Site Inspection Report
Kromona Mine and Millsite
Mt. Baker-Snoqualmie National Forest

December 2005

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SITE INSPECTION
Kromona Mine and Millsite
Mt. Baker-Snoqualmie National Forest

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Prepared for:	USDA Forest Service Mt. Baker-Snoqualmie National Forest
Site Location:	Kromona Mine and Millsite Mt. Baker-Snoqualmie National Forest Snohomish County, Washington

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Cover Photo: Kromona Mine – Upper Workings Tramline

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EXECUTIVE SUMMARY

A Site Inspection (SI) was performed at the Kromona Mine and Millsite (Site), an abandoned copper mine and mill, located in the Mt. Baker-Snoqualmie National Forest, near Sultan, Washington. The Site consists of two open adits and associated wasterock pile, the concrete foundation of the former mill with partially processed ore, a tailings area, and miscellaneous debris including an aboveground and underground storage tanks. Water drains from both adits at the upper workings and a sump at the mill level. The Site is situated adjacent to the Middle Fork of the South Fork of the Sultan River (MFSF) in Washington's central Cascades. Mining waste was been introduced into the surface water by historic disposal practices and by erosion of fine-grained waste material during high rainfall events and spring snowmelt. Based on the information gathered during these tasks, the results indicate the following:

Groundwater Pathway: The groundwater pathway is incomplete because there are no wells or groundwater protection areas within a 4-miles radius of the Site. Further assessment is not recommended.

Surface Water Pathway: The surface water pathway is complete for both human and ecological receptors due to elevated concentrations of arsenic in surface water samples and several elevated metals (primarily arsenic and copper) in stream sediment samples. Based on the pore water samples not exceeding any comparison criteria, pore water does not appear to be affected by the Site. The aquatic ecological survey indicates there are differences in invertebrate assemblages at several stations, but there is no apparent contamination at the station immediately downstream of the Site. Thus, the slight differences do not appear to represent mine-related chemical or physical impacts to invertebrate populations downstream of the Site. Rainbow Trout, cutthroat trout, eastern brook trout, and brown bullhead may inhabit the streams upstream of Spada Lake and in the vicinity of the Site.

Soil Pathway: The soil exposure pathway is complete for both human and ecological receptors, and a release of hazardous substances has been documented in this SI. This is based on concentrations of 15 metals in wasterock, tailings, and soil samples exceeding both the 90% upper confident limit (90UCL) of background soil concentration and one or more comparison criteria. Arsenic (total, III and V), cobalt, copper, lead, mercury, selenium, silver, and zinc appear to be the metals of concern. Based on ABA results, ore and soil have a slight potential to produce acid rock drainage (ARD); however, tailings and wasterock are not expected to produce ARD. None of the samples exceeded the Washington Department of Ecology (Ecology) toxicity characterization leaching procedure Dangerous Waste limit. Numerous federal and state rare, threatened, or endangered mammals, birds, and herpetiles have potential habitat in the vicinity of the Site.

Air Pathway: The air pathway is complete because metal contaminated soil and wasterock are concentrated at the surface where human and ecological receptors could be exposed. In addition, asbestos containing material has been identified at the Site. The most probable air pathway is due to inhalation of particulate matter. However, addressing and/or eliminating the soil exposure pathway will render the air exposure pathway incomplete. Therefore, further assessment of the air pathway is not recommended.

Based on the information gathered as part of the SI and presented in this report, CES recommends performing a streamlined Engineering Evaluation / Cost Analysis (EECA) at the Site. A risk assessment should also be performed to assess the human and ecological impacts, establish removal cleanup standards, and assess if a removal action is warranted. The conclusions presented are based on aquatic samples collected during moderately-high flow conditions. Surface water, pore-water, and sediment concentrations are likely to differ with the change in flow rates within the MRSF and other tributaries. CES recommends that an additional sampling event be performed to determine surface water, pore water, and sediment concentrations during low flow conditions (typically in the fall). These data would supplement the previously collected data and incorporated into the EECA and risk assessments.

SITE INSPECTION DATA SUMMARY SHEET

Project Name: Kromona Mine Site Inspection

Project Location: Section 13, Township 28 North, Range 9 East of the Willamette Meridian **Latitude:** 47° 54’ 57” **Longitude:** 121° 35’ 32”

Nearest Surface Water Body: Middle Fork of South Fork Sultan River

Area of Disturbance: 4 acres: Upper workings 1.25 acres; Millsite 2.8 acres,

SUMMARY OF ANALYTICAL/DOCUMENTED CONTAMINATION

Media	Sample Location	Rate of Discharge/Volume (cfs, gpm, or CY)	Contaminant	Highest Concentration	Lowest Criterion Eco – Ecological HH – Human Health	Background Concentration
Surface Water	MFSF-SW2	25 cfs	Arsenic, TR	0.51 μg/L	0.018 μg/L – HH	<0.43 μg/L
	MFSF-SW3	50 cfs	Arsenic, TR	0.61 μg/L	0.018 μg/L – HH	<0.43 μg/L
	SFSR-SW2	120 cfs	Arsenic, TR	0.46 μg/L	0.018 μg/L – HH	<0.43 μg/L
	KM-TP1-SW1	pond	Arsenic V, TR Arsenic, TR Copper, TR Lead , TR	12.51 μg/L 13.1 μg/L 94.5 μg/L 0.62 μg/L	3.1 μg/L – Eco 0.018 μg/L – HH 1.1 μg/L – Eco 0.07 μg/L- Eco	<0.404 μg/L <0.43 μg/L <3 μg/L <0.6 μg/L
	KM-DS-SW1	0.012 cfs	Arsenic V, TR Arsenic, TR Copper, TR	9.39 μg/L 11.4 μg/L 58.5 μg/L	3.1 ug/L – Eco 0.018 ug/L – HH 1.1 ug/L – Eco	<0.404 μg/L <0.43 μg/L <3 μg/L
	KM-AS1	0.017 cfs	Arsenic V, TR Arsenic, TR Copper, TR	29.54 μg/L 30.7 μg/L 30.6 μg/L	3.1 μg/L – Eco 0.018 μg/L – HH 1.1 μg/L – Eco	<0.404 μg/L <0.43 μg/L <3 μg/L
	KM-AS2	0.012 cfs	Arsenic, TR Copper, TR	2.18 μg/L 110 μg/L	0.018 μg/L – HH 1.1 μg/L – Eco	<0.43 μg/L <3 μg/L
Pore Water		Not Applicable (NA)	None			
Sediment	MFSF-SS2	NA	Arsenic Copper	27.4 mg/kg 143 mg/kg	5.9 mg/kg – Eco 36 mg/kg – Eco	12.6 mg/kg 60 mg/kg
	MFSF-SS3	NA	Arsenic Copper	26.9 mg/kg 121 mg/kg	5.9 mg/kg – Eco 36 mg/kg – Eco	12.6 mg/kg 60 mg/kg
	SFSF-SS2	NA	Arsenic Copper	22.6 mg/kg 125 mg/kg	5.9 mg/kg – Eco 36 mg/kg – Eco	12.6 mg/kg 60 mg/kg
Waste Material Wasterock Piles	KM-WR2-1 KM-WR2-2 KM-WR2-3 KM-TH-1	8,250 cy	Arsenic V Arsenic Barium Cadmium Cobalt Copper Chromium Iron Manganese Mercury Nickel Selenium Silver Vanadium Zinc	2,488 mg/kg 2,490 mg/kg 107 mg/kg 5.08 mg/kg 186 mg/kg 42,100 mg/kg 46 mg/kg 101,000 mg/kg 1,270 mg/kg 0.349 mg/kg 58.5 mg/kg 6.46 mg/kg 39.1 mg/kg 106 mg/kg 409 mg/kg	10 mg/kg – Eco 1.6 mg/kg – Eco 102 mg/kg – Eco 2 mg/kg - Eco 20 mg/kg – Eco 50 mg/kg – Eco 0.4 mg/kg – Eco 100,000 – HH 1,100 – Eco 0.00051 mg/kg – Eco 30 mg/kg – Eco 0.21 mg/kg – Eco 2 mg/kg – Eco 2 mg/kg– Eco 8.5 mg/kg – Eco	38.5 mg/kg 43 mg/kg 57 mg/kg 0.43 mg/kg 4.2 mg/kg 68.9 mg/kg 42 mg/kg 20,838 mg/kg 288 mg/kg 0.054 mg/kg 17 mg/kg 0.5 mg/kg 0.6 mg/kg 78.3 mg/kg 34.5 mg/kg

SUMMARY OF ANALYTICAL/DOCUMENTED CONTAMINATION (cont.)

Media	Sample Location	Rate of Discharge/Volume (cfs, gpm, or CY)	Contaminant	Highest Concentration	Lowest Criterion Eco – Ecological HH – Human Health	Background Concentration
Waste Material Partially Processed Ore	KM-WR1-1 KM-WR1-2 KM-WR1-3 KM-WR1-4 KM-WR1-5	265 cy	Arsenic V Arsenic Cobalt Copper Lead Mercury Selenium Silver Vanadium Zinc	10,448 mg/kg 10,500 mg/kg 114 mg/kg 36,000 mg/kg 180 mg/kg 0.22 mg/kg 17.6 mg/kg 26.4 mg/kg 114 mg/kg 366 mg/kg	10 mg/kg – Eco 1.6 mg/kg – HH 20 mg/kg – Eco 50 mg/kg – Eco 40.5 mg/kg – Eco 0.00051 mg/kg - Eco 0.21 mg/kg – Eco 2 mg/kg - Eco 2 mg/kg - Eco 8.5 mg/kg – Eco	38.5 mg/kg 43 mg/kg 4.2 mg/kg 68.9 mg/kg 52 mg/kg 0.054 mg/kg 0.5 mg/kg 0.6 mg/kg 78.3 mg/kg 34.5 mg/kg
Waste Material Tailings	KM-TP1-1 KM-TP1-2 KM-TP1-SS1	310 cy	Arsenic V Arsenic Chromium Copper Selenium Vanadium Zinc	520 mg/kg 624 mg/kg 69.2 mg/kg 1,490 mg/kg 0.6 mg/kg 108 mg/kg 103 mg/kg	10 mg/kg – Eco 1.6 mg/kg – HH 0.4 mg/kg - Eco 50 mg/kg – Eco 0.21 mg/kg – Eco 2 mg/kg - Eco 8.5 mg/kg – Eco	38.5 mg/kg 43 mg/kg 42 mg/kg 68.9 mg/kg 0.5 mg/kg 78.3 mg/kg 34.5 mg/kg
Site Soils	KM-DS-SS1 KM-S-1 KM-S-2 KM-S-3 KM-S-4 KM-S-5 KM-S-6 KM-S-7	7,500 cy	Arsenic V Arsenic Barium Cadmium Cobalt Copper Iron Lead Manganese Mercury Nickel Selenium Silver Vanadium Zinc	1,371 mg/kg 4,470 mg/kg 241 mg/kg 7.46 mg/kg 99 mg/kg 12,600 mg/kg 193,000 mg/kg 169 mg/kg 9,680 mg/kg 0.91 mg/kg 80.1 mg/kg 4.12 mg/kg 9.21 mg/kg 106 mg/kg 2,010 mg/kg	10 mg/kg – Eco 1.6 mg/kg – HH 102 mg/kg _ Eco 2 mg/kg – Eco 20 mg/kg – Eco 50 mg/kg – Eco 100,000 mg/kg – HH 40.5 mg/kg - Eco 1,100 mg/kg – Eco 0.00051 mg/kg – Eco 30 mg/kg - Eco 0.21 mg/kg – Eco 2 mg/kg – Eco 2 mg/kg - Eco 8.5 mg/kg – Eco	38.5 mg/kg 43 mg/kg 57 mg/kg 0.43 mg/kg 4.2 mg/kg 68.9 mg/kg 20,838 mg/kg 52 mg/kg 288 mg/kg 0.054 mg/kg 17 mg/kg 0.5 mg/kg 0.6 mg/kg 78.3 mg/kg 34.5 mg/kg

Notes: This table only lists sample concentrations that are at least 1.5 times higher than the lowest criterion and/or background concentration. These exceedances are considered the major contaminants of concern (COCs) and not a complete list of all COCs.
Highest background concentration in waters and sediments used since only two samples were collected; background soil concentrations listed are the 90UCL of six samples.
TR = Total Recoverable Metals; Diss. = Dissolved Metals; cfs = cubic feet per second; µg/L = micrograms per liter; mg/kg = milligrams per kilogram

1.0 INTRODUCTION AND OBJECTIVES

The United States Department of Agriculture, Forest Service (USFS) retained Cascade Earth Sciences (CES) to perform a Site Inspection (SI) at the Kromona Mine and Millsite (Site). The SI was performed in accordance to the U.S. Environmental Protection Agency (EPA) publication, *Guidance for Performing Site Inspections Under CERCLA* (USEPA, 1992). The purpose of the SI is to determine the potential threat to human health and the environment from issues identified during the Abbreviated Preliminary Assessment (APA) conducted by the USFS at the Site. The work was performed under our existing 5-year USFS Contract (#10181-1-D007) and in accordance with Purchase Order #53-05K3-4-0005.

In general, the objectives of the SI were to (1) assess the immediate or potential threat that (mining) wastes pose to human health and/or the environment, and (2) collect sufficient information to support a decision regarding the need for further action. The information was collected in general accordance with CERCLA protocols and documentation requirements for assessments involving hazardous substances. Specifically, as outlined in the EPA CERCLA guidance document (USEPA, 1992), "the sampling locations are strategically planned to identify the substances present, determine whether hazardous substances are being released to the environment, and determine whether hazardous substances have impacted specific targets."

The SI field activities included sampling and analysis of soil, wasterock, tailings, surface water, pore water, and sediment samples from the Site and vicinity. This SI was performed following the Field Operation Plan (FOP) developed by CES, and approved by the USFS on May 10, 2005 (CES, 2005). The FOP was developed based on the APA completed by the USFS in 2003, the Statement of Work (SOW) provided by the USFS in the request for proposals dated October 15, 2003, and the Washington Department of Natural Resources (WA-DNR) report on mines in the Spada Lake Watershed (Phipps et. al., 2003). Prior to field activities, CES made several modifications to the sampling locations and analyses after discussions and concurrence with the USFS Contracting Officers Representative (COR).

2.0 SITE DESCRIPTION AND OPERATIONAL HISTORY

The following section gives a specific description of the Site location and an operational history of the Site. Photographs of the Site and sampling locations are included in Appendix A. No regulatory removal activities have been undertaken at the Site. However, an investigation was performed in the summer of 2000 by the WA-DNR (Phipps et. al., 2003) and an APA was performed by the USFS in 2003 (USFS, 2003). Results of the inspection and assessment are discussed in Section 3.2.3. No permits or violations have been documented at the Site

2.1 Description and Location

The Site lies within the Sultan Mining District, located in the Mt. Baker-Snoqualmie National Forest in Snohomish County, approximately 10 miles northeast of Sultan, Washington (Plate 1). The Site is adjacent to the Middle Fork of the South Fork of the Sultan River (MFSF) approximately 3.75 miles upstream from Spada Lake (Figure 1 and Plate 1). According to the USGS 7 ½ Minute Quadrangle Map - Mt. Stickney (USGS, 1989), the Site location is described as:

- Section 13, Township 28 North, Range 9 East of the Willamette Meridian
- Mine / Main Adit: Latitude - 47°, 54', 57.2"
  Longitude - 121°, 35', 32.3"
  Elevation - 3,390 feet (ft) above mean seal level (amsl)
- Millsite: Latitude - 47°, 55', 4.8"
  Longitude - 121°, 36', 9.8"
  Elevation - 2,394 ft amsl

The Site is accessed from Olney Pass, south of Spada Lake. Snohomish County and the WA-DNR have gated the 5-mile gravel access road to the Site (formerly Forest Service Road 6110) at Olney Pass because of several embankment failures along the road.

