.
As III analyses by Brooks Rand in Seattle, WA per EPA Method 1631.
Digestion (except As III) by EPA Method 3050B
mg/kg = milligrams per kilogram
% = percent
< value = analyte not detected above Method Detection Limit (MDL, shown)
B = analyte detected between MDL and Practical Quantification Limit (PQL, not shown)
MDL and PQL are not consistent among samples
Chromium III was calculated by subtracting Chromium VI from Total Chromium
Bolded values indicate that the value exceeds one or more standard
NA = Not Analyzed
HF = High-Flow sampling event

STANDARD NOTES:

1 - State of Washington, Development of Freshwater Sediment Quality Values (DOE, Sept 2003)
2 - State of Washington, Marine Sediment Management Standards (DOE, 1995)
3 - EPA Threshold Effects Level (NOAA, 1999)
4 - EPA Probable Effects Level (NOAA, 1999)
5 - ORNL ecological screening level values for freshwater, lowest chronic value used (ORNL, 1996)
NS = No Standard

Table 3. Background Soil Analytical Results
Oriole Mine EECA, Colville National Forest, Washington

Sample ID	Sample Date	Sample Depth	% Solids	pH	Aluminum, Total	Antimony, Total	Arsenic III, Total	Arsenic V, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total
		feet	%	su	mg/kg																								
OM-BGS-1	7/28/2004	0.5-1	88.1	6.2	**34,600**	0.2 B	NA	NC	**3.9**	**327**	0.9 B	0.8	1,970	**11**	10	18	17,500	17.5	1,770	848	< 0.05	18	870	< **0.50**	0.19	280	0.15	**23.0**	**80**
OM-BGS-2	7/28/2004	0.5-1	98.7	7.2	**9,510**	0.9	0.055 B	4.05	**4.1**	**160**	0.5 B	**3.31**	11,600	**12**	15	34	13,500	**116**	14,300	**4,920**	< 0.05	16	700	< **0.50**	0.77	40 B	0.09 B	**17.7**	**169**
OM-BGS-3	7/28/2004	0.5-1	65.3	6.3	**32,000**	0.4 B	0.07 B	4.13	**4.2**	**880**	0.9 B	**4.6**	10,200	**15**	12	30	19,400	**64**	2,280	**4,240**	< 0.04	26	1,160	< **1.00**	0.34	280	0.29 B	**22.9**	**673**
BGS-4	4/1/2006	0.5-1	73.4	NA	**21,500**	0.5 B	NA	NA	**9.9**	**791**	0.7 B	**2.74**	5,070	**12**	19	25	17,400	**61.6**	4,600	**5,500**	< 0.05	28	860	**0.25** B	0.29	160	0.28 B	**30.7**	**192**
BGS-5	4/1/2006	0.5-1	68.5	NA	**40,900**	1.0 B	NA	NA	**11.1**	**549**	1.4	**3.56**	3,910	**21**	19	46	28,900	**129**	9,100	**6,230**	**0.06** B	29	1,530	**0.47**	1.36	290	0.30	**47.7**	**381**
BGS-6	4/1/2006	0.5-1	76.8	NA	**22,700**	< 0.2	NA	NA	**5.8**	**424**	0.8 B	**0.55**	2,590	**18**	14	15	22,900	**13.6**	3,140	**2,300**	< 0.05	25	1,290	**0.28** B	0.19	100 B	0.20 B	**45.2**	**57**
MEAN				6.6	**26,868**	0.5	NC	NC	**6.5**	**522**	0.9	**2.6**	5,890	**15**	15	28	19,933	**67**	5,865	**4,006**	< 0.05	24	1,068	**0.25**	0.5	192	0.22	**31.2**	**259**
95% UCL					**35,071**	0.8	NC	NC	**8.8**	**723**	1.1	**3.8**	8,849	**18**	18	36	23,843	**102**	9,447	**5,502**	NC	28	1,297	**0.45**	0.9	270	0.28	**40.4**	**429**
Standards																													
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]					NS	NS	NS	NS	20	NS	NS	2	NS	19	NS	NS	NS	1,000	NS	NS	2	NS	NS	NS	NS	NS	NS	NS	NS
WA - Ecological Receptors (p=plant, b=soil biota, w=wildlife)[2]					50 p	5 p	7 w	10 p	NS	102 w	10 p	4 p	NS	42 bp	20 p	50 b	NS	50 p	NS	1,100 p	0.1 b	30 p	NS	0.3 w	2 p	NS	1 p	2 p	86 p
EPA Indust. PRGs - Human Receptors[3]					100,000	410	NS	NS	1.6	67,000	1,900	7.4	NS	64	1,900	41,000	100,000	750	NS	19,000	310	20,000	NS	5,100	5,100	NS	67	7,200	100,000
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate, p=plant)[4]					NS	21 m	NS	NS	37 p	NS	NS	29 p	NS	5 p	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i
ORNL - Ecological Receptors[5]					NS	5	NS	NS	9.9	283	10	4	NS	0.4	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5

NOTES:
Analysis was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO using EPA Method 6000 Series & Method 7471.
mg/kg = milligrams per kilogram
su = standard units
% = percent
< value = analyte not detected above indicated Method Detection Limit (MDL).
B = analyte detected between MDL and practical quantification limit (PQL).
NC = Not Calculated

STANDARD NOTES:
1 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 745-1 (Ecology, 2001).
2 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 749-2 (Ecology, 2001).
3 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2002).
4 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000)
5 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 1997
NS = No standard

Table 4. Ore Stockpiles and Wasterock Analytical Results
Oriole Mine EECA, Colville National Forest, Washington

Sample ID	Sample Date	Sample Depth (feet)	Waste Rock (WR), Ore, or Native Soil	Solids	Paste pH	Aluminum, Total	Antimony, Total	Arsenic III, Total	Arsenic V, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total	Total Sulfur	Sulfur Forms: Organic Sulfur	Sulfur Forms: Pyritic Sulfur	Sulfur Forms: Sulfate Sulfur	ABAs: Acid Generation Potential	ABAs: Acid Neutralization Potential	ABAs: Acid-Base Potential
				%	su	mg/kg																									%	%			t $CaCO_3$/Kt		
OM-OP1-1	7/27/2004	2-4	Ore	93.5	6.2	4,290	170	0.184	84.116	84.3	50.8	0.4 B	222	109,000	19	25	1,740	27,600	16,300	66,100	2,200	1.66	38.5	390	20	100	< 30	10 B	19.4	37,400	3.04	1.55	1.13	0.36	95	618	523
OM-OP1-2	7/28/2004	0.5	Ore	95.7	7.0	2,570	280	NA	NC	173	36.5	0.2 B	260	97,500	15	20	1,640	34,000	42,900	57,900	2,260	3.45	36.4	450	2.5 B	203	< 30	10 B	31.5	55,600	NA	NA	NA	NA	NA	NA	NA
OM-OP2-1	7/28/2004	1-2	Ore	89.4	6.3	11,000	550	NA	NC	164	125	0.4 B	204	50,000	13	16	2,020	20,500	20,300	35,300	2,280	1.91	27	420	9.4	199	80 B	6 B	17.2	33,300	NA	NA	NA	NA	NA	NA	NA
OM-OP3-1	7/28/2004	0.5	Ore	95.3	6.6	2,320	160	NA	NC	76.8	30.7	0.2 B	430	78,800	12	9	700	27,800	39,100	51,900	1,880	3.2	23.1	480	5.1	143	30 B	10 B	24.1	93,000	NA	NA	NA	NA	NA	NA	NA
OM-WR1-1	7/27/2004	2-5	WR	73.1	7.1	6,010	382	NA	NC	65.7	49.1	0.5 B	76.2	113,000	24	24	1,560	19,800	14,300	71,400	2,630	1.56	50.4	340	7.3	298	< 30	1 B	19.1	33,100	NA	NA	NA	NA	NA	NA	NA
OM-WR1-1	7/27/2004	6.0	Native	87.6	7.7	16,000	3.1	NA	NC	12.9	164	0.7 B	7.38	20,900	25	19	49.2	19,900	501	26,000	4,170	< 0.04	34.1	680	< 0.5	3.07	60 B	0.2 B	47.9	1,310	NA	NA	NA	NA	NA	NA	NA
OM-WR1-2	7/27/2004	9.0	WR	93.4	7.8	2,300	70	< 0.035	29.483	29.5	27.1	0.3 B	91.9	136,000	12	25	440	14,300	7,640	79,400	1,840	1.63	35.1	390	2.7	48	< 30	7 B	11.9	19,900	0.37	0.25	0.06B	0.06B	12	816	804
OM-WR1-3	7/27/2004	1.0	WR	99.2	7.6	1,530	110	0.113	30.987	31.1	20.4	< 0.2	116	166,000	3 B	11	500	11,600	3,400	92,400	2,210	0.9	18.7	150	10.8	38	< 30	1 B	6.3	15,400	0.23	0.19	0.04B	<0.01	7	972	965
OM-WR1-3	7/27/2004	2.0	WR	93.7	6.9	1,320	1,150	NA	NC	211	17.3	< 0.2	390	90,600	5 B	7	2,800	11,500	103,000	54,300	1,690	3.44	14	120	25	330	< 30	30 B	6.6	62,500	NA	NA	NA	NA	NA	NA	NA
OM-WR1-4	7/27/2004	7.0	WR	98.1	8.0	3,320	67	NA	NC	29.1	35.6	0.3 B	63	150,000	10	25	550	14,100	3,060	86,000	2,360	2.25	34.9	290	1.9 B	36	< 30	1 B	16.0	9,760	NA	NA	NA	NA	NA	NA	NA
OM-WR2-1	7/27/2004	0-1	WR	97.8	7.6	6,460	12	0.055 B	9.745	9.8	95.2	0.3 B	17.1	112,000	14	11	163	10,900	736	66,200	2,750	0.7	23.1	390	< 0.5	5.93	40 B	< 0.3	13.3	2,470	0.04B	0.03B	0.01B	<0.01	1	699	698
OM-WR2-2	7/27/2004	4-10	WR	94.7	8.1	7,860	9 B	< 0.035	10.783	10.8	94.1	0.4 B	13.0	107,000	34	11	94.2	11,600	1,560	62,500	2,720	0.32	38.1	460	< 0.5	9.66	30 B	< 0.5	16.8	1,190	0.03B	0.03B	<0.01	<0.01	1	639	638
OM-WR2-3	7/27/2004	0.5-3	WR	97.4	7.5	6,330	145	NA	NC	60.1	48.1	0.5 B	52.4	152,000	32	37	900	22,200	7,790	89,800	2,720	1.37	47.3	480	7.1	111	< 30	< 1	25.5	14,400	NA	NA	NA	NA	NA	NA	NA
OM-WR2-3	7/27/2004	3.0	Native	84.5	7.7	14,400	4.8	NA	NC	3.7	269	0.5 B	6.92	22,700	14	14	31	20,000	121	20,000	6,820	< 0.05	18.4	520	< 0.5	0.79	80 B	0.1 B	25.1	667	NA	NA	NA	NA	NA	NA	NA
OM-WR3-1	7/28/2004	1.0	WR	95.7	7.2	6,040	90	NA	NC	64.1	46	0.4 B	112	104,000	10	55	1,910	22,100	15,100	64,800	2,450	0.59	42.9	490	3	86	30 B	4 B	26.2	17,300	0.02B	0.03B	<0.01	<0.01	1B	685	684
OM-WR4-1	7/28/2004	0.5	WR	86.9	6.6	4,130	0.7	< 0.042	5.182	5.2	29.8	0.6 B	0.4	420	14	8	18.5	32,700	191	240	1,740	< 0.05	12.3	550	< 0.5	0.05 B	< 30	0.45	20.4	294	<0.01	<0.01	<0.01	<0.01	0	3B	3
OM-WR5-1	7/28/2004	0.5	WR	85.0	6.3	5,830	< 1	< 0.042	11.079	11.1	54.5	0.5 B	0.55	590	10	17	18.9	34,100	1,050	300	900	0.12 B	19.3	430	< 0.5	0.05	< 30	0.5 B	25.8	560	<0.01	<0.01	<0.01	<0.01	0	2B	2
BLACKSMITH ADIT	4/1/2006	0.5	WR	98.0	NA	4,800	0.4 B	NA	NA	3.7	25.6	0.4 B	0.31	134,000	5 B	4 B	8	2,890	8.18	83,100	1,250	< 0.04	4 B	470	0.12 B	0.16	< 30	< 0.05	11.3	27	NA	NA	NA	NA	NA	NA	NA
AVERAGE						5,917	178	0.061	25.91	58.1	67.7	0.4	114.6	91,362	15	19	841	19,866	15,392	55,980	2,493	1.29	28.8	417	5.36	89.5	29	4.6	20.2	22,121	NC	NC	NC	NC	NC	NC	NC
95% UCL						35,071	0.8	NC	NC	8.8	723	1.1	3.8	8,849	18	18	36	23,843	102	9,447	5,502	NC	27.6	1,297	0.45	0.9	270	0.3	40.4	429	NC	NC	NC	NC	NC	NC	NC
Standards																																					
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]						NS	NS	NS	NS	20	NS	NS	2	NS	19	NS	NS	NS	1,000	NS	NS	2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
WA - Ecological Receptors (p=plant, b=soil biota, w=wildlife)						50 p	5 p	7w	10 p	NS	102 w	10 p	4 p	NS	42 pb	20 p	50 b	NS	50 p	NS	1,100 p	0.1 b	30 p	NS	0.3 w	2 p	NS	1 p	2 p	86 p	NS	NS	NS	NS	NS	NS	NS
EPA Indust. PRGs - Human Receptors[3]						100,000	410	NS	NS	1.6	67,000	1,900	7.4	NS	64	1,900	41,000	100,000	750	NS	19,000	310	20,000	NS	5,100	5,100	NS	67	7,200	100,000	NS	NS	NS	NS	NS	NS	NS
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate, p=plant)[4]						NS	21 m	NS	NS	37 p	NS	NS	29 p	NS	5 p	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i	NS	NS	NS	NS	NS	NS	NS
ORNL - Ecological Receptors[5]						NS	5	NS	NS	9.9	283	10	4	NS	0.4	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5	NS	NS	NS	NS	NS	NS	NS

NOTES:

Analysis was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO using EPA Method 6000 Series & Method 7471.
mg/kg = milligrams per kilogram
su = standard units
% = percent
< value = analyte not detected above indicated Mewthod Detection Limit (MDL
B = analyte detected between MDL and practical quantification limit (PQL
NA = not analyzed
NC = Not calculated
Mean values calculated using one half the MDL if results were below the MDL.
Shaded cells indicate an exceedence of a criterion and 95%UCL.
t $CaCO_3$/Kt = tons of calcium carbonate needed to neutralize 1000 tons of waste/soil. Negative number indicates lack of $CaCO_3$, positive value indicates excess (no need).

STANDARD NOTES:

1 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 745-1 (Ecology, 2001).
2 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 749-2 (Ecology, 2001)
3 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2002).
4 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000
5 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 19
NS = No standard

Table 5. Synthetic Precipitation Leaching Procedure and Toxicity Characteristic Leaching Procedure Results for Wasterock and Ore Samples
Oriole Mine EECA, Colville National Forest, Washington

Sample ID	Sample Date	Sample Depth (feet)	Waste Rock (WR) or Ore	SPLP Arsenic	TCLP Arsenic	SPLP Barium	TCLP Barium	SPLP Cadmium	TCLP Cadium	SPLP Chromium	TCLP Chromium	SPLP Lead	TCLP Lead	SPLP Mercury	TCLP Mercury	SPLP Selenium	TCLP Selenium	SPLP Silver	TCLP Silver
				mg/L															
OM-OP1-1	7/27/2004	2-4	Ore	< 0.04	< 0.04	0.045	0.003 B	**0.454**	**3.22**	< 0.001	< 0.01	**0.31**	**39.2**	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
OM-WR1-2	7/27/2004	9.0	WR	< 0.04	NA	0.011	NA	< 0.005	NA	< 0.001	NA	0.06 B	NA	< 0.0002	NA	< 0.04	NA	< 0.005	NA
OM-WR1-3	7/27/2004	1.0	WR	< 0.04	< 0.04	0.006 B	0.12	< 0.005	0.253	< 0.001	< 0.001	0.06 B	**13.2**	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
OM-WR2-1	7/27/2004	0-1	WR	< 0.04	< 0.04	0.013	0.565	< 0.005	0.109	< 0.001	< 0.001	< 0.04	1.13	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
OM-WR2-2	7/27/2004	4-10	WR	< 0.04	NA	0.015	NA	< 0.005	NA	< 0.001	NA	< 0.04	NA	< 0.0002	NA	< 0.04	NA	< 0.005	NA
OM-WR3-1	7/28/2004	1.0	WR	< 0.04	NA	0.011	NA	< 0.005	NA	< 0.001	NA	0.1 B	NA	< 0.0002	NA	< 0.04	NA	< 0.005	NA
OM-WR4-1	7/28/2004	0.5	WR	< 0.04	NA	< 0.003	NA	< 0.005	NA	< 0.001	NA	< 0.04	NA	< 0.0002	NA	< 0.04	NA	< 0.005	NA
OM-WR5-1	7/28/2004	0.5	WR	< 0.04	NA	< 0.003	NA	< 0.005	NA	< 0.001	NA	< 0.04	NA	< 0.0002	NA	< 0.04	NA	< 0.005	NA
Standards																			
RCRA TCLP Disposal Limits				5	5	100	100	1	1	5	5	5	5	0.2	0.2	1	1	5	5
MTCA Leachability Criteria For Groundwater Protection				0.005	NA	NS	NA	0.05	NA	0.05	NA	0.15	NA	0.002	NA	NS	NA	NS	NA

NOTES:

Analysis was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO (EPA Method 1312 for SPLP and Method 1311 for TCLP)
mg/L = milligrams per liter
< value = analyte not detected above method detection limit (MDL)
B = analyte detected between method detection limit (MDL) and practical quantification limit (PQL)
Bolded values indicate that the value exceeds one or more standard

Table 6. Vegetation Analytical Results
Oriole Mine EECA, Colville National Forest, Washington

Sample ID	Sample Date	Onsite (O) or Background (B)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
			mg/kg																						
OM-V1	07/28/04	O	40	< 0.1	< 0.3	34.8	< 0.2	0.13 B	23,500	1 B	< 1	4 B	86	0.7	9,640	44.6	< 0.05	< 1	14,400	< 0.5	0.03 B	< 30	0.07 B	< 0.5	24
OM-V2	07/28/04	B	57	0.2 B	< 0.3	27.4	< 0.2	0.25 B	19,900	1 B	< 1	4 B	96	4.55	7,810	74.0	< 0.05	< 1	12,700	< 0.5	0.06 B	< 30	< 0.03	< 0.5	28
OM-V3	07/28/04	O	47	0.2 B	< 0.3	56.0	< 0.2	0.3 B	18,100	1 B	< 1	6	83	3.98	7,130	56.0	< 0.05	< 1	16,800	< 0.5	0.08 B	< 30	0.06 B	< 0.5	35
OM-V4	07/28/04	B	43	0.2 B	< 0.3	6.7	< 0.2	0.59	16,000	< 1	< 1	9	135	3.4	8,190	132	< 0.05	< 1	18,300	< 0.5	0.05 B	< 30	< 0.03	< 0.5	45
OM-V5	07/28/04	B	68	< 0.1	< 0.3	40.6	< 0.2	0.05 B	19,100	< 1	< 1	8	137	0.85	7,370	66.5	< 0.05	< 1	17,800	< 0.5	< 0.03	< 30	< 0.03	< 0.5	16

NOTES:

Analysis was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO, per EPA Method 6010/7000 series.
Digestion by EPA Method 3050B
mg/kg = milligrams per kilogram
< value = analyte not detected above Method Detection Limit (MDL, shown)
B = analyte detected between MDL and Practical Quantification Limit (PQL, shown)
NA = not analyzed

Table 7. Removal Action Technology Screening Summary
Oriole Mine, Colville National Forest, Washington

Technology Class	Process Option	Description	Effectiveness	Implementability	Cost	Operation and Maintenance	Land Impacts	Pros	Cons	Retained?
No Action										
No Action	No Action	No Action	Not Applicable (NA)	NA	NA	NA	None	No Cost	Does not address risk	**Yes**
Institutional Controls										
Access Restrictions	Fencing	Security fences installed around contaminated areas to limit access	Medium	High	Medium	Medium - due to vandalism	Minimal impact to undisturbed areas	Exposure reduced, exist on-site	High potential for vandalism	No
	Bat Gates	Install adit bate gates	High	High	Low	Medium - due to vandalism	None	Reduces human risk and maintains habitat	High potential for vandalism	**Yes**
	Land Use Controls	Legal restrictions to control current and future land use	Medium	Medium	Low	None	None	Low Cost	Difficult to implement	No
Engineering Controls										
Solid Containment	Water- Balanced Soil Cover	Apply soil and establish vegetation to cover contaminant source	High	High	Medium	Low - Inspect for erosion	Would impact 1-2 acres of undisturbed areas for stockpile and access	Easily implementable, surface infiltration controlled by evapotranspiration	Not effective in high rainfall areas such as the Oriole Mine	No
	Soil Cover	Soil cover with rock capillary barrier	High	High	Medium	Low - Inspect for erosion		Easily implementable, control erosion of waste.	Does not control infiltration into waste material	**Yes**
	Geosynthetic Cover	Multilayer with geomembrane, soil and seed	High	High	High	Low - Inspect for erosion		Surface infiltration controlled	Difficult to install and test	No
	Multi-Layered RCRA Cap	Compacted clay layer covered with soil and vegetation in contaminated surface areas	High	High	High	Low - Inspect for erosion		Effective for isolated wastes, surface infiltration would be significantly reduced	High cost	No
Water Containment / Control	**Diversion/Infiltration**	Divert adit discharge to a constructed infiltration system	High	High	Medium	Low - Inspect for plugging	Would impact 1 acre of undisturbed area	Diversion, control, and treatment of discharge	Added cost & maintenance	**Yes**
	Adit Plugs	Install concrete or polyurethane to stop direct discharge	Medium	High	Low	Medium Inspect for leaks	Minimal impact to undisturbed areas	Eliminated point source discharge	Potential to cause non point source discharge; may reduced flow with ecological ramifications	No
	Underground Control / Reroute	Reroute portions of the underground water away from sulfide deposits and metal loads	High	Medium	Medium	Medium Inspect for leaks	Minimal impact to undisturbed areas	Reduces the metal load to Linton Creek with or without the need for ponds or wetlands	Assessment of underground workings would be first, cost and risk would be high.	No
Surface Controls	**Consolidation**	Combining wasterock into single area	Medium	High	Medium	Low - Inspect for erosion	Would impact 1-2 acres of undisturbed areas	Easily implemented, waste material consolidated	Effectiveness dependent on combining with other options	No
	Grading	Level wasterock to reduce slopes for managing runoff, erosion and surface infiltration	Medium	High	Medium	Low - Inspect for erosion	Would impact 1-2 acres of undisturbed areas	Easily implemented, offsite transport of waste greatly reduced	Effectiveness dependent on combining with other options, limited surface area	**Yes**
	Revegetation	Add amendments to wasterock and seed to promote vegetation for controlling water infiltration & erosion	Medium	High	Medium	Low - Inspect for erosion	Minimal impact to undisturbed areas	Easily implemented, offsite transport of waste greatly reduced	Effectiveness dependent on combining with other options, highly dependent on amount of topsoil.	**Yes**
	Erosion Protection/ Run-on Control	Erosion resistant materials, commercial fabrics placed on steep slopes; run-on diversion structures to channel water away	Medium	High	Medium	Low - Inspect for erosion	Minimal impact to undisturbed areas	Easily implemented, offsite transport of waste greatly reduced	Effectiveness dependent on combining with other options, exposure to human and terrestrial receptors not reduced	**Yes**
Land Disposal										
Onsite Disposal	**Constructed Repository**	Excavate wasterock and place in onsite repository with cover	High	High	Medium	Medium – inspect stability of cap and leachate collection	Would impact 2-4 acres of forest for suitable location	Risk and exposure reduced	High cost, suitable onsite location unknown, long term liability	**Yes**
Offsite Disposal	**RCRA Landfill**	Excavate wasterock and disposed in RCRA-C landfill	High	High	High	None – material hauled off site	Minor impacts to transport material off site	Easily implementable, risk and exposure eliminated	High transport and disposal costs	**Yes**
	Solid Waste Landfill	Excavate wasterock and disposed in solid waste landfill	High	High	Medium	None – material hauled off site	Minor impacts to transport material off site	Easily implementable, risk and exposure eliminated	High transport costs	**Yes**
Treatment										
Solid Treatment	Reprocessing - Milling And Smelting	Shipping waste material to operating mill and/or smelter facility for extraction of metals	Medium	Low	High	Low – Inspect for erosion	Minor impact to transport material to be processed or process at mine	Risk and exposure eliminated	High Costs, difficult to locate a facility willing to accept material, spent material must be disposed	No
	Thermal Treatment	Thermal treatment of waste material onsite	High	Medium	High	Low – Inspect for erosion	Minor impact to transport thermal unit onsite	Risk and exposure eliminated	High Cost and spent material must be disposed	No
	Cement/ Pozzolan Additive	Ore/waster rock are solidified with non-leachable cement or pozzolan	High	High	Medium	Low – Inspect for erosion	Minor impact to transport material to be processed or process at mine	Toxicity and mobility reduced, proven technology at other local mines	Volume of material will increase, need to be combined with water balance cap to control infiltration	No
	Physical/ Chemical Stabilization	Waste material treated in place when injected with stabilizing agent(s)	Medium	Low	Medium	Medium – may need to re inject agent	Minor impact to transport material to be processed or process at mine	Toxicity and mobility reduced	Difficult to implement and mix thoroughly, need to be combined with water balance cap	No

Notes: Bold items retained for evaluation.