The Site consists of two areas: the Millsite (Figure 2) and the upper workings (Figure 3). The upper workings contain the open Main Adit, the upper tram terminal, and a large wasterock pile. A second adit, the Reservoir Adit, is located in the gulch 600 ft east and 300 feet above the Main Adit. Water drains from the Main Adit through a culvert beneath the upper workings area and infiltrates into the large wasterock pile below. The Reservoir Adit was historically dammed and used as the water supply for the upper camp and mine; currently water flows down the gulch along with surface water runoff. Miscellaneous wood and metal debris associated with the bunkhouse, cookhouse, and tramway are present at the upper workings. In addition, an above ground storage tank (AST) was observed on the upper level that most likely contained (diesel) fuel to operate machinery.

A 120 ton per day (tpd) mill was constructed in 1952 near the MFSF, 1,000 ft below the Main Adit. A tramway transported ore from the upper adits to the mill. Beneficiation methods consisted of a jaw and/or roll crusher, followed by a ball mill, and then the floatation process. A drain (1.5-ft x 1.5-ft) and sump were observed in the lowest mill foundation. Water was flowing into the drain during the field activities. The outfall was located below the generator platform shown on Figure 2. The drainage flows downhill into a small pond eventually infiltrating into forest soils approximately 50 ft above the MFSF. An underground storage tank (UST) was located near the generator platform on the mill foundation level. Scattered drums and debris were encountered below the mill area and around the tram terminal. Based on field observations, the drums likely contained hydraulic oil or lube oil, and were either empty or were filled with soil or cement. A small tailings pond is located adjacent to the mill foundations. What appeared to be an overflow channel and effluent outfall were observed and shown on Figure 2. Furthermore, tailings were reportedly used as binder for the 3-mile road leading from the mill to the highway (Western Mining and Industrial News, 1956).

2.1.1 Operational History and Waste Characteristics

Information regarding the operational history of the Site was gleaned from newspaper clippings (Spokane Review and Wallace Miner) on file with the WA-DNR as well as summaries from Huntting (1956), Derkey et. al. (1990), and Phipps et. al. (2003). The following information is a chronological summary of the operational history of the Site and the estimated ore production.

- 1900 – Earliest prospects on the property known as the Scriber and Jones claims. Originally consisted of eight claims and five millsites - later abandoned.
- 1916 – Joe Krom, dba Kromona Mining and Smelting Co., relocates prospects and holds eight claims: Kromona, Kromona Numbers 1, 2, 3, 4, 5, Moonlight, and Moonlight No. 1. Developed the mine, includes road, trail, houses, and 2 tunnels.
- 1931 – Surveys and work begins on upper and lower tunnels; assays of high grade veins shows 24% copper, 0.09 ounces gold, and 4.11 ounces silver per ton (Keffer, 1931).

- 1937 – Kromona Mines Corporation takes possession of claims and continues mine development.
- 1952 – Extended underground development. Assays on 2.5 ton shipments to Tacoma smelter showed 0.58 ounce gold, 1.76 ounce silver, and 12.81% copper per ton. Assays show 0.58% to 15.2 % tungsten trioxide. A 500 pound sample assayed at 10.46% copper, 0.365 ounce gold, 1.653 ounce silver and 0.58% tungsten per ton. Jig tables, to be installed in mill, ordered to recover tungsten from mill tailings. Tunnel shed built of heavy timbers at Main Adit entrance. Headframe for tram constructed at tunnel level. Mill foundation completed (Kromona Mines Corporation, 1953).
- 1953 – Flotation Mill building completed by April. Two truckloads (roughly 13 tons) of concentrates shipped to Tacoma smelter resulting in 9,964 pounds of copper, 78 ounces silver, and 11.59 ounces gold (Spokane Chronicle, 1953).
- 1954 – 1,500 ft of underground workings developed. New electric hoist installed at mill level to move supplies to upper mine area. Operation of 100 tpd flotation mill resumed. Ore yielded 102 tons of copper concentrates shipped to Tacoma Smelter (Wallace Miner, 1955).
- 1955 – 15,000 tons of copper, gold, and silver ore developed. 1,500 pounds of rough tungsten concentrates not marketed.
- 1957 – Kromona Mines Corporation was liquidated in court; assets of mine were purchased by Mr. J.F. Brand who set up Victory Mines Corporation (WA-DNR, 1981).
- 1958 – Kromona Consolidated Mines acquires assets of Victory Mine Corporation and resumes development.
- 1968 – 500 ft of underground development and 600 ft of core drilling within 2 ,000 acres of land added to mine holdings; changes in mill for extraction of molybdenum.
- 1970 – Property increases number of claims to 40 claims; Exel Explorations Ltd acquires an option to purchase the Mine.

2.1.2 Climate

Climate data were compiled from the Western Regional Climate Center (WRCC, 2005). Climate in Snohomish County varies depending on elevation and distance from the Cascade summit. Precipitation increases and temperatures decrease as elevation rises to the summit of the Cascade Range. The Site lies along the western slope of the Cascade Range at an elevation of approximately 3,400 ft amsl. The following climate data was compiled from the Stevens Pass, Washington monitoring station, although not the closest station to the Site it is appropriate because of the similar elevation. Stevens Pass is located approximately 26 miles southeast of the Site at an elevation of 4,056 ft amsl. The annual prevailing wind direction is to the east-southeast; however, it shifts to the north-northwest in the summer.

- Total average precipitation is approximately 82 inches per year.
- The average minimum temperature of approximately 19° F occurs in January.
- The average maximum temperature of approximately 66° F occurs in July.

3.0 PATHWAYS AND ENVIRONMENTAL HAZARD ASSESSMENT

<u>3.1 Groundwater Exposure Pathway</u>

3.1.1 Geologic Setting

Regional geologic information presented in this section was obtained from Orr and Orr (2002). Site-specific geology was compiled from Carithers (1943) and Northwest Underground Explorations (1997), as well as site-specific reconnaissance performed by a CES Washington Registered Geologist.

3.1.1.1 Regional Geology

The Site is located in the Olney Pass Terrane (Western Mélange Belt) within the North Cascades physiographic province. The North Cascades province is comprised of folded, faulted, and metamorphically altered rocks ranging in age from Precambrian through Lower Cretaceous. The province is subdivided into numerous terranes which were accreted onto the North American plate during the Cretaceous. The Olney Pass Terrane is an incredibly coarse mixture of enormous sandstone blocks, some measuring thousands of ft across, set in a shaley matrix. This area of the Cascades, containing shale, chert, and pillow basalt indicative of volcanic island arc environments, has been interpreted as an ancient subduction zone between two converging tectonic plates where the rocks were thoroughly fragmented before being jammed together in a chaotic mélange. The accreted terranes were intruded by Tertiary plutons and dotted with Quaternary age volcanoes.

3.1.1.2 Site Specific Mining Geology

The Site lies across a contact between Upper Jurassic-Lower Cretaceous metamorphic rocks, consisting of gray and black thinly bedded argillite and quartzite, and a large intruding body of granodiorite and tonalite namely the Oligocene aged Index batholith. The mineralized zones occur near the periphery of the granodiorite batholith. The deposit is essentially a shear zone 1 to 3 ft wide striking north 50-60^{o} E and dipping 50-80^{o} northwest. The fracturing is augmented by 2 or more sets of joint planes striking about north-south and east-west. The host rock for the mineralization is composed of granodiorite, tonalite, and gneiss.

The major commodity at the Site was copper, although gold, silver, and tungsten were also present in viable quantities. The primary ore minerals at the Site were chalcopyrite, molybdenite, scheelite, powellite, bornite, and malachite; gangue minerals include: quartz, calcite, pyrite, pyrrhotite, marcasite, and shattered wall rock (Derkey and others, 1990).

3.1.2 Hydrogeology

The Site is located within the MFSF watershed. A review of the Washington Water Resources Department (WA-WRD) well log database indicates that there is one well located within a 4-mile radius of the Site. The physical address of this well is located at 4212 State Route 2, near the town of Goldbar, and is registered to Pat Bryan. According to the Snohomish County Assessors Office, the property at 4212 State Route is owned by William Bryan; and the Range (9E) and Section (9) are identical to that on the well log, and the Township (27) is one township different from the well log report (28). CES was unable to contact Pat or William Bryan. Based on this information, it appears that there is an error on the well log; therefore, no wells are located within 4-miles of the Site.

The hydrogeology of the granodiorite is unknown; however, it is probable that groundwater flows preferentially through fractures in the hard rock. Adits associated with the Site had flowing drainage during the field investigation.

3.1.3 Targets

Targets are defined as receptors that are located within the target distance for a particular pathway. For the groundwater pathway, the target distance has been defined as 4-miles and example targets are drinking water wells, wellhead protection areas, etc (See Plate 1). No wellhead protection areas or water supply wells were identified within a 4-mile radius of the Site.

3.1.4 Groundwater Exposure Pathway Summary

Groundwater is not used for drinking water within 4-miles of the Site. Based on this, the groundwater pathway is incomplete and no further assessment is warranted.

3.2 Surface Water Exposure Pathway

3.2.1 Hydrologic Setting

The Site is bordered on the southwest by the MFSF as shown on Plate 1 and Figure 1. According to the USGS 7½ minute quadrangle maps (USGS, 1989) of the area, the MFSF watershed above the Site is approximately 720 acres or 1.1 square miles (Plate 1). The MFSF originates approximately 1 mile upstream from the Site. Overland flow at the Site flows down the slope, across the Site, and ultimately into the MFSF. The confluence of the MFSF with the North Fork of the South Fork of the Sultan River (NFSF) approximately 1.75 miles downstream from the Site forms the South Fork of the Sultan River (SFSR). The SFSR flows west 2 miles before discharging to Spada Lake, the drinking water source for the City of Everett (~400,000 people). The remainder of the Sultan River flows from Spada Lake west and south for 24 miles before reaching the Skykomish River. The Skykomish River flows west 34 miles before discharging into the Puget Sound.

A USGS gaging station, number 12137290, is located on the SFSR just above Spada Lake. The elevation of the station is 1,475 ft amsl with a drainage area of 11.6 square miles. The flow rates in the MFSF, the NFSF, and the SFSR were measured on May 16 to May 18, 2005. Flows ranged from 22 cubic feet per second (cfs) at MFSF-01 to 150 cfs in NFSF-01 (see Figure 1 and Table 1). In comparison, the flow rate at the USGS gaging station 12137290 from May 16, 17, and 18 was 180, 129, and 132 cfs, respectively.

3.2.2 Targets

For the surface water pathway, the target distance has been defined as 15-miles, and example targets are surface water intakes, drinking water supplies, sensitive environments (i.e., wetlands), and aquatic organisms.

3.2.2.1 Local Surface Water Use

Plate 1 shows the 1 and 4-mile radius from the Site. Although there are no residences within a 4-mile radius of the Site, recreational use in the watershed is high. There are no surface water rights within 4 miles of the Site. However, Spada Lake is the principal source of drinking water for Snohomish County's population and is also used for hydroelectric production. Surface water rights for hydroelectric power are located beyond the 4-mile radius. Only targets above Spada Lake are considered targets because of the large difference in flow rates from the MFSF to the NFSR and the additional inflows into Spada Lake from other tributaries. Surface water uses were not field-verified as part of the SI; however; surface water in or around the Site may be used for recreational purposes such as swimming, camping (washing dishes, cooking), and fishing.

3.2.2.2 Wetlands

The National Wetlands Inventory (NWI) utilizes maps as a preliminary tool for determining the location of potential wetlands, although the map alone is not sufficient for ascertaining the presence of jurisdictional wetlands. The following areas are "listed" on the NWI map (USF&W, 1995) that could be affected by the Site.

- The NFSF is designated as Riverine, Upper Perennial, Open Water/Unknown Bottom, Intermittently Exposed/Permanent (R3OWZ); and
- The SFSR, located approximately 1¼ mile downstream of the Site is classified as R3OWZ.

The NWI map does not clearly outline the boundaries of riverine wetland systems. Therefore, the lateral boundaries adjacent to the stream cannot be determined without a jurisdictional wetland delineation conducted in accordance with the U.S. Army Corps of Engineers (USACE) Technical Report/Y-87-1.

According to CERCLA (40 CFR 230.5) and USACE Technical Report/Y-87-1, "wetlands are those areas that are inundated or saturated by surface or ground water 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 USACE standards was not conducted during this investigation. As such, the exact boundaries and areas of potential wetlands were not defined. Based on this definition, other wetlands are probably present near the adit drainages and other areas of the Site (i.e. along the MFSF).

3.2.2.3 Aquatic Ecological Survey

Aquatic surveys were conducted within two reference reaches (one upstream of the Site on the MFSR and one on the NFSR upstream of the confluence with the MFSR) and three reaches downstream of the Site on the MFSR and SFSR as shown on Figure 1. The surveys were completed to assess the potential effects of the Site on instream habitat, benthic macroinvertebrate community, and presence of fish species due to the potential for site-related physical impacts or chemical contamination. Refer to Appendix B for supplemental text, figures, and tables. The rare, threatened, or endangered (RTE) species known or expected to inhabit the area surrounding the Site are also listed in Appendix B.

Riparian habitat was fairly consistent across all stations with less canopy coverage along the banks at MFSF-01. Overall instream physical habitat conditions (sum of 10 habitat parameters; Barbour 1999) were optimal but some individual habitat parameters were rated as marginal or poor. Substrate within the upstream two reaches of the MFSF was bedrock, boulder, and cobble. The three lower reaches (MFSF-03, NFSF-01, and SFSR-02) included a higher proportion of boulder, cobble, gravel, and sand, compared to the upper reaches.

Both pool and riffle habitats were available at all reaches. Pool habitat (primarily the amount of fine versus coarse grained material) varied somewhat between the pools and was predominantly beside the main channel behind large woody debris piles or other obstacles. No Site related erosion features were noted along the banks of the MFSF.

Stream invertebrates in the pool at MFSF-03 showed slight unexpected differences compared to other stations. Stream invertebrates in riffles at NFSF-01, MFSF-03, and SFSR-02 are potentially slightly different than at the other stations. However, there is no clear evidence that these differences are a result of Site. No anadromous fish reside in the investigated stream reaches. However, rainbow trout, cutthroat trout, eastern brook trout, and brown bullhead may inhabit the streams in the vicinity of the Site and upstream of Spada Lake.

Overall, results of the aquatic survey indicate there are differences in invertebrate assemblages at NFSF-01, MFSF-03, and possibly SFSR-02, but there is no apparent impact at the station immediately downstream of the Site. Thus, the slight differences at these stations do not appear to represent Site related chemical or physical impacts to invertebrate populations downstream of the Site.

3.2.3 Previous Investigations

The WA-DNR collected surface water samples from the Site in the summer of 2000 and reported analytical results in Phipps et. al. (2003). The results indicated concentrations of total copper, iron, and lead exceed Washington State chronic surface water standards from water collected at the Millsite, and copper concentrations exceed the Washington State chronic surface water standards in the discharge from both the Main and Reservoir adits. Analytical results are summarized below.

Summary of 2000 WA-DNR Surface Water Results

Sample Location	Flow rate	pH	Arsenic	Copper	Iron	Lead	Zinc
	gpm	su	µg/L				
Main Adit	~1	4	27	18	ND	ND	16
Below upper wasterock below tramline	NM	7.5	25	ND	ND	ND	22
Reservoir Adit	2-5	5	ND	200	220	ND	21
Millsite	trickle	5	180	400	3,000	17	20
WA chronic surface water criterion			**190**	**11.4**	**1,000**	**2.5**	**104**

Notes: gpm = gallons per minute; µg/L = micrograms per liter; su = standard units; NM = not measured
ND = not detected above the method detection limit (MDL)
Surface water criterion are based a hardness of 100 milligrams per liter (mg/L)
Mercury and sulfate were analyzed but not detected above the MDL
pH values are suspect due to meter malfunctioning

3.2.4 Site Inspection Analytical Results

This section presents the surface water, pore water, and stream sediment analytical results for the SI conducted at the Site. Sample locations are shown on Figures 1, 2, and 3; analytical results are tabulated in Tables 1, 2, and 3; and the original laboratory reports are available in the USFS Project File. Photographs of selected sampling locations are included in Appendix A. A complete report of the quality assurance / quality control (QA/QC) procedures and results is available in the USFS Project File. Field activities were conducted from May 16 through 19, and June 28 through 29, 2005; the reader is referred to the FOP (CES, 2005) for sampling procedure and protocols.

A total of 15 water samples (10 surface water and 6 pore water) and 7 sediment samples were collected from pool substations in the MFSF, the NFSF, the SFSR, and from onsite water sources during the SI field activities (Figures 1, 2, and 3). Surface water, pore water, and sediment results are summarized in the following table.

Summary of Surface Water, Pore Water, and Sediment Metals Results

Sample Type	Table / Sample ID	Metals Exceeding One or More Comparison Criterion	Trends Observed and Comments
Surface Water	**Table 1**	**Total Recoverable Metals (μg/L)**	
Adjacent to Site	MFSF-SW2	Arsenic (0.51)	Arsenic detected above lowest criterion (0.018)
Downstream of Site, above confluence with N. Fork	MFSF-SW3	Arsenic (0.61)	
S. Fork of Sultan River, upstream from Spada Reservoir	SFSR-SW2	Arsenic (0.46)	
Suspected tailings pond	KM-TP1-SW1	Arsenic (13.1), arsenic V (12.5), barium (5.5) copper (94.5), and lead (0.62)	Arsenic, barium, copper, and lead above lowest criterion and background
Outflow from mill sump drain	KM-DS-SW1	Arsenic (11.4), arsenic V (9.39), barium (6.3), copper (58.5), and lead (0.65)	Arsenic concentration 633 times higher than lowest criterion; arsenic V 4 times higher than lowest criterion; copper concentration 53 times higher than lowest criterion; lead concentration 6 times higher than lowest criterion.
Discharge of Main Adit	KM-AS1	Arsenic (30.7), arsenic V (29.54), copper (30.6),	Highest concentration of total arsenic and arsenic V in water; copper exceeds background and lowest criterion
Discharge of Reservoir Adit	KM-AS2	Arsenic (2.18), copper (110)	Arsenic, copper above lowest criterion and background
Pore Water	**Table 2**	**Dissolved Metals (μg/L)**	
None of the samples exceeded the lowest regulatory criterion.			
Sediment	**Table 3**	**Total Metals (mg/kg)**	
N. Fork of S. Fork of Sultan River, upstream from confluence with Middle Fork (background)	NFSF-SS1	Copper (44.5)	Copper concentration exceeds lowest criterion
Upstream of Kromona millsite (background)	MFSF-SS1	Arsenic (12.6), chromium (69.1), copper (60), nickel (56.3), zinc (163)	Highest concentrations of chromium and nickel in sediment
Adjacent to millsite	MFSF-SS2	Arsenic (27.4), chromium (57.5), copper (143), nickel (40.7),	Arsenic and copper concentrations well in excess of background concentrations.
Downstream of millsite, above confluence with N. Fork	MFSF-SS3	Arsenic (26.9), chromium (49.6), copper (121), nickel (37.2)	
S. Fork of Sultan River, downstream from confluence with Middle Fork	SFSR-SS1	Copper (57.4)	Copper concentration lower than background concentration.
S. Fork of Sultan River, upstream from Spada Reservoir	SFSR-SS2	Arsenic (22.6), copper (125), nickel (29)	Arsenic and copper concentrations well in excess of background concentrations.

3.2.5 Surface Water Exposure Pathway Summary

Based on the information presented in this section, metals have been released into the MFSF from the Site, and appear to have affected stream sediments and surface water. The highest concentration of arsenic detected in the Sultan River tributaries is 0.61 μg/L detected at Station MFSF-SW3 downstream from the Site. The Main Adit had the highest arsenic concentration at 30.7 μg/L and the Reservoir Adit had the highest copper concentration at 110 μg/L. The sump drain had the highest lead concentration detected at 0.65 μg/L; arsenic and copper were detected at 11.4 μg/L and 58.5 μg/L, respectively. The drainage flows downhill into a small pond eventually infiltrating into forest soils approximately 50 ft above the MFSF.

The highest concentration of arsenic (27.4 mg/kg) and copper (143 mg/kg) in sediment was detected at MFSF-02, adjacent to the Site. However, the background sediment samples also exceeded the lowest criteria for arsenic, chromium, copper, nickel, and zinc.

The aquatic ecological survey indicated there are differences in invertebrate assemblages at NFSF-01, MFSF-03, and possibly SFSR-02, but there is no apparent impact at the station immediately downstream of the Site. Thus, the slight differences at these stations do not appear to represent Site related chemical or physical impacts to invertebrate populations downstream of the Kromona Mine Rainbow trout, cutthroat trout, eastern brook trout, and brown bullhead may inhabit the streams in the vicinity of the Site and upstream of Spada Lake.

The surface water pathway is complete for both human and ecological receptors and further assessment is warranted. The main metals of concern are arsenic (total and V) and copper. The sump drain is affecting soils and possibly shallow groundwater and further investigation is recommended to identify the source of water in the drain. The conclusions presented are based on aquatic samples collected during moderately-high flow conditions. Surface water, pore-water, and sediment concentrations are likely to differ with the change in flow rates within the MRSF and other tributaries. CES recommends that an additional sampling event be performed to determine surface water, pore water, and sediment concentrations during low flow conditions (typically in the fall).

3.3 Soil Exposure Pathway

3.3.1 Targets

3.3.1.1 Local Use

There are no onsite workers or persons living within 200 ft of the Site. Public use of the Site and vicinity is moderate, though public access records are not maintained**.** The Site is described in *Discovering Washington's Historic Mines* (Northwest Underground Explorations, 1997) which encourages public exploration of the Site. Numerous hiking books also publicize hiking to the Site. Access is currently not restricted by fencing, nor were any "No Trespassing" signs noted during the SI. In general, land uses in this area are limited to timber harvesting, firewood cutting, recreation (hiking, fishing, camping, hunting, etc.), and some minerals prospecting.

3.3.1.2 Terrestrial Ecological Survey

Terrestrial habitats and animals that are present or expected at, and surrounding, the Site were documented during the ecological survey and via examination of information provided by regional biologists regarding the area. Two 30-minute bird surveys were also conducted. A majority of plants were identified across each identified major vegetative community. Qualitative surveys were conducted at and surrounding the Site for mammal and terrestrial invertebrate presence and use. Lists of RTE plants and animals expected or known to be present in the vicinity of the Site were obtained from the USFS, the Washington Department of Natural Resources Natural Heritage Information System, and the Washington Department of Fish and Wildlife Priority Habitats and Species Program (See Appendix B). Full results of the terrestrial ecological survey are provided in Appendix B. Results of the terrestrial ecological surveys showed:

The Site is primarily within a coniferous forest community and adjacent to the MFSF. The disturbed mine area was primarily 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 millsite were clearly different from the other communities surrounding the Site. Other than within the primary disturbed mine area, there were also areas of mine-related disturbance such as roadways and clearings where habitat was similar to naturally disturbed areas.

Invertebrate noted on and near the Site included black carpenter ants, butterflies, moths, mosquitoes, and black flies. None of these or any other invertebrates in the vicinity of the Site are known RTE species.

Game trails were not clearly present, but evidence of deer, bear, mountain beaver, squirrels, and chipmunks were noted in the vicinity of the Site. Although not observed at the Site, Townsend's big-eared bats (RTE mammals), have the potential to inhabit the Site and underground workings.

The birds observed or expected at the Site represent an assemblage common among western Washington coniferous forests. Of these, northern flicker, olive-sided flycatcher, willow flycatcher, and pileated woodpecker are RTE species that may be long-term inhabitants in the vicinity of the Site. Other RTE bird species may inhabit the forest surrounding the Site, but are unlikely to forage in the disturbed mine area.

Red-legged frogs were noted in a pool surrounding the foundation of the former ore processing site. No RTE herpetile species were identified as inhabiting the Site, but the state candidate species western toad has the potential to inhabit the Site.

Of the invertebrates and wildlife documented or likely to inhabit the Site, plants, ground-dwelling invertebrates such as ants, and the frogs present at the processing area are the species most likely to be exposed to mine-related contamination.

3.3.2 Previous Investigations

In 2003, the USFS performed an APA, which consisted of collecting several samples from wasterock piles at the Site (USFS, 2003). The purpose of the investigation was to determine whether or not there is a potential for a release of contaminants to the environment and/or to human health, and whether further site characterization is warranted. A Niton XRF 700 Series, using *in situ* field screening methods, was utilized to help in the preliminary screening of the Site. Results show arsenic concentrations detected in tailings, partially processed ore on the mill foundation, and wasterock exceed the EPA Region IX Industrial Preliminary Remediation Goals (PRGs). The WA-DNR also collected soils and sediment at the Site for laboratory analysis in the summer of 2000. The samples were analyzed for arsenic, copper, iron, lead, and zinc by ICP (EPA Method 6010) and by CVAA for mercury (EPA Method 7471). The results also show concentrations of arsenic, copper, and iron exceeded the EPA Region IX Industrial PRGs (Phipps et. al., 2003).

3.3.3 Site Inspection Analytical Results

The following section presents the background soil, partially processed ore, soils, wasterock, and tailings analytical results for the Site. Sample locations are shown on Figures 1, 2, and 3. Analytical results for background soils are tabulated in Table 4; soils and waste source material metal/pH results are in Table 5; toxicity characterization leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP) results are in Table 6; and miscellaneous samples are in Table 7. The complete laboratory analytical results and a discussion of QA/QC procedures and results are in the USFS Project File.

The volume of wasterock piles, tailings, and ore was estimated by field measurements and the prismoidal formula and are summarized below:

- Ore on mill foundation = 135 cubic yards (cy) - coarse ore and 130 cy of finely crushed ore
- Main Adit wasterock = 8,250 cy
- Tailings near the mill foundation = 310 cy
- Mixture of soil and wasterock near the mill foundation = 7,500 cy (assuming a 10 ft thickness)

3.3.3.1 Background Soil, Site Soil, and Waste Material Metal/pH Results

Background soil samples were collected from six locations upgradient of the Site or in undisturbed areas to provide representative chemistry of undisturbed areas around the Site. BGS-1 and BGS-2 were collected generally upgradient from the Mill foundation, BGS-3 and BGS-04 were collected upgradient from the Main Adit, and BGS-5 and BGS-6 were collected upgradient from the access road (Figure 1).

A total of nine ore, four wasterock, five tailings, eight mill and road soil, and six background soil samples were collected around the Site (Figures 1, 2, and 3). With the exception of the ore, subsurface samples could not be collected because mechanized equipment could not access the steep slopes of the Site, and the size of the substrate prevented hand auguring. One soil sample (KM-S-7), collected near the former generator platform and UST, was analyzed for total petroleum hydrocarbons as diesel (TPH-Dx) and TPH-lube oil. An attempt to hand auger beneath the UST to collect additional samples was unsuccessful due to subsurface conditions.

Background soil pH ranged from 2.9 to 4.2 su, ore pH ranged from 4.6 to 7.8 su, wasterock pH ranged from 7.3 to 7.7 su, tailings pH ranged from 7.0 to 7.4 su, and soil pH ranged from 4.8 to 7.8. The soil sample analyzed for TPH did not have TPH-Dx detected above 125 mg/kg (Table 7). The concentration of TPH-lube oil was 19,200 mg/kg, which exceeds the Washington Department of Ecology (Ecology) soil cleanup standards of 2,000 and 15,000 mg/kg. The following table summarizes the metals results for background soil and waste source sample at the Site. The table only presents metals that exceeded at least one comparison criteria and the 90UCL of the six background samples.

Summary of Background Soil, Site Soil, and Waste Source Metals Results

SAMPLE TYPE	TABLE / SAMPLE ID	METALS EXCEEDING AT LEAST ONE CRITERION	METALS EXCEEDING ONE CRITERION AND 90UCL OF BACKGROUND SOIL	TRENDS OBSERVED AND COMMENTS
Background Soil	**Table 4**	**Total metals (units in mg/kg)**		
Background Soil	KM-BGS-1 to BGS-6,	Arsenic V, arsenic (total), chromium, copper, mercury, selenium, vanadium, and zinc.	Not Applicable (NA)	NA
Kromona Mine	**Table 5**	**Total metals (units in mg/kg) / Criterion: Eco = Ecological, HH = Human Health**		
Partially Processed Ore	KM-WR-1-1,-2,-3,-4,-5	Aluminum, antimony, arsenic V, arsenic (total), barium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc.	Aluminum (20,500), antimony (6.04), arsenic V (10,448), arsenic (10,500), barium (143), chromium (70), cobalt (114), copper (36,000), lead (180), mercury (0.22), nickel (39.5), selenium (17.6), silver (26.4), vanadium (114), and zinc (366).	Arsenic, cobalt, copper, selenium, silver, and zinc are the metals of concern when compared to the lowest comparison criterion (arsenic = 1.6-HH, cobalt = 20-Eco, copper = 50-Eco, lead = 40.5 Eco, mercury = 0.00051-Eco, selenium=0.21-Eco, silver=2-Eco, and zinc=8.5-Eco) and 90UCL background concentrations (arsenic=43, cobalt=4.2, copper=68.9, lead = 52, mercury = 0.054, selenium=0.5, silver=0.6, and zinc=34.5) In general, all other metals were slightly above the 90UCL for background soils and/or the lowest comparison criterion.
Wasterock Piles	KM-WR -2-1,-2,-3, and-TH	Aluminum, arsenic V, arsenic (total), barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc.	Aluminum (20,900), arsenic V (2,488.5), arsenic (2,490), barium (107), cadmium (5.08), chromium (46), cobalt (186), copper (42,100), iron (101,000), lead (118), manganese (1,270), mercury (0.349), nickel (58.5), selenium (6.46), silver (39.1), vanadium (106), and zinc (409).	
Soil	KM-S1, -S2, -S3, -S4, –S5, -S6, -S7, and –DS-SS1	Aluminum, antimony, arsenic V, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.	Aluminum (32,300), antimony (5.85), arsenic V (1,371), arsenic (4,470), barium (241), cadmium (7.46), chromium (94), cobalt (99), copper (12,600), iron (193,000), lead (169), manganese (9,680), mercury (0.449), nickel (80.1), selenium (4,12), silver (9.21), thallium (2), vanadium (106), and zinc (2,010).	
Tailings	KM-TP1-1, -2, -3, -4, -5, -6, -7, and -8, TP-SS-1	Aluminum, arsenic V, arsenic, barium, chromium, cobalt, copper, selenium, vanadium, and zinc.	Aluminum (20,600), arsenic V (520), arsenic (624), barium (135), chromium (69.2), cobalt (23.3), copper (1,490), selenium (0.6), vanadium (108), and zinc (103).	