TABLE 8: Comparative Analysis Of Retained Removal Action Alternatives
Oriole Mine, Colville National Forest, Washington

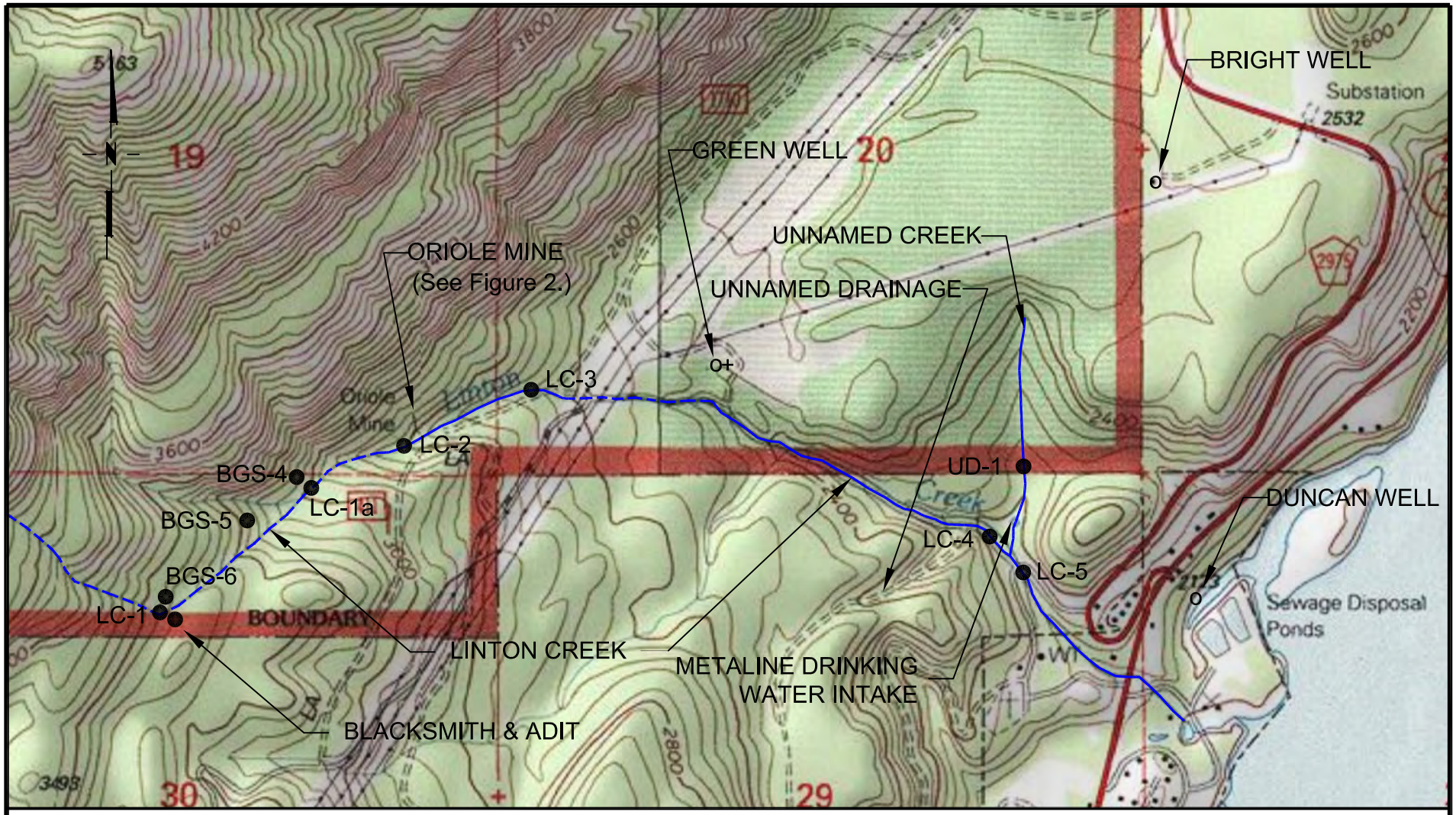
Assessment Criteria	Alternative 1: No Action	Alternative 2: Onsite Consolidation of Ore and Wasterock	Alternative 3: Excavation and Offsite Disposal of Ore and Wasterock
EFFECTIVENESS			
Compliance with Removal Action Goals and Objectives	Does not comply	Complies	Complies
Overall Protection of Public Health and the Environment	No Protection	Provides protection by isolation of ore material and and capping of wasterock. Ecological exposure and migration of metals to Linton Creek controlled by soil cover and revegetation.	Provides protection removal and offsite disposal of ore material and wasterock. Ecological exposure and migration of metals to Linton Creek also mitigated by offsite disposal.
Compliance with ARARs	Does not comply	Complies with all ARARs.	Complies with all ARARs.
Long Term Effectiveness and Permanence	None	Provides long term effectiveness and permanence, minimal maintenance expected.	Provides long term effectiveness and permanence, minimal maintenance expected.
Reduction of Toxicity, Mobility, or Volume	None	Onsite toxicity and reduced. Metal mobility eliminated by isolation. Mobility of wasterock piles reduced by onsite containment and revegatation.	Onsite toxicity and volume reduced. Metal mobility and wasterock pile mobility eliminated by offsite disposal.
Short Term Effectiveness	None	Easily constructed within one field season, risks to community/workers will be minimal.	Easily completed within one field season, risks to community/workers will be minimal.
IMPLEMENTABILITY			
Technical Feasibility	Not Applicable	Moderately difficult to complete due to steep terrain and poor access road; monitoring requirements consist of soil cover, and erosion controls.	Moderately difficult to complete due to steep terrain, poor access road, and long haul routes; monitoring requirements consist of erosion controls.
Administrative Feasibility	Not Applicable	Easily implemented; no permits are required; need to comply with Washington, Oregon, and Federal transportation regulations.	Easily implemented; no permits are required; need to comply with Washington, Oregon, and Federal transportation regulations.
Availability of Services and Materials	Not Applicable	Services and materials are available in Spokane, except disposal services, which are located in Arlington, Oregon.	Services and materials are available in Spokane, except disposal services, which are located in Arlington, Oregon.
State and Community Acceptance	Presumed unacceptable	Presumed acceptable, because ore material is isolated and wasterock piles contained onsite.	Presumed acceptable, because all waste material is removed offsite. Community may be concerned about high cost relative to problem scale.
COST			
Estimated Total Present Worth Cost	$0	$307,000	$3,837,000

TABLE 9: Attributes and Advantages of Removal Action Alternatives
Oriole Mine, Colville National Forest, Washington

Assessment Criteria		Alternative 1: No Action	Alternative 2: Onsite Consolidation of Ore and Wasterock	Alternative 3: Excavation and Offsite Disposal of Ore and Wasterock
EFFECTIVENESS				
Overall Protectiveness of Public Health, Safety and Environment	**Attributes**		Ore material from collapsed ore bin isolated,wasterock capped, and ecological protection enhanced.	All appropriate MTCA criteria waste is removed from site.
	Advantages		+ Provides ecological protection	+ Provides ecological protection
Compliance with ARARs	**Attributes**		All waste is isolated and/or capped; ecological impact of waste mitigated.	All MTCA criteria waste is removed.
	Advantages		+ Complies	+ Complies
Long Term Effectiveness and Permanence	**Attributes**		Ore material removed and ecological impacts of wasterock piles controlled by revegetation.	All MTCA criteria waste is removed.
	Advantages		+ Minimal liability associated with isolation, facility cleanup. + Ore material isolatred.	+ No liability associated with future offsite disposal facility cleanup. + MTCA criteria waste mitigated.
Reduction of Toxicity, Mobility and Volume	**Attributes**		Mobility and exposure controlled by soil cover. No reduction in toxicity and volume of ore or wasterock.	Mobility and exposure controlled by removal offsite. No reduction in toxicity and volume of ore or wasterock.
	Advantages		+ Mobility and exposure is controlled by soil cover and revegetation and offsite disposal.	+ Mobility and exposure is controlled by disposal in an offsite facility.
Short-Term Effectiveness	**Attributes**		No short term effect with onsite containment and and isolation of ore material.	No short term effect with offsite disposal of Dangerous Waste and wasterock piles
	Advantages		+ Eliminates some potential spillage along highway that could impact humans and environment.	
IMPLEMENTABILITY				
Technical Feasibility	**Attributes**		Moderately difficult to complete due to steep terrain, poor access road and long haul routes	Moderately difficult to complete due to steep terrain, poor access road and long haul routes
	Advantages		+ MTCA Criteria waste mitigated.	+ MTCA Criteria waste mitigated.
Administrative Feasibility	**Attributes**		Easy to moderately difficult to implement	Moderately difficult to implement.
	Advantages		+ Only transport and disposal permits are required	+ Only transport and disposal permits are required
Availability of Services and Materials	**Attributes**		Services and materials available in Spokane, except offsite disposal.	Services and materials available in Spokane, except offsite disposal.
	Advantages		+ MTCA criteria waste is also mitigated.	+ MTCA criteria waste are removed.
State and Community Acceptance	**Attributes**		Presumed accepted because isolation and soil covers are proven methods and ARARs are complied with.	Presumed accepted because offsite disposal is proven a method and ARARs are complied with. Community may be concerned with high cost relative to problem scale.
	Advantages		+ Highest level of acceptance and MTCA criteria waste is mitigated.	+ Highest level of technical acceptance, but expensive relative to problem scale..
COST				
Estimated Total Present Worth Cost	**Attributes**	$0	$307,000	$3,837,000
	Advantages	+ $3,837,000	+ $3,530,000	

FIGURES

Figure 1. **Surface Water, Sediment, and Background Sampling Stations**
Figure 2. **Oriole Mine Layout and Sampling Locations**



EXPLANATION

LC-2 ● Sampling Stations

Perennial Streamflow

Ephemeral Streamflow

+ Nearest Residence

o Wells

0 1200 FEET

SCALE
(LOCATIONS ARE APPROXIMATE)

(SOURCE: 7.5 MIN USGS TOPOGRAPHIC MAP PRINTED NATIONAL GEOGRAPHIC HOLDINGS)

Figure 1. Surface Water, Sediment, And Background Sampling Stations

PROJECT NUMBER: 2523035	ORIOLE MINE EECA
DATE: 01/22/07	
DWG BY: RHL / DWG NO: 2523035F1.dwg	USDA FOREST SERVICE COLVILLE NATIONAL FOREST METALINE, WASHINGTON
PROJECT MANAGER: RHL	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

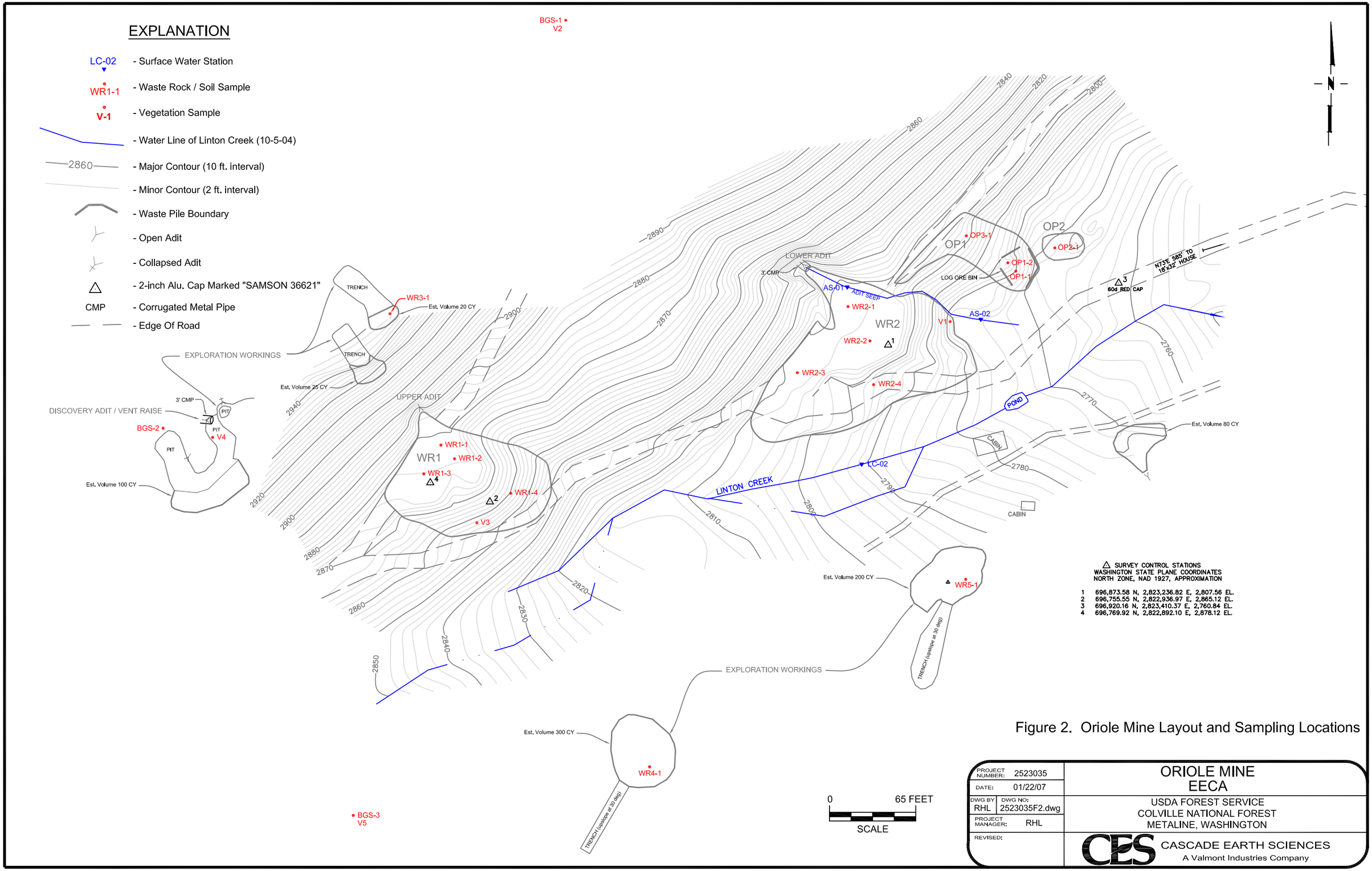


Figure 2. Oriole Mine Layout and Sampling Locations

PROJECT NUMBER: 2523035	ORIOLE MINE EECA
DATE: 01/22/07	
DWG BY: RHL; DWG NO: 2523035F2.dwg	USDA FOREST SERVICE COLVILLE NATIONAL FOREST METALINE, WASHINGTON
PROJECT MANAGER: RHL	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

APPENDICES

Appendix A. **Human Health and Ecological Risk Assessment**
Appendix B. **Data Gap Investigation Photographs**
Appendix C. **Applicable or Relevant and Appropriate Requirements**
Appendix D. **Preliminary Removal Action Cost Estimates**

Appendix A.

Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
Oriole Mine
Colville National Forest

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Colville National Forest

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ATTACHMENTS

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Attachment E: Ecological Risk-Based Screening Tables

ACRONYMS AND ABBREVIATIONS

CTE	central tendency exposure
COI	chemical of interest
COPC	chemical of potential concern for human health
COPEC	contaminant of potential ecological concern
ODEQ	Oregon Department of Environmental Quality
Ecology	Washington State Department of Ecology
ECR	excess cancer risk
EPC	exposure point concentrations
ERA	ecological risk assessment
ERBSC	ecological risk-based screening concentration
HHRA	human health risk assessment
PRG	Preliminary Remediation Goals
RfD	reference dose
RME	reasonable maximum exposure
SI	Site Inspection
95UCL	95th percentile upper confidence limit on the arithmetic mean
EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

Potential human health and ecological risks associated with mining-related contamination at the Oriole Mine (Site) were assessed through a streamlined risk assessment process. In general, the risk assessment process follows United States Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) guidelines. Potential risks and hazards were evaluated by comparing Site-specific chemical concentrations to readily available risk-based screening concentrations for selected human health and ecological exposure pathways. Section 2.0 describes the analytical data used and the initial screening, which determines the chemicals of interest (COIs). The human health risk assessment (HHRA) and ecological risk assessment (ERA) are presented in Sections 3.0 and 4.0, respectively. Conclusions and recommendations based on the results of the risk assessments are presented in Section 5.0.

2.0 RISK ASSESSMENT DATA AND INITIAL SCREENING

The analytical data used in the risk assessment are from soil/wasterock, vegetation, surface water, and sediment samples collected during the Site Inspection (SI) and Data Gap Investigation (DGI) conducted by Cascade Earth Sciences (CES) in 2005 and 2006 (CES, 2005 and CES, 2006). To identify potential worst-case concentrations at the Site and in accordance with SI methodology (40 CFR 300.410(d)), CES selectively collected media samples in areas of known or suspected contamination. This approach is conservative in that it results in an overestimation of Site-related chemical concentrations and is appropriate for screening level risk assessments.

CES collected the following samples during the SI and DGI:

- 6 background surface soil samples
- 3 background vegetation samples
- 4 background surface water samples
- 3 background sediment samples
- 12 surface soil/wasterock samples
- 6 subsurface soil/wasterock samples
- 2 vegetation samples
- 13 surface water samples (including 2 adit seep samples)
- 8 sediment samples

Analysis of these samples was primarily for metals. Soil samples were also analyzed for acid based accounting, pH, synthetic precipitation leaching procedure, and toxicity precipitation leaching procedure. Water samples were also analyzed for water quality parameters (e.g., pH, conductivity, dissolved oxygen, and hardness).

Standard laboratory quality control procedures were used and analytical results were quality assured and qualified, as necessary, by the laboratory. The analytical data were considered good quality and useable for the risk assessment.

The data were initially screened using the following criteria:

- Essential Nutrients: Calcium, magnesium, potassium, and sodium were removed from further assessment because they are considered essential nutrients.
- Frequency of Detection: COIs detected in 5% or fewer of the samples were removed from further consideration.

- Background: Maximum concentrations of metals that occurred at concentrations less than the 95th percentile upper confidence limit on the arithmetic mean (95UCL), or the average background concentration if the 95UCL was greater than the maximum background concentration, were eliminated from further assessment.
- Reporting Limits: COIs with maximum reporting limit concentrations greater than background concentrations and the lowest medium-specific human health or ecological screening risk-based screening concentrations were retained for further assessment. The primary background concentrations were the 95UCL. If the 95UCL was greater than the maximum detected concentration or there were fewer than five samples, the average background concentration was used.

For the reporting limit screening, the risk-based screening concentrations for human health were the EPA Region IX industrial soil and tap water Preliminary Remediation Goals (PRGs) for soil and water exposure (EPA, 2004a). The ecological risk-based screening concentrations (ERBSCs) are shown in Attachment A, Table A-1. Details of the initial screening for the HHRA and ERA are shown in Attachment A, Tables A-2 through A-6. Table 2-1 lists the chemicals retained following the initial screening.

Table 2-1. Chemicals of Interest Remaining Following the Initial Screening

Chemicals of Interest	Surface Soil/ Wasterock		Vegetation	Surface Water		Sediment	
	HHRA	ERA	ERA	HHRA	ERA	HHRA	ERA
Aluminum				X	X	X	X
Antimony	X	X		X	X	X	X
Arsenic, III		X					
Arsenic, V		X					X
Arsenic, total	X	X		X	X	X	X
Barium			X	X	X	X	X
Beryllium				X	X	X	X
Cadmium	X	X		X	X	X	X
Chromium VI					X		
Chromium, total		X		X	X	X	X
Cobalt	X	X				X	X
Copper	X	X		X	X	X	X
Iron	X	X		X	X	X	X
Lead	X	X		X	X	X	X
Manganese		X		X	X	X	X
Mercury	X	X			X	X	X
Nickel	X	X				X	X
Selenium	X	X				X	X
Silver	X	X	X	X	X	X	X
Thallium	X	X	X	X	X	X	X
Vanadium				X	X	X	X
Zinc	X	X		X	X	X	X

NOTES:
HHRA = human health risk assessment.
ERA = ecological risk assessment.
X = Chemical of Interest selected for further screening.

3.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA evaluated the potential for adverse health effects that could result from current or future human exposures to hazardous substances present at the Site. The purpose of this evaluation was to select chemicals of potential concern (COPCs) from the COIs using approved human health risk-based screening procedures, and to calculate the exposure doses for each COPC and receptor. The exposure doses were then compared to acceptable doses of the COPCs using approved screening numbers. The following are the primary elements of the HHRA:

- Hazard identification and selection of COPCs
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Summary of human health risks

3.1 Hazard Identification and Selection of COPCs

This section presents the rationale for the selection of the COPCs. The media of interest for human health included surface soil/wasterock, surface water, and sediment. Maximum concentrations of the COIs in these media were compared to EPA Region IX PRGs (EPA, 2004a). Industrial PRGs were selected as the most appropriate screening criteria for soil/wasterock and sediment, and tap water PRGs represented a very conservative screen for surface water. Attachment B, Table B-1 presents the PRG screening. Table 3-1 lists the COPCs.

Table 3-1. Chemicals of Potential Concern for the Human Health Exposure Media

Chemical of Potential Concern	Surface Soil/ Wasterock	Surface Water	Sediment
Arsenic	X	X	X
Lead[1]	X	X	X

NOTES:
X = Chemical of Interest selected for further screening.
1. No PRG for lead in water.

3.2 Exposure Assessment

Assessing the exposure at a given Site includes (1) the development of the conceptual human exposure model, which includes identification of potentially exposed populations and the development of exposure pathways, and (2) the calculation of exposure point concentrations (EPCs) and average daily doses.

3.2.1 Conceptual Human Exposure Model

The conceptual human exposure model is a flowchart that outlines contaminant sources, release mechanisms, transport routes and media, potential receptor populations, and potential exposure routes. The model identifies the potential receptors and exposure pathways at the Site. Figure 3-1 presents the conceptual human exposure model for the Site. The following sections provide justification and further discussion on the exposure routes and receptors.

3.2.1.1 Potentially Exposed Population

Land uses in the area are limited to timber harvesting, recreation (hiking, fishing, camping, hunting, etc.), and some minerals prospecting. There are no on-site workers, occupied structures, or people who live

within one-half mile of the Site. Public use of the Site appears to be minimal, although public access records are not maintained**.** There is no fencing to restrict access, and CES did not observe any "No Trespassing" signs. The potential for significant activity or contact with COPCs at the Site is considered low due to the following factors:

- The Site is located in a relatively unpopulated area;
- There are no formal campsites located on the Site; and
- Access is by foot only.

In addition, the Site is not currently occupied on a regular basis and is unlikely to be occupied for extensive periods, even by campers. Therefore, the risk of long-term exposure to COPCs at the Site is considered very low. Regardless, because hikers, hunters, and campers could access the Site, they were selected as the current and future potential receptor populations for the Site.

3.2.1.2 Identification of Potential Exposure Pathways

This section evaluates potential pathways for human exposures to the identified COPCs. Complete exposure pathways were evaluated for receptors within the current and future potentially exposed populations and included:

- inhalation of wasterock particulates;
- incidental ingestion of wasterock, and sediment; and
- dermal contact with wasterock and sediment.

Although lead was identified as a COPC in surface water, it cannot be quantitatively addressed, as no toxicity value is available. Lead is addressed qualitatively in the risk characterization section of the report (Section 3.4). Use of groundwater as potential drinking water was eliminated as a pathway of concern because there are no reported drinking water wells near the Site. Additional information regarding the hydrogeology at and surrounding the Site is presented in the SI.

3.2.2 Exposure Assumptions

Exposure assumptions include factors such as body weight, averaging time, exposure frequency, exposure duration, and chemical bioavailability. Separate assumptions were made for both the central tendency exposure (CTE) and reasonable maximum exposure (RME). In general, the RME scenario is a conservative or worst-case estimate of potential exposure, while the CTE scenario is typically more realistic and uses exposure factors that are more indicative of the average recreational user.

Neither the EPA nor Ecology has developed default scenarios for recreational or camping exposure scenarios at abandoned mines. However, recreational exposure assumptions used for this HHRA have been developed based on considerations of Site location and access. The exposure factors used in this risk assessment are presented in Attachment B, Table B-2.

3.2.3 Exposure Point Concentrations and Average Daily Dose

An EPC represents the COPC concentration in each exposure medium that a receptor will potentially contact during the exposure period. Generally, the EPC is not the maximum concentration detected at the Site because, in most situations, it is not reasonable to assume long-term contact with the maximum concentration. Where the data set contains five or more samples, the 95UCL was calculated using ProUCL (EPA, 2004b). The lowest number between the 95UCL and the maximum detected concentration was used as the EPC. For data sets with less than five samples, the maximum detected

concentration was used as the EPC. The equations used to calculate the EPC are found in the ProUCL Users Guide (EPA, 2004c). The human health EPCs are presented in Table 3-2 along with the basis for the EPC.

Table 3-2. Human Health Exposure Point Concentrations

Chemical of Potential Concern	n	Maximum	Central Tendency Exposure[1]	Reasonable Maximum Exposure[2]	Comments
Surface Soil (mg/kg)					
Arsenic	8	173	47	125	95UCL
Lead	8	10,300	19,000	42,900	Z adj[3]
Surface Water (mg/L)					
Arsenic	12	0.0009	0.000377	0.000471	95UCL
Sediment (mg/kg)					
Arsenic	8	23.9	9.53	15.3	95UCL
Lead	8	1,880	658	1,090	95UCL

NOTES:
mg/kg = milligrams per kilogram.
mg/L = milligrams per liter.
n = Number of samples.
Max = maximum concentration detected.
[1] Simple average concentration. Surface water EPC is 80% of the calculated EPC to account for the bioavailable fraction.
[2] 95UCL concentration. Surface water EPC is 80% of the calculated EPC to account for the bioavailable fraction.
[3] 95UCL calculated using the adjusted Z statistic (EPA, 2004c).

The EPCs are used to calculate the average daily dose of a contaminant. The EPC, representing the concentration of the chemical in a medium, is multiplied by intake factors that account for the frequency and duration of exposure to derive the amount of chemical (i.e., average daily dose) to which the receptor is exposed on a daily basis. The exposure factors used in this risk assessment are presented in Attachment B, Table B-2 and a summary of the intake factors used to calculate the average daily dose are presented in Attachment B, Tables B-3 through B-8. Potential human health effects and toxicity values of the COPCs are discussed in the next section.

3.3 Toxicity Assessment

The purpose of the toxicity assessment is to present the critical toxicity factors for the COPCs. The twofold process is:

- to identify the cancer and non-cancer effects that may arise from direct or indirect exposure of humans to the COPCs ; and
- to provide an estimate of the quantitative relationship between the magnitude and duration of exposure, and the probability or severity of adverse effects.

3.3.1 Toxicity Values

Toxicity values are used to quantitatively describe the relationship between the extent of exposure to a COPC and the potential increased likelihood of adverse effects. The sources for obtaining toxicity values are listed below.

- Integrated Risk Information System computer database (EPA, 2006)
- Health Effects Assessment Summary Table (EPA, 1997)

Chemicals are classified into those that cause cancer and those that cause other, non-cancer, health effects. The method for assessing the potential for these two types of health effects differs. Where a chemical can cause both cancer and non-cancer health effects, the risk evaluation calculates the potential for both types of effects. The following sections provide background information on the toxicity values for non-carcinogenic and carcinogenic chemicals.

3.3.2 Non-Carcinogenic Toxicity Values

The potential for toxicity of non-carcinogenic COPCs is determined using reference doses (RfDs). An RfD represents an estimated intake rate that is unlikely to produce measurable adverse effects over a lifetime of exposure. The EPA RfD Work Group or the health effects assessment documents developed by the EPA Office of Research and Development determine the RfDs.

A RfD assumes a threshold for adverse non-carcinogenic effects. That is, exposures below the RfD are considered unlikely to cause any adverse health effects. RfDs are route-specific. As such, RfDs may be different for ingestion, inhalation, or other routes of exposure. The critical toxicity values for the non-carcinogenic COPCs are presented in Table 3-3.

Table 3-3. Critical Toxicity Values for Non-Carcinogenic Chemicals of Potential Concern

Chemical of Potential Concern	Chronic Reference Dose (mg/kg/day)		Confidence in Reference Dose	Endpoint
	Oral	Inhalation		
Arsenic	0.0003	Not Available	Medium	Hyperpigmentation, vascular

NOTE:
mg/kg/day = milligrams per kilogram per day.

3.3.3 Carcinogenic Toxicity Values

Chemicals that cause cancer are classified according to the type of scientific information available about the types of cancer they might produce. This classification system is called the Weight of Evidence. The 1986 guidelines established five Weight of Evidence categories, ranging from known human carcinogens (Group A) to chemicals that have been determined not to cause cancer (Group E). Of the COPCs identified at the Site, arsenic is a known human carcinogen (Group A) and lead is a probable human carcinogen based on sufficient animal data (Group B2).

Unlike non-carcinogens, carcinogenic chemicals are assumed not to have a threshold value below which no human health effects are likely to be seen. The potential for developing cancer from exposure to a carcinogenic chemical (toxicity value) is determined using a slope factor. The slope factor represents a conservative estimate of the potential cancer risk associated with exposure. It is used with the average daily dose to calculate the increased probability of developing cancer over a lifetime. This is measured in terms of excess cancer risk (ECR). Slope factors are determined by the EPA Carcinogen Risk Assessment Verification Endeavor Work Group, or from the health effects assessment documents developed by the EPA Office of Research and Development. Based on EPA guidelines documents, information on the slope factors derived for arsenic is presented in Table 3-4.

Table 3-4. Critical Toxicity Values for Carcinogenic Chemicals of Potential Concern

Chemical of Potential Concern	Slope Factor (mg/kg/day)-1		Weight of Evidence Classification Ingestion/Inhalation	Type of Cancer Ingestion/Inhalation	Basis of Slope Factor Oral/Inhalation
	Oral	Inhalation			
Arsenic	1.5	15	Group A	Skin	Epidemiological studies

NOTE:
mg/kg/-day = milligrams per kilogram per day.

3.3.4 Lead

Meaningful oral and inhalation critical toxicity values have not been developed for lead. Many of the non-cancer effects associated with lead may not exhibit a threshold, especially in young children. The EPA considers lead to be a Group B2 carcinogen. In lieu of a reference dose or slope factor, EPA has developed the Integrated Exposure Uptake/Biokinetic Model and the Adult Lead Model, which correlate dose with blood lead levels.

The Lowest Adverse Effect Level of lead is considered to be 10 micrograms per deciliter (µg/dl) in children and fetuses and 30 µg/dl in adults. Empirically derived ratios of 0.04 and 0.16 µg/dl per micrograms per day (µg/day) ingestedare used to predict concentrations in young children and adults, respectively, as recommended by FDA (1990). Applying an uncertainty factor of 10 results in provisional tolerable intake levels of 6 µg/day for children 6 years old or less, 15 µg/day for children over 6 years old, 25 µg/day for pregnant women, and 75 µg/day for men.

3.4 Risk Characterization

Potential human health impacts associated with exposure to COPCs at the Site were evaluated by estimating the potential for both non-carcinogenic and carcinogenic health effects. The following sections discuss the assessment of non-carcinogenic hazards and carcinogenic risks associated with exposure to COPCs at the Site. The SI sampling locations were selected as locations where levels of concentrations were suspected to be the highest. Targeted sampling identifies the worst-case situations and is intended to be a conservative data set that is sufficient for the specific purposes of risk assessment.

Non-carcinogenic hazard is estimated as the ratio of the average daily dose of the non-carcinogenic chemical through a specific exposure route, to the chronic RfD for that exposure route. This ratio is called the Hazard Quotient (HQ). Hazard Quotients greater than 1.0 indicate the potential for adverse health effects because the intake exceeds the RfD. A HQ is calculated for each chemical that elicits a non-carcinogenic health effect. The sum of all individual chemical specific HQs is termed the Hazard Index (HI) and is calculated under each exposure pathway. Thus, HIs less than 1.0 are not anticipated to produce unacceptable human health effects. The calculated HQs and HIs are shown in Attachment B, Table B-9.

Carcinogenic risk is estimated as the probability that a chemical will produce a carcinogenic effect. The excess lifetime carcinogenic risk is the incremental increase in the probability of developing cancer compared to a background probability of developing cancer with no exposure to Site contaminants. The potential for cancer is evaluated in terms of ECRs. That is, the number of cancer cases over and above background cancer rates that may be expected due to contact with Site related contaminants. The EPA accepts a risk range of one in ten thousand to one in one million. However, Ecology considers an ECR greater than one in one million to be unacceptable. For example, an ECR of one in one million represents an increase of one additional case of cancer (above background) in one million people exposed to a

carcinogen over their lifetime (70 years). The calculated ECRs and total ECR for the recreational receptor are shown in Attachment B, Table B-10.

The results of the quantitative risk assessment are presented below for each medium and summarized in Table 3-4. Calculation worksheets are presented in Attachment B, Tables B-2 through B-10.

3.4.1 Non-Carcinogenic Risk

The assessment identified arsenic as a non-carcinogenic COPC in soil, wasterock, and sediment. Table 3-5 summarizes the non-carcinogenic risks. The HQs for soil, wasterock, and sediment exposure routes were all below the regulatory standard of 1.0. Therefore, no unacceptable non-carcinogenic health impacts are anticipated.

Table 3-5. Summary of Non-Carcinogenic Risks

Exposure Route	Chemical of Potential Concern	Hazard Quotient	
		Central Tendency Exposure	Reasonable Maximum Exposure
Soil and Wasterock			
Ingestion	Arsenic	0.001	0.01
Dermal Contact	Arsenic	0.00008	0.004
Surface Water			
Ingestion	Arsenic	0.00004	0.0001
Dermal	Arsenic	0.000001	0.000002
Sediment			
Ingestion	Arsenic	0.0001	0.0009
Dermal Contact	Arsenic	0.00002	0.0004
	HAZARD INDEX	**0.002**	**0.02**

3.4.2 Carcinogenic Risks

The assessment identified arsenic as the only carcinogenic COPC at the Site. Table 3-6 summarizes carcinogenic risks. ECRs for the CTE and RME receptors did not exceed Ecology's regulatory standard of one in one million.

Table 3-6. Summary of Carcinogenic Risks

Exposure Route	Chemical of Potential Concern	Excess Cancer Risk	
		Central Tendency Exposure	Reasonable Maximum Exposure
Soil and Wasterock			
Ingestion	Arsenic	0.00000005	0.0000008
Dermal Contact	Arsenic	0.000000005	0.0000006
Inhalation of Particles	Arsenic	0.0000000009	0.00000001
Surface Water			
Ingestion	Arsenic	0.000000008	0.00000003
Dermal Contact	Arsenic	0.00000000006	0.0000000006
Sediment			
Ingestion	Arsenic	0.00000002	0.00000005
Dermal Contact	Arsenic	0.0000000009	0.00000007
SUM OF EXCESS CANCER RISK		**0.00000009**	**0.000002**

3.4.3 Lead

The EPA's lead models simulate soil lead exposures at a single location. Two models have been developed, the Integrated Exposure Uptake/Biokinetic Model and the Adult Lead Model. These models require a minimum of three months of continuous exposure of at least one day per week. Three months is considered to be the minimum exposure to produce a quasi-steady-state lead concentration. The reliability of the models for predicting lead concentrations for exposure durations shorter than three months has not been assessed. To address noncontinuous exposures, the EPA Office of Solid Waste and Emergency Response has developed a guidance document for evaluating intermittent exposures to lead for scenarios such as recreational users and trespassers. Since the exposure frequency is less than three months, predicted intake values were compared with the provisional values discussed in Section 3.3.4. Table 3-7 presents the results of the lead intake calculations and lead screening. Only the ingestion pathway is quantified.

Table 3-7. Summary of Human Health Risks Due to Lead

Exposure Point Concentration (mg/kg)		Intake (mg/kg/day)		Predicted Intake (mg/day)		Provisional Intake Value (mg/day)
Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure	
Soil						
19,500	42,900	0.00000001	0.00000004	0.0002	0.002	0.075
Sediment						
658	1,090	0.000000005	0.00000002	0.000004	0.00002	0.075
			TOTAL INTAKE	**0.0002**	**0.002**	**0.075**

NOTES:
mg/kg = milligrams per kilogram.
Mg/kg/day = milligrams per kilogram per day.
mg/day = milligrams per day.

Lead was identified as a COPC in surface water because no PRG was available for screening. Meaningful oral and inhalation critical toxicity values have not been developed for lead. Many of the non-carcinogenic effects associated with lead may not exhibit a threshold, especially in young children. The maximum concentration of lead found in surface water at the Site was 0.0009 milligrams per liter (mg/L). The Federal Action Level for lead in drinking water is 0.015 mg/L (EPA, 2003). Since the maximum concentration of lead did not exceed the Federal Action Level for drinking water standards, no unacceptable risk is anticipated from lead in surface water.

3.5 Summary of Human Health Risks

Of the 19 COIs identified at the Site, only arsenic and lead were identified as COPCs. Based on current and future land use, individuals who might come in contact with Site-related contaminants through recreational activities (e.g., hunting, hiking, and camping) were identified as the only potential receptors.

The risk assessment determined that there are no unacceptable human health impacts from lead in surface water. The maximum concentration lead found in surface water (0.0009 mg/L) did not exceed the Federal Action Limit for lead in drinking water (0.015 mg/L).

The risk assessment determined that there were no unacceptable carcinogenic or non-carcinogenic health effects expected from exposure to arsenic in soil, wasterock, ore, surface water, or sediment. Therefore, no unacceptable human health risks are anticipated due to recreational exposure.

4.0 ECOLOGICAL RISK ASSESSMENT

The goal of the ERA is to provide an ecological risk-based screening and determine whether unacceptable ecological risks are likely associated with COIs at the Site. An ecological survey was conducted as part of a previously completed SI (CES, 2006). The SI report documented ecological features and conditions at and near the Site. A terrestrial ecological exclusion assessment was completed based on this survey, in accordance with Ecology requirements (Ecology, 2001), and is provided in Attachment C. Based on the terrestrial ecological exclusion assessment, an exclusion from further terrestrial ecological evaluation is not acceptable and a Site-specific terrestrial ERA is warranted. Ecology does not provide specific guidance for the ecological assessment of water or freshwater sediment, and specific methods are not prescribed for Site-specific ERA of soil. Therefore, risk-based screening methods appropriate for Ecology (2001) and the EPA (1997, 1999) were implemented to assess the potential for risks to be posed by Site-related COIs in surface soil and wasterock, vegetation, surface water, and sediment. This report consists of the following:

- Problem formulation
- Risk-based screening
- Risk characterization (including uncertainty analysis)
- Summary of ecological risks

4.1 Problem Formulation

The scope of the ERA is defined through problem formulation. This step describes physical and chemical characteristics of the Site and the important ecological habitats, plants, invertebrates, fish, and wildlife that are present or likely to be present. This information is used to identify the COIs and ecological receptors of concern, and to develop a conceptual ecological exposure model. The conceptual ecological exposure model depicts the expected fate and transport of COIs at the Site, the potential exposure media, and likely exposure pathways for selected ecological receptor groups of concern. The problem

formulation concludes with identification ecological endpoints. These endpoints delineate the focus (i.e., objectives) of the remainder of the ERA. Generally, problem formulation includes a description of the Site and summary of previous investigations. However, because extensive versions of these have been provided in the SI (CES, 2006) they are not repeated herein.

4.1.1 Ecological Stressors

Ecological receptors may be affected through exposure to chemicals (i.e., toxicity), physical stresses (i.e., destruction of habitat), and biological stresses (i.e., viruses and bacteria). While biological stressors may affect ecological receptors, they are more frequently associated with discarded food or human waste and in areas where wildlife congregate in large numbers. Because the remote nature of the Site limits human presence and wastes, biological stresses are not considered to pose a substantial threat. Due to the habitat types present at and surrounding the Site, ecological receptors are also unlikely to congregate near the Site in numbers that could result in significant biological infection or passage of wildlife diseases. Thus, biological stressors are unlikely to be a significant factor at the Site and are not considered further.

Past physical disturbances include the development of the Site and supporting structures, and mining activities. The Site has been abandoned for decades. Direct vehicle access to the Site is currently very difficult and current physical disturbance is limited to a low number of recreational visitors walking to the Site. Given the relatively remote nature of the Site within the Colville National Forest and the length of time since active mining has occurred, ecological impacts due to physical disturbance are considered limited.

As described in Section 2.0, the primary COIs are metals. The COIs retained for the ERA are listed above in Table 2-1.

4.1.2 Ecological Setting

The regional and Site-specific ecology, sensitive environments, and rare, threatened, and endangered species were presented in the ecological survey report, which was part of the SI (CES, 2006). Linton Creek is the only potentially sensitive environment near the Site. As shown in Attachment D, Table D-1, there were no threatened or endangered (i.e., protected) species expected or observed at the Site.

The Site is primarily comprised of a mixed successional deciduous and coniferous forest, surrounded by a coniferous forest community, adjacent to Linton Creek. The main adit areas consist primarily of wasterock or excavated and compacted gravelly soil with patchy colonizing and weedy herbaceous and shrub species, and no significant canopy layer. The vegetation within close proximity to the adits and mill site is clearly different from the other communities surrounding the Site. There are also areas of mine-related disturbance such as roadways and clearings where habitat is similar to naturally disturbed areas.

Linton Creek is located adjacent to the Site and during low flow is approximately one to two feet wide and less than a foot deep. During periods of high flow the creek is about twice as large as during low flow. In dryer months the flow in Linton Creek, upstream from the Site, is underground and daylights just above the Site as a spring. During significant periods of runoff such as in the spring, Linton Creek flows above ground, originating from the steep slopes west of the Site. During low flow periods, Linton Creek disappears into the stream substrate approximately 600 feet downstream of the mine and the channel becomes ill defined. About one-half mile downstream from the Site, a perennial stream joins Linton Creek and the water remains in the channel until its confluence with the Pend Oreille River. There are no fish in the upstream reaches of Linton Creek near the Site. However, rainbow trout (*Oncorhynchus mykiss*) and west slope cutthroat trout (O*ncorhynchus clarki lewisi*) may inhabit the lower reaches of the creek near its confluence with the Pend Oreille River.

4.1.3 Conceptual Ecological Exposure Model

The conceptual ecological exposure model depicts the sources of contamination, contaminant release and transport mechanisms, impacted exposure media, and exposure routes for ecological receptor types at the Site. The primary source of COIs are the wasterock piles. Based on previous investigations and current understanding of Site conditions, the potentially contaminated exposure media for ecological receptors are outlined in Figure 4-1 and include:

- surface soil and wasterock piles at the Site;
- surface water in Linton Creek and adit seep surface water; and
- sediment in Linton Creek.

Given these exposure media, terrestrial, aquatic, and benthic ecological receptors may be exposed to COIs as depicted in Figure 4-1.

4.1.4 Assessment Endpoints and Measures

Assessment endpoints are qualitative or quantitative expressions of the environmental values to be protected and, therefore, assessed in the ERA. As such, assessment endpoints link the ERA and risk management processes by highlighting ecological aspects that are of concern to risk managers. Assessment measures are characteristics of the Site, selected ecological receptors, or ecosystems that are measured through monitoring or sampling activities, which are related qualitatively or quantitatively to the selected assessment endpoint(s).

4.1.4.1 Assessment Endpoints

Within a screening level ERA, assessment endpoints are generalized to reflect the risk-based screening process and protective ERBSCs. The assessment endpoints for this ERA include:

- protection of the reproduction and survival of non-protected plants, invertebrates, reptiles, birds, and mammals exposed to COIs in soil and wasterock at the Site;
- protection of the reproduction and survival of non-protected aquatic life (including amphibians), birds, and mammals exposed to COIs in surface water within Linton Creek; and
- protection of the reproduction and survival of benthic invertebrates, amphibians, birds, and mammals exposed to COIs in sediment within Linton Creek.

4.1.4.2 Assessment Measures

Assessment measures are used to evaluate the response of the indicator communities/species when exposed to a stressor. Generally, they are measurable ecological characteristics and define what samples and/or data will be collected to address the assessment endpoints. For this ERA, the assessment measures are comprised of:

- measured concentrations of COIs in soil/wasterock, surface water, vegetation, and sediment; and
- readily available ERBSCs available from Ecology guidance (Ecology, 2001) and other applicable guidance or published literature (e.g., ODEQ, 2001).

4.2 Ecological Risk-Based Screening

Ecological risk-based screening begins with the list of COIs remaining following the initial screening, as shown in Table 2-1. The EPCs are then determined for each COI in each potential exposure medium, and compared to selected ERBSCs with consideration of chemical-specific bioaccumulation potential, reporting limit adequacy, and exposures to multiple chemicals and multiple media. The result is a list of Site-related contaminants of potential ecological concern (COPEC). As described in Section 3.2.3, the preferred EPCs used in the risk-based screening were the lower of the 95UCL or the maximum detected concentrations. If the 95UCL was greater than the maximum concentration, or if fewer than five samples were available, then the maximum detected concentration was used as the EPC. One-half the method detection limit was used in these calculations when a particular chemical was not detected above laboratory reporting limits. The maximum sample reporting limit for a given chemical and medium was also included in the risk-based screening as a secondary EPC to identify undetected COIs with elevated laboratory reporting limits that may be contributing to ecological risks. The EPCs for each medium are listed in Table 4-1. Because there are no ERBSCs for vegetation, EPCs for vegetation are not presented in this table. The potential risks due to COIs in vegetation are based on an exceedance of background concentrations and are discussed in Section 4.3.

Ecological soil screening values and water quality standards developed by Ecology (2001, 2003), are the preferred ERBSCs used in risk-based screening. If an ERBSC for a COI was not available in these preferred sources, Screening Level Values were selected from those provided by the Oregon Department of Environmental Quality (ODEQ, 2001) or from other peer-reviewed risk-based screening concentrations (e.g., EPA [2006] ecological soil screening levels). If no alternate ERBSCs were available, a surrogate chemical was substituted, when appropriate. Exceptions to the primary ERBSCs and the use of surrogates are referenced in Attachment A, Table A-1.

Table 4-1. Exposure Point Concentrations for Ecological Exposure Media

Chemical of Interest	Surface Soil/ Wasterock	Surface Water	Sediment
	mg/kg	µg/L	mg/kg
Aluminum	Not a COPEC	0.2	12,000
Antimony	773	0.001	2
Arsenic III	0.1	Not a COPEC	Not a COPEC
Arsenic V	31	Not a COPEC	15
Arsenic, total	143	0.0006	15
Barium	Not a COPEC	0.02	98
Beryllium	Not a COPEC	0.001	0.6
Cadmium	220	0.0006	2
Chromium VI	Not a COPEC	0.009	Not a COPEC
Chromium, total	17	0.006	23
Cobalt	26	Not a COPEC	13
Copper	2,210	0.002	24
Iron	26,100	0.5	63,800
Lead	71,500	0.006	1,090
Manganese	3,210	0.01	1,570
Mercury	3	Not a COPEC	0.4
Nickel	30	Not a COPEC	25
Selenium	12	Not a COPEC	0.6
Silver	154	0.00004	1
Thallium	16	0.0001	0.8
Vanadium	Not a COPEC	0.003	35
Zinc	79,900	0.06	1,640

NOTES:
mg/kg = milligrams per kilogram.
µg/L = microgram per liter.
COPEC = chemical of potential ecological concern.

The EPCs were compared to the medium- and receptor group-specific ERBSCs to calculate chemical-specific risk ratios (R_{ij}) and receptor group risk ratios (R_j; the sum of the R_{ij}). Each COI was also examined for the potential to bioaccumulate, elevated reporting limits, and to determine whether it contributed an inordinate amount to the receptor group risk. Risk ratios greater than 1.0 indicate unacceptable risks for aquatic life and benthic invertebrates, while risk ratios greater than 5.0 indicate unacceptable risks for other receptor groups. The COIs with unacceptable predicted risks become the COPECs. The results of the ecological risk-based screening were medium-specific lists of the COPECs as shown in Table 4-2. The risk ratios and number of samples for each COPEC with concentrations that exceeded acceptable risk ratios and background concentrations are shown in Tables 4-3 through 4-5. Details of the risk-based screening are shown in Attachment E, Tables E-1 through E-4.

Table 4-2. Selected Contaminants of Potential Ecological Concern

Contaminant of Potential Ecological Concern	Surface Soil/Wasterock	Surface Water	Sediment
Aluminum	X	X	X[2]
Antimony		X[2]	
Arsenic III	X[1]		
Arsenic V	X[1]		X
Arsenic, total	X	X[1]	X
Barium		X	X[2]
Beryllium		X[2]	X[2]
Cadmium	X	X[1]	X
Chromium VI		X[1]	
Chromium, Total			
Cobalt			X[2]
Copper	X		
Iron	X	X[2]	X[2]
Lead	X	X	X
Manganese	X		
Mercury	X		X
Nickel			
Selenium	X		X
Silver	X	X[2]	
Thallium	X	X[2]	X[2]
Vanadium			X[2]
Zinc	X	X	X

NOTES:
X = Chemical of Interest selected for further screening
1. Selected as a COPEC due solely to a potential for bioaccumulation.
2. Selected as a COPEC solely because an ERBSC was not available.

Table 4-3. Ecological Risk Ratios for Surface Soil/Wasterock

Contaminant of Potential Ecological Concern	Terrestrial Plants (R_{ij})	n	Terrestrial Invertebrates (R_{ij})	n	Birds (R_{ij})	n	Mammals (R_{ij})	n
Antimony	**155**	7	**10**	2	No ERBSC	0	**52**	7
Arsenic III	0.01	0	0.002	0	0.02	0	0.02	0
Arsenic V	3	0	0.5	0	0.2	0	0.2	0
Arsenic, total	**8**	3	2	0	3	0	3	0
Cadmium	**55**	7	**11**	6	**37**	7	2	0
Copper	**22**	6	**44**	7	**10**	4	**39**	7
Iron	**2,613**	4	**131**	4	No ERBSC	0	No ERBSC	0
Lead	**1,429**	9	**143**	7	**606**	9	**606**	9
Manganese	3	1	**32**	1	2	0	2	0
Mercury	**10**	4	**29**	8	0.5	0	0.5	0
Selenium	**12**	4	0.2	0	**40**	7	**40**	7
Silver	**77**	7	3	1	No ERBSC	0	No ERBSC	0
Thallium	**16**	4	**16**	4	No ERBSC	0	**16**	4
Zinc	**929**	10	**399**	8	**222**	8	**2,120**	10
Total Receptor Group Risk (R_j)	**5,334**		**822**		**922**		**2,882**	

NOTES:
Bold = COPECs with risk ratio greater than acceptable levels (i.e., >5).
n = number of exceedances of both an ERBSC and background concentration.