Notes: For multiple samples, the concentration listed is the highest detected concentration in the sample set. Concentrations listed are “total” concentrations, unless indicated (i.e., arsenic V)

3.3.3.2 Site Soils and Waste Source Acid Base Accounting Results

Three ore samples, one wasterock sample, two tailings samples, and three soil 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) of the ore ranged from -71 to 7.67 t $CaCO_3$/Kt (ABP units are presented as tons of calcium carbonate needed to neutralize a kiloton of waste). ABP is the result of the ANP minus the AGP; a negative ABP indicates that the AGP is greater than the ANP. The ABP of tailings ranged from 50 to 54 t $CaCO_3$/Kt. The ABP of the wasterock was 21.2 t $CaCO_3$/Kt and the ABP of soil samples ranged from -8.13 to 38.5 t $CaCO_3$/Kt. The soil sample from the road was 6.93 t $CaCO_3$/Kt. Based on this, the ore and soils have the slight potential to produce ARD, and the tailings and wasterock are not likely to produce ARD.

3.3.3.3 Wasterock TCLP / SPLP Results

Three ore samples, one wasterock sample, two tailings, and three soil samples were submitted for TCLP and SPLP (Table 6) analyses for the 8 Resource Conservation Recovery Act (RCRA) metals. There are no applicable standards for SPLP; however, the results can be compared to RCRA TCLP disposal limits. None of the samples had SPLP or TCLP results in excess of the TCLP standard.

3.3.4 Soil Exposure Pathway Summary

Metal concentrations in background soils are elevated; all six background samples exceeded one or more comparison criteria for arsenic, chromium, vanadium, and zinc; five background samples exceeded criteria for selenium; two exceeded criteria for copper; and one for mercury. However, 15 metals were detected in wasterock, tailings, and soil samples at concentrations exceeding both the 90UCL for background soil and one or more comparison criteria. In comparing wasterock concentrations to 90UCL background soil concentrations, arsenic (total, III, and V), cobalt, copper, lead, mercury, selenium, silver, and zinc are the metals of concern. Arsenic and copper concentrations were detected significantly above several comparison criteria at the Site. Three soil samples collected from the sump drain infiltration area had the highest concentration of arsenic (4,470 mg/kg), copper (12,600 mg/kg), iron (193,000 mg/kg), and zinc (2,010 mg/kg) detected at the Site. The highest detection of mercury (0.449 mg/kg) was detected in soil sample KM-S-5 from the access road. The source of the mercury is not known, but tailings were reportedly used to build the road (Western Mining and Industrial News, 1956).

One soil samples was analyzed for TPH-Dx and TPH-lube oil. The TPH-Dx concentration was below the laboratory method detection limit of 125 mg/kg; the TPH-lube oil concentration was 19,200 mg/kg, which exceeds the Ecology soil cleanup standards of 2,000 and 15,000 mg/kg. However, based on field observations, the hydrocarbon contaminated soil appears to be limited to the small area around the generator platform.

Analyses of ABAs indicated waste material, specifically ore and onsite soil, has the slight potential to produce ARD. None of the samples analyzed for TCLP or SPLP exceeded the Ecology TCLP Hazardous Waste limit. Numerous federal and state RTE mammals, birds, and herpetiles have potential habitat in the vicinity of the Site, thus the potential exists that ecological receptors could be affected.

The soil exposure pathway is considered complete for both human and ecological receptors, and a release of hazardous substances has been documented in this SI.

3.4 Air Exposure Pathway

3.4.1 Targets

The target distance for the air pathway has been defined as one and four miles from the Site. There are no homes within four miles of the Site. The nearest year-round residences are in Goldbar, approximately six miles south of the Site. The annual prevailing wind direction is to the east-southeast; however, the wind direction shifts to the north-northwest in the summer. There is little sign of dust migration, and neither millsite soil, tailings, nor wasterock are easily wind-eroded. Sensitive environments, including wetlands, which are located within four miles from the Site, are outlined in Section 3.2.2.

3.4.2 Air Exposure Pathway Summary

Air samples were not collected as part of the SI field activities. However, based on field observations, CES collected two samples of suspect materials from pipes and insulation at the upper workings for analyses of asbestos containing material (ACM). Results show that one sample had 2% ACM and none was detected in the second sample (Table 7). In addition, arsenic and other metals were released to the air during processing (i.e., crushing, sorting). However, processing is currently not occurring at the Site and has not occurred for over 40 years. The most probable air pathway is due to inhalation of particulate matter. As with soil exposure, this pathway is considered complete because metal contaminated soil and waste material, as well as ACM, is concentrated at the surface where human and ecological receptors could be exposed to particulate matter. Because the air pathway is linked to the soil exposure pathway, addressing and/or eliminating the soil exposure pathway will address the air exposure pathway for metals. Further assessment of the air pathway is not recommended.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Relevant conclusions and recommendations are presented below.

Groundwater Pathway

The groundwater pathway is incomplete because there are no wells or groundwater protection areas within a 4-miles radius of the Site. Therefore, further assessment is not recommended.

Surface Water Pathway

The surface water pathway is complete for both human and ecological receptors due to elevated concentrations of arsenic in surface water samples, and arsenic and copper in stream sediment samples. Pore water in the MFSF and SFSR does not appear to be contaminated by the Site as samples did not exceed any comparison criteria. Metals (primarily arsenic and copper) have been released into the MFSF sediment from the Site. Potential source areas include the ore remaining on the mill foundation, as well as the sump drain and two adit drainages (Main and Reservoir), all of which have elevated arsenic and other metal concentrations.

The aquatic survey indicates there are differences in invertebrate assemblages at NFSF-01, MFSF-03, and possibly SFSR-02, but there is no apparent impact at the station immediately downstream of the Site. Thus, the slight differences at these stations do not appear to represent mine-related chemical or physical impacts to invertebrate populations downstream of the Site. Rainbow trout, cutthroat trout, eastern brook trout, and brown bullhead may inhabit the streams upstream of Spada Lake and in the vicinity of the Site.

Soil Pathway

The soil exposure pathway is complete for both human and ecological receptors, and a release of hazardous substances has been documented in this SI. This is based on concentrations of 15 metals in wasterock, ore, tailings, and soil samples exceeding both the 90UCL background soil concentration and one or more comparison criteria. Arsenic (total, III and V), cobalt, copper, lead, mercury, selenium, silver, and zinc appear to be the metals of concern. Based on ABA results, ore and soil have a slight potential to produce ARD; however, tailings and wasterock are not expected to produce ARD. None of the samples exceeded the Ecology TCLP Hazardous Waste limit. Numerous federal and state RTE mammals, birds, and herpetiles have potential habitat in the vicinity of the Site.

Air Pathway

The air pathway is complete because metal contaminated soil, wasterock, tailings, and ore are concentrated at the surface where human and ecological receptors could be exposed. In addition, limited quantities of ACM in pipes and insulation have been identified at the Site. The most probable air pathway is due to inhalation of particulate matter. However, addressing and/or eliminating the soil exposure pathway will render the air exposure pathway incomplete. Therefore, further assessment of the air pathway is not recommended.

Based on the information gathered as part of the SI and presented in this report, CES recommends performing a streamlined Engineering Evaluation / Cost Analysis (EECA) at the Site. The conclusions presented are based on aquatic samples collected during moderately-high flow conditions. Surface water, pore-water, and sediment concentrations are likely to differ with the change in flow rates within the MRSF and other tributaries. CES recommends that an additional sampling event be performed to determine surface water, pore water, and sediment concentrations during low flow conditions (typically in the fall). As part of the streamlined EECA, a risk assessment should be performed to assess the human and ecological impacts, establish removal cleanup standards, and assess if a removal action are warranted.

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 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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TABLES

Table 1. Surface Water Analytical Results
Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Results in µg/L

Sample I.D.	Sample Date	Aluminum, TR M200.7	Antimony, TR M200.8	Arsenic (III), TR M1632 Mod.	Arsenic (V), TR Calculated	Arsenic Total, TR M200.8	Barium, TR M200.7	Beryllium, TR M200.7	Cadmium, TR M200.8	Calcium, TR M200.7	Chromium, TR M200.7	Cobalt, TR M200.7	Copper, TR M200.8
MFSF-SW1	5/18/2005	50	< 5.6	0.026	< 0.404 C	< *0.43*	< 2	< 0.66	< 0.12	945	< 6	< 6	< *3*
MFSF-SW2	5/18/2005	< 30	< 5.6	0.034	0.476 C	0.51	2.3	< 0.66	< 0.12	1,300	< 6	< 6	< *3*
MFSF-SW3	5/17/2005	52	< 5.6	NA	NC	0.61	2.6	< 0.66	< 0.12	2,310	< 6	< 6	< *3*
NFSF-SW1	5/17/2005	50	< 5.6	0.009 B,H	< 0.421 C	< *0.43*	2.3	< 0.66	< 0.12	682	< 6	< 6	< *3*
SFSR-SW1	5/17/2005	75	< 5.6	0.041	< 0.389 C	< *0.43*	2.3	< 0.66	< 0.12	1,180	< 6	< 6	< *3*
SFSR-SW2	5/16/2005	45	< 5.6	NA	NC	0.46	2.6	< 0.66	< 0.12	1,230	< 6	< 6	< *3*
KM-TP1-SW1	5/18/2005	62	< 5.6	0.591 H	12.51 C	13.1	5.5	< 0.66	< 0.12	1,930	< 6	< 6	94.5
KM-DS-SW1	5/18/2005	57	< 5.6	2.01	9.39 C	11.4	6.3	< 0.66	< 0.12	2,730	< 6	< 6	58.5
KM-AS1	6/29/2005	42	< 5.6	1.16 H	29.54 C	30.7	2.3	< 0.66	< 0.12	9,310	< 6	< 6	30.6
KM-AS2	6/29/2005	42	< 5.6	0.081 H	2.10 C	2.18	3.3	< 0.66	< 0.12	2,770	< 6	< 6	110
Standards, corrected for hardness where applicable (used <u>4.0</u> mg/L average for surface water samples, excluding portal and other seeps)													
Washington - Aquatic Life (Chronic) [1]		NS	NS	NS	NS	*190*	NS	NS	<u>0.09</u>	NS	NS	NS	<u>0.8</u>
Washington - Human Health [2]		NS	14	NS	NS	0.018	NS	NS	NS	NS	NS	NS	NS
Washington Drinking Water Criteria[3]		NS	6	NS	NS	10	2,000	4	5	NS	100	NS	NS
EPA - Aquatic Life (CCC) [4]		NS	NS	NS	NS	*150*	NS	NS	<u>0.025</u>	NS	NS	NS	<u>0.6</u>
EPA - Human Health (Water+Organism) [5]		NS	5.6	NS	NS	*0.018*	NS	NS	NS	NS	NS	NS	1,300
ORNL - Surface Water PRGs [6]		87	30	190	3.1	NS	4	0.66	1.10	NS	NS	23	12

Sample I.D.	Iron, TR* M200.7	Lead, TR M200.8	Magnesium, TR M200.7	Manganese, TR* M200.7	Mercury, Total M245.1	Mercury, Total, Trace M1631, Rev. E	Nickel, TR M200.7	Potassium, TR M200.7	Selenium, TR M200.8	Silver, TR M200.8	Sodium, TR M200.7	Thallium, TR M200.8	Vanadium, TR M200.7	Zinc, TR M200.7
MFSF-SW1	< 60	< *0.6*	150	< 4	< *0.2*	0.000513	< 10	< 500	< *0.62*	< 0.12	< 500	< 0.24	< 5	< 10
MFSF-SW2	< 60	< *0.6*	274	< 4	< *0.2*	0.000461	< 10	< 500	< *0.62*	< 0.12	540	< 0.24	< 5	< 10
MFSF-SW3	< 60	< *0.6*	356	< 4	< *0.2*	0.000583	< 10	< 500	< *0.62*	< 0.12	630	< 0.24	< 5	< 10
NFSF-SW1	< 60	< *0.6*	88	< 4	< *0.2*	0.000932	< 10	< 500	< *0.62*	< 0.12	< 500	< 0.24	< 5	< 10
SFSR-SW1	< 60	< *0.6*	176	< 4	< *0.2*	0.000703 H	< 10	< 500	< *0.62*	< 0.12	< 500	< 0.24	< 5	< 10
SFSR-SW2	< 60	< *0.6*	225	< 4	< *0.2*	0.000988 H	< 10	< 500	< *0.62*	< 0.12	530	< 0.24	< 5	< 10
KM-TP1-SW1	127	0.62	469	< 4	< *0.2*	0.00319 H	< 10	560	< *0.62*	< 0.12	530	< 0.24	< 5	< 10
KM-DS-SW1	69	0.65	515	4.2	< *0.2*	0.001640	< 10	< 500	< *0.62*	< 0.12	720	< 0.24	< 5	< 10
KM-AS1	< 60	< 0.6	1,030	< 4	< *0.2*	0.002630	< 10	1140	< 1.24	< 0.12	1,110	< 0.48	< 5	< 10
KM-AS2	< 60	< 0.6	337	< 4	< *0.2*	0.000320	< 10	< 500	< 1.24	< 0.12	870	< 0.48	< 5	< 10
Washington - Aquatic Life (Chronic) [1]	NS	<u>0.05</u>	NS	NS	0.012	0.012	<u>16.9</u>	NS	5	NS	NS	NS	NS	<u>7.00</u>
Washington - Human Health [2]	NS	NS	NS	NS	0.14	0.14	610	NS	170	NS	NS	1.7	NS	NS
Washington Drinking Water Criteria[3]	300	NS	NS	50	2	2	100	NS	50	100	NS	2	NS	50,000
EPA - Aquatic Life (CCC) [4]	NS	<u>0.05</u>	NS	NS	*0.77*	0.77	<u>3.46</u>	NS	5	NS	NS	NS	NS	<u>7.92</u>
EPA - Human Health (Water+Organism) [5]	NS	NS	NS	NS	NS	NS	610	NS	170	NS	NS	1.7	NS	7,400
ORNL - Surface Water PRGs [6]	1,000	3.20	NS	120	*1.3*	*1.3*	160	NS	0.39	0.36	NS	9	20	110

Sample I.D.	Sample Date	Flow Rate (cfs)	Temperature (Field) (°C)	pH (Field) (su)	pH (Lab) M150.1 (su)	Turbidity (Field) (NTU)	Conductivity (Field) (µS/cm)	Conductivity @25C (Lab) M150.1 (µS/cm)	Dissolved Oxygen (Field) (mg/L)	Oxygen Reduction Potential (Field) (mV)	Hardness as $CaCO_3$, TR SM2340B (mg/L)	TDS (Field) (mg/L)	TDS, Residue, Filterable @180C M160.1 (mg/L)	TSS, Residue, Non-Filterable @105C M160.2 (mg/L)	Sulfate M375.3 (mg/L)
MFSF-SW1	5/18/2005	22	5.36	6.4	6.25	28	11	9	10.6	225	2.98	10	< 10	< 5	0.98
MFSF-SW2	5/18/2005	25	5.53	6.4	6.47	21	15	13	10.76	218	4.36	10	< 10	< 5	1.21
MFSF-SW3	5/17/2005	40	6.6	6.4	6.44	16	21	19	10.84	201	7.22	10	11	< 5	1.46
NFSF-SW1	5/17/2005	100	6.37	5.9	6.35	22	9	8	10.72	204	2.06	10	11	< 5	0.73
SFSR-SW1	5/17/2005	140	6.98	6.2	6.38	29	13	11	10.83	201	3.67	10	15	< 5	0.94
SFSR-SW2	5/16/2005	150	7.15	6.3	6.5	51	15	12	10.67	192	4	10	13	< 5	0.96
KM-TP1-SW1	5/18/2005	NM	15.8	7.0	6.44	12	18	17	9.07	140	6.75	10	< 10	5	1.76
KM-DS-SW1	5/18/2005	0.012	20	6.7	6.55	1	25	23	9.69	134	8.93	10	19	< 5	1.66
KM-AS-1	6/29/2005	0.017	4.2	7.49*	6.27	NM	72	64	10.2	45.7	27.5	NM	32	< 5	7.36
KM-AS-2	6/29/2005	0.012	4.6	7.48*	6.06	NM	16	23	9.2	64.2	8.29	NM	< 10	< 5	2.54
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 (Water+Organism) [5]		NS	NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ORNL - Surface Water PRGs [6]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

GENERAL NOTES:

All analyses except Arsenic (III), TR & Mercury, Total, Trace were conducted by SVL Analytical, Inc., Kellogg, ID following digestion by M200.2
Arsenic (III), TR and Mercury, Total, Trace anlyses were conducted by Brooks Rand, Seattle, WA
Arsenic (V) was calculated from difference between Arsenic, TR and Arsenic (III), TR
mg/L = Milligrams per liter
µg/L = Micrograms per liter
su = Standard Units
mS = MicroSiemans
NM = Not measured
< value = Analyte not detected above Method Detection Limit (MDL)
B = Analyte detected between MDL and Practical Quantification Limit (PQL)
Shaded cells indicate that the value exceeds one or more standard; corresponding criteria also shaded.
Italic values indicate that the MDL exceeds the lowest standard
H = Sample exceeded hold time or temperature before analysis
* = Data are suspect due to meter malfuntion

STANDARD NOTES:

1 - State of Washington Aquatic Life criteria (WAC 173-201A), <u>underline</u> - corrected for hardness
2 - State of Washington criteria for protection of human health (CLARC-Part IIIf)
3 - State of Washington drinking water criteria (WAC 246-290)
4 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002), <u>underline</u> - 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. Pore Water Analytical Results
Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Results in µg/L

Sample I.D.	Sample Date	Aluminum, Diss. M200.7	Antimony, Diss. M200.8	Arsenic (III), Diss M1632 Mod.	Arsenic (V), Diss Calculated	Arsenic Total, Diss. M200.8	Barium, Diss. M200.7	Beryllium, Diss. M200.7	Cadmium, Diss. M200.8	Calcium, Diss. M200.7	Chromium, Diss. M200.7	Cobalt, Diss. M200.7	Copper, Diss. M200.8	Iron, Diss. M200.7	Lead, Diss. M200.8	Magnesium, Diss. M200.7	Manganese, Diss. M200.7	Mercury, Diss. M245.1	Mercury, Diss. M1631, Rev. E	Nickel, Diss. M200.7	Potassium, Diss. M200.7	Selenium, Diss. M200.8	Silver, Diss M200.8	Sodium, Diss. M200.7	Thallium, Diss. M200.8	Vanadium, Diss. M200.7	Zinc, Diss. M200.7
MFSF-PW1	5/18/2005	< 30	< 5.6	0.010 B	0.44	0.45	< 2.0	< 0.66	< 0.1	929	< 6	< 6	< *3*	< 60	< *0.6*	163	< 4	< *0.2*	0.000536	< *10*	< 500	< 0.39	< 0.12	< 500	< 0.24	< 5	< *10*
MFSF-PW2	5/18/2005	< 30	< 5.6	< 0.007	1.49	1.49	3.3	< 0.66	< 0.1	2,300	< 6	< 6	< *3*	< 60	< *0.6*	580	< 4	< *0.2*	0.000768	< *10*	< 500	< 0.39	< 0.12	680	< 0.24	< 5	< *10*
MFSF-PW3	5/17/2005	50	< 5.6	0.008 B	1.00	0.67	2.4	< 0.66	< 0.1	2,240	< 6	< 6	< *3*	< 60	< *0.6*	354	< 4	< *0.2*	0.000583	< *10*	< 500	< 0.39	< 0.12	660	< 0.24	< 5	< *10*
NFSF-PW1	5/17/2005	70	< 5.6	< 0.007 H	0.19	0.19	< 2.0	< 0.66	< 0.1	645	< 6	< 6	< *3*	< 60	< *0.6*	78	< 4	< *0.2*	0.000694	< *10*	< 500	< 0.39	< 0.12	< 500	< 0.24	< 5	< *10*
SFSR-PW1	5/17/2005	72	< 5.6	< 0.007	0.22	0.22	2.2	< 0.66	< 0.1	766	< 6	< 6	< *3*	< 60	< *0.6*	111	< 4	< *0.2*	0.000881	< *10*	< 500	< 0.39	< 0.12	< 500	< 0.24	< 5	< *10*
SFSR-PW2	5/16/2005	64	< 5.6	0.223	0.74	0.96	3.0	< 0.66	< 0.1	1,360	< 6	< 6	< *3*	< 60	< *0.6*	286	13.8	< *0.2*	0.00185	< *10*	< 500	< 0.39	< 0.12	540	< 0.24	< 5	< *10*
Standards, corrected for hardness where applicable (used 4.5 mg/L average for surface water samples, excluding portal seeps)																											
Washington - Aquatic Life (Chronic) [1]		NS	NS	NS	NS	190	NS	NS	0.10	NS	NS	NS	0.8	NS	0.08	NS	NS	0.012	0.012	18.5	NS	5	NS	NS	NS	NS	7.56
Washington Drinking Water Criteria [2]		NS	6	NS	NS	10	2,000	4	5	NS	100	NS	NS	300	NS	NS	50	2	2	100	NS	50	100	NS	2	NS	50,000
EPA - Aquatic Life (CCC) [3]		NS	NS	NS	NS	150	NS	NS	0.028	NS	NS	NS	0.6	NS	0.08	NS	NS	0.77	0.77	3.8	NS	4.61	NS	NS	NS	NS	8.55
ORNL - Surface Water PRGs [4]		87	30	190	3.1	NS	4	0.66	1.10	NS	NS	23	12	1,000	3.20	NS	120	1.30	1.30	160	NS	5.00	0.36	NS	12	20	110

Sample I.D.	Sample Date	Temperature (Field)	pH (Field)	pH (Lab)	Turbidity	Conductivity (Field)	Conductivity @25C (Lab) M150.1	Dissolved Oxygen (Field)	Oxygen Reduction Potential (Field)	Hardness as $CaCO_3$, TR SM2340B	TDS (Field)	TDS, Residue, Filterable @180 M160.1	Cyanide, WAD SM4500-CN I	Sulfate M375.3
		°C	su	su	NTU	µS/cm	µS/cm	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L
MFSF-PW1	5/18/2005	6.1	6.7	6.66	20	11	10	10.39	115	2.99	10	17	NA	0.99
MFSF-PW2	5/18/2005	6.13	6.6	6.4	13	24	22	9.33	203	8.14	20	18	< 0.01	1.48
MFSF-PW3	5/17/2005	7.47	7	6.64	40	21	19	10.47	142	7.05	10	12	NA	1.47
NFSF-PW1	5/17/2005	6.8	6.7	6.54	52	9	7	10.64	165	1.93	10	< 10	< 0.01	0.72
SFSR-PW1	5/16/2005	7.41	6.7	6.35	19	10	9	10.55	182	2.37	10	10	NA	0.75
SFSR-PW2	5/18/2005	8.01	6.2	6.02	39	17	14	5.83	161	4.57	10	16	NA	0.85
Standards														
Washington - Aquatic Life (Chronic) [1]		12	6.5-8.5	6.5-8.5	5>Bkg	NS	NS	9.5	NS	NS	NS	NS	5.2	NS
Washington Drinking Water Criteria [2]		NS	6.5-8.5	6.5-8.5	NS	700	700	NS	NS	NS	500	500	200	250
EPA - Aquatic Life (CCC) [3]		9-19	6.5-9	6.5-9	NS	NS	NS	9.5	NS	NS	NS	NS	5.2	NS
ORNL - Surface Water PRGs [4]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.2	NS

STANDARD NOTES:

1 - State of Washington Aquatic Life criteria (WAC 173-201A), underline - corrected for hardness

2 - State of Washington drinking water criteria (WAC 246-290)

3 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life (CCC) used (EPA, 2002), underline - corrected for hardness

4 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)

NS = No Standard

GENERAL NOTES:

All analyses except Arsenic (III) , TR & Mercury, Total were conducted by SVL Analytical, Inc., Kellogg, ID following digestion by M200.2

Arsenic (III), TR and Mercury, Total, Trace anlyses were conducted by Brooks Rand, Seattle, WA

Arsenic (V) was calculated from difference between Arsenic, TR and Arsenic (III), TR

mg/L = Milligrams per liter

µg/L = Micrograms per liter

su = Standard Units

mS = MicroSiemans

NA = Not Analyzed

NC = Not Calculated

Table 3. Sediment Analytical Results
Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Sample ID	Sample Date	Aluminum, Total M6010B	Antimony, Total M6020	Arsenic - Total M6020	Barium, Total M6010B	Beryllium, Total M6010B	Cadmium, Total M6020	Calcium, Total M6010B	Chromium, Total M6010B	Cobalt, Total M6010B	Copper, Total M6020	Iron, Total M6010B	Lead, Total M6020	Magnesium, Total M6010B	Manganese, Total M6010B	Mercury, Total M7471A	Nickel, Total M6020	Potassium, Total M6010B	Selenium, Total M6020	Silver, Total M6020	Sodium, Total M6010B	Thallium, Total M6020	Vanadium, Total M6010B	Zinc, Total M6020
		mg/kg																						
MFSF-SS-1	5/18/2005	25,700	< 2	12.6	202	0.32	0.72	4,040	69.1	12.4	60	35,000	7.83	11,500	540	0.09	56.3	6,380	0.9	< 0.5	531	0.22	91.3	163
MFSF-SS-2	5/18/2005	21,300	< 2	27.4	203	0.31	0.37	3,360	57.5	11.5	143	32,300	7.77	9,730	461	0.05	40.7	5,920	1.2	< 0.5	468	0.2	86.3	86.5
MFSF-SS-3	5/17/2005	19,500	< 2	26.9	151	0.29	0.2	2,970	49.6	9.83	121	28,900	6.11	9,210	424	0.17	37.2	4,030	0.6	< 0.5	390	< 0.2	78	73.7
NFSF-SS-1	5/17/2005	6,730	< 2	3.11	59.1	< 0.2	< 0.2	1,360	8.81	3.69	44.5	11,500	2.79	3,640	141	< 0.03	5.6	1,390	< 0.3	< 0.5	161	< 0.2	28.7	20.2
SFSR-SS-1	5/18/2005	9,050	< 2	5.17	68	< 0.2	< 0.2	1,610	10.8	5.26	57.4	15,400	2.81	5,420	207	< 0.03	7.3	1,700	< 0.3	< 0.5	170	< 0.2	39.2	26.7
SFSR-SS-2	5/16/2005	14,600	< 2	22.6	108	0.21	< 0.2	2,420	34.3	9.27	125	24,600	5.68	8,690	339	< 0.03	29	2,390	< 0.3	< 0.5	196	< 0.2	64.8	48
Standards																								
WA - Freshwater (under development) [1]		NS	0.6	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	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	5.9	NS	NS	0.596	NS	37.3	NS	35.7	NS	35	NS	NS	0.174	18	NS	NS	NS	NS	NS	NS	123.1
EPA - Freshwater PEL [4]		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	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 ASA No. 9 29-2.2.4	Size Fraction by Hydrometer ASTM D-422			Solids (BR) CLPSOW390, PART F, D-98	Texture Classification ASTM D-422
			Clay	Sand	Silt		
		%					
MFSF-SS-1	5/18/2005	**0.08**	0	98	2	73.6	Sand
MFSF-SS-2	5/18/2005	0.17	1	98	1	72.4	Sand
MFSF-SS-3	5/17/2005	0.24	2	96	2	NA	Sand
NFSF-SS-1	5/17/2005	0.16	2	98	0	74.4	Sand
SFSR-SS-1	5/18/2005	0.14	1	98	1	72.2	Sand
SFSR-SS-2	5/16/2005	0.79	2	90	8	NA	Sand

GENERAL NOTES:
All analysis was conducted by SVL Analytical, Inc., Kellogg, ID following digestion by M3050B
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, not shown)
MDL and PQL are not consistent among samples
Shaded values indicate that the value exceeds one or more standard; corresponding criteria also shaded.
-- = Not applicable.
NA = Not analyzed

STANDARD NOTES:
1 - State of Washington, Development of Freshwater Sediment Quality Values (DOE recommendations, Sept 2003)
2 - State of Washington, Marine Sediment Management Standards (WAC 172-204-320)
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, 1997)
NS = No Standard

Table 4. Background Soil Analytical Results
Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Sample ID	Sample Date	Sample Depth (feet)	Paste pH USDA No. 60 (21)	Aluminum, Total M6010B	Antimony, Total M6020	Arsenic (III), Total M1632 Mod.	Arsenic (V), Total Calculated	Arsenic, Total M6020	Barium, Total M6010B	Beryllium, Total M6010B	Cadmium, Total M6020	Calcium, Total M6010B
			su		mg/kg							
KM-BGS-1	6/28/2005	0-0.5	2.9	3,060	4.34	< 0.507 H	18.5	18.5	64.7	< 0.2	0.45	179
KM-BGS-2	6/28/2005	0-0.5	3.6	10,400	< 0.3	NA	NC	16.3	32.2	< 0.2	< 0.2	815
KM-BGS-3	6/29/2005	0-0.5	4.2	4,560	< 0.3	< 0.307 H	30.2	30.2	20.6	< 0.2	0.39	464
KM-BGS-4	6/29/2005	0-0.5	4.2	23,700	< 0.3	NA	NC	64.7	43.5	< 0.2	0.43	236
KM-BGS-5	6/29/2005	0-0.5	3.8	14,600	< 0.3	NA	NC	28.7	60.3	< 0.2	0.41	228
KM-BGS-6	6/29/2005	0-0.5	4.2	6,150	0.48	< 0.578 H	35.4	35.4	58.3	< 0.2	0.38	600
		Mean	3.8	10412	1	0.464	31.84	32.3	46.6	NC	0.38	420
		Mean/90% UCL		15,165	2	0.573	38.5	43.0	57.4	NC	0.43	575
Standards												
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]				NS	NS	NS	NS	20	NS	NS	2	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
EPA Indust. PRGs - Human Receptors[3]				100,000	410	NS	NS	1.6	67,000	1,900	450	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
ORNL - Ecological Receptors[5]				NS	5	NS	NS	9.9	283	10	4	NS