Table 4-4. Ecological Risk Ratios for Surface Water

Contaminant of Potential Ecological Concern	Aquatic Life (R_{ij})	n	Birds (R_{ij})	n	Mammals (R_{ij})	n
Aluminum	**3**	2	0.0003	0	0.03	0
Antimony	0.001	0	No ERBSC	0	0.001	0
Arsenic, Total	0.004	0	0.00003	0	0.0001	0
Barium	**5**	5	0.0001	0	0.0005	0
Beryllium	0.2	0	No ERBSC	0	No ERBSC	0
Cadmium	1	4	0.0001	0	0.0001	0
Chromium VI	0.9	0	0.001	0	0.0004	0
Iron	0.5	0	No ERBSC	0	No ERBSC	0
Lead	**9**	7	0.0002	0	0.00002	0
Silver	0.3	0	No ERBSC	0	No ERBSC	0
Thallium	0.003	0	No ERBSC	0	0.002	0
Zinc	**2**	4	0.0006	0	0.00005	0
Total Receptor Group Risk (R_j)	**23**		0.004		0.03	

NOTES:
Bold = COPECs with risk ratio greater than acceptable levels (i.e., >1 for aquatic life and >5 for other receptors).
n = number of exceedances of an ERBSC and background concentration.

Table 4-5. Ecological Risk Ratios for Sediment

Contaminant of Potential Ecological Concern	Benthic Invertebrates (R_{ij})	n	Birds and Mammals (R_{ij})	n
Aluminum	No ERBSC	0	No ERBSC	0
Arsenic, V	**3**	1	4	0
Arsenic, Total	**3**	2	4	1
Barium	No ERBSC	0	No ERBSC	0
Beryllium	No ERBSC	0	0.01	0
Cadmium	**4**	5	**719**	8
Cobalt	No ERBSC	0	No ERBSC	0
Iron	No ERBSC	0	No ERBSC	0
Lead	**31**	4	**9**	3
Mercury	**2**	1	No ERBSC	0
Selenium	No ERBSC	0	**6**	2
Thallium	No ERBSC	0	1	0
Vanadium	No ERBSC	0	No ERBSC	0
Zinc	**13**	6	**546**	8
Total Receptor Group Risk (R_j)	**60**		**1,291**	

NOTES:
Bold = COPECs with risk ratio greater than acceptable levels (i.e., >1).
n = number of exceedances of an ERBSC and average background concentration.

Based on the number and extent of unacceptable risks, the ecological risk-based screening results indicate a potential for ecological risk due to 12 metals in soil and wasterock (primarily antimony, iron, lead, and zinc); aluminum, barium, lead, and zinc in surface water; and 7 metals (primarily cadmium, lead, and zinc) in sediment. Total arsenic, cadmium, mercury, selenium, and thallium were the COPECs that exceeded ERBSCs in two media. Lead and zinc exceed ERBSCs in all three media. The COPECs with risk ratios greater than 10 included antimony, cadmium, copper, iron, lead, manganese, mercury, selenium, silver, thallium, and zinc in soil and wasterock; as well as cadmium, lead, and zinc in sediment. COPECs with risk ratios greater than 100 included antimony, iron, lead, and zinc in surface soil; and cadmium and zinc in sediment. The results of the ecological risk-based screening are discussed further in Section 4.3.

4.3 Ecological Risk Characterization

The ecological risk characterization includes a description of risk, an uncertainty analysis, and an evaluation of the presence of elevated "hot spots" of chemical concentrations.

4.3.1 Risk Description

Ecological risk description involves examining the predicted risks to determine whether they are likely or artifacts of the risk assessment process.

4.3.1.1 Soil and Wasterock

The COPECs for soil/wasterock and the associated risk ratios are listed in Table 4-3. Arsenic III and arsenic V were selected as COPECs solely due to bioaccumulation potential. The remaining COPECs had at least one risk ratio greater than one. Plants and invertebrates had the highest number of COPECs with unacceptable risk ratios. Iron, lead, and zinc contributed an inordinate amount of the overall risk for plants, birds, and invertebrates/mammals, respectively. None of the COPECs had elevated detection limits. Antimony, total arsenic, cadmium, copper, lead, mercury, selenium, silver, thallium, and zinc

exceeded their respective background concentrations by more than a factor of five in five or more sample locations.

Considering the extent and number of exceedances of background concentrations and ERBSCs by multiple chemicals, it is likely the concentrations of some COPECs in soil and wasterock are elevated enough to result in ecological risks under conditions of significant exposure. COPECs with significantly elevated risk ratios (i.e., >10), exceedances of two or more receptor group ERBSCs, and exceedances at more than four sample locations include antimony, cadmium, copper, iron, lead, selenium, silver, and zinc. Mercury, selenium, silver, and thallium also contributed to the potential ecological risks, but at fewer locations and with lower risk ratios. COPECs with risk ratios greater than 100 include antimony, iron, lead, and zinc. However, iron and zinc are generally only bioavailable at elevated or reduced pH conditions (less than 5, greater than 8; EPA, 2005). Such extremes in pH were not observed at the Site during SI field activities in 2004 and 2006. Therefore, iron and zinc are not likely to present a significant ecological risk at the Site. In addition, the maximum iron concentration exceeded the iron background concentration by less than a factor of two, further suggesting that iron is not contributing significantly to ecological risks at the Site.

Because wasterock is not widely distributed at the Site, the most significant risk would be posed to plants and invertebrates growing within the main areas of wasterock. More mobile and wide-ranging wildlife species are unlikely to congregate for extended durations on or around the wasterock piles, and thus, are less likely to be adversely impacted by COPECs.

4.3.1.2 Vegetation

No ERBSCs are available for vegetation; therefore, exceedances of background concentrations were examined. As shown in Attachment A, Table A-4, barium, silver, and thallium were selected as COIs. Thallium was not detected in background samples and a comparison to Site-related concentrations could not be made. Barium and silver exceeded their respective background concentrations by less than a factor of two. These COIs are very likely to be within the range of natural background concentrations and, therefore, are not considered further. Thus, the available evidence suggests Site-related COIs are not significantly bioaccumulating in vegetation and, therefore, have little potential to bioaccumulate in the terrestrial food chain.

4.3.1.3 Surface Water

COPECs for surface water and the associated risk ratios (based on total metals concentrations) are listed in Table 4-4. Total arsenic, cadmium, and chromium VI were selected as COPECs solely due to bioaccumulation potential. Based on a lack of bird and mammal ERBSCs, antimony, beryllium, iron, silver, and thallium were also selected as COPECs. Antimony, beryllium, silver, and thallium were detected only in adit seep samples at very low concentrations. Iron was also detected at very low concentrations except for in LC-SW-04 and 05, the two farthest downstream sample locations. The potential for bioaccumulative or direct effects to birds and mammals is dependent on the areal extent of contamination, which determines the potential for exposure to these species. Aluminum, barium, lead, and zinc had slightly elevated risk ratios of three, five, nine, and two, respectively, for aquatic life. Of these, barium and lead exceeded the aquatic life ERBSC and background concentration at more than four sample locations. Concentrations of aluminum exceeded the background concentration and ERBSCs only at stations LC-SW-04 and LC-SW-05 during the high flow sampling event. These two stations are downstream of the Site and the confluence of the perennial creek entering Linton Creek from the southwest. Because the locations are so far downstream, and the samples collected adjacent to and immediately downstream of the Site did not have aluminum at elevated concentrations, it seems that the aluminum may be contributed by sources other than the Site. Barium exceeded its respective background concentration in the adit seep samples and LC-SW-04 by a factor of less than three. The concentrations

of lead exceeded their respective background concentration and ERBSCs at all four locations in the adit seeps and at LC-SW-04 and LC-SW-05. At station LC-SW-02 and LC-SW-03 near the Site, the concentration of lead did not exceed an ERBSC. Concentrations of zinc only exceeded ERBSCs at the adit seep sample locations.

An examination of dissolved chemical concentration data showed copper as the only COPEC. The concentration of copper exceeded the aquatic life ERBSC by a factor of four at station LC-SW-02 during low flow conditions.

Combined, these data suggest the adit seep and stations LC-SW-04 and LC-SW-05 contain elevated concentrations of some metals. However, LC-SW-04 and LC-SW-05 are both well downstream from the Site and there are other streams joining Linton Creek upstream from these sampling locations. Given the lack of elevated chemical concentrations in the creek near the Site, it seems these other tributaries may be contributing metals to Linton Creek. In addition, the dissolved chemical concentration data (which may best represent the bioavailable fraction of chemicals in surface water) suggest that potential impacts to aquatic life in surface water are limited to copper, adjacent to the Site. The limited areal extent of apparent Site-related contamination also suggests birds and mammals are unlikely to be significantly impacted given their generally large foraging areas.

4.3.1.4 Sediment

The COPECs for sediment are shown in Table 4-5. Aluminum, barium, beryllium, cobalt, iron, thallium, and vanadium were selected as COPECs solely because of a lack of ERBSCs. Arsenic V, total arsenic, cadmium, lead, mercury, selenium, and zinc had at least one risk ratio greater than 1 but only cadmium, lead, and zinc exhibited risk ratios greater than 10. Concentrations of aluminum, arsenic V, total arsenic, barium, beryllium, cobalt, selenium, and vanadium exceeded the respective background concentrations by a factor of approximately three or less. Concentrations of cadmium, iron, lead, and thallium exceeded background concentrations by a factor of eight or less. Concentrations of zinc were elevated above background by more than a factor of 25. Based on the extent and number of exceedances of background concentrations and ERBSCs, cadmium, lead, and zinc present the highest potential for ecological risk to birds and mammals; invertebrates; and both receptor groups, respectively. The consistency of slightly to moderately elevated concentrations of COPECs at stations LC-SW-02, LC-SW-03, and LC-SW-04, suggests the potential presence of Site-related chemicals in the sediment of Linton Creek.

4.3.2 Uncertainty Analysis

Uncertainty analysis identifies and characterizes the main sources of uncertainty in the risk estimates during the risk characterization phase. . The uncertainty analysis combined with the risk characterization provides the information needed to form conclusions and recommendations regarding ecological risks.

4.3.2.1 Analytical Data

The analytical data are from samples collected in areas of known and suspected high contamination. This results in an overestimation of the potential chemical exposure to mobile species. The highest potential for contamination is expected to occur with sessile species (plants and invertebrates) that are exposed to COPECs. Even in these cases, only individuals among the receptor population are likely to be impacted, which is critical only for protected species. Mobile species are exposed over a wider area that likely has lower concentrations or none of the Site-related chemicals. Thus, the calculated risks likely overestimate the actual risks posed to upper trophic level species (i.e., birds and mammals).

4.3.2.2 Risk-Based Screening Procedures

The use of maximum detected concentration or 95UCL as the EPC is a conservative approach that is purposefully designed to result in some overestimation of the potential ecological risks. Therefore, predicted risks probably overestimate actual ecological risks at the Site.

Inclusion of the maximum sample reporting limit screening is a conservative approach that includes COIs as COPECs when they are actually not detected above laboratory reporting limits. Including a COI as a COPEC in the ERA, at one-half the detection limit, likely results in an overestimation of the potential for ecological risks because the undetected COI is likely present at a concentration less than one-half of the method detection limit.

The risk-based screening assumes 100 percent exposure of ecological receptors to contaminated media. This is a reasonable assumption for widespread contamination and immobile receptors such as invertebrates and plants. However, at this Site, the contamination is generally within close proximity to the Site. Thus, only individual receptors (versus receptor populations) are likely to be exposed to Site-related contamination.

4.3.2.3 Ecological Data Gaps

The lack of ERBSCs for some receptors precludes calculation of risk for those receptors. This may result in over or underestimation of the potential for ecological risks.

4.3.2.4 Ecotoxicological Data

Many of the ERBSCs used for this ERA are intended to be no observed adverse effect level. Because actual ecological effects occur at an unknown concentration somewhere between the no observed adverse effect level and the lowest observed adverse effect level, simply exceeding an ERBSC does not necessarily indicate the potential for significant ecological effects. As such, using no observed adverse effect level based ERBSCs likely results in an overestimation of potential ecological risk.

4.3.3 Ecological Hot Spots

A hot spot in soil is generically defined as an area where the contamination is “highly concentrated,” highly mobile, or cannot be reliably contained. For this ERA, hot spot levels corresponded to COPEC concentrations that exceed both ERBSCs and background concentrations by a factor of 10 or more. Ecological hot spots in soil/wasterock, surface water, and sediment are shown in Table 4-6.

Table 4-6. Ecological Hot Spot Concentrations and Locations

Contaminant of Potential Ecological Concern	Hot Spot Concentration	Hot Spot Locations
Soil/Wasterock (mg/kg)		
Antimony	50	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3, OM-WR3-1
Total Arsenic	180	OM-WR1-3
Cadmium	40	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3, OM-WR3-1
Copper	500	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3, OM-WR3-1
Lead	1,070	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3, OM-WR3-1
Mercury	1	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3
Selenium	4.3	OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3
Silver	20	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3, OM-WR3-1
Thallium	10	OM-WR1-3
Zinc	4,500	OM-OP1-2, OM-OP2-1, OM-OP3-1, OM-WR1-3, OM-WR2-3, OM-WR3-1
Surface Water (mg/L)		
Lead	0.0066	OM-AS-02, LC-SW-04 (HF)
Sediment (mg/kg)		
Zinc	883	LC-SS-03, LC-SS-04, LC-SS-03 (HF), LC-SS-04 (HF)

4.4 Summary of Ecological Risks

Elevated concentrations of COPECs are present in nearly all the soil/wasterock samples collected from the Site. Therefore, it is probable that individual plants and invertebrates are adversely impacted within these localized areas. Based on the elevated risk ratios and distribution, antimony, cadmium, copper, iron, lead, selenium, silver, and zinc in soil/wasterock are likely to present the highest potential ecological impacts. Overall, terrestrial ecological receptor populations are unlikely to be significantly impacted due to the limited area of potential exposure. Based on the large amount of relatively undisturbed habitat available surrounding the Site, habitat loss resulting from effects on plants also will not likely result in significant effects to upper trophic level species.

Given its proximity to Linton Creek, wasterock is likely a former and current source for chemical transport to Linton Creek via surface water runoff and erosion. Surface water risk-based screening suggests the adit seep and stations LC-SW-04 and LC-SW-05 may contain elevated total concentrations of metals. Low elevated total metal concentrations at stations adjacent to and immediately downstream from the Site may indicate the perennial tributary of Linton Creek entering from the southwest, approximately one-half mile below the Site, is contributing elevated metals concentrations. Dissolved metals concentrations in surface water suggest a slight potential for impacts to aquatic life in surface water at LC-SW-02, adjacent to the Site, but this was not mirrored by total concentrations.

Cadmium, lead, and zinc present the highest potential for ecological risk in sediment. The consistency of slightly to moderately elevated concentrations of COPECs at stations LC-SW-02, LC-SW-03, and LC-SW-04, suggests the potential presence of Site-related chemicals in the sediment of Linton Creek.

Excluding individual plants and invertebrates exposed to Site-related COPECs in soil/wasterock and surface water, significant ecological impacts are not expected at the Site. However, Linton Creek sediments appear to be partially impacted by the Site as indicated by elevated concentrations of several metals (cadmium, lead and zinc) in downstream Stations. In addition, numerous ecological hot spots are present in wasterock, and several ecological hot spots are present in surface water and sediment.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A recreational user was identified as the only likely human receptor at the Site. The risk assessment determined that no unacceptable human health impacts are expected from exposure to surface water, soil, or sediment under recreational conditions.

Potential ecological risks were predicted for terrestrial, aquatic, and benthic ecological receptors. Numerous Site-related hot spots of contamination exist in wasterock. Remediation or control of ecological exposure to COPECs at most of the wasterock sample locations, and at some sediment sample locations would be necessary to reduce the risks predicted by this assessment. However, the soil/wasterock contamination is localized, elevated surface water and sediment COPEC concentrations are limited and localized, and the benthic macroinvertebrate survey conducted during the SI (CES, 2006) indicated a lack of Site-related impacts. Given this, population level impacts to plants, invertebrates, birds, or mammals were deemed unlikely and remedial actions are unnecessary solely for the protection of ecological receptor populations at the Site. Hot spots of contamination in wasterock may require further consideration and action.

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FIGURES

Figure 3-1. Conceptual Human Health Exposure Model
Figure 4-1. Conceptual Ecological Exposure Model

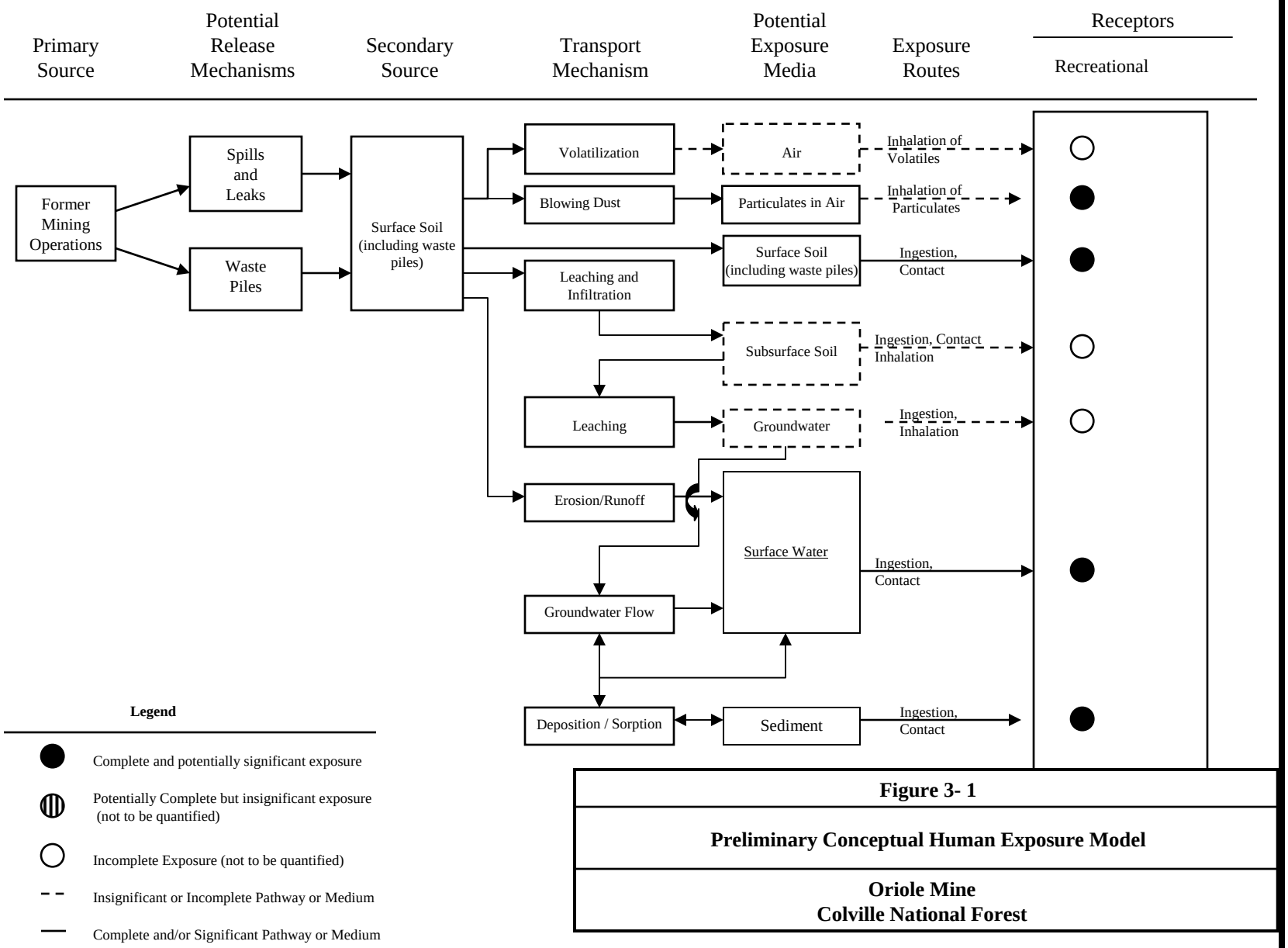
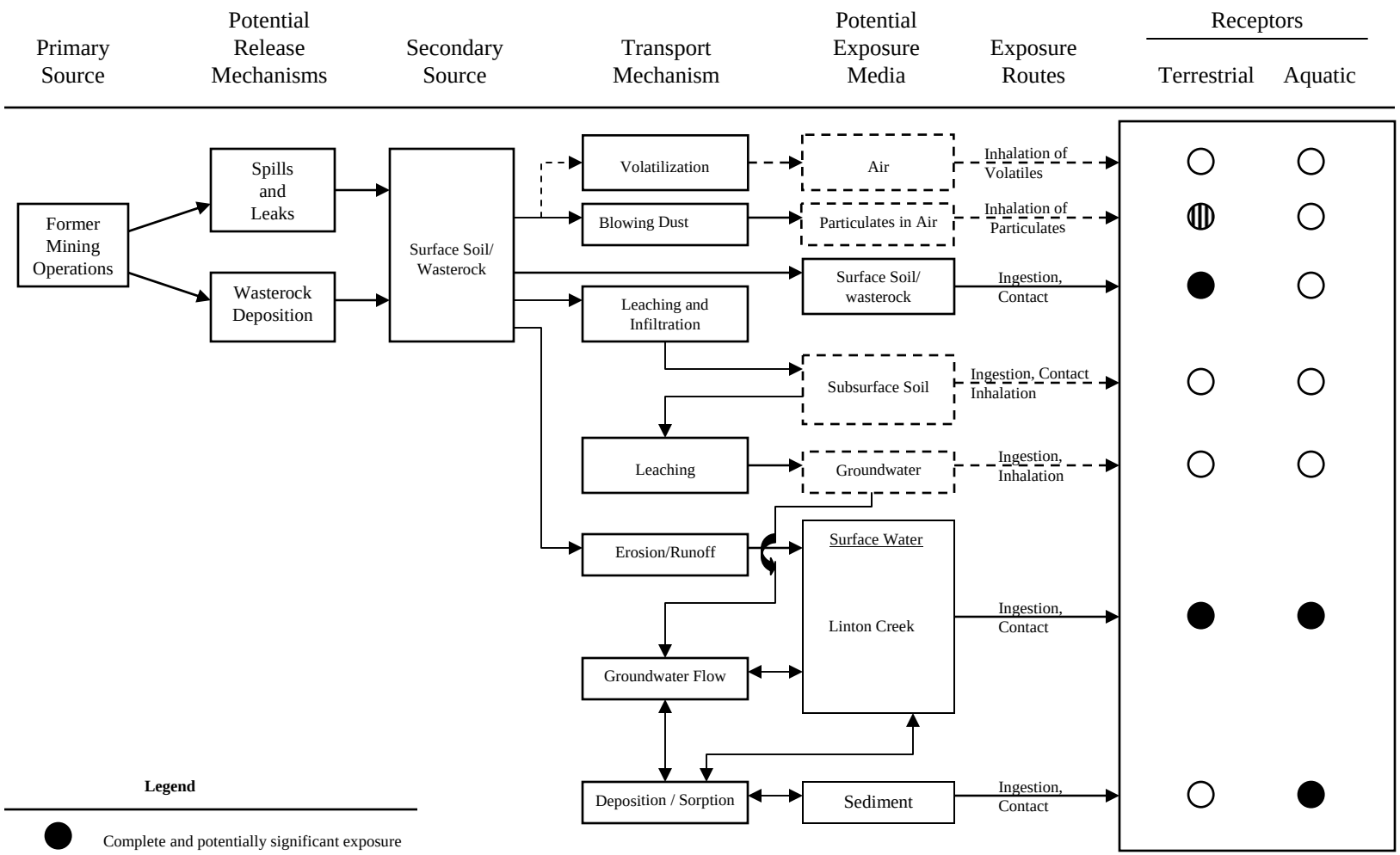


Figure 3- 1

Preliminary Conceptual Human Exposure Model

Oriole Mine
Colville National Forest



Legend

- Complete and potentially significant exposure
- Potentially Complete but insignificant exposure (not to be quantified)
- Incomplete Exposure (not to be quantified)
- Insignificant or Incomplete Pathway or Medium
- Complete and/or Significant Pathway or Medium

Figure 4-1

Preliminary Conceptual Ecological Exposure Model

Oriole Mine
Colville National Forest
Metaline, Washington

ATTACHMENTS

Attachment A.	**Initial Screening Results**
Attachment B.	**Human Health Risk Calculations**
Attachment C.	**Terrestrial Ecological Exclusion Evaluation**
Attachment D.	**Rare, Threatened, and Endangered Species**
Attachment E.	**Ecological Risk-Based Screening Tables**

Attachment A.