Sample ID	Chromium, Total M6010B	Cobalt, Total M6010B	Copper, Total M6020	Iron, Total M6010B	Lead, Total M6020	Magnesium, Total M6010B	Manganese, Total M6010B	Mercury, Total M7471A	Nickel, Total M6020	Potassium, Total M6010B	Selenium, Total M6020	Silver, Total M6020	Sodium, Total M6010B	Thallium, Total M6020	Vanadium, Total M6010B	Zinc, Total M6020
				mg/kg												
KM-BGS-1	26.8	0.96	19.2	2,940	89.7	321	17.2	0.107	5.4	322	1.01	0.73	129	< 1.5	13.9	50.1
KM-BGS-2	64	3.81	55.6	18,600	17.4	3650	172	0.088	11.8	724	< 0.06	< 0.5	226	< 1.5	58.6	25.2
KM-BGS-3	8.01	1.00	18.9	10,000	18.5	511	17.1	0.047	6.1	307	0.41	0.51	95	< 1.5	38.1	13.6
KM-BGS-4	35.9	4.16	107	26,100	15.7	3710	75.9	0.085	24.9	915	0.6	< 0.5	74	< 1.5	93	23.7
KM-BGS-5	28.1	3.33	65.4	22,100	13.7	3180	108	0.095	14.4	740	0.77	< 0.5	82	< 1.5	87.8	23
KM-BGS-6	19.9	5.48	11.8	14,300	44.4	1380	569	0.075	11.4	858	0.66	< 0.5	113	< 1.5	67.9	26.7
Mean	30.5	3.12	46.3	15,673	33.2	2125.3	159.9	0.041	12.3	644.3	0.29	0.5	120	NC	59.88	27.1
Mean/90% UCL	42	4.23	68.9	20,838	51.6	3,089	287.9	0.054	16.7	807	0.49	0.6	154	NC	78.3	34.5
Standards																
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]	NS	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]	42 bp	20 p	50 b	NS	50 p	NS	1,100 p	0.1 b	30	NS	0.3 w	2 p	NS	1 p	2 p	86 p
EPA Indust. PRGs - Human Receptors[3]	450	1,900	41,000	100,000	800	NS	19,000	310	20,000 *	NS	5,100	5,100	NS	67	1,000	100,000
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate, p=plant)[4]	5 p	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i
ORNL - Ecological Receptors[5]	0.4	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5

GENERAL NOTES:

All analysis except Arsenic (III), Total and Chromium (VI), Total was conducted by SVL Analytcial, Inc., Kellogg ID following digestion by M3050B

Arsenic (III), Total and Chromium (VI), Total analysis was conducted by Brooks Rand, Seattle, WA

Arsenic (V), TR was calculated from difference between Arsenic, Total and Arsenic (III), Total

mg/kg = Milligrams per kilogram

su = Standard Units

< value = Analyte not detected above indicated Method Detection Limit (MDL).

B = Analyte detected between MDL and Practical Quantification Limit (PQL).

NC = Not Calculated

Shaded values indicate that the value exceeds one or more standard; corresponding criteria also shaded.

Average values calculated using one half the MDL if results were below the MDL.

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 749-3 (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

* = As soluble salt only

NS = No standard

Table 5. Millsite Soil, Tailings, and Wasterock Analytical Results
Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Sample ID	Sample Date	Sample Depth (feet)	Paste pH USDA No. 60 (21) (su)	Aluminum, Total M6010B (mg/kg)	Antimony, Total M6020 (mg/kg)	Arsenic (III), Total M1632 Mod. (mg/kg)	Arsenic (V), Total Calculated (mg/kg)	Arsenic, Total M6020 (mg/kg)	Barium, Total M6010B (mg/kg)	Beryllium, Total M6010B (mg/kg)	Cadmium, Total M6020 (mg/kg)	Calcium, Total M6010B (mg/kg)	Chromium, Total M6010B (mg/kg)	Cobalt, Total M6010B (mg/kg)	Copper, Total M6020 (mg/kg)	Iron, Total M6010B (mg/kg)
Millsite Soil:																
KM-DS-SS1	5/18/2005	0-0.5	NA	17,000	5.7	NA	NC	4,470	97.6	< 0.20	0.22	5,280	36	93.5	12,600	51,400
KM-S-1	6/28/2005	0-0.5	4.9	9,490	5.85	38.78 H	1,371 C	1,410	110	< 0.20	7.46	6,680	54	86.4	6,410	193,000
KM-S-2	6/28/2005	0-0.5	5.2	10,700	4.15	NA	NC	533	241	< 0.20	6.34	13,500	29	99	4,380	83,400
KM-S-3	6/28/2005	0-0.5	7.8	16,700	1.53	< 0.228 H	947 C	947	104	< 0.20	0.52	16,800	63	25.5	6,160	48,100
KM-S-4	6/29/2005	0-0.5	4.8	30,100	< 0.3	NA	NC	56	140	0.47	0.59	1,660	62	14.4	82	36,500
KM-S-5	6/29/2005	0-0.5	4.9	32,300	< 0.3	< 0.238 H	56 C	56	184	0.67	0.78	2,850	72	17.6	104	40,800
KM-S-6	6/29/2005	0-0.5	5.2	21,700	< 0.3	NA	NC	11	50.4	0.25	0.4	2,770	53	12.5	46.3	33,400
KM-S-7	6/29/2005	0-0.5	NA	16,800	0.502	NA	NC	97	106	< 0.20	0.55	7,770	94	11.6	243	31,300
Tailings:																
KM-TP 1-1	6/28/2005	0 - 0.5	7.4	18,200	< 0.3	NA	NC	546	126	< 0.20	< 0.2	14,900	53	19.7	1,140	42,400
KM-TP 1-1	6/28/2005	0.5 - 1	7.2	17,800	< 0.3	3.242 H	459 C	462	116	< 0.20	< 0.2	15,600	57	19.6	925	40,000
KM-TP 1-2	6/28/2005	0 - 0.5	7.4	20,600	< 0.3	NA	NC	624	135	< 0.20	< 0.2	11,300	68	23.3	1,290	46,200
KM-TP 1-2	6/28/2005	0.5 - 1	7.3	17,500	< 0.3	7.611 H	387 C	395	114	< 0.20	< 0.2	15,800	62	18.5	1,080	39,300
KM-TP 1-SS1	6/28/2005	0 - 0.5	7.0	15,800	< 0.3	7.9 H	520 C	528	101	< 0.20	< 0.2	10,800	69	20.8	1,490	39,400
Partially Processed Ore:																
KM-WR 1-1	6/28/2005	0.5 - 1	7.5	18,600	0.674	1.183 H	637 C	638	135	< 0.20	< 0.2	10,400	59	23.6	1,800	44,300
KM-WR 1-1	6/28/2005	1.5 - 2	6.4	19,500	0.674	2.194 H	494 C	496	143	< 0.20	< 0.2	7,210	61	25.7	2,090	46,800
KM-WR 1-2	6/28/2005	0.5-1	4.6	9,820	6.04	52.076 H	10,448 C	10,500	76.7	< 0.20	2.16	2,940	46	112	36,000	96,000
KM-WR 1-3	6/28/2005	0.5-1	6.9	10,700	4.2	3.783 H	6,526 C	6,530	100	< 0.20	1.93	8,500	44	114	20,200	68,700
KM-WR 1-4	6/28/2005	0.5 - 1	7.7	14,800	0.724	NA	NC	1,530	102	< 0.20	0.94	15,200	56	39	8,650	47,700
KM-WR 1-4	6/28/2005	1.5 - 2	7.8	14,000	0.512	1.109 H	858 C	859	96.1	< 0.20	0.68	18,000	51	29.2	8,110	47,300
KM-WR 1-4	6/28/2005	2 - 2.5	5.5	20,500	< 0.3	NA	NC	33	89	0.24	< 0.2	3,370	70	11.7	211	31,400
KM-WR 1-5	6/28/2005	0.5 - 1	7.3	16,600	0.516	NA	NC	1,650	118	< 0.20	2.33	12,600	63	112	19,100	58,100
KM-WR 1-5	6/28/2005	1.5 - 2	7.4	16,700	< 0.3	NA	NC	497	143	< 0.20	1.4	13,000	72	83.6	12,600	45,600
Wasterock:																
KM-WR 2-1	6/29/2005	0.5 - 1	7.3	20,000	0.3	1.54 H	2,488 C	2,490	100	< 0.20	1.55	11,900	46	81.9	5,760	54,500
KM-WR 2-2	6/29/2005	0.5 - 1	7.7	20,900	< 0.3	NA	NC	997	97.9	< 0.20	1.65	6,480	46	47.5	10,400	57,100
KM-WR 2-3	6/29/2005	0.5 - 1	7.5	14,900	0.525	3.744 H	1,496 C	1,500	107	< 0.20	1.11	7,180	34	31.1	4,000	47,800
KM-TH-1	6/29/2005	0.5 - 1	7.3	11,900	0.915	NA	NA	6,370	48.8	< 0.20	5.08	28,200	25	186	42,100	101,000
Standards																
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]			2 - 12.5	NS	NS	NS	NS	20	NS	NS	2	NS	NS	NS	NS	NS
WA - Ecological Receptors (p=plant, b=soil biota, w=wildlife)[2]			NS	50 *p	5.00 p	7 w	10 p	NS	102 w	10.00 p	4 p	NS	42 bp	20 p	50 b	NS
EPA Indust. PRGs - Human Receptors[3]			NS	100,000	410.00	NS	NS	1.6	67,000	1900.00	450	NS	450	1,900	41,000	100,000
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate,			NS	NS	21.00 m	NS	NS	37 p	NS	NS	29 p	NS	5 p	32 b	61 i	NS
ORNL - Ecological Receptors[5]			NS	NS	5.00	NS	NS	9.9	283	10.00	4	NS	0.4	20	60	NS

Sample ID	Lead, Total M6020 (mg/kg)	Magnesium, Total M6010B (mg/kg)	Manganese, Total M6010B (mg/kg)	Mercury, Total M7471A (mg/kg)	Nickel, Total M6020 (mg/kg)	Potassium, Total M6010B (mg/kg)	Selenium, Total M6020 (mg/kg)	Silver, Total M6020 (mg/kg)	Sodium, Total M6010B (mg/kg)	Thallium, Total M6020 (mg/kg)	Vanadium, Total M6010B (mg/kg)	Zinc, Total M6020 (mg/kg)	Cyanide, WAD SM4500-CN I (mg/kg)	Sulfur Forms M600/2-78-054 3.2.4: Sulfur, Total (%)	Sulfur, Pyritic Calculated (%)	Sulfur, Sulfate (%)	ABAs M600/2-78-054 1.3 & 3.2.3: Acid Generation Potential (t $CaCO_3$/Kt)	Acid Neutralization Potential (t $CaCO_3$/Kt)	Acid-Base Potential (t $CaCO_3$/Kt)
Millsite Soil:																			
KM-DS-SS1	118	9,000	1,140	0.91	26.8	2,430	2.96	9.21	455	< 2.0	79.4	373	NA	NA	NA	NA	NA	NA	NA
KM-S-1	169	3,170	2,500	0.122	39.1	969	4.12	< 0.5	213	< 1.5	52.7	2,010	< 0.5	0.42	0.26	0.14	8.13	< 0.3	-8.13
KM-S-2	130	1,870	9,680	< 0.033	26.1	486	2.24	< 0.5	87	2	65.5	592	NA	NA	NA	NA	NA	NA	NA
KM-S-3	27.6	12,300	770	0.172	18.5	6,620	2.11	2.83	415	< 1.5	100	123	< 0.5	0.77	0.4	0.2	12.5	51	38.5
KM-S-4	20.5	11,500	690	0.037	59.4	2,810	0.37	< 0.5	192	< 1.5	83.7	95.5	NA	NA	NA	NA	NA	NA	NA
KM-S-5	10.1	9,790	817	0.449	80.1	6,750	< 0.3	< 0.5	304	< 1.5	106	91.8	< 0.5	0.03	0.02	0.01	0.63	7.56	6.93
KM-S-6	7.7	12,000	621	< 0.033	61	824	< 0.3	< 0.5	164	< 1.5	58.7	77.1	NA	NA	NA	NA	NA	NA	NA
KM-S-7	25	10,500	526	0.052	28.4	4,090	< 0.6	< 0.5	537	< 1.5	77.2	341	NA	NA	NA	NA	NA	NA	NA
Tailings:																			
KM-TP 1-1	16.1	13,000	750	< 0.033	20.3	6,930	< 0.6	< 0.5	778	< 1.5	101	67.3	NA	NA	NA	NA	NA	NA	NA
KM-TP 1-1	10.0	12,300	698	< 0.033	19.2	6,470	< 0.6	< 0.5	660	< 1.5	94.3	53.4	< 0.5	0.09	0.08	0.01	2.5	56.6	54.1
KM-TP 1-2	17.5	12,900	850	< 0.033	22.1	7,030	< 0.6	< 0.5	901	< 1.5	108	71.7	NA	NA	NA	NA	NA	NA	NA
KM-TP 1-2	12.7	12,600	691	< 0.033	20.5	6,270	< 0.6	< 0.5	678	< 1.5	93.5	60.7	< 0.5	0.13	0.09	0.04	2.81	53.2	50.4
KM-TP 1-SS1	22.4	10,600	638	0.033	18.7	4,700	0.6	< 0.5	689	< 1.5	82.7	103	NA	NA	NA	NA	NA	NA	NA
Partially Processed Ore:																			
KM-WR 1-1	11	12,000	595	< 0.033	21.5	7,870	7.07	< 0.5	842	< 1.5	104	91.7	NA	0.14	0.11	0.02	3.44	32.9	29.5
KM-WR 1-1	10.4	12,500	623	< 0.033	23	7,830	8.7	< 0.5	736	< 1.5	114	101	NA	NA	NA	NA	NA	NA	NA
KM-WR 1-2	180	6,710	521	0.22	38.6	3,760	17.6	26.4	418	< 1.5	66.8	366	NA	3.7	2.42	0.39	75.6	4.64	-71
KM-WR 1-3	103	8,480	878	0.11	39.5	4,450	8.67	13.3	473	< 1.5	74.5	360	NA	NA	NA	NA	NA	NA	NA
KM-WR 1-4	22.6	11,200	715	0.122	23.8	6,030	2.7	4.15	379	< 1.5	94.8	163	NA	NA	NA	NA	NA	NA	NA
KM-WR 1-4	14.6	11,500	841	0.075	20.3	5,370	2.56	3.88	370	< 1.5	93.9	138	NA	NA	NA	NA	NA	NA	NA
KM-WR 1-4	6.23	10,700	452	0.05	32.5	2,500	< 0.3	< 0.5	468	< 1.5	81.8	64.6	NA	0.07	0.02	0.05	0.63	8.3	7.67
KM-WR 1-5	133	11,700	810	0.047	25.6	6,630	4.64	14.9	522	< 1.5	105	316	NA	NA	NA	NA	NA	NA	NA
KM-WR 1-5	21.4	10,900	608	0.063	23.6	7,490	3.19	8.23	718	< 1.5	97	218	NA	NA	NA	NA	NA	NA	NA
Wasterock:																			
KM-WR 2-1	220	14,500	882	0.119	55.5	4,970	1.04	5.53	166	< 1.5	106	161	NA	0.19	0.14	0.03	4.38	25.6	21.2
KM-WR 2-2	47.5	14,700	1,100	0.1	58.5	4,650	0.99	7.26	199	< 1.5	103	164	NA	NA	NA	NA	NA	NA	NA
KM-WR 2-3	41.1	11,100	968	0.114	42.6	3,660	1.63	4.11	227	< 1.5	96.4	137	NA	NA	NA	NA	NA	NA	NA
KM-TH-1	118	12,100	1,270	0.349	57.1	3,110	6.46	39.1	< 50	< 1.5	65.7	409	NA	NA	NA	NA	NA	NA	NA
Standards																			
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]	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)[2]	50 p	NS	1,100 p	0.1 b	30	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]	800	NS	19,000	310	20,000 *	NS	5,100	5,100	NS	67	1,000	100,000	12,000	NS	NS	NS	NS	NS	NS
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate,	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i	NS	NS	NS	NS	NS	NS	NS
ORNL - Ecological Receptors[5]	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5	NS	NS	NS	NS	NS	NS	NS