Initial Screening Results

Table A-1. Ecological Risk-Based Sdcreening Concentrations
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Screening Level Values for Plants	Soil Screening Level Values for Invertebrates	Soil Screening Level Values for Birds	Soil Screening Level Values for Mammals	Freshwater Screening Level Values for Aquatic Life	Freshwater Screening Level Values for Birds	Freshwater Screening Level Values for Mammals	Freshwater Sediment Screening Level Values	Sediment Bioaccumulation Screening Level Values
	mg/kg				mg/L			mg/kg	
Aluminum	5.0E+01 Ecology, 2001	6.0E+02 ODEQ, 2001	4.5E+02 ODEQ, 2001	1.07E+02 ODEQ, 2001	8.70E-02 ODEQ, 2001	7.97E+02 ODEQ, 2001	8.00E+00 ODEQ, 2001	No Data	No Data
Antimony	5.0E+00 Ecology, 2001	1.50E+01 DMHSPE 2001	No Data ODEQ, 2001	1.50E+01 ODEQ, 2001	1.60E+00 ODEQ, 2001	No Data	1.00E+00 ODEQ, 2001	3.00E+00 ODEQ, 2001	1.00E+01 ODEQ, 2001
Arsenic III	1.0E+01 ODEQ, 2001	6.0E+01 ODEQ, 2001	7.0E+00 Ecology, 2001	7.0E+00 Ecology, 2001	1.50E-01 ODEQ, 2001	1.80E+01 ODEQ, 2001	6.00E+00 ODEQ, 2001	6.00E+00 ODEQ, 2001	4.00E+00 ODEQ, 2001
Arsenic V	1.0E+01 Ecology, 2001	6.0E+01 Ecology, 2001	1.3E+02 Ecology, 2001	1.3E+02 Ecology, 2001	1.50E-01 ODEQ, 2001	1.80E+01 Arsenic III	6.00E+00 Arsenic III	6.00E+00 Arsenic III	4.00E+00 Arsenic III
Arsenic, Total	1.0E+01 Arsenic III	6.0E+01 Arsenic III	1.0E+01 Arsenic III	2.9E+01 Arsenic III	1.90E-01 Ecology, 2003	1.80E+01 Arsenic III	6.00E+00 Arsenic III	6.00E+00 Arsenic III	4.00E+00 Arsenic III
Barium	5.0E+02 Ecology, 2001	3.0E+03 ODEQ, 2001	1.0E+02 Ecology, 2001	1.0E+02 Ecology, 2001	4.00E-03 ODEQ, 2001	1.50E+02 ODEQ, 2001	3.90E+01 ODEQ, 2001	No Data	No Data
Beryllium	1.0E+01 Ecology, 2001	1.0E+01 Efroymsen et al. 1997a	1.4E+01 Ecology, 2001	1.4E+01 Ecology, 2001	5.30E-03 ODEQ, 2001	No Data	No Data	No Data	1.22E+02 ODEQ, 2001
Cadmium	4.0E+00 Ecology, 2001	2.0E+01 Ecology, 2001	6.0E+00 ODEQ, 2001	1.3E+02 ODEQ, 2001	4.23E-04 Ecology, 2003	1.00E+01 ODEQ, 2001	8.00E+00 ODEQ, 2001	6.00E-01 ODEQ, 2001	3.00E-03 ODEQ, 2001
Chromium III	1.0E+00 ODEQ, 2001	4.0E-01 ODEQ, 2001	4.0E+00 ODEQ, 2001	3.4E+05 ODEQ, 2001	6.64E-02 Ecology, 2003	7.20E+00 ODEQ, 2001	2.10E+04 ODEQ, 2001	3.70E+01 Chromium, Total	4.20E+03 Chromium, Total
Chromium VI	1.0E+00 Chromium III	4.0E-01 Chromium III	4.0E+00 Chromium III	4.1E+02 ODEQ, 2001	1.00E-02 Ecology, 2003	7.20E+00 Chromium III	2.50E+01 ODEQ, 2001	3.70E+01 ODEQ, 2001	4.20E+03 ODEQ, 2001
Chromium, Total	4.2E+01 Ecology, 2001	4.2E+01 Ecology, 2001	6.7E+01 Ecology, 2001	6.7E+01 Ecology, 2001	1.00E-02 Chromium III	7.20E+00 Chromium III	2.50E+01 Chromium VI	3.70E+01 Chromium, Total	4.20E+03 Chromium, Total
Cobalt	2.0E+01 Ecology, 2001	1.0E+03 ODEQ, 2001	No Data	1.5E+02 ODEQ, 2001	2.30E-02 ODEQ, 2001	No Data	9.00E+00 ODEQ, 2001	No Data	No Data
Copper	1.0E+02 Ecology, 2001	5.0E+01 Ecology, 2001	2.2E+02 Ecology, 2001	5.68E+01 Ecology, 2001	4.06E-03 Ecology, 2003	3.41E+02 ODEQ, 2001	5.30E+01 ODEQ, 2001	3.60E+01 ODEQ, 2001	1.00E+01 ODEQ, 2001
Iron	1.0E+01 ODEQ, 2001	2.0E+02 ODEQ, 2001	No Data	No Data	1.00E+00 ODEQ, 2001	No Data	No Data	No Data	No Data
Lead	5.0E+01 Ecology, 2001	5.0E+02 Ecology, 2001	1.2E+02 Ecology, 2001	1.2E+02 Ecology, 2001	6.64E-04 Ecology, 2003	2.80E+01 ODEQ, 2001	3.23E+02 ODEQ, 2001	3.50E+01 ODEQ, 2001	1.28E+02 ODEQ, 2001
Magnesium	No Data	No Data	No Data	No Data	8.20E+01 ODEQ, 2001	No Data	No Data	No Data	No Data
Manganese	1.1E+03 Ecology, 2001	1.0E+02 ODEQ, 2001	1.5E+03 Ecology, 2001	1.5E+03 Ecology, 2001	1.20E-01 ODEQ, 2001	7.24E+03 ODEQ, 2001	6.76E+02 ODEQ, 2001	1.10E+03 ODEQ, 2001	No Data
Mercury	3.0E-01 Ecology, 2001	1.0E-01 Ecology, 2001	5.5E+00 Ecology, 2001	5.5E+00 Ecology, 2001	1.20E-05 Ecology, 2003	3.30E+00 ODEQ, 2001	1.00E+01 ODEQ, 2001	2.00E-01 ODEQ, 2001	No Data
Mercury, Methyl	2.0E-04 ODEQ, 2001	No Data ODEQ, 2001	4.0E-01 Ecology, 2001	4.0E-01 Ecology, 2001	No Data	5.0E-02 ODEQ, 2001	2.5E-01 ODEQ, 2001	No Data	No Data
Nickel	3.0E+01 Ecology, 2001	2.0E+02 Ecology, 2001	9.8E+02 Ecology, 2001	5.68E+01 Ecology, 2001	5.68E-02 Ecology, 2003	5.62E+02 ODEQ, 2001	3.80E+01 ODEQ, 2001	1.80E+01 ODEQ, 2001	3.16E+02 ODEQ, 2001
Selenium	1.0E+00 Ecology, 2001	7.0E+01 Ecology, 2001	3.0E-01 Ecology, 2001	3.0E-01 Ecology, 2001	5.00E-03 Ecology, 2003	3.60E+00 ODEQ, 2001	1.50E+00 ODEQ, 2001	No Data	1.00E-01 ODEQ, 2001
Silver	2.0E+00 Ecology, 2001	5.0E+01 ODEQ, 2001	No Data	No Data	1.20E-04 ODEQ, 2001	No Data	No Data	4.50E+00 ODEQ, 2001	No Data
Thallium	1.0E+00 Ecology, 2001	1.0E+00 CCME 1999	No Data	1.0E+00 ODEQ, 2001	4.00E-02 ODEQ, 2001	No Data	6.00E-02 ODEQ, 2001	No Data	7.00E-01 ODEQ, 2001
Vanadium	2.0E+00 Ecology, 2001	No Data ODEQ, 2001	4.7E+01 ODEQ, 2001	2.5E+01 ODEQ, 2001	2.00E-02 ODEQ, 2001	8.20E+01 ODEQ, 2001	1.60E+00 ODEQ, 2001	No Data	No Data
Zinc	8.6E+01 Ecology, 2001	2.0E+02 Ecology, 2001	3.6E+02 Ecology, 2001	3.77E+01 Ecology, 2001	3.77E-02 Ecology, 2003	1.05E+02 ODEQ, 2001	1.23E+03 ODEQ, 2001	1.23E+02 ODEQ, 2001	3.00E+00 ODEQ, 2001

NOTES:
mg/kg = milligrams pe kilogram
mg/L = milligrams per liter
No Data = No Data Available
CWQG = Canadian Water Quality Guideline
Use of surrogate chemical toxicity data indicated by chemical name adjacent to concentration.

Table A-2. Data Summary and Initial Screening for Surface Soil Ecological Risk Assessment
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	95% Upper Confidence Limit	Exposure Point Concentration*	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Soil Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Background Concentration	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?
				mg/kg													
Metals																	
Aluminum	12	12	100%	1.32E+03	1.44E+04	7.57E+03	7.57E+03	Not Applicable	Not Applicable	5.00E+01	1.00E+05	3.61E+04	Yes	No	No	No	No
Antimony	12	11	92%	4.00E-01	1.15E+03	7.73E+02	7.73E+02	5.00E-01	5.00E-01	5.00E+00	4.09E+02	8.17E-01	Yes	No	No	Yes	Yes
Arsenic III	4	2	50%	5.50E-02	1.13E-01	Not Applicable	1.13E-01	2.10E-02	2.10E-02	7.00E+00	No Data	6.25E-02	Yes	No	No	Yes	Yes
Arsenic V	4	4	100%	5.18E+00	3.10E+01	Not Applicable	3.10E+01	Not Applicable	Not Applicable	1.00E+01	No Data	4.09E+00	Yes	No	No	Yes	Yes
Arsenic, total	12	12	100%	3.70E+00	2.11E+02	1.43E+02	1.43E+02	Not Applicable	Not Applicable	1.00E+01	1.59E+00	9.13E+00	Yes	No	No	Yes	Yes
Barium	12	12	100%	1.73E+01	2.69E+02	1.08E+02	1.08E+02	Not Applicable	Not Applicable	1.02E+02	6.66E+04	7.49E+02	Yes	No	No	No	No
Beryllium	12	10	83%	2.00E-01	6.00E-01	4.41E-01	4.41E-01	2.00E-01	2.00E-01	1.00E+01	1.94E+03	1.11E+00	Yes	No	No	No	No
Cadmium	12	12	100%	3.10E-01	4.30E+02	2.20E+02	2.20E+02	Not Applicable	Not Applicable	4.00E+00	4.51E+02	3.91E+00	Yes	No	No	Yes	Yes
Chromium, Total	12	12	100%	3.00E+00	3.20E+01	1.71E+01	1.71E+01	Not Applicable	Not Applicable	4.20E+01	4.48E+02	1.81E+01	Yes	No	No	Yes	Yes
Cobalt	12	12	100%	4.00E+00	5.50E+01	2.63E+01	2.63E+01	Not Applicable	Not Applicable	2.00E+01	1.92E+03	1.78E+01	Yes	No	No	Yes	Yes
Copper	12	12	100%	8.00E+00	2.80E+03	2.21E+03	2.21E+03	Not Applicable	Not Applicable	5.00E+01	4.09E+04	3.72E+01	Yes	No	No	Yes	Yes
Iron	12	12	100%	2.89E+03	3.41E+04	2.61E+04	2.61E+04	Not Applicable	Not Applicable	1.00E+01	1.00E+05	2.43E+04	Yes	No	No	Yes	Yes
Lead	12	12	100%	8.18E+00	1.03E+05	7.15E+04	7.15E+04	Not Applicable	Not Applicable	5.00E+01	8.00E+02	1.07E+02	Yes	No	No	Yes	Yes
Manganese	12	12	100%	9.00E+02	6.82E+03	3.21E+03	3.21E+03	Not Applicable	Not Applicable	1.00E+02	1.95E+04	5.69E+03	Yes	No	No	Yes	Yes
Mercury	12	9	75%	1.20E-01	3.45E+00	2.88E+00	2.88E+00	4.00E-02	5.00E-02	1.00E-01	3.07E+02	4.22E-02	Yes	No	No	Yes	Yes
Nickel	12	12	100%	4.00E+00	4.73E+01	3.05E+01	3.05E+01	Not Applicable	Not Applicable	3.00E+01	2.04E+04	2.81E+01	Yes	No	No	Yes	Yes
Selenium	12	8	67%	1.20E-01	2.50E+01	1.21E+01	1.21E+01	5.00E-01	5.00E-01	3.00E-01	5.11E+03	4.31E-01	Yes	Yes	No	Yes	Yes
Silver	12	12	100%	5.00E-02	3.30E+02	1.54E+02	1.54E+02	Not Applicable	Not Applicable	2.00E+00	5.11E+03	9.04E-01	Yes	No	No	Yes	Yes
Thallium	12	10	83%	5.00E-02	3.00E+01	1.61E+01	1.61E+01	3.00E-01	1.00E+00	1.00E+00	6.75E+01	2.89E-01	Yes	No	No	Yes	Yes
Vanadium	12	12	100%	6.30E+00	3.15E+01	2.38E+01	2.38E+01	Not Applicable	Not Applicable	2.00E+00	1.02E+03	4.15E+01	Yes	No	No	No	No
Zinc	12	12	100%	2.70E+01	9.30E+04	7.99E+04	7.99E+04	Not Applicable	Not Applicable	3.77E+01	1.00E+05	4.50E+02	Yes	No	No	Yes	Yes

NOTES:
mg/kg = milligram per kilogram
NA = considered as total arsenic
* upper confidence limit on the mean or maximum (whichever is lower)

Table A-3. Data Summary and Initial Screening for Surface Soil For Human Health Risk Assessment
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	95% Upper Confidence Limit	Exposure Point Concentration*	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Human Health Risk-Based Screening Concentration	Background Concentration	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Human Health Chemical of Interest?
				mg/kg												
Metals																
Aluminum	8	8	100%	1.53E+03	6.46E+03	5.47E+03	5.47E+03	Not Applicable	Not Applicable	1.00E+05	3.61E+04	Yes	No	No	No	No
Antimony	8	7	88%	4.00E-01	2.80E+02	1.49E+02	1.49E+02	5.00E-01	5.00E-01	4.09E+02	8.17E-01	Yes	No	No	Yes	Yes
Arsenic III	4	2	50%	5.50E-02	1.13E-01	Not Applicable	1.13E-01	2.10E-02	2.10E-02	No Data	6.25E-02	Yes	No	No	Yes	Yes
Arsenic V	4	4	100%	5.18E+00	3.10E+01	Not Applicable	3.10E+01	Not Applicable	Not Applicable	No Data	4.09E+00	Yes	No	No	Yes	Yes
Arsenic, total	8	8	100%	3.70E+00	1.73E+02	1.25E+02	1.25E+02	Not Applicable	Not Applicable	1.59E+00	9.13E+00	Yes	No	No	Yes	Yes
Barium	8	8	100%	2.04E+01	9.52E+01	5.84E+01	5.84E+01	Not Applicable	Not Applicable	6.66E+04	7.49E+02	Yes	No	No	No	No
Beryllium	8	7	88%	2.00E-01	6.00E-01	4.50E-01	4.50E-01	1.00E-01	1.00E-01	1.94E+03	1.11E+00	Yes	No	No	No	No
Cadmium	8	8	100%	3.10E-01	4.30E+02	8.76E+02	4.30E+02	Not Applicable	Not Applicable	4.51E+02	3.91E+00	Yes	No	No	Yes	Yes
Chromium, Total	8	8	100%	3.00E+00	1.50E+01	1.33E+01	1.33E+01	Not Applicable	Not Applicable	4.48E+02	1.81E+01	Yes	No	No	No	No
Cobalt	8	8	100%	4.00E+00	5.50E+01	3.10E+01	3.10E+01	Not Applicable	Not Applicable	1.92E+03	1.78E+01	Yes	No	No	Yes	Yes
Copper	8	8	100%	8.00E+00	1.91E+03	3.22E+03	1.91E+03	Not Applicable	Not Applicable	4.09E+04	3.72E+01	Yes	No	No	Yes	Yes
Iron	8	8	100%	2.89E+03	3.41E+04	3.02E+04	3.02E+04	Not Applicable	Not Applicable	1.00E+05	2.43E+04	Yes	No	No	Yes	Yes
Lead	8	8	100%	8.18E+00	4.29E+04	9.06E+04	4.29E+04	Not Applicable	Not Applicable	8.00E+02	1.07E+02	Yes	No	No	Yes	Yes
Manganese	8	8	100%	9.00E+02	2.75E+03	2.35E+03	2.35E+03	Not Applicable	Not Applicable	1.95E+04	5.69E+03	Yes	No	No	No	No
Mercury	8	6	75%	1.20E-01	3.45E+00	3.73E+00	3.45E+00	2.00E-02	2.50E-02	3.07E+02	4.22E-02	Yes	No	No	Yes	Yes
Nickel	8	8	100%	4.00E+00	4.29E+01	3.08E+01	3.08E+01	Not Applicable	Not Applicable	2.04E+04	2.81E+01	Yes	No	No	Yes	Yes
Selenium	8	5	63%	1.20E-01	1.08E+01	8.79E+00	8.79E+00	2.50E-01	2.50E-01	5.11E+03	4.31E-01	Yes	No	No	Yes	Yes
Silver	8	8	100%	5.00E-02	2.03E+02	5.23E+02	2.03E+02	Not Applicable	Not Applicable	5.11E+03	9.04E-01	Yes	No	No	Yes	Yes
Thallium	8	7	88%	5.00E-02	1.00E+01	1.12E+01	1.00E+01	1.50E-01	1.50E-01	6.75E+01	2.89E-01	Yes	No	No	Yes	Yes
Vanadium	8	8	100%	6.30E+00	3.15E+01	2.57E+01	2.57E+01	Not Applicable	Not Applicable	1.02E+03	4.15E+01	Yes	No	No	No	No
Zinc	8	8	100%	2.70E+01	9.30E+04	1.61E+05	9.30E+04	Not Applicable	Not Applicable	1.00E+05	4.50E+02	Yes	No	No	Yes	Yes

NOTES:
mg/kg = milligram per kilogram
NA = considered as total arsenic
* upper confidence limit on the mean or maximum (whichever is lower)

Table A-4. Data Summary and Initial Screening for Sub-Surface Soil
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	95% Upper Confidence Limit	Exposure Point Concentration*	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Human Health Risk-Based Screening Concentration	Background Concentration	Exceeds 5% Frequency of Detection?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Human Health Chemical of Interest?
				mg/kg											
Metals															
Aluminum	6	6	100%	2.30E+03	1.60E+04	1.07E+04	1.07E+04	Not Applicable	Not Applicable	1.00E+05	3.61E+04	Yes	No	No	No
Antimony	6	6	100%	3.10E+00	3.82E+02	2.35E+02	2.35E+02	Not Applicable	Not Applicable	4.09E+02	8.17E-01	Yes	No	Yes	Yes
Arsenic III	3	1	33%	1.84E-01	1.84E-01	Not Applicable	1.84E-01	1.75E-02	1.75E-02	No Data	6.25E-02	Yes	No	Yes	Yes
Arsenic V	3	3	100%	1.08E+01	8.41E+01	Not Applicable	8.41E+01	Not Applicable	Not Applicable	No Data	4.09E+00	Yes	No	Yes	Yes
Arsenic, total	6	6	100%	1.08E+01	8.43E+01	6.32E+01	6.32E+01	Not Applicable	Not Applicable	1.59E+00	9.13E+00	Yes	No	Yes	Yes
Barium	6	6	100%	2.71E+01	1.64E+02	1.12E+02	1.12E+02	Not Applicable	Not Applicable	6.66E+04	7.49E+02	Yes	No	No	No
Beryllium	6	6	100%	3.00E-01	7.00E-01	5.57E-01	5.57E-01	Not Applicable	Not Applicable	1.94E+03	1.11E+00	Yes	No	No	No
Cadmium	6	6	100%	7.38E+00	2.22E+02	1.43E+02	1.43E+02	Not Applicable	Not Applicable	4.51E+02	3.91E+00	Yes	No	Yes	Yes
Chromium, Total	6	6	100%	1.00E+01	3.40E+01	2.80E+01	2.80E+01	Not Applicable	Not Applicable	4.48E+02	1.81E+01	Yes	No	Yes	Yes
Cobalt	6	6	100%	1.10E+01	2.50E+01	2.36E+01	2.36E+01	Not Applicable	Not Applicable	1.92E+03	1.78E+01	Yes	No	Yes	Yes
Copper	6	6	100%	4.92E+01	1.74E+03	1.34E+03	1.34E+03	Not Applicable	Not Applicable	4.09E+04	3.72E+01	Yes	No	Yes	Yes
Iron	6	6	100%	1.16E+04	2.76E+04	2.27E+04	2.27E+04	Not Applicable	Not Applicable	1.00E+05	2.43E+04	Yes	No	Yes	Yes
Lead	6	6	100%	5.01E+02	1.63E+04	1.28E+04	1.28E+04	Not Applicable	Not Applicable	8.00E+02	1.07E+02	Yes	No	Yes	Yes
Manganese	6	6	100%	1.84E+03	4.17E+03	3.32E+03	3.32E+03	Not Applicable	Not Applicable	1.95E+04	5.69E+03	Yes	No	No	No
Mercury	6	5	83%	3.20E-01	2.25E+00	1.96E+00	1.96E+00	2.00E-02	2.00E-02	3.07E+02	4.22E-02	Yes	No	Yes	Yes
Nickel	6	6	100%	3.41E+01	5.04E+01	4.40E+01	4.40E+01	Not Applicable	Not Applicable	2.04E+04	2.81E+01	Yes	No	Yes	Yes
Selenium	6	4	67%	1.90E+00	2.00E+01	2.40E+01	2.00E+01	2.50E-01	2.50E-01	5.11E+03	4.31E-01	Yes	No	Yes	Yes
Silver	6	6	100%	3.07E+00	2.98E+02	3.30E+02	2.98E+02	Not Applicable	Not Applicable	5.11E+03	9.04E-01	Yes	No	Yes	Yes
Thallium	6	5	83%	2.00E-01	1.00E+01	1.37E+01	1.00E+01	2.50E-01	2.50E-01	6.75E+01	2.89E-01	Yes	No	Yes	Yes
Vanadium	6	6	100%	1.19E+01	4.79E+01	3.26E+01	3.26E+01	Not Applicable	Not Applicable	1.02E+03	4.15E+01	Yes	No	Yes	Yes
Zinc	6	6	100%	1.19E+03	3.74E+04	3.00E+04	3.00E+04	Not Applicable	Not Applicable	1.00E+05	4.50E+02	Yes	No	Yes	Yes

NOTES:
mg/kg = milligram per kilogram
NA = considered as total arsenic
* upper confidence limit on the mean or maximum (whichever is lower)

Table A-5. Data Summary and Initial Screening for Vegetation
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	95% Upper Confidence Limit	Exposure Point Concentration*	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Terrestrial Ecological Risk-Based Screening Concentration	Background Concentration	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?
				mg/kg											
Metals															
Aluminum	2	2	100%	4.00E+01	4.70E+01	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	5.60E+01	Yes	No	No	No
Antimony	2	1	50%	2.00E-01	2.00E-01	Not Applicable	Not Applicable	5.00E-02	5.00E-02	No Data	2.00E-01	Yes	No	No	No
Arsenic, total	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	1.50E-01	1.50E-01	No Data	0.00E+00	No	No	No	No
Barium	2	2	100%	3.48E+01	5.60E+01	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	4.06E+01	Yes	No	Yes	Yes
Beryllium	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	1.00E-01	1.00E-01	No Data	0.00E+00	No	No	No	No
Cadmium	2	2	100%	1.30E-01	3.00E-01	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	5.90E-01	Yes	No	No	No
Chromium, Total	2	2	100%	1.00E+00	1.00E+00	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	1.00E+00	Yes	No	No	No
Cobalt	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	5.00E-01	5.00E-01	No Data	0.00E+00	No	No	No	No
Copper	2	2	100%	4.00E+00	6.00E+00	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	9.00E+00	Yes	No	No	No
Iron	2	2	100%	8.30E+01	8.60E+01	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	1.37E+02	Yes	No	No	No
Lead	2	2	100%	7.00E-01	3.98E+00	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	4.55E+00	Yes	No	No	No
Manganese	2	2	100%	4.46E+01	5.60E+01	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	1.32E+02	Yes	No	No	No
Mercury	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	2.50E-02	2.50E-02	No Data	0.00E+00	No	No	No	No
Nickel	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	5.00E-01	5.00E-01	No Data	0.00E+00	No	No	No	No
Selenium	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	2.50E-01	2.50E-01	No Data	0.00E+00	No	No	No	No
Silver	2	2	100%	3.00E-02	8.00E-02	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	6.00E-02	Yes	No	Yes	Yes
Thallium	2	2	100%	6.00E-02	7.00E-02	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	0.00E+00	Yes	No	Yes	Yes
Vanadium	2	0	0%	Not Detected	Not Detected	Not Applicable	Not Applicable	2.50E-01	2.50E-01	No Data	0.00E+00	No	No	No	No
Zinc	2	2	100%	2.40E+01	3.50E+01	Not Applicable	Not Applicable	Not Applicable	Not Applicable	No Data	4.50E+01	Yes	No	No	No

NOTES:
mg/kg = milligram per kilogram
* upper confidence limit on the mean or maximum (whichever is lower)

Table A-6. Data Summary and Initial Screening for all Surface Water - Total
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	95% Upper Confidence Limit	Exposure Point Concentration*	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Surface Water Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Background Concentration	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?	Human Health Chemical of Interest?
				mg/L														
Metals																		
Aluminum	12	7	58%	3.00E-02	6.30E-01	2.22E-01	2.22E-01	1.50E-02	1.50E-02	8.70E-02	3.65E+01	3.6E-02	Yes	No	No	Yes	Yes	Yes
Antimony	12	4	33%	1.60E-03	1.70E-03	1.07E-03	1.07E-03	1.00E-04	2.00E-04	1.00E+00	1.46E-02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Arsenic III	6	2	33%	1.40E-05	2.40E-05	1.68E-05	1.68E-05	3.50E-06	3.50E-06	1.50E-01	No Data	3.60E-05	Yes	No	No	No	No	NA
Arsenic V	6	2	33%	4.86E-04	8.76E-04	6.47E-04	6.47E-04	2.48E-04	2.48E-04	1.50E-01	No Data	1.06E-03	Yes	No	No	No	No	NA
Arsenic, Total	12	7	58%	5.00E-04	9.00E-04	5.89E-04	5.89E-04	2.50E-04	2.50E-04	1.90E-01	4.48E-05	6.50E-04	Yes	No	No	Yes	Yes	Yes
Barium	12	12	100%	7.00E-03	2.80E-02	1.99E-02	1.99E-02	Not Applicable	Not Applicable	4.00E-03	2.55E+00	1.08E-02	Yes	No	No	Yes	Yes	Yes
Beryllium	12	1	8%	2.00E-03	2.00E-03	1.23E-03	1.23E-03	1.00E-03	1.00E-03	5.30E-03	7.30E-02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Cadmium	12	4	33%	8.00E-04	1.20E-03	6.34E-04	6.34E-04	5.00E-05	5.00E-05	4.23E-04	1.82E-02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Chromium III	6	0	0%	Not Detected	Not Detected	Not Applicable	0.00E+00	5.00E-03	5.00E-03	6.64E-02	5.47E+01	0.00E+00	No	No	No	No	No	No
Chromium VI	6	3	50%	1.00E-02	1.00E-02	9.34E-03	9.34E-03	5.00E-03	5.00E-03	1.00E-02	1.09E-01	0.00E+00	Yes	No	No	Yes	Yes	Yes
Chromium, Total	12	1	8%	1.00E-02	1.00E-02	6.16E-03	6.16E-03	5.00E-03	5.00E-03	1.00E-02	No Data	0.00E+00	Yes	No	No	Yes	Yes	Yes
Cobalt	12	0	0%	Not Detected	Not Detected	Not Applicable	0.00E+00	5.00E-03	5.00E-03	2.30E-02	7.30E-01	0.00E+00	No	No	No	No	No	No
Copper	12	2	17%	1.90E-03	2.10E-03	3.95E-03	2.10E-03	2.50E-04	5.00E-03	4.06E-03	1.46E+00	0.00E+00	Yes	Yes	No	Yes	Yes	Yes
Iron	12	7	58%	1.00E-02	7.60E-01	4.68E-01	4.68E-01	5.00E-03	1.00E-02	1.00E+00	1.09E+01	2.50E-02	Yes	No	No	Yes	Yes	Yes
Lead	12	9	75%	1.00E-04	9.10E-03	6.15E-03	6.15E-03	5.00E-05	2.50E-04	6.64E-04	No Data	6.25E-05	Yes	No	No	Yes	Yes	Yes
Manganese	12	5	42%	6.00E-03	2.10E-02	9.95E-03	9.95E-03	2.50E-03	2.50E-03	1.20E-01	8.76E-01	5.88E-03	Yes	No	No	Yes	Yes	Yes
Mercury	12	6	50%	1.60E-07	5.10E-06	7.52E-05	5.10E-06	1.00E-04	1.00E-04	1.20E-05	1.09E-02	7.51E-05	Yes	Yes	No	No	Yes	No
Nickel	12	0	0%	Not Detected	Not Detected	Not Applicable	0.00E+00	5.00E-03	5.00E-03	5.68E-02	7.30E-01	0.00E+00	No	No	No	No	No	No
Selenium	12	4	33%	1.00E-04	2.00E-04	1.55E-03	2.00E-04	5.00E-05	5.00E-03	5.00E-03	1.82E-01	2.25E-04	Yes	No	No	No	No	No
Silver	12	2	17%	7.00E-05	7.00E-05	4.16E-05	4.16E-05	2.50E-05	2.50E-05	1.20E-04	1.82E-01	0.00E+00	Yes	No	No	Yes	Yes	Yes
Thallium	12	1	8%	3.00E-04	3.00E-04	1.27E-04	1.27E-04	5.00E-05	5.00E-05	4.00E-02	2.41E-03	6.25E-05	Yes	No	No	Yes	Yes	Yes
Vanadium	12	1	8%	5.00E-03	5.00E-03	3.08E-03	3.08E-03	2.50E-03	2.50E-03	2.00E-02	3.65E-02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Zinc	12	6	50%	1.00E-02	1.20E-01	6.49E-02	6.49E-02	5.00E-03	5.00E-03	3.77E-02	1.09E+01	0.00E+00	Yes	No	No	Yes	Yes	Yes

NOTES:
mg/L = milligrams per liter
NA = considered as total arsenic
* upper confidence limit on the mean or maximum (whichever is lower)

Table A-7. Data Summary and Initial Screening for Sediment
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI)	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	95% Upper Confidence Limit	Exposure Point Concentration*	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Sediment Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Background Concentration	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?	Human Health Chemical of Interest?
				mg/kg														
Metals																		
Aluminum	8	8	100%	7.17E+03	1.65E+04	1.20E+04	1.20E+04	Not Applicable	Not Applicable	No Data	1.00E+05	9.38E+03	Yes	No	No	Yes	Yes	Yes
Antimony	8	7	88%	2.00E-01	2.60E+00	1.59E+00	1.59E+00	1.00E-01	1.00E-01	3.00E+00	4.09E+02	2.67E-01	Yes	No	No	Yes	Yes	Yes
Arsenic III	4	2	50%	5.70E-02	1.24E-01	Not Applicable	1.24E-01	1.90E-02	5.15E-02	4.00E+00	No Data	1.24E-01	Yes	No	No	No	No	No
Arsenic V	4	4	100%	5.15E+00	1.53E+01	Not Applicable	1.53E+01	Not Applicable	Not Applicable	4.00E+00	No Data	4.68E+00	Yes	No	No	Yes	Yes	Yes
Arsenic, total	8	8	100%	3.70E+00	2.39E+01	1.53E+01	1.53E+01	Not Applicable	Not Applicable	4.00E+00	1.59E+00	6.80E+00	Yes	No	No	Yes	Yes	Yes
Barium	8	8	100%	4.67E+01	1.38E+02	9.78E+01	9.78E+01	Not Applicable	Not Applicable	No Data	6.66E+04	7.83E+01	Yes	No	No	Yes	Yes	Yes
Beryllium	8	8	100%	2.00E-01	8.00E-01	6.41E-01	6.41E-01	Not Applicable	Not Applicable	1.22E+02	1.94E+03	3.67E-01	Yes	No	No	Yes	Yes	Yes
Cadmium	8	8	100%	5.60E-01	3.09E+00	2.16E+00	2.16E+00	Not Applicable	Not Applicable	3.00E-03	4.51E+02	4.63E-01	Yes	No	No	Yes	Yes	Yes
Chromium, Total	8	8	100%	1.60E+01	3.20E+01	2.31E+01	2.31E+01	Not Applicable	Not Applicable	3.70E+01	4.48E+02	1.70E+01	Yes	No	No	Yes	Yes	Yes
Cobalt	8	8	100%	5.00E+00	1.40E+01	1.26E+01	1.26E+01	Not Applicable	Not Applicable	No Data	1.92E+03	8.00E+00	Yes	No	No	Yes	Yes	Yes
Copper	8	8	100%	9.00E+00	3.20E+01	2.40E+01	2.40E+01	Not Applicable	Not Applicable	1.00E+01	4.09E+04	1.34E+01	Yes	No	No	Yes	Yes	Yes
Iron	8	8	100%	1.54E+04	9.63E+04	6.38E+04	6.38E+04	Not Applicable	Not Applicable	No Data	1.00E+05	1.64E+04	Yes	No	No	Yes	Yes	Yes
Lead	8	8	100%	3.58E+01	1.88E+03	1.09E+03	1.09E+03	Not Applicable	Not Applicable	3.50E+01	8.00E+02	2.98E+02	Yes	No	No	Yes	Yes	Yes
Manganese	8	8	100%	4.97E+02	2.57E+03	1.57E+03	1.57E+03	Not Applicable	Not Applicable	1.10E+03	1.95E+04	7.60E+02	Yes	No	No	Yes	Yes	Yes
Mercury	8	6	75%	4.00E-02	6.40E-01	4.20E-01	4.20E-01	2.00E-02	2.50E-02	2.00E-01	3.07E+02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Nickel	8	8	100%	1.50E+01	2.80E+01	2.52E+01	2.52E+01	Not Applicable	Not Applicable	1.80E+01	2.04E+04	1.74E+01	Yes	No	No	Yes	Yes	Yes
Selenium	8	6	75%	1.70E-01	9.00E-01	6.15E-01	6.15E-01	2.50E-01	2.50E-01	1.00E-01	5.11E+03	2.57E-01	Yes	No	No	Yes	Yes	Yes
Silver	8	6	75%	9.00E-02	2.01E+00	1.03E+00	1.03E+00	1.50E-01	1.50E-01	4.50E+00	5.11E+03	4.97E-01	Yes	No	No	Yes	Yes	Yes
Thallium	8	8	100%	1.00E-01	9.50E-01	7.50E-01	7.50E-01	Not Applicable	Not Applicable	7.00E-01	6.75E+01	1.27E-01	Yes	No	No	Yes	Yes	Yes
Vanadium	8	8	100%	1.38E+01	5.37E+01	3.49E+01	3.49E+01	Not Applicable	Not Applicable	No Data	1.02E+03	3.04E+01	Yes	No	No	Yes	Yes	Yes
Zinc	8	8	100%	9.40E+01	2.32E+03	1.64E+03	1.64E+03	Not Applicable	Not Applicable	3.00E+00	1.00E+05	8.83E+01	Yes	No	No	Yes	Yes	Yes

NOTES:
mg/kg = milligram per kilogram
NA = considered as total arsenic
* upper confidence limit on the mean or maximum (whichever is lower)

Attachment B.

Human Health Risk Calculations

CALCULATION OF EXPOSURE POINT CONCENTRATIONS

An exposure point concentration is needed to calculate the Average Daily Dose (ADD) of a contaminant. Generally, the exposure point concentration is not the maximum concentration detected at the Site because, in most situations, it is not reasonable to assume long-term contact with the maximum concentration. Average concentrations are used because toxicity criteria are based on lifetime average exposures, and an average concentration is most representative of the concentration contacted over time, based on the assumption that an exposed individual moves randomly across an exposure area. Exposure for a chemical can be calculated using the exposure point concentration in units of mg/L for water, mg/kg for soil, or mg/m^3 for air.

When data sets are small, the maximum concentration detected is used as the exposure point concentration. However, average concentrations represent more realistic exposure point concentrations as they assume equal access to all portions of the Site. Where the data set is greater than ten, statistical analysis and calculation of the 95 percent upper confidence level on the arithmetic mean (95UCL) can be used as the EPC assuming that a normal distribution of the data can be demonstrated. The 95UCL is a conservative estimate of the average chemical concentration.

There are several methods by which the normality of a data set can be tested. EPA has recommended the use of the W test (Shapiro and Wilk, 1965) or D'Agostino's Test. Both of these methods can be used to test whether the data differ significantly from a normal distribution. It cannot determine whether the data are normally distributed, but rather whether a normal distribution can be assumed. The W test is recommended for data sets with 50 or fewer samples; D'Agostino's for data sets great than 50.

$$95\text{UCL} = e^{\left(\bar{x} - 0.5s^2 + \frac{sH_{1-\alpha}}{\sqrt{n-1}}\right)}$$

Environmental data sets are often asymmetrical and frequently positively skewed. Transforming the raw data points by taking the natural log of each concentration can normalize the data set. This is calculated as follows:

(transformed data point) = ln (raw data point)

The logarithmically transformed data set can be tested for normality in several ways. If the W test or D'Agostino's test indicates that the assumption of normality is valid, the 95UCL on the mean is calculated using Land's Method (Gilbert, R. O., Statistical Methods for Environmental Pollution Monitoring, 1987).

$$95\text{UCL} = \exp(x + 0.5s^2 + sH/\sqrt{n-1})$$

For data sets wherein neither a normal nor a lognormal distribution could be demonstrated, a Z calculation adjusted for skewness was used to determine the 95UCL calculation. (EPA, 1997).

$$95\text{UCL} = x + Z_{a,adj} * s/n^{0.5}$$

Where:

X	=	sample mean
$Z_{a,adj}$	=	the Z value adjusted for skewness
S	=	sample standard deviation
N	=	sample size

And,

$$Z_{a,adj} = Z_a + k^2/6n^{0.5}\,(1 + 2Z_a^{\,2})$$

Where:

$Z_{a,adj}$	=	the Z value adjusted for skewness
K	=	sample coefficient of skewness
N	=	sample size
Z_a	=	the Z parameter for a one-sided upper 90 percent confidence limit

6.1.1.1.1
6.1.1.1.2 CALCULATION OF AVERAGE DAILY DOSE

While presented individually in the equations, USEPA Region X allows for the calculation of Summary Intake Factors (Intake Factors). Intake Factors represent the sum lifetime exposure to contaminated soil, water, or air through the pathway. The Intake Factor represents everything except the chemical concentration in the generic intake equation.

$$I = \frac{CR * EFD}{BW} * \frac{1}{AT}$$

Where:

I	=	Intake Factor (mg/kg-BW-day;l/kg-BW-day)
CR	=	Media Contact Rate (mg/kg/day or L/kg/day)
EFD	=	Receptor exposure factors(days/year, years)
BW	=	Body weight (kg)
AT	=	Averaging Time (days)

Ingestion of Soil and Sediment

The ADD from ingestion of soil is calculated as follows:

<u>*Carcinogens, other*</u>

$$ADD = \frac{EPC_s \cdot IRS \cdot CF_{km} \cdot \left(EF_{hd}/CF_{hd}\right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

<u>*Non-carcinogens*</u>

$$ADD = \frac{EPC_s \cdot IRS \cdot CF_{km} \cdot \left(EF_{hd}/CF_{hd}\right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

Where:

ADD	=	Average daily dose from incidental soil ingestion (mg/[kg·d])
EPC_s	=	Contaminant concentration in soil (mg/kg)
IRS_{adj}	=	Age-adjusted incidental soil ingestion factor ([mg·yr]/[kg·d])
IRS	=	Incidental soil ingestion rate (mg/d)
CF_{km}	=	Conversion factor (10^{-6} kg/mg)
EF_{hd}	=	Exposure frequency (hr/d)
CF_{hd}	=	Conversion factor (24 hr/d)
BW	=	Body weight (kg)
EF_{dy}	=	Exposure frequency (d/yr)
ED	=	Exposure duration (yr)
AT_n	=	Averaging time, noncarcinogens (d)
AT_c	=	Averaging time, carcinogens (d)

Dermal Contact with Soil and Sediment

The ADD from dermal contact with soil is calculated as follows:

<u>*Carcinogens, other*</u>

$$ADD = \frac{DA_{soil} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

<u>*Non-carcinogens*</u>

$$ADD = \frac{DA_{soil} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

$$DA_{soil} = EPC_s \cdot AF \cdot DAF \cdot CF_{km}$$

Where:

ADD	=	Absorbed daily dose from contact with soil (mg/[kg·d])
SA	=	Exposed skin surface area (cm^2)
SFS_{adj}	=	Age-adjusted soil dermal contact factor ([mg·yr]/[kg·event])
EF_{dy}	=	Exposure frequency (d/yr)
EF_{evd}	=	Event frequency (events/d)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT_n	=	Averaging time, noncarcinogens (d)
AT_c	=	Averaging time, carcinogens (d)
DA_{soil}	=	Absorbed dose per soil contact event (mg/cm^2·event)
EPC_s	=	Contaminant concentration in soil (mg/kg)
AF	=	Soil-to-skin adherence factor (mg/cm^2·event)
CF_{km}	=	Conversion factor (10^{-6} kg/mg)
DAF	=	Dermal absorption factor (unitless)
BW	=	Body weight (kg)

Inhalation of Soil Particles

The ADD from inhalation of soil particles is calculated as follows:

<u>*Carcinogens, other*</u>

$$ADD = \frac{PM_{10} \cdot IRA \cdot \left(EF_{hd} / CF_{hd}\right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

<u>*Non-carcinogens*</u>

$$ADD = \frac{PM_{10} \cdot IRA \cdot \left(EF_{hd} / CF_{hd}\right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

$$PM_{10} = \left(\frac{EPC_s}{PEF} \right) \cdot F_s$$

Where:

ADD	=	Average daily dose from inhalation of particulates (mg/[kg·d])
PM_{10}	=	Concentration of respirable particulates in air (mg/m^3)
INF_{adj}	=	Age-adjusted inhalation factor ([m^3·yr]/[kg·d])
IRA	=	Inhalation rate (m^3/d)
F_s	=	Fraction of soil contaminated (unitless)
EF_{hd}	=	Exposure frequency (hr/d)
CF_{hd}	=	Conversion factor (24 hr/d)
EF_{dy}	=	Exposure frequency (d/yr)
ED	=	Exposure duration (yr)
BW	=	Body weight of *k*th age (kg)
AT_n	=	Averaging time, noncarcinogens (d)
AT_c	=	Averaging time, carcinogens (d)
PEF	=	Particulate emission factor (m^3/kg)

Ingestion of Surface Water

The ADD from ingestion of surface water is calculated as follows:

Carcinogens, occupational

$$ADD = \frac{EPC_{sw} \cdot IRW \cdot \left(EF_{hd} / CF_{hd} \right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Non-carcinogens

$$ADD = \frac{EPC_{sw} \cdot IRW \cdot \left(EF_{hd} / CF_{hd} \right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

Where:

ADD	=	Average daily dose from tap water ingestion (mg/[kg·d])
EPC_{sw}	=	Contaminant concentration in water (mg/L)
IRW_{adj}	=	Age-adjusted water ingestion factor ([L·yr]/[kg·d])
IRW	=	Drinking (tap) water ingestion rate (L/d)
EF_{hd}	=	Exposure frequency (hr/d)
CF_{hd}	=	Conversion factor (24 hr/d)
EF_{dy}	=	Exposure frequency (d/yr)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT_n	=	Averaging time, noncarcinogens (d)
AT_c	=	Averaging time, carcinogens (d)

Dermal Contact with Surface Water

The ADD from dermal contact with surface water is calculated as follows:

Carcinogens, occupational

$$ADD = \frac{DA_{sw} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Non-carcinogens

$$ADD = \frac{DA_{sw} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

Inorganics in water

$$DA_{sw} = 10^{-3} \cdot \left(EPC_{sw} \cdot CF_{cl}\right) \cdot t_{event}$$

Where:

ADD	=	Absorbed daily dose from contact with water (mg/[kg·d])
SA	=	Exposed skin surface area (cm^2)
SAS_{adj}	=	Age-adjusted water dermal contact factor ([cm^2·yr]/kg)
EF_{evd}	=	Event frequency (events/d)
EF_{dy}	=	Exposure frequency (d/yr)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT_n	=	Averaging time, noncarcinogens (d)
AT_c	=	Averaging time, carcinogens (d)
DA_{sd}	=	Dose absorbed per unit area per water contact event (mg/cm^2·event)
EPC_{sw}	=	Contaminant concentration in water (mg/L)
CF_{cl}	=	Conversion factor (10^{-3} L/cm^3)
t_{event}	=	Duration of exposure event (hr/event)
K_p	=	Dermal permeability coefficient (cm/hr)
τ	=	Lag time (hr/event)
t*	=	Time to reach steady-state (hr)
B	=	Relative contribution of permeability coefficients (unitless)
K_{ow}	=	*n*-Octanol-water partition coefficient
MW	=	Contaminant-specific molecular weight (g/mol)

Table B-1. Seclection of Human Health Chemicals of Potential Concern
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest	Surface Soil				Subsurface Soil				Sediment				Surface Water			
	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (R_{ij})	Chemical of Potential Concern?	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (R_{ij})	Chemical of Potential Concern?	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (R_{ij})	Chemical of Potential Concern?	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (R_{ij})	Chemical of Potential Concern?
	mg/kg				mg/kg				mg/kg				µg/L			
Aluminum									1.00E+05	1.20E+04	0.1	No	3.65E+04	2.22E+02	6.00E-03	No
Antimony	4.09E+02	1.49E+02	0	No	4.09E+02	2.35E+02	0.6	No	4.09E+02	1.59E+00	0.004	No	1.50E+01	1.00E+00	0.07	No
Arsenic	1.59E+00	1.25E+02	79	**YES**	1.59E+00	6.32E+01	40	**YES**	1.59E+00	1.53E+01	10	**YES**	4.48E-02	5.89E-01	13	**YES**
Barium									6.66E+04	9.78E+01	0.001	No	2.55E+03	1.99E+01	0.008	No
Beryllium									1.94E+03	6.41E-01	0.0003	No	7.30E+01	1.23E+00	0.02	No
Cadmium	4.50E+02	4.30E+02	1.0	No	4.50E+02	1.43E+02	0.3	No	4.50E+02	2.16E+00	0.005	No	1.82E+01	6.34E-01	0.03	No
Chromium					2.10E+02	2.80E+01	0.1	No	2.10E+02	2.31E+01	0.1	No	1.09E+02	6.16E+00	0.06	No
Cobalt	1.92E+03	3.10E+01	0.02	No	1.92E+03	2.36E+01	0.01	No	1.92E+03	1.26E+01	0.01	No				
Copper	4.09E+04	1.91E+03	0.05	No	4.09E+04	1.34E+03	0.03	No	4.09E+04	2.40E+01	0.0006	No	1.46E+03	2.10E+00	0.001	No
Iron	1.00E+05	3.02E+04	0.3	No	1.00E+05	2.27E+04	0.2	No	1.00E+05	6.38E+04	0.6	No	1.09E+04	4.68E+02	0.04	No
Lead	8.00E+02	4.29E+04	54	YES	8.00E+02	1.28E+04	16	YES	8.00E+02	1.09E+03	1	**YES**	NA	6.15E+00		**YES**
Manganese									1.95E+04	1.57E+03	0.08	No	8.76E+02	9.95E+00	0.01	No
Mercury	3.07E+02	3.45E+00	0.01	No	3.07E+02	1.96E+00	0.01	No	3.07E+02	4.20E-01	0.001	No				
Nickel	1.60E+03	3.08E+01	0.02	No	1.60E+03	4.40E+01	0.03	No	1.60E+03	2.52E+01	0.02	No				
Selenium	5.11E+03	8.79E+00	0.002	No	5.11E+03	2.00E+01	0.004	No	5.11E+03	6.15E-01	0.0001	No				
Silver	5.11E+03	2.03E+02	0.04	No	5.11E+03	2.98E+02	0.06	No	5.11E+03	1.03E+00	0.0002	No	1.82E+02	4.16E-02	0.0002	No
Thallium	6.75E+01	1.00E+01	0.1	No	6.75E+01	1.00E+01	0.1	No	6.75E+01	7.50E-01	0.01	No	2.41E+00	1.27E-01	0.05	No
Vanadium					1.02E+03	3.26E+01	0.03	No	1.02E+03	3.49E+01	0.03	No	3.65E+01	3.08E+00	0.08	No
Zinc	1.00E+05	9.30E+04	0.9	No	1.00E+05	3.00E+04	0.3	No	1.00E+05	1.64E+03	0.02	No	1.09E+04	6.49E+01	0.006	No
		Sum of R_{ij}:	135			Sum of R_{ij}:	58			Sum of R_{ij}:	12			Sum of R_{ij}:	14	
		No. of Samples:	13			No. of Samples:	15			No. of Samples:	19			No. of Samples:	14	
		1/No. of Samples:	0.08			1/No. of Samples:	0.07			1/No. of Samples:	0.05			1/No. of Samples:	0.1	

NOTE:
mg/kg = milligram per kilogram

Table B-2. Chemical Exposure and Intake Factors
Oriole Mine Risk Assessment, Metaline, Washington

	Recreational				Source
	Child		Adult		
	CTE	RME	CTE	RME	
Exposure Factors					
Body Weight (kg)	15	15	70	70	EPA, 1997
Exposure Frequency (d/yr) soil	6	12	9	18	Site Specific
Exposure Frequency (d/yr) sediment	6	12	9	18	Site Specific
Exposure Frequency (d/yr) surface water	6	12	9	18	Site Specific
Event time (hr/event) surface water	2	2	9	2	Site Specific
Event time (hr/event) soil	1	2	2	2	Site Specific
Event Frequency (events/d)	1	1	1	1	Site Specific
Exposure Duration (yr)	6	6	9	24	EPA, 1997
Averaging Time (d)					
carcinogens	25,550	25,550	25,550	25,550	EPA, 1989
non-carcinogens	2,190	2,190	3,285	8,760	EPA, 1989
Intake Factors					
Ingestion of soil (mg/d)	100	200	50	100	EPA, 1997
Incidental ingestion of sediment (mg/d)	50	100	25	50	EPA, 1997
Incidental surface water ingestion (L/hr)	0.05	0.05	0.05	0.05	EPA, 1997
Exposed skin surface area (cm^2)	6,600	7,300	18,000	22,000	EPA, 2004a
Inhalation rate (m^3/day)	8.3	8.3	15.2	15.2	EPA, 1997
Dermal absorption factor					
volatile vp> 12000 Pa	0.0005	0.0005	0.0005	0.0005	EPA, 2004a
volatile vp< 12000 Pa	0.03	0.03	0.03	0.03	EPA, 2004a
inorganics	0.1	0.01	0.01	0.01	EPA, 2004a
Soil Adherence Factor (mg/cm^2-event)	0.01	0.07	0.01	0.07	EPA, 2004a
PEF (mg^3/kg)	1,320,000,000	1,320,000,000	1,320,000,000	1,320,000,000	EPA, 2004a

NOTES:
CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure
kg = kilogram
d/yr = days per year
hr/event - hours per event
events/d = events per day
yr = year
d = day
mg/d = milligrams per day
L/hr = liters per hour
cm^2 = sqaure centimeters
m^3/hour - cubic meters per hour
m^3/kg - cubic meters per kilogram
mg/cm^2-event = milligram per square centimeter - event
Averaging Time = Exposure Duration (yrs) X 365 days/year
vp = vapor pressure
Pa = Pascal
PEF = Particulate Emission Factor

SOURCES:
USEPA, 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). EPA/540/1-89/002.
USEPA, 1997. "Exposure Factors Handbook". Volumes I - III. EPA Office of Research and Development. August
USEPA, 2004a. "Risk Assessment Guide for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment." July
USEPA, 2004b. "Region IV Preliminary Remediation Goals". 2004 Update. EPA. December

Table B-3. Exposure Point Concentrations
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Potential Concern	n	Maximum Concentrations	CTE [1]	RME [2]
Surface Soil (mg/kg)				
Arsenic	8	1.73E+02	4.70E+01	1.25E+02
Lead	8	1.03E+05	1.90E+04	4.29E+04
Sediment (mg/kg)				
Arsenic	8	2.39E+01	9.53E+00	1.53E+01
Lead	8	1.88E+03	6.58E+02	1.09E+03
Surface Water (µg/L)				
Arsenic	12	9.00E-04	4.71E-04	5.89E-04