GENERAL NOTES:

All analysis except Arsenic (III), Total and Chromium (VI), Total was conducted by SVL Analytical, Inc., Kellogg, ID following digestion by M3050B
Arsenic (III), Total and Chromium (VI), Total analysis was conducted by Brooks Rand, Seattle, WA
Arsenic (V), Total was calculated from difference between Arsenic, Total and Arsenic (III), Total
Chromium (III), Total was calculated from difference between Chromium, Total and Chromium (VI), Total
Sulfur, Pyritic was calculated from the difference between Sulfur, Total and Sulfur, Sulfate
mg/kg = Milligrams per kilogram
su = Standard Units
< value = Analyte not detected above indicated Method Detection Limit (MDL).
B = Analyte detected between MDL and Practical Quantification Limit (PQL).
NA = Not Analyzed
NC = Not Calculated
Shaded values indicate that the value exceeds one or more standard; corresponding criteria also shaded.
Average values calculated using one half the MDL if results were below the MDL.
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).
H = Sample exceeded storage temperature or hold time before analysis

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 749-3 (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
* = As soluble salt only
NS = No standard
Paste pH criteria is a Dangerous Waste/RCRA Hazardous Waste designation

Table 6. Toxicity Characterization Leaching Procedure and Synthetic Precipitation Leaching Procedure Results
Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Sample ID	Sample Date	Sample Depth (feet)	Arsenic, TCLP M6010B	Arsenic, SPLP M6010B	Barium, TCLP M6010B	Barium, SPLP M6010B	Cadmium, TCLP M6010B	Cadmium, SPLP M6010B	Chromium, TCLP M6010B	Chromium, SPLP M6010B	Lead, TCLP M6010B	Lead, SPLP M6010B	Mercury, TCLP M7470	Mercury, SPLP M7470	Selenium, TCLP M6010B	Selenium, SPLP M6010B	Silver, TCLP M6010B	Silver, SPLP M6010B
			mg/L															
Tailings:																		
KM-TP1-1	6/28/2005	0.5 - 1	0.067	0.08	0.603	0.011	0.0025	< 0.002	< 0.006	< 0.006	< 0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
KM-TP1-2	6/28/2005	0.5 - 1	0.126	0.12	0.595	0.005	0.0028	< 0.002	< 0.006	< 0.006	< 0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
Wasterock / Ore:																		
KM-WR1-1	6/28/2005	0.5 - 1	< 0.025	0.03	0.435	< 0.002	0.0059	< 0.002	< 0.006	< 0.006	< 0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
KM-WR1-2	6/28/2005	0.5 - 1	0.064	< 0.03	0.302	0.037	0.0095	< 0.002	< 0.006	< 0.006	0.01	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	0.006	< 0.005
KM-WR1-4	6/28/2005	2 - 2.5	< 0.025	< 0.03	0.491	0.002	0.0121	< 0.002	< 0.006	< 0.006	0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
KM-WR2-1	6/29/2005	0.5 - 1	0.041	0.12	0.498	< 0.002	0.0061	< 0.002	< 0.006	< 0.006	0.248	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
Soil:																		
KM-S-1	6/28/2005	0 - 0.5	< 0.025	0.03	0.816	0.052	0.024	< 0.002	< 0.006	< 0.006	< 0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
KM-S-3	6/28/2005	0 - 0.5	< 0.025	< 0.03	0.56	0.003	< 0.002	< 0.002	< 0.006	< 0.006	0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
KM-S-5	6/29/2005	0 - 0.5	< 0.025	< 0.03	0.52	0.004	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	< 0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
Applicable Standards																		
RCRA TCLP Disposal Limits			5		100		1		5		5		0.2		1		5	

GENERAL NOTES:

Analysis was conducted by SVL Analytical, Inc., Kellogg, ID

mg/L = Milligrams per liter

< value = Analyte not detected above Method Detection Limit (MDL)

B = Analyte detected between MDL and Practical Quantification Limit (PQL)

Table 7. Total Petroleum Hydrocarbons and Asbestos Containing Material Analytical Results Kromona Mine Site Inspection, Mt. Baker-Snoqualmie National Forest, Washington

Sample ID	Sample Date	Sample Depth (feet)	Total Petroleum Hydrocarbons as Diesel (mg/kg)	Total Petroleum Hydrocarbons as Lube Oil (mg/kg)	Asbestos Type	Asbestos Percent
Millsite Soil:						
KM-S-7	6/29/2005	0-0.5	< 125	19,200	NA	NA
Debris Upper Workings						
KM-Asb/gray	6/29/2005	0 - 0.5	NA	NA	ND	ND
KM-Asb/red	6/29/2005	0 - 0.5	NA	NA	Chrysotile	2
Standards						
WA - Method A Indust. Soil Cleanup Levels - Human Receptors[1]			2,000	2,000	NS	NS
WA - Ecological Receptors - Soil biota[2]			15,000	15,000	NS	NS
WA-Ecological Receptors - Wildlife[3]			200	200	NS	NS

GENERAL NOTES:

Total Petroleum Hydrocarbons analysis performed by Anatek Laboratories, Inc.Spokane, Washington

Asbestos analysis performed by NVL Laboratories, Inc. in Seattle, Washinigton

< value = Analyte not detected above indicated Method Detection Limit (MDL).

NA = Not Analyzed

ND = Not Detected

Shaded values indicate that the value exceeds one or more standard; corresponding criteria also shaded.

STANDARD NOTES:

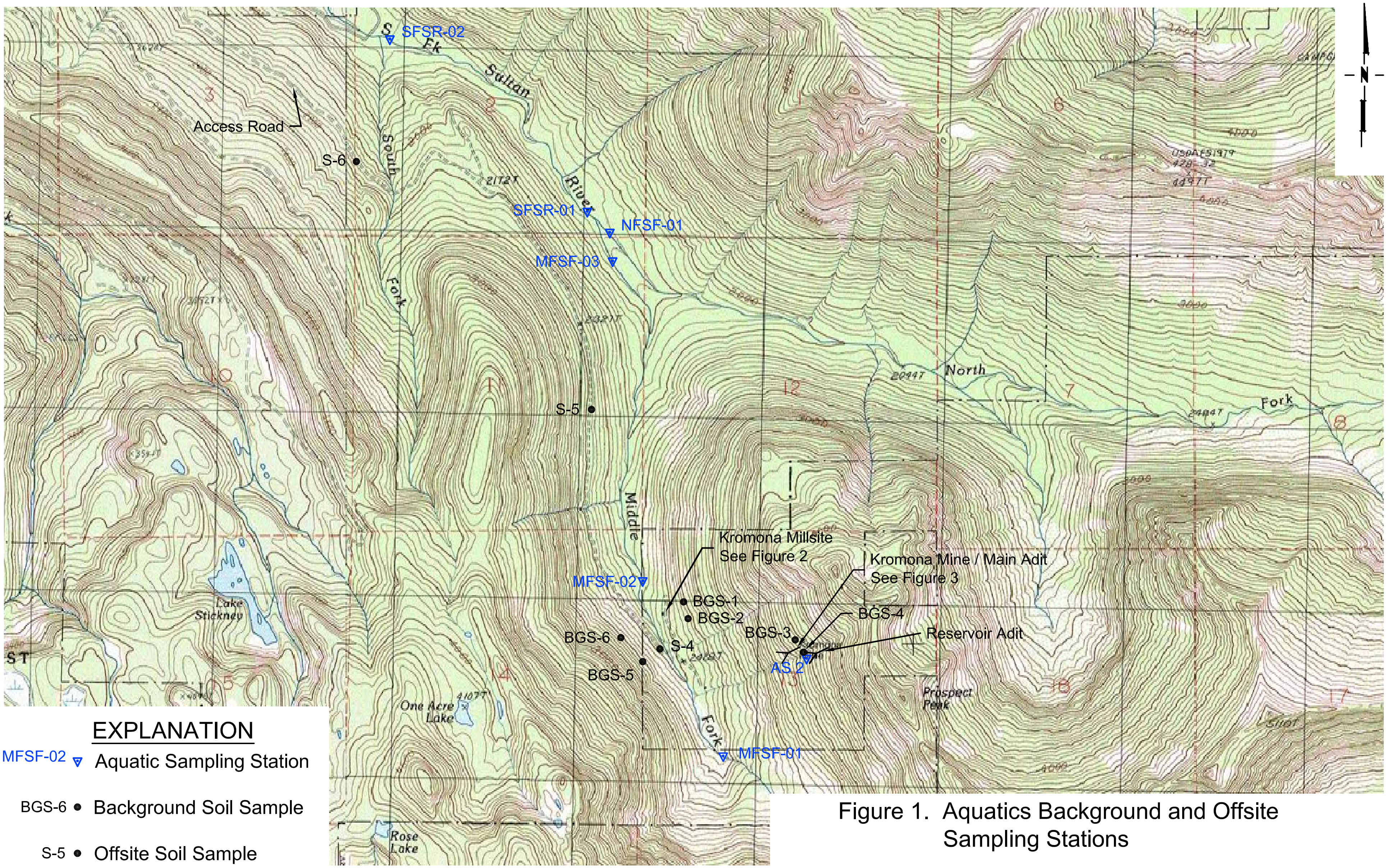
1 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 745-1 (Ecology, 2001).

2 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 749-2 (Ecology, 2001).

3 = Wasington Department of Ecology MTCA (WAC 173-340) Industial criteria, Table 749-3 (Ecology, 2001).

NS = No standard

FIGURES



EXPLANATION

MFSF-02 ▿ Aquatic Sampling Station

BGS-6 • Background Soil Sample

S-5 • Offsite Soil Sample

⅄ Adit

Note:
The prefix KM (Kromona Mine) has been removed from sample ID's.

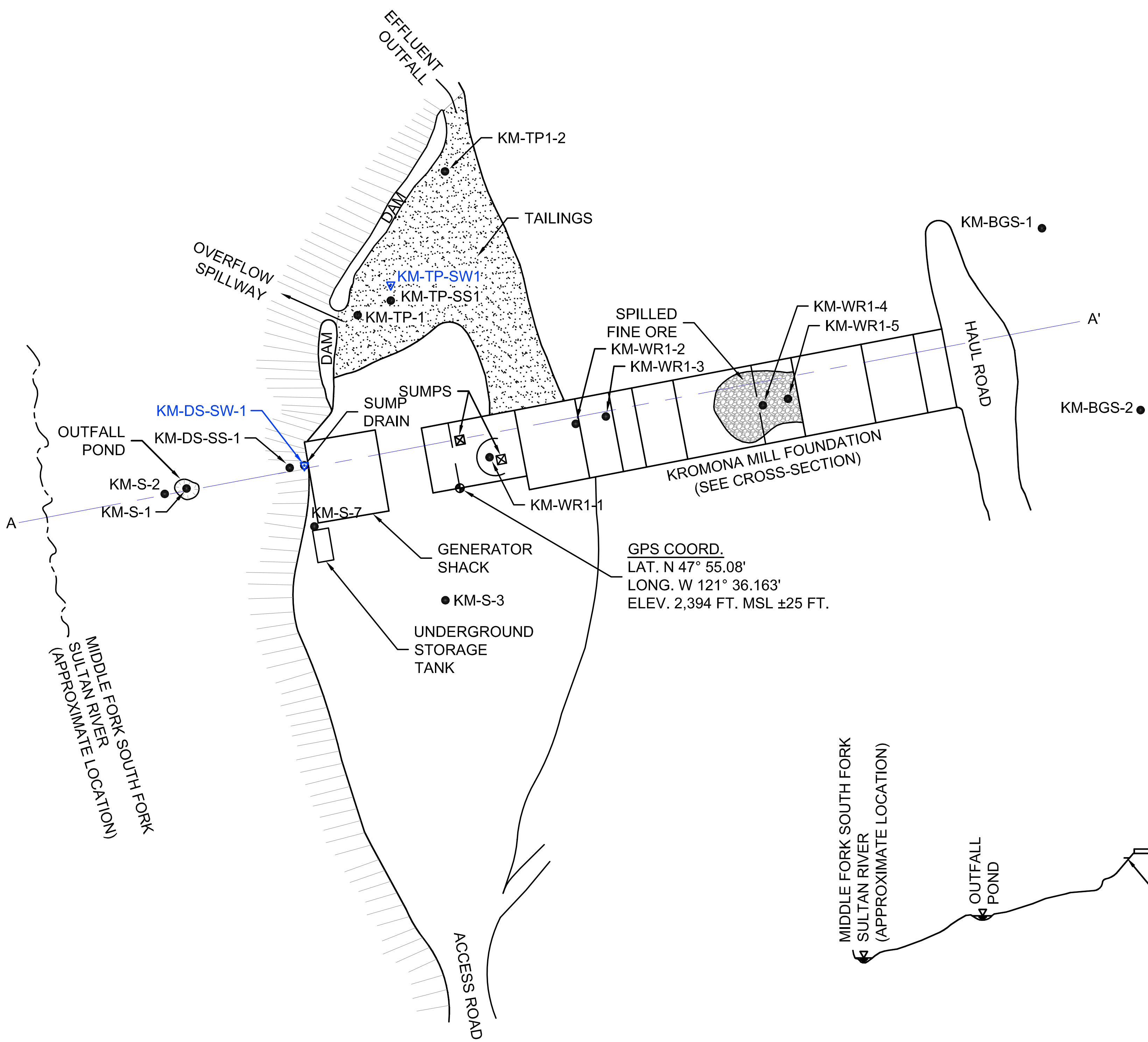
(SOURCE: USGS 7.5 MIN. TOPOGRAPHIC MAPS OF OREGON ON CD-ROM, NATIONAL GEOGRAPHIC, 2003)