NOTES:
n = number of samples
CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure
mg/kg = milligram per kilogram
µg/L = microgram per liter
1 Average Concentration
2 95% Upper Confidence Limit on the mean if greater then 5 datapoints or maximum concentration if less than 5 datapoints

Table B-4. Human Chemical Intake Rates
Oriole Mine Risk Assessment, Metaline, Washington

Scenario	Carcinogen		Non-Carcinogen	
	CTE	RME	CTE	RME
	mg/kg/day			
Recreational				
Surface Soil				
Ingestion	9.71E-10	5.14E-09	1.06E-08	4.24E-08
Inhalation of particulates	1.63E-12	7.93E-12	1.50E-11	4.38E-11
Dermal	8.15E-01	5.31E+00	6.34E+00	1.55E+01
Sediments				
Ingestion	1.52E-09	2.57E-09	5.30E-09	2.12E-08
Dermal	8.15E-01	5.31E+00	6.34E+00	1.55E+01
Surface Water				
Ingestion	1.39E-05	4.29E-05	3.52E-05	7.05E-05
Dermal	5.28E-02	4.43E-01	1.06E-06	9.69E-07

NOTES:
CTE = central tendency exposure
RME = reasonable maximum exposure
mg/kg/day = milligrams per kilogram per day

Table B-5. Human Health Dermal Absorption Factors for Soil
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Potential Concern	Dermal Absorption Factor	Conversion Factor	Recreational Adherence Factors		Recreational Dermal Absorption	
			CTE	RME	CTE	RME
Arsenic	0.01	0.000001	1.00E-02	7.00E-02	1.00E-10	7.00E-10

NOTES:
CTE = central tendency exposure
RME = reasonable maximum exposure

Table B-6. Human Health Dermal Absorption Factors for Carcinogens
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Potential Concern	Dermal Absorption Factor	Conversion Factor	Recreational Adherence Factors		Recreational Dermal Absorption	
			CTE	RME	CTE	RME
Arsenic	0.01	0.000001	1.00E-02	7.00E-02	1.00E-10	7.00E-10

NOTES:
CTE = central tendency exposure
RME = reasonable maximum exposure

Table B-7. Critical Toxicity Factors for Non-Carcinogenic Chemicals of Potential Concern
Oriole Mine Risk Assessment, Metaline, Washington

Contaminant of Potential Concern	Chronic Reference Dose* (mg/kg/day)		Confidence in Reference Dose	Endpoint
	Oral	Inhalation		
Arsenic	0.0003	Not Applicable	Medium	Hyperpigmentation, Vascular

NOTES:
* From Region IX Preliminary Remediation goal tables.
mg/kg/day = milligrams per kilogram per day

Table B-8. Critical Toxicity Factors for Carcinogenic Chemicals of Potential Concern
Oriole Mine Risk Assessment, Metaline, Washington

Contaminant of Potential Concern	Slope Factor $(mg/kg/day)^{-1}$		Weight of Evidence Classification	Type of cancer	Basis of Slope Factor
	Oral	Inhalation	Oral/ Inhalation	Oral/ Inhalation	Oral/ Inhalation
Arsenic	1.5	15	A	skin	EPI studies

NOTES:
mg/kg/day - milligrams per kilogram per day
A = Known Human Carcinogen

Table B-9. Hazard Quotients for Non-Carcinogenic Chemicals of Potential Concern
Oriole Mine Risk Assessment, Metaline, Washington

Route of Exposure	Chemical of Potential Concern	Exposure Point Concentration (mg/kg or mg/L)		Chemical Intake (mg/kg/day)		Oral Reference Dose (mg/kg/day)	Hazard Quotient	
		CTE	RME	CTE	RME		CTE	RME
Soil								
Ingestion	Arsenic	3.76E+01	1.00E+02	1.06E-08	4.24E-08	3.00E-04	1E-03	1E-02
Dermal	Arsenic	3.76E+01	1.00E+02	6.34E-10	1.08E-08	3.00E-04	8E-05	4E-03
Sediments								
Ingestion	Arsenic	7.62E+00	1.22E+01	5.30E-09	2.12E-08	3.00E-04	1E-04	9E-04
Dermal	Arsenic	7.62E+00	1.22E+01	6.34E-10	1.08E-08	3.00E-04	2E-05	4E-04
Surface Water								
Ingestion	Arsenic	3.77E-04	4.71E-04	3.52E-05	7.05E-05	3.00E-04	4E-05	1E-04
Dermal	Arsenic	3.77E-04	4.71E-04	1.06E-06	9.69E-07	3.00E-04	1E-06	2E-06
						Total:	2E-03	2E-02

NOTES:
CTE = central tendency exposure
RME = reasonable maximum exposure
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg/day = milligrams per kilogram per day

Table B-10. Excess Cancer Risks for Carcinogenic Chemicals of Potential Concern
Oriole Mine Risk Assessment, Metaline, Washington

Route of Exposure	Chemical of Potential Concern	Exposure Point Concentration (mg/kg or mg/L)		Chemical Intake (mg/kg/day)		Oral Slope Factor $(mg/kg/day)^{-1}$	Inhalation Slope Factor $(mg/kg/day)^{-1}$	Excess Cancer Risk	
		CTE	RME	CTE	RME			CTE	RME
Soil									
Ingestion	Arsenic	3.76E+01	1.00E+02	9.71E-10	5.14E-09	1.5		5E-08	8E-07
dermal	Arsenic	3.76E+01	1.00E+02	8.15E-11	3.72E-09	1.5		5E-09	6E-07
Inhalation of particulates	Arsenic	3.76E+01	1.00E+02	1.63E-12	7.93E-12		15	9E-10	1E-08
Sediments									
Ingestion	Arsenic	7.62E+00	1.22E+01	1.52E-09	2.57E-09	1.5		2E-08	5E-08
dermal	Arsenic	7.62E+00	1.22E+01	8.15E-11	3.72E-09	1.5		9E-10	7E-08
Surface Water									
Ingestion	Arsenic	3.77E-04	4.71E-04	1.39E-05	4.29E-05	1.5		8E-09	3E-08
dermal	Arsenic	3.77E-04	4.71E-04	1.06E-07	8.86E-07	1.5		6E-11	6E-10
							Total:	9E-08	1E-06

NOTES:
CTE = central tendency exposure
RME = reasonable maximum exposure
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
mg/kg/day = milligrams per kilogram per day

Attachment C.

Terrestrial Ecological Exclusion Evaluation

Voluntary Cleanup Program

Washington State Department of Ecology – Toxics Cleanup Program

TERRESTRIAL ECOLOGICAL EVALUATION EXCLUSION

Some contaminated sites are excluded from conducting a Terrestrial Ecological Evaluation (TEE). If your site meets the criteria for exclusion as described in WAC 173-340-7491, please complete this form.

Please note that exclusion from the TEE does not exclude the site for consideration of effects on aquatic or sediment ecological receptors.

SITE NAME: Oriole Mine

SITE ADDRESS: Colville National Forest, Pend Orielle County, near Metaline, Washington

EVALUATOR'S NAME: RONE BREWER, SOUND ECOLOGICAL ENDEAVORS

REASONS FOR EXCLUSION:

A site is eligible for exclusion if it meets any of the following criteria:

1. POINT OF COMPLIANCE WAC 173-340-7491(1)(A)

- No contamination present at site.
  1-☐
- All contamination is below 15 feet prior to remedial activities.
  2-☐
- All contamination is below six feet and an institutional control has been implemented, as required by WAC 173-340-440 .
  3-☐
- All contamination is below a site-specific point of compliance established in compliance with WAC 173-340-7490(4)(b) with an institutional control implemented as required by WAC 173-340-440.
  4-☐
  Please provide documentation that describes the rational for setting a site-specific point of compliance.

2. BARRIERS TO EXPOSURE WAC 173-340-7491(1)(B)

- All contaminated soil is or will be covered by physical barriers that prevent exposure to plants and wildlife and an institutional control has been implemented, as required by WAC 173-340-440.
  5-☐
  An exclusion based on future land use must have a completion date for future development that is acceptable to Ecology.

3. Undeveloped land WAC 173-340-7491 (1)(c)

- There is less than one-quarter acre of contiguous undeveloped land on or within 500 feet of any area of the site and any of the following chemicals is present: chlorinated dioxins or furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene.
  6-☐
- For sites not containing any of the chemicals mentioned above, there is less than one-and-a-half acres of contiguous undeveloped land on or within 500 feet of any area of the site.
  7-☐

"Undeveloped land" is land that is not covered by building, roads, paved areas, or other barriers that would prevent wildlife from feeding on plants, earthworms, insects, or other food in or on the soil.

"Contiguous" undeveloped land is an area of undeveloped land that is not divided into smaller areas of highways, extensive paving, or similar structures that are likely to reduce the potential use of the overall area by wildlife.

4. Background concentrations WAC 173-340-7491 (1) (d)

- Concentrations of hazardous substances in soil do not exceed background levels as described in WAC 173-340-709.
  8-☐

Explanation of Exclusion (If required):

Exclusion not possible. Conditions warrant site-specific ecological assessment

If your site does not meet the TEE exclusions, you may have to conduct a simplified TEE in accordance with WAC 173-340-7492 or a site-specific TEE in accordance with WAC 173-340-7493. Please contact regional VCP staff with questions about conducting a simplified or site-specific TEE.

Ecology is an equal opportunity employer. For alternative format, please contact the Toxic Cleanup Program at (360) 407-7170 or 711 or 1-800-833-6388 (TTY).

Attachment D.

Rare, Threatened, and Endangered Species

Table D-1. Summary of Rare, Threatened, or Endangered Species in the Vicinity
Oriole Mine Risk Assessment, Metaline, Washington

Common Name	Species Name	State Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
AQUATIC INVERTEBRATES					
None					
FISH					
Westslope cutthroat	***Oncorhynchus clarki lewisi***		**Concern**		**Expected**
Rainbow trout	***Oncorhynchus Mykiss***	**Priority**			**Expected**
PLANTS					
Crested shield-fern	*Dryopteris cristata*	**Sensitive**			**Expected**
Blue-eyed grass	*Sisyrinchium septentrionale*	Sensitive			Possible
Bronze sedge	*Carex foenea*	Threatened			Possible
Creeping snowberry	*Gaultheria hispidula*	Sensitive			Possible
Kidney-leaved violet	*Viola renifolia*	Sensitive			Possible
Yellow sedge	*Carex flava*	Sensitive			Possible
TERRESTRIAL INVERTEBRATES					
None Identified					
REPTILES AND AMPHIBIANS (HERPETILES)					
Spotted frog	***Rana pretiosa***	**Endangered**	**Candidate**	**Sensitive**	**Expected**
Northern leopard frog	*Rana pipiens*	Endangered	Concern		Possible
BIRDS					
Pileated woodpecker	***Dryocopus pileatus***	**Candidate**			**Observed**
Black-backed woodpecker	***Picoides arcticus***	**Candidate**			**Expected**
Great gray owl	***Strix nebulosa***			**Sensitive**	**Expected**
Northern goshawk	***Accipiter gentilis***	**Candidate**	**Concern**	**Sensitive**	**Expected**
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened		Possible
Harlequin duck	*Histrionicus histrionicus*	Priority			Possible
Flammulated owl	*Otus flammeolus*	Candidate			Possible
Golden eagle	*Aquila chrysaetos*	Candidate			Possible
Lewis' woodpecker	*Melanerpes lewis*	Candidate			Possible
Olive-sided flycatcher	*Contopus borealis*		Concern		Possible
Vaux's swift	*Chaetura vauxi*	Candidate			Possible
White-headed woodpecker	*Picoides albolarvatus*	Candidate			Possible
Willow flycatcher	*Empidonax traillii*		Concern		Possible
MAMMALS					
Townsend's big-eared bat	***Coryhorhinus townsendii***	**Candidate**	**Concern**		**Expected**
Canada lynx	*Lynx canadensis*	Threatened	Threatened	Sensitive	Possible
Yuma myotis	*Myotis yumanensis*	none	Concern		Possible
Gray wolf	*Canis Lupus*	Endangered	Threatened	Sensitive	Possible
Wolverine	*Gulo gulo*	Candidate	Concern		Possible

NOTES:

Blank status indicates the species is not rare, threatened, or endangered under that jurisdiction.

Bold indicates species observed or expected at or near the Rainy mine.

Underlined species names are linked to internet fact sheets

Attachment E.

Ecological Risk-Based Screening Tables

Table E-1. Ecological Risk-Based Screening for Surface Soil/Waste Material
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI) (a)	Exposure Point Concentration*	Half of Maximum Sample Reporting Limit	Risk-Based Screening Value for Plants	Risk-Based Screening Value for Invertebrates	Risk-Based Screening Value for Birds	Risk-Based Screening Value for Mammals	Risk Ratio (Rij) (b)				Bioaccumulator? (c)
	mg/kg						Plants	Invertabrates	Birds	Mammals	
Metals											
Antimony	7.73E+02	5.00E-01	5.00E+00	7.80E+01	No Data	1.50E+01	**155**	**10**	0	**52**	No
Arsenic III	1.13E-01	2.10E-02	1.00E+01	6.00E+01	7.00E+00	7.00E+00	0.01	0.002	0.02	0.02	**Yes**
Arsenic V	3.10E+01	Not Applicable	1.00E+01	6.00E+01	1.32E+02	1.32E+02	3	1	0.2	0.2	**Yes**
Arsenic, Total	1.43E+02	Not Applicable	1.80E+01	6.00E+01	4.30E+01	4.60E+01	**8**	2	3	3	**Yes**
Cadmium	2.20E+02	Not Applicable	4.00E+00	2.00E+01	6.00E+00	1.25E+02	**55**	**11**	**37**	2	**Yes**
Chromium, Total	1.71E+01	Not Applicable	4.20E+01	4.20E+01	6.70E+01	6.70E+01	0.4	0.4	0.3	0.3	No
Cobalt	2.63E+01	Not Applicable	2.00E+01	1.00E+03	1.20E+02	1.50E+02	1	0.03	0.2	0.2	No
Copper	2.21E+03	Not Applicable	1.00E+02	5.00E+01	2.17E+02	5.68E+01	**22**	**44**	**10**	**39**	No
Iron	2.61E+04	Not Applicable	1.00E+01	2.00E+02	No Data	No Data	**2,613**	**131**	0	0	No
Lead	7.15E+04	Not Applicable	5.00E+01	5.00E+02	1.18E+02	1.18E+02	**1,429**	**143**	**606**	**606**	**Yes**
Manganese	3.21E+03	Not Applicable	1.10E+03	1.00E+02	1.50E+03	1.50E+03	3	**32**	2	2	No
Mercury	2.88E+00	5.00E-02	3.00E-01	1.00E-01	5.50E+00	5.50E+00	**10**	**29**	1	1	**Yes**
Nickel	3.05E+01	Not Applicable	3.00E+01	2.00E+02	9.80E+02	5.68E+01	1	0.2	0.03	1	No
Selenium	1.21E+01	5.00E-01	1.00E+00	7.00E+01	3.00E-01	3.00E-01	**12**	0.2	**40**	**40**	**Yes**
Silver	1.54E+02	Not Applicable	2.00E+00	5.00E+01	No Data	No Data	**77**	3	0	0	No
Thallium	1.61E+01	1.00E+00	1.00E+00	1.00E+00	No Data	1.00E+00	**16**	**16**	0	**16**	No
Zinc	7.99E+04	Not Applicable	8.60E+01	2.00E+02	3.60E+02	3.77E+01	**929**	**399**	**222**	**2,120**	No
							5,334	**822**	**922**	**2,882**	:Sum of R_{ij} (R_j)
							17	17	17	17	:Number of COIs (N_{ij})
							0.06	0.06	0.06	0.06	:1/N_{ij}

NOTES:
mg/kg = milligrams per kilogram
Unknown = Chemical was detected, but no screening criteria are available.

Bold indicates chemicals of potential concern that may require further assessment at the site.
* Upper confidence limit on the mean or maximum (whichever is lower)

(a) Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
(b) The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
(c) As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).
(d) The COI is considered a COPEC if:
1) The risk ratio (R_{ij}) is greater than 5 (non-protected) or 1 (protected)
2) The Chemical of Interest is a bioaccumulator
3) No SLV or bioaccumulation vaule is available.
4) Not Calculated = Risk was not calculated for analytes with no screening criteria or bioaccumulation data.

Table E-1. Ecological Risk-Based Screening for Surface Soi
Oriole Mine Risk Assessment, Metaline, Washing

Chemical of Interest (COI) (a)	Risks Posed to Non-Protected Species (R_{ij}>5) (d)				Risks Posed to Non-Protected Species Due to Elevated Reporting Limit				Inordinate Contribution to Overall Risks for Non-Protected Species (R_{ij}/R_j > 5/N_{ij})				Risks Posed to Non-Protected Species			
	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals
Metals																
Antimony	**Yes**	**Yes**	Not Calculated	**Yes**	No	No	No	No	No	No	Unkown	No	**Yes**	**Yes**	No	**Yes**
Arsenic III	No	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**
Arsenic V	No	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**
Arsenic, Total	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No	**Yes**	No	**Yes**	**Yes**
Cadmium	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**
Chromium, Total	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cobalt	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Copper	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**
Iron	**Yes**	**Yes**	Not Calculated	Not Calculated	No	No	No	No	**Yes**	No	Unkown	Unkown	**Yes**	**Yes**	No	No
Lead	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Manganese	No	**Yes**	No	No	No	No	No	No	No	No	No	No	No	**Yes**	No	No
Mercury	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**
Nickel	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Selenium	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No	**Yes**	No	**Yes**	**Yes**
Silver	**Yes**	No	Not Calculated	Not Calculated	No	No	No	No	No	No	Unkown	Unkown	**Yes**	No	No	No
Thallium	**Yes**	**Yes**	Not Calculated	**Yes**	No	No	No	No	No	No	Unkown	No	**Yes**	**Yes**	No	**Yes**
Zinc	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

NOTES:
mg/kg = milligrams per kilogram
Unknown = Chemical was detected, but no screening criteria are available.

Bold indicates chemicals of potential concern that may require further assessment at the site.
* Upper confidence limit on the mean or maximum (whichever is lower)

(a) Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
(b) The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
(c) As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).
(d) The COI is considered a COPEC if:
1) The risk ratio (R_{ij}) is greater than 5 (non-protected) or 1 (protected)
2) The Chemical of Interest is a bioaccumulator
3) No SLV or bioaccumulation vaule is available.
4) Not Calculated = Risk was not calculated for analytes with no screening criteria or bioaccumulation data.

Table E-2. Ecological Risk-Based Screening for Surface Water
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI) (a)	Exposure Point Concentration*	Half of Maximum Sample Reporting Limit	Freshwater Risk-Based Screening Value for Aquatic Life	Freshwater Risk-Based Screening Value for Birds	Freshwater Risk-Based Screening Value for Mammals	Risk Ratio (Rij) (b)			Bioaccumulator? (c)	Risks Posed to Aquatic Life (R_{ij}>1) (d)	Risks Posed to Non-Protected Species (R_{ij}>5) (d)		Risks Posed to Aquatic Life Due to Elevated Reporting Limit	Risks Posed to Non-Protected Species Due to Elevated Reporting Limit		Inordinate Contribution to Overall Risks for Non-Protected Species (R_{ij}/R_j > $5/N_{ij}$)			Risks Posed to Non-Protected Species		
	mg/L					Aquatic Life	Birds	Mammals			Birds	Mammals		Birds	Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals
Metals																					
Aluminum	2.22E-01	1.50E-02	8.70E-02	7.97E+02	8.00E+00	**3**	0.0003	0.03	No	**Yes**	No	No	No	No	No	**Yes**	No	No	**Yes**	No	No
Antimony	1.07E-03	2.00E-04	1.60E+00	No Data	1.00E+00	0.0007	0	0.001	No	No	Not Calculated	No	No	No	No	No	No	No	No	Unknown	No
Arsenic, Total	5.89E-04	2.50E-04	1.50E-01	1.80E+01	6.00E+00	0.004	0.00003	0.0001	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	**Yes**	**Yes**
Barium	1.99E-02	Not Applicable	4.00E-03	1.50E+02	3.90E+01	**5**	0.0001	0.0005	No	**Yes**	No	No	No	No	No	**Yes**	No	No	**Yes**	No	No
Beryllium	1.23E-03	1.00E-03	5.30E-03	No Data	No Data	0.2	0	0	No	No	Not Calculated	Not Calculated	No	No	No	No	No	No	No	Unknown	Unknown
Cadmium	6.34E-04	5.00E-05	4.23E-04	1.00E+01	8.00E+00	1	0.00006	0.00008	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	**Yes**	**Yes**
Chromium VI	9.34E-03	5.00E-03	1.00E-02	7.20E+00	2.50E+01	1	0.001	0.0004	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	**Yes**	**Yes**
Chromium, Total	6.16E-03	5.00E-03	1.00E-02	7.20E+00	2.50E+01	1	0.00086	0.0002	No	No	No	No	No	No	No	No	No	No	No	No	No
Copper	2.10E-03	5.00E-03	4.06E-03	3.41E+02	5.30E+01	1	0.000006	0.00004	No	No	No	No	No	No	No	No	No	No	No	No	No
Iron	4.68E-01	1.00E-02	1.00E+00	No Data	No Data	0	0	0	No	No	Not Calculated	Not Calculated	No	No	No	No	No	No	No	Unknown	Unknown
Lead	6.15E-03	2.50E-04	6.64E-04	2.80E+01	3.23E+02	**9**	0.0002	0.00002	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	**Yes**	No	No	**Yes**	**Yes**	**Yes**
Manganese	9.95E-03	2.50E-03	1.20E-01	7.24E+03	6.76E+02	0	0.000001	0.00001	No	No	No	No	No	No	No	No	No	No	No	No	No
Silver	4.16E-05	2.50E-05	1.20E-04	No Data	No Data	0	0	0	No	No	Not Calculated	Not Calculated	No	No	No	No	No	No	No	Unknown	Unknown
Thallium	1.27E-04	5.00E-05	4.00E-02	No Data	6.00E-02	0	0	0.0021	No	No	Not Calculated	No	No	No	No	No	No	No	No	Unknown	No
Vanadium	3.08E-03	2.50E-03	2.00E-02	8.20E+01	1.60E+00	0	0.00004	0.002	No	No	No	No	No	No	No	No	No	No	No	No	No
Zinc	6.49E-02	5.00E-03	3.77E-02	1.05E+02	1.23E+03	**2**	0.0006	0.00005	No	**Yes**	No	No	No	No	No	No	No	No	**Yes**	No	No
						23	0.004	0.03	:Sum of R_{ij} (R_j)												
						16	16	16	:Number of COIs (N_{ij})												
						0.06	0.06	0.06	:$1/N_{ij}$												

NOTES:
mg/L = milligrams per liter
Unknown = Chemical was detected, but no screening criteria are available.
Bold indicates chemicals of potential ecological concern that may require further assessment at the site.
* Upper confidence limit on the mean or maximum (whichever is lower)

(a) Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
(b) The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
(c) As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).
(d) The COI is considered a COPEC if:
1) The risk ratio (R_{ij}) is greater than 1 for protected species and aquatic life.
2) The risk ratio (R_{ij}) is greater than 5 for other species.
3) The Chemical of Interest is a bioaccumulator
4) The Chemical of Interest has an elevated detection limit
5) No risk-based screening or bioaccumulation vaule is available.
6) Inordinate contribution to overall risk (R_j).

Table E-3. Ecological Risk-Based Screening for Sediment
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI) (a)	Sediment Exposure Point Concentration	Maximum Sample Reporting Limit	Freshwater Sediment Risk-Based Screening Value for Benthic Invertebrates	Freshwater Sediment Risk-Based Screening Value for Bioaccumulation	Risk Ratio (Rij) (b)		Bioaccumulator? (c)	Risks Posed to Invertebrates (R_{ij}>1) (d)	Risks Posed to Non-Protected Birds and Mammals (R_{ij}>5) (d)	Risks Posed to Invertebrates Due to Elevated Reporting Limit	Risks Posed to Non-Protected Birds and Mammals Due to Elevated Reporting Limit	Inordinate Contribution to Overall Risks for Non-Protected Species (R_{ij}/R_j > $5/N_{ij}$)		Risks Posed to Non-Protected Species	
	mg/kg				Benthic Invertebrates	Birds and Mammals						Benthic Invertebrates	Birds and Mammals	Benthic Invertebrates	Birds and Mammals
Metals															
Aluminum	1.20E+04	Not Applicable	No Data	No Data	0	0	No	Not Calculated	No	No	No	Unknown	Unknown	Unknown	No
Antimony	1.59E+00	1.00E-01	3.00E+00	1.00E+01	0.5	0.2	Not Required	No	No	No	No	No	No	No	No
Arsenic V	1.53E+01	Not Applicable	6.00E+00	4.00E+00	**3**	4	Not Required	**Yes**	No	No	No	No	No	**Yes**	No
Arsenic, Total	1.53E+01	Not Applicable	6.00E+00	4.00E+00	**3**	4	Not Required	**Yes**	No	No	No	No	No	**Yes**	No
Barium	9.78E+01	Not Applicable	No Data	No Data	0	0	No	Not Calculated	No	No	No	No	No	Unknown	No
Beryllium	6.41E-01	Not Applicable	No Data	1.22E+02	0	0.005	Not Required	Not Calculated	No	No	No	No	No	Unknown	No
Cadmium	2.16E+00	Not Applicable	6.00E-01	3.00E-03	**4**	**719**	Not Required	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**
Chromium, Total	2.31E+01	Not Applicable	3.70E+01	4.20E+03	0.6	0.005	Not Required	No	No	No	No	No	No	No	No
Cobalt	1.26E+01	Not Applicable	No Data	No Data	0	0	No	Not Calculated	No	No	No	No	No	Unknown	No
Copper	2.40E+01	Not Applicable	3.60E+01	1.00E+01	0.7	2	Not Required	No	No	No	No	No	No	No	No
Iron	6.38E+04	Not Applicable	No Data	No Data	0	0	No	Not Calculated	No	No	No	No	No	Unknown	No
Lead	1.09E+03	Not Applicable	3.50E+01	1.28E+02	**31**	**9**	Not Required	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**
Manganese	1.57E+03	Not Applicable	1.10E+03	No Data	1	0	No	No	No	No	No	No	No	No	No
Mercury	4.20E-01	2.50E-02	2.00E-01	No Data	**2**	0	**Yes**	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**
Nickel	2.52E+01	Not Applicable	1.80E+01	3.16E+02	1	0.08	Not Required	No	No	No	No	No	No	No	No
Selenium	6.15E-01	2.50E-01	No Data	1.00E-01	0	**6**	Not Required	Not Calculated	**Yes**	No	No	No	No	Unknown	**Yes**
Silver	1.03E+00	1.50E-01	4.50E+00	No Data	0.2	0	No	No	No	No	No	No	No	No	No
Thallium	7.50E-01	Not Applicable	No Data	7.00E-01	0	1	Not Required	Not Calculated	No	No	No	No	No	Unknown	No
Vanadium	3.49E+01	Not Applicable	No Data	No Data	0	0	No	Not Calculated	No	No	No	No	No	Unknown	No
Zinc	1.64E+03	Not Applicable	1.23E+02	3.00E+00	**13**	**546**	No	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**

NOTES:	60	1,291	:Sum of R_{ij} (R_j)
mg/kg = milligrams per kilogram	20	20	:Number of COIs (N_{ij})
Unknown = Chemical was detected, but no screening criteria are available.	0.05	0.05	:$1/N_{ij}$

Bold indicates chemicals of potential ecological concern that may require further assessment at the site.
* Upper confidence limit on the mean or maximum (whichever is lower)

(a) Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
(b) The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
(c) As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).
Bioaccumulation screening not required when a bioaccumulation screening value is available.
(d) The COI is considered a COPEC if:
1) The risk ratio (R_{ij}) is greater than 1 for protected species and benthic invertebrates.
2) The risk ratio (R_{ij}) is greater than 5 for other species.
3) The Chemical of Interest is a bioaccumulator
4) The Chemical of Interest has an elevated detection limit
5) No risk-based screening or bioaccumulation vaule is available.
6) Inordinate contribution to overall risk (R_j).

Table E-4. Ecological Risk-Based Screening for Surface Water
Oriole Mine Risk Assessment, Metaline, Washington

Chemical of Interest (COI) (a)	Exposure Point Concentration*	Half of Maximum Sample Reporting Limit	Freshwater Risk-Based Screening Value for Aquatic Life	Freshwater Risk-Based Screening Value for Birds	Freshwater Risk-Based Screening Value for Mammals	Risk Ratio (R_{ij}) (b)			Bioaccumulator? (c)	Risks Posed to Aquatic Life (R_{ij}>1) (d)	Risks Posed to Non-Protected Species (R_{ij}>5) (d)		Risks Posed to Aquatic Life Due to Elevated Reporting Limit	Risks Posed to Non-Protected Species Due to Elevated Reporting Limit		Inordinate Contribution to Overall Risks for Non-Protected Species ($R_{ij}/R_j > 5/N_{ij}$)			Risks Posed to Non-Protected Species		
	mg/L					Aquatic Life	Birds	Mammals			Birds	Mammals		Birds	Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals
Metals																					
Copper	1.70E-02	1.50E-03	4.06E-03	3.41E+02	5.30E+01	**4**	0.00005	0.0003	No	**Yes**	No	No	No	No	No	**Yes**	No	No	**Yes**	No	No
Lead	8.00E-04	5.00E-03	6.64E-04	2.80E+01	3.23E+02	1	0.00003	0.000002	**Yes**	No	**Yes**	**Yes**	**Yes**	No	No	No	No	No	**Yes**	**Yes**	**Yes**
Thallium	1.80E-03	2.50E-04	4.00E-02	No Data	6.00E-02	0.05	0	0.03	No	No	Not Calculated	No	No	No	No	No	No	No	No	Unknown	No
Zinc	2.00E-02	5.00E-03	3.77E-02	1.05E+02	1.23E+03	0.5	0.0002	0.00002	No	No	No	No	No	No	No	No	No	No	No	No	No

NOTES:
mg/L = milligrams per liter
Unknown = Chemical was detected, but no screening criteria are available.
Bold indicates chemicals of potential ecological concern that may require further assessment at the site.
* Maximum detected concentration.

6	0.0003	0.03	:Sum of R_{ij} (R_j)
4	4	4	:Number of COIs (N_{ij})
0.25	0.25	0.25	:1/N_{ij}

(a) Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
(b) The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
(c) As listed in the Draft Sediment Evaluation Guidance (ODEQ, 2002).
(d) The COI is considered a COPEC if:
1) The risk ratio (R_{ij}) is greater than 1 for protected species and aquatic life.
2) The risk ratio (R_{ij}) is greater than 5 for other species.
3) The Chemical of Interest is a bioaccumulator
4) The Chemical of Interest has an elevated detection limit
5) No risk-based screening or bioaccumulation vaule is available.
6) Inordinate contribution to overall risk (R_j).

Appendix B.

Data Gap Investigation Photographs

Appendix B. Data Gap Investigation Photos

Photo 1. Sample station LC-1

Photo 2. High flow at sample station LC-1

Photo 3. Sample station LC-1a

Photo 4. Sample Station LC-1a, downstream

Photo 5. Sample station LC-2

Photo 6. Sample station LC-3

Appendix B. Data Gap Investigation Photos

Photo 7. Sample station LC-5

Photo 8. Background soil BGS-6

Photo 9. Adit near Blacksmith Shop

Photo 10. Blacksmith Shop near Station LC-1

Photo 11. Ducknest forge in Blacksmith Shop

Photo 12. Sample station LC-3

Appendix C.

Applicable or Relevant and Appropriate Requirements

Appendix C. Table 1
Chemical-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Safe Drinking Water Act	40 USC § 300		
National Primary Drinking Water Regulations	40 CFR Part 141	Establishes health-based standards, maximum contaminant levels (MCLs) and MCL goals (MCLGs), for public water systems.	Applicable, not Relevant and Appropriate because no public water systems are impacted by the Oriole Mine
National Secondary Drinking Water Regulations-	40 CFR Part 143	Establishes secondary MCLs for aesthetic standards for public water systems.	Applicable, not Relevant and Appropriate because no public water systems are impacted by the Oriole Mine
Clean Water Act	33 USC § 1251-1376		
National Recommended Water Quality Criteria	Section 304(a)	Guidelines established for evaluating toxic effects on human health and aquatic organisms.	Relevant and Appropriate
National Ambient Water Quality Criteria	40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	Applicable
Clean Air Act	40 USC § 7409		
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes air quality levels that protect public health.	Not an ARAR, only "major" sources are subject to requirements related to NAAQS.
Preliminary Remediation Goals (PRGs) for soil and water	US Environmental Protection Agency (EPA) Region 9	PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements. The PRGs contained in the Region 9 PRG Table are generic; they are calculated without site specific information. However, they may be re-calculated using site specific data. PRGs are EPA guidelines, not legally enforceable standards.	Relevant and Appropriate
Resource Conservation and Recovery Act	40 USC § 7601		
Lists of Hazardous Wastes	40 CFR Part 261, Subpart D and C	Defines those solids wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271.	Not an ARAR, mine waste is not a listed hazardous waste, Bevill exempt. Even if TCLP testing confirmed a characteristic waste (Subpart C), it is still exempt. Parts of the RCRA regulations may be relevant and appropriate; however, and are discussed under action-specific requirements.

Appendix C. Table 1
Chemical-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON			
Model Toxics Control Act (MTCA) Cleanup Regulations	WAC 173-340	Establishes administrative processes and standards to identify, investigate, and cleanup where hazardous substances have been released.	Relevant and Appropriate
MTCA Surface Water Cleanup Standards	WAC 173-340-730	Establishes surface water cleanup criteria based on estimates of highest beneficial use and reasonable maximum exposure for current and potential users.	Relevant and Appropriate
MTCA Soil Cleanup Standards – Residential Soils	WAC 173-340-740	Establishes soil cleanup levels for current and potential site use conditions.	Not an ARAR, because the Site is located in a remote area of the CNF.
MTCA Soil Cleanup Standards – Industrial Soils	WAC 173-340-745	Establishes soil cleanup levels where industrial site use represents reasonable maximum exposure.	Relevant and Appropriate
MTCA Air Quality Standards	WAC 173-340-750	Sets cleanup standards to protect air quality based on current and future site uses.	Relevant and Appropriate
MTCA Groundwater Cleanup Standards	WAC 173-340-720	Establishes clean-up levels based on the highest beneficial use and the reasonable maximum exposure expected.	Relevant and Appropriate
MTCA Human Health Risk Assessment	WAC 173-340-708	Defines the risk assessment framework to establish cleanup levels, and remediation levels using a quantitative risk assessment.	Relevant and Appropriate
MTCA Terrestrial Ecological Evaluation Procedures	WAC 173-340-7490	Establishes site specific cleanup standards for protection of terrestrial plants and animals. Does not include ecological receptors in sediment, surface water or wetlands.	Relevant and Appropriate
MTCA Simplified Terrestrial Ecological Evaluation Procedures	WAC 173-340-7492	Outlines the process for evaluating sites which do not have a substantial potential for posing a threat of significant adverse effects to terrestrial receptors.	Relevant and Appropriate
Water Quality Standards for Groundwater	WAC 173-200	Establishes groundwater quality standards to provide for the protection of public health, and current and future beneficial uses. This rule exempts CERCLA and MTCA cleanup actions.	Applicable, not Relevant and Appropriate because the groundwater pathway is incomplete.
Washington Department of Health Standards for Public Water Supplies	WAC 246-290	Establishes the regulatory requirements to protect consumers using public drinking water supplies.	Applicable, not Relevant and Appropriate because no public water systems are impacted by the Oriole Mine
Washington Dangerous Waste Regulations	WAC 173-303	Establishes the methods and procedures to determine if solid waste requires management as dangerous waste.	Relevant and Appropriate

Appendix C. Table 1
Chemical-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON (cont.)			
Surface Water Quality Standards	WAC 173-201A	Establishes water quality standards to protect public health, and the propagation and protection of fish, shellfish, and wildlife.	Relevant and Appropriate
Sediment Management Standards	WAC 173-204	Establishes standards to reduce and eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination.	Relevant and Appropriate

Appendix C. Table 2
Location-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Resource Conservation and Recovery Act	40 USC § 7601		
Hazardous and Solid Waste Regulations	40 CFR Part 264.18	Location standards and restrictions for hazardous waste treatment, storage, and disposal (TSD) facilities.	Relevant and Appropriate
	40 CFR §§ 257.3-1 through 257.3-4	Location standards and restrictions for municipal solid waste (MSW) facilities.	Not an ARAR, no MSW facilities at the Site.
National Historic Preservation Act	16 USC § 470; 36 CFR Part 800 40 CFR 6.301(b)	Requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on any property with historic, architectural, archeological, or cultural value that is included in or eligible for inclusion in the National Register of Historic Places.	Applicable
Historic Site, Buildings, Objects, and Antiquities Act	16 USC § 461-467	Requires preservation of historic sites, buildings, and objects that are discovered that national significance.	Applicable
Archeological and Historic Preservation Act	16 USC § 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of significant scientific, prehistoric, historic, and archeological data that might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Applicable
The Archaeological Resources Protection Act of 1979	16 USC § 470	Regulates requirements for authorized removal of archaeological resources from public or tribal lands.	Applicable
Executive Order 11593	16 USC § 469 40 CFR § 6.301(c)	Provides for the inventory and nomination of historical and archeological sites.	Applicable

Appendix C. Table 2
Location-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Native American Graves Protection and Repatriation Act	25 USC 3001-3013 43 CFR Part 10	Regulations that pertain to the identification, protection, and appropriate disposition of human remains, funerary objects, sacred objects, or objects of cultural patrimony.	Applicable
Protection of Wetlands Executive Order No. 11990	40 CFR Part 6; Appendix A, 40 CFR 6.302(a)	Avoid adverse impacts associated with the destruction or loss of wetlands and avoid support of new construction in wetlands if a practicable alternative exists.	Applicable
Dredge and Fill Regulations	33 USC § 1344, 33 CFR 323.1 et seq	Prohibits discharge of dredged or fill material into waters of the United States without a permit	Applicable, not Relevant and Appropriate, no dredge or fill material anticipated to be discharged
Fish and Wildlife Coordination Act	16 USC § 661-667 40 CFR 6.302(g)	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body to assure adequate protection of fish and wildlife resources.	Applicable, not Relevant and Appropriate because no modification is likely.
Fish and Wildlife Conservation Act	16 USC § 2901-2911	Promotes conservation of non-game fish and wildlife	Applicable
Wilderness Act	16 USC § 1131-1136	Requires that wilderness areas are left unimpaired for future use as a wilderness	Not an ARAR, the Site is not in a wilderness area
Federal Land Policy and Management Act of 1976	43 USC § 1701	Provides for multiple use and inventory, protection, and planning for cultural resources on public lands.	Relevant and Appropriate
Floodplain Management Executive Order No. 11988	40 CFR Part 6, Appendix A 40 CFR 6.302(b)	Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain to the extent possible.	Applicable, not relevant and appropriate because there is no floodplain at the site.
National Forest Management Act	16 USC § 1600-1614	The NFMA is the primary statute that requires the management of national forests to be based on multiple-use and sustained-yield principals.	Relevant and Appropriate

Appendix C. Table 2
Location-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
Executive Order No. 11593 – Protection and Enhancement of the Cultural Environment	Executive Order No. 11593	Requires federal agencies to nominate historic properties to the National Register of Historic Places and to treat eligible properties as if on the list.	Applicable
Executive Order No. 13007 – Indian Sacred Sites	Executive Order No. 13007	Required federal agencies to avoid disturbing and access to sacred Indian sites.	Applicable
The American Indian Religious Freedom Act	16 USC § 1996	The Act requires that federal agencies protect the right of Indian tribes to exercise their traditions.	Applicable
Endangered Species Act	16 USC § 1531-1544; 40 CFR 6.302 (h); 50 CFR Part 402	Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat.	Relevant and Appropriate
Migratory Bird Treaty Act	16 USC § 703 et seq	Establishes federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	Relevant and Appropriate
Bald Eagle Protection Act	16 USC § 668 et seq	Requires continued consultation with the USFWS during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald or golden eagle.	Relevant and Appropriate
Washington Department of Game	WAC 232-012	Defines the requirements that the Department of Game must take to protect endangered or threatened species.	Relevant and Appropriate
Washington State Shoreline Management Act	RCW Ch. 90.58 WAC 173-18, 22, 27	The substantive requirements of this statute and its implementing regulations apply to activities within 200 feet of shorelines in the state, which includes the shoreline of Gold Creek.	Relevant and Appropriate

Appendix C. Table 3
Action-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Clean Water Act	33 USC § 1342		
Section 402. National Pollutant Discharge Elimination System	33 USC § 1342 40 CFR Part 122.26	In general, Part 122 provides permit requirements for the discharge of pollutants from any point source into waters of the United States. Part 122.26 requires permits for storm-water discharges.	Substantive Requirements are Applicable, but not Relevant and Appropriate because permits are not required under CERCLA.
Section 404. Discharge of Dredge and Fill Materials	33 USC § 1344	Establishes program to regulate the discharge of dredged and fill materials into the waters of the US.	Substantive Requirements are Applicable, but not Relevant and Appropriate because permits are not required under CERCLA.
Surface Mining Control and Reclamation Act	30 USC §§ 1201-1328	Performance standards for surface mining activities.	Applicable, not Relevant and Appropriate, because this is an underground mine
Hazardous Materials Transportation Act	49 USC §§ 1801-1813 49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials.	Relevant and Appropriate, if any hazardous materials are transported offsite.
Resource Conservation and Recovery Act	46 USC § 7601		
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities	40 CFR Part 264.13.14	Requirements for proper handling, treatment, storage, and disposal of hazardous wastes.	Relevant and Appropriate
Land Disposal Restrictions (LDRs)	40 CFR Part 268	LDRs place specific restrictions (conc. or trmt) on RCRA hazardous wastes prior to their placement in a land disposal unit. Relevant and appropriate LDR requirements will be met if any material accumulations are treated *ex situ*.	Relevant and Appropriate
Disposal of Solid Waste	RCRA 42 U.S.C. § 6901 *et seq*; 40 CFR 257	Facility or practices in floodplains will not restrict flow of basic flood, reduce the temporary water storage capacity of the floodplain or otherwise result in a wash-out of solid waste.	Applicable, not Relevant and Appropriate because the site is not in a floodplain
Closure Requirements	RCRA/HWMA 40 CFR & 264, Subpart G	Closure of hazardous waste repositories must meet protective standards. Regulations to minimize contaminant migration, provide leachate collection and prevent contaminant exposure will be met.	Relevant and Appropriate

Appendix C. Table 3
Action-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Landfill Design and Construction	RCRA/HWMA 40 CFR & 264, Subpart N	Hazardous waste landfills must meet minimum design standards. Protectiveness will be achieved through capping and institutional controls.	Relevant and Appropriate
Ground Water Monitoring	RCRA/HWMA 40 CFR & 264, Subpart F 40 CFR & 264, Subpart X	Establishes standards for detection and compliance monitoring. Site wide monitoring will accommodate specific ground water monitoring requirements.	Applicable, not Relevant and Appropriate because the groundwater pathway is incomplete.
Clean Air Act	42 USC § 7401 40 CFR 50	The Act establishes requirements to protect ambient air quality by limited air emissions.	Applicable
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for determining which solid waste disposal practices pose threats to human health and the environment.	Relevant and Appropriate
Occupational Exposure to Asbestos	29 CFR Parts 1910 and 1926	Establishes OSHA requirements for asbestos-related work in the construction and demolition industry. Requirements on exposure limits, work practices and engineering controls to provide worker safety in handling, removal, disposal, or other workplace exposure to asbestos.	Applicable, not Relevant and Appropriate because no asbestos is present at the Site.
Fugitive Dust Emissions	40 CFR Section 50.6	Establishes standards for PM-10	Relevant and Appropriate

Appendix C. Table 3
Action-Specific Applicable or Relevant and Appropriate Requirements
Oriole Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON			
MTCA	RCW Ch. 70.105D WAC 173-340	MTCA establishes administrative processes and standards to investigate and remediate sites where hazardous substances are present.	Relevant and Appropriate
Hazardous Waste Management Act and Dangerous Waste Regulations	RCW Ch. 70.105 WAC 173-303	Regulations that apply to handling and disposal of dangerous wastes.	Applicable
Solids Waste Management, Recovery, and Recycling Act	RCW Ch. 70.95 WAC 173-350	Substantive provisions and requirements may be applicable if a removal action is taken.	Relevant and Appropriate
General Closure and Post-Closure Requirements, Landfilling Standards	WAC 173-304 – 407 WAC 173-460	Outlines capping requirements for onsite repositories.	Relevant and Appropriate
Criteria for Municipal Solid Waste Landfills	WAC 173-351	Establishes minimum state-wide standards for all municipal solid waste landfills.	Not an ARAR, no municipal solid waste landfill is present at the Site.
State Waste Discharge Program	WAC 173-216	Requirements of this program may be applicable if removal action includes discharge to the ground surface.	Relevant and Appropriate
National Pollution Elimination System Permit Program	WAC 173-220	Establishes state program pursuant to the federal NPDES program. Substantive sections may be applicable if removal action involves discharge to waters of the state.	Relevant and Appropriate
Aquatic Lands Management	RCW Ch. 79.90 WAC 332-30	Establishes criteria for managing state-owned aquatic lands to promote uses and protect resources.	Applicable, not Relevant and Appropriate because there are no state lands or aquatic lands at the site.
Maximum Noise Levels	RCW Ch. 70.107 WAC 173-60	Establish maximum noise levels allowed in identified environments and use standards related to reception of noise within areas.	Applicable
State Environmental Policy Act	RCW 43.21C WAC 197-11	SEPA legislation is to ensure that federal agencies consider the environmental impacts of an action prior to implementation.	Substantive Requirements are Applicable
Washington Clean Air Act	RCW Ch. 70.94 RCW Ch. 43.21A	Substantive requirements may be applicable if removal action results in release of fugitive emissions.	Applicable

Appendix D.

Preliminary Removal Action Cost Estimates

PRELIMINARY COST ESTIMATE FOR ALTERNATIVE 3 - EXCAVATION AND OFFSITE DISPOSAL OF ORE MATERIAL AND ONSITE CONTAINMENT OF WASTEROCK PILES

TASK	QUANTITY	UNITS	UNIT $	COST $
MOBILIZATION, BONDING & INSURANCE	1	Unit	10,000	10,000
LOGISTICS				
Access Road Improvements	1	Unit	10,000	10,000
Site Clearing/Preparation	1	Unit	6,000	6,000
PORTAL IMPROVEMENT				
Metal portal sets	1	Unit	15,000	15,000
EXCAVATION, TRANSPORT, AND CONSOLIDATION OF ORE IN WR2				
Excavation, transport, consolidate, and cap internally	130	bcy	50	6,500
DEMOLITION AND DISPOSAL OF BUILDINGS, EQUIPMENT, AND DEBRIS				
Demolition, transport, and disposal of debris at ChemWaste, Arlington, OR	10	tons	200	2,000
REGRADING AND SOIL COVER				
Regrading of wasterock piles	40	HR	300	12,000
Soil covering (assume local availability), load, transport and place	2,300	bcy	25	57,500
REVEGETATION				
Road Decommissioning, water bars and ripping	1	Unit	4,000	4,000
Seed/Fertilization	3	Acre	2,000	5,000
Mulch	3	Acre	2,000	5,000
RUNON/RUNOFF CONTROLS				
Runon Ditches	950	Feet	4.5	4,275
ADIT DISCHARGE CONTROL				
Capture discharge, convey, and construct infiltration system	1	Unit	20,000	20,000
HEALTH AND SAFETY, DECON, CONFIRMATION SAMPLES, AND NITON	1	Unit	7,000	7,000
DEMOBILIZATION	1	Unit	7,500	7,500
Subtotal Capital Costs				**171,775**
Data Gaps				15,000
Design Expenses (15%)				25,766
Construction Oversight (15%)				25,766
Post Construction Monitoring (3 years)				30,000
Subtotal Indirect Capital Costs				268,308
Contingency (10%)				26,831
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				**295,138**
POST CLOSURE MONITORING AND MAINTENANCE COSTS TO USFS				
Inspections	2	per year	500	1,000
Maintenance	1	Unit	1,000	1,000
TOTAL ANNUAL O&M COSTS				**2,000**
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				295,138
PRESENT WORTH O&M COST				
10 YRS. (10%)				12,289
TOTAL PRESENT WORTH COST (Rounded)				**307,000**

PRELIMINARY COST ESTIMATE FOR ALTERNATIVE 4 - EXCAVATION AND OFFSITE DISPOSAL OF ORE MATERIAL AND WASTEROCK PILES

TASK	QUANTITY	UNITS	UNIT $	COST $
MOBILIZATION, BONDING & INSURANCE	1	Unit	20,000	20,000
LOGISTICS				
Access Road Improvements	1	Unit	10,000	10,000
Site Clearing/Preparation	1	Unit	6,000	6,000
PORTAL IMPROVEMENT				
Metal portal sets	1	Unit	15,000	15,000
EXCAVATION, TRANSPORT, AND DISPOSAL OF SOIL AND WASTE MATERIAL				
Excavation, transport, and dispose at ChemWaste, Arlington, OR	16,330	bcy	200	3,266,000
DEMOLITION AND DISPOSAL OF BUILDINGS, EQUIPMENT, AND DEBRIS				
Demolition, transport, and disposal of debris at ChemWaste, Arlington, OR	10	tons	200	2,000
REGRADING WASTEROCK PILES				
Regrading native soil beneath wasterock piles	32	HR	300	9,600
REVEGETATION				
Road Decommissioning, water bars and ripping	1	Unit	4,000	4,000
Seed/Fertilization	3	Acre	2,000	5,000
Mulch	3	Acre	2,000	5,000
RUNON/RUNOFF CONTROLS				
Runon Ditches	1,000	Feet	4.5	4,500
ADIT DISCHARGE CONTROL				
Capture discharge, convey, and construct infiltration system	1	Unit	20,000	20,000
HEALTH AND SAFETY, DECON, CONFIRMATION SAMPLES, AND NITON	1	Unit	7,000	7,000
DEMOBILIZATION	1	Unit	7,500	7,500
Subtotal Capital Costs				**3,381,600**
Data Gaps				15,000
Design Expenses (Fixed)				25,000
Construction Oversight (Fixed)				25,000
Post Construction Monitoring (3 years)				30,000
Subtotal Indirect Capital Costs				3,476,600
Contingency (10%)				347,660
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				**3,824,260**
POST CLOSURE MONITORING AND MAINTENANCE COSTS TO USFS				
Inspections	2	per year	500	1,000
Maintenance	1	Unit	1,000	1,000
TOTAL ANNUAL O&M COSTS				**2,000**
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				3,824,260
PRESENT WORTH O&M COST				
10 YRS. (10%)				12,289
TOTAL PRESENT WORTH COST (Rounded)				**3,837,000**