0 2500 FEET

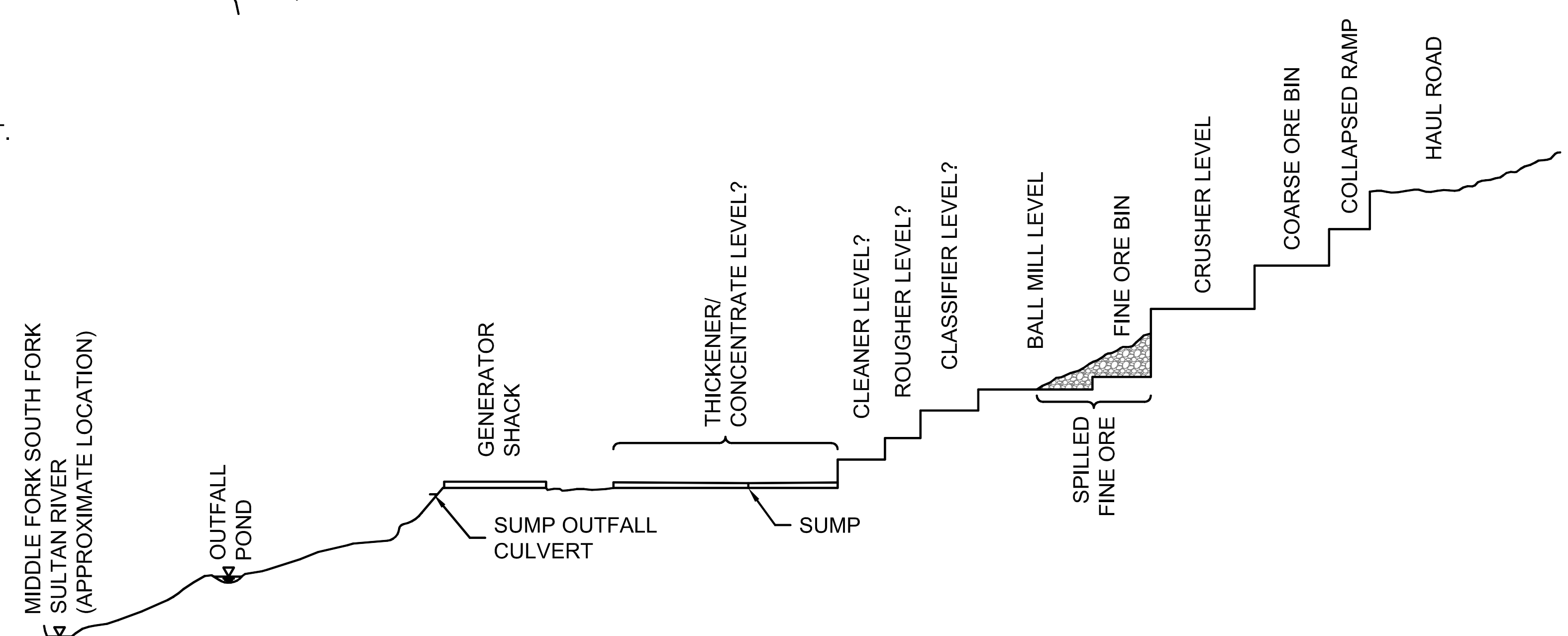
CONTOUR INTERVAL = 40 FEET
(SCALE & LOCATIONS ARE APPROXIMATE)

Figure 1. Aquatics Background and Offsite Sampling Stations

PROJECT NUMBER: 2423004/002	KROMONA MINE & MILLSITE SITE INSPECTION
DATE: 9/28/2005	
DWG BY: 8DEO / DWG NO: 2423004-002F1.DWG	USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR GOLD BAR, WASHINGTON
PROJECT MANAGER: 6DGW	
REVISED:	CES CASCADE EARTH SCIENCES A Valmont Industries Company



Kromona Mill Plan View



Kromona Mill Cross Section A-A'

Figure 2. Site Layout and Sampling Locations
Kromona Millsite

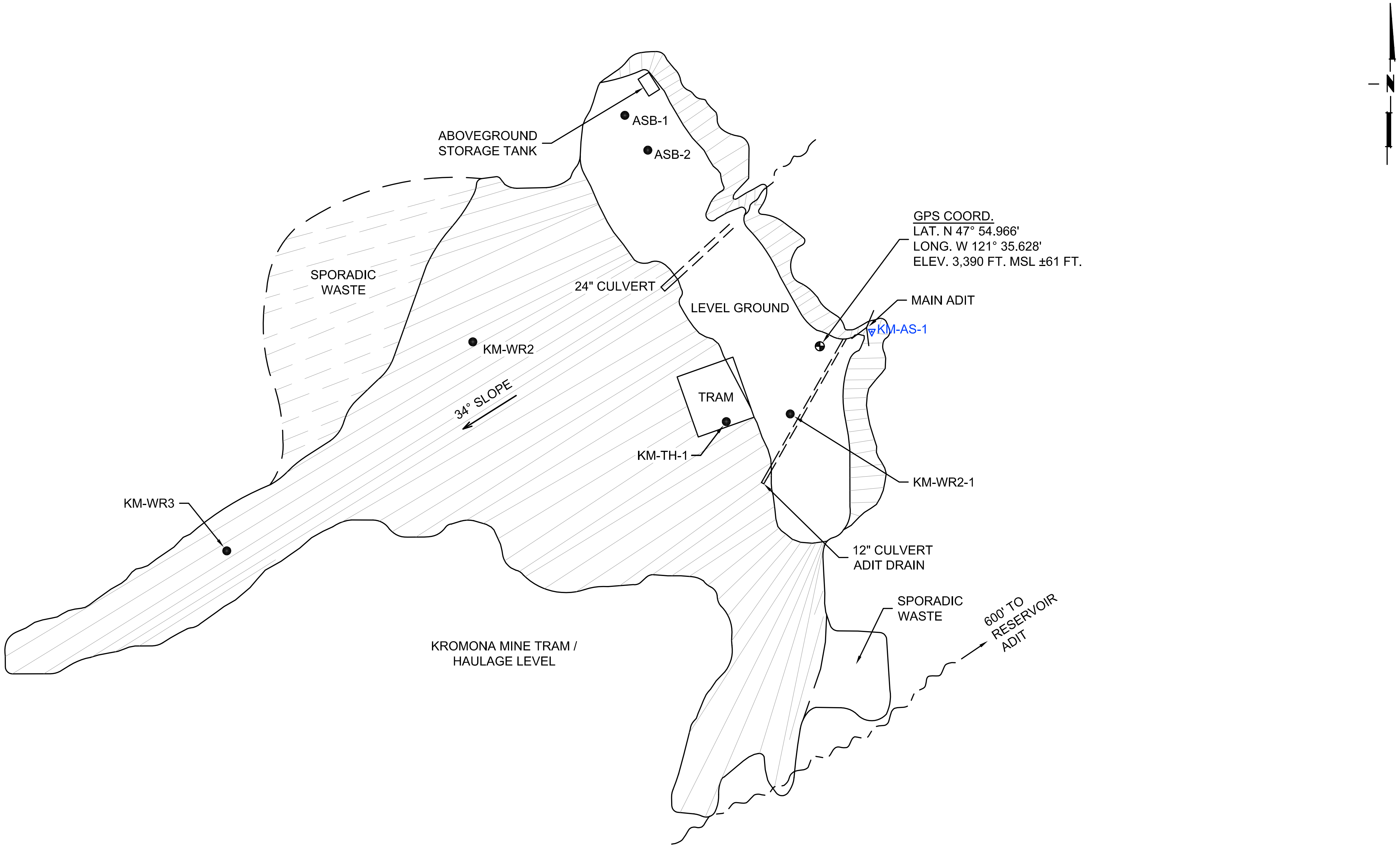
EXPLANATION

KM-TP-SW1 Surface Water Sample

● KM-S-3 Tailings, Wasterock, Soil Sample Location

0 50 FEET
(SCALE & LOCATIONS ARE APPROXIMATE)

PROJECT NUMBER: 2423004/002	KROMONA MINE & MILLSITE SITE INSPECTION
DATE: 9/27/2005	
DWG BY 8DEO; DWG NO: 2423004-002F2,3.DWG	USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR GOLD BAR, WASHINGTON
PROJECT MANAGER: 6DGW	
REVISED:	CES CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

- KM-WR2-2 Wasterock Sample Location
- KM-AS-1 Surface Water Sample Location
- ASB-1 Asbestos Sample
- Adit

Figure 3. Site Layout and Sample Locations
Kromona Mine Upper Workings

PROJECT NUMBER: 2423004/002	KROMONA MINE & MILLSITE SITE INSPECTION
DATE: 9/27/2005	
DWG BY 8DEO / DWG NO: 2423004-002F2,3.DWG	USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR GOLD BAR, WASHINGTON
PROJECT MANAGER: 6DGW	
REVISED:	CES CASCADE EARTH SCIENCES A Valmont Industries Company

PLATES

Plate 1. Kromona Mine and Millsite Watershed Boundary with 1- and 4-mile radii from Site

EXPLANATION

Watershed Boundary

Radius Surrounding Mine

SCALE 1 INCH = 2,500 FEET

1 1/2 0 1 MILE

CONTOUR INTERVAL = 40 FT.

Plate 1. Kromona Mine Watershed Boundary
with 1 and 4 Mile Radii

PROJECT NUMBER: 2423004	KROMONA MINE SITE INSPECTION
DATE: 9/28/2005	
DWG. 8DEO / DWG NO: 2423004-002P1.DWG	USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR GOLD BAR, WASHINGTON
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

APPENDICES

Appendix A.

Photographs


Photograph 1. View upstream at Station NFSR-01. (CES 5-17-05)


Photograph 2. View upstream at Station MFSF-02 adjacent to the Kromona Mine. (CES 5-17-05)

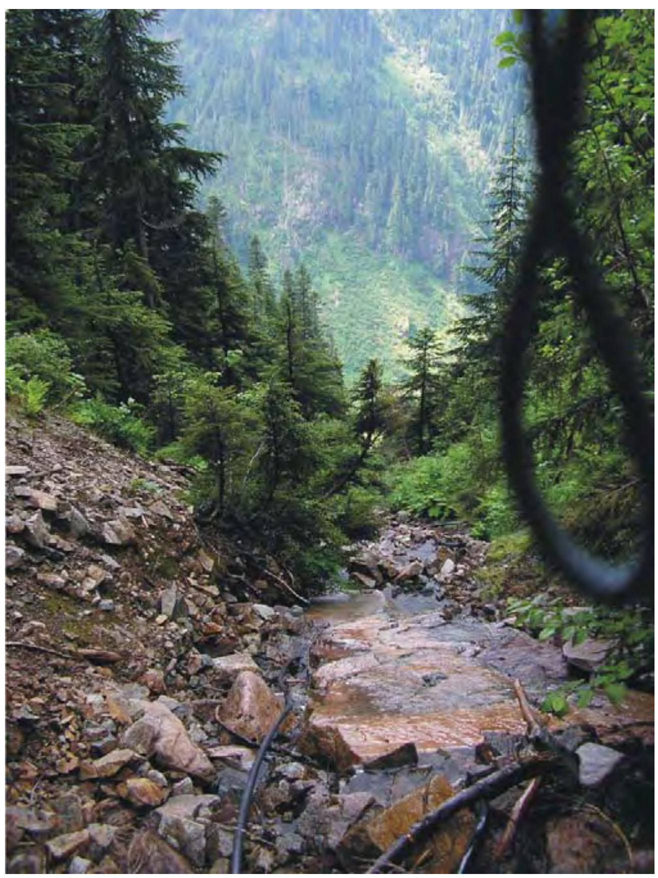
Photograph 3. Looking upstream at Station MFSF-03. (CES 5-17-05)

Photograph 4. Looking upstream. (CES 5-17-05)

Photograph 5. View upstream at Station SFSR-02. (CES 5-17-05)

Photograph 6. View east at the Main Adit portal at Kromona Mine. (CES 6-29-05)

Photograph 7. View east at the Reservoir Adit. (CES 6-29-05)



Photograph 8.View west from the Reservoir Adit drainage.

Photograph 9. View of the sump drainage seep where it infiltrates into the ground above the creek.

Photograph 10. View north at debris at upper (Main Adit) level at Kromona Mine. (CES 6-28-05)

Photograph 11. View north at an above ground storage tank on the upper workings level. (CES 6-29-05)

Photograph 12. View southeast at the upper tram terminal and waste rock at the Kromona Mine. (CES 6-29-05)

Photograph 13. View north at the tailings area in the Kromona Mill foundation area. (CES 6-28-05)

Photograph 14. View east at Kromona Mill foundation and tailings area. (CES 6-29-05)

Photograph 15. View east at Kromona Mine Mill Foundation. Note copper staining. (CES 6-18-05)

Photograph 16. Ponded water on the thickener level on the base of the Kromona Mill.

Appendix B.

Ecological Survey

1.0 INTRODUCTION AND OBJECTIVES

This ecological survey report provides the methods and results of an ecological survey at the Kromona Mine and Millsite (Site). The Site is located approximately 7 miles north of Index, WA on the Skykomish Ranger District of the Mount Baker-Snoqualmie National Forest. The Site is adjacent to the Middle Fork of the South Fork of the Sultan River and falls within the Sultan Mining District. The ecological survey was conducted as part of the Site Inspection process which is intended to determine the need for further assessment of and/or remedial actions for Site-related chemicals.

The overall objective of the ecological survey was to document the ecology in close proximity to the Site and provide a preliminary assessment of the potential for Site-related ecological effects. The specific objectives were:

- Characterize terrestrial and stream habitats and document terrestrial macroinvertebrates, herpetiles (reptiles and amphibians), birds, mammals, fish, and benthic invertebrates that were present, or likely to be present at the Site, including the presence of threatened and endangered species and their habitat;

- Provide an initial characterization of the potential for exposure of ecological receptors to Site-related chemicals and of ecological effects that may occur as a result of this exposure, or as a result of Site-related physical disturbance of the environment;

- Compare stream invertebrate populations upstream and downstream of the Site; and

- Make recommendations regarding the need for further ecological effects assessment at the Site, and, as necessary, suggest possible actions to better understand the potential ecological effects.

Section 2.0 of this report provides the methods and results of the field surveys. Section 3.0 summarizes the ecological survey results and the potential for Site-related ecological effects. Recommendations are made in Section 4.0 regarding the need for, and approach to, further ecological assessment, and references are provided in Section 5.0.

2.0 METHODS AND RESULTS

2.1 AQUATIC ECOLOGICAL SURVEY

Aquatic surveys were conducted within the Middle Fork of the South Fork Sultan River (MFSF) and portions of the North Fork of the South Fork Sultan River (NFSF) and the South Fork Sultan River (SFSR) to assess the potential impacts of the Site on the instream habitat, benthic macroinvertebrate community, and presence of fish species due to the site-related physical habitat alteration or chemical contamination.

2.1.2. HABITAT

In the vicinity of the Site, the MFSF is a small, perennial first order stream (Armantrout 1998). The Site is located within one mile of the headwaters of the MFSF in a very steep headwall canyon. At the time of our investigation in May, flow was moderately high and likely higher than base flow conditions given recent moderate rainfall in the weeks prior to the survey. The volume of the MFSF increased with distance downstream from the Site and flows approximately 1¾ miles to the confluence with the NFSF resulting in the SFSR. The SFSR flows west 2 miles before reaching Spada Lake. The Site is 3¾ miles upstream from Spada Lake – a drinking water source for approximately 400,000 people in the city of Everett. A portion of Sultan River is diverted from Spada Lake and piped via aqueduct to downstream towns and cities for drinking water. The remainder of the Sultan River leaves Spada Lake and flows west and south approximately 24 miles before reaching the Skykomish River.

Three stream reaches, each approximately 50 m long were established on the MFSF, with one (MFSF-01) upgradient of the Site, one (MFSF-02) immediately downstream of Site and associated processing buildings, and one (MFSF-03) just upstream of the confluence of the MFSF with the NFSF. A fourth sampling reach (NFSF-01) was established on the NFSF, just upstream of its confluence with the MFSF. A fifth and final reach (SFSR-02) was established approximately 1 mile downstream of NFSF-01. The sampling stations are shown on Figure 1 of the SI. The NFSF-01 and MFSF-01 were considered to represent background conditions. Invertebrate sampling was conducted in both riffle and pool habitats in each of the five stream reaches. Numeric habitat ratings were developed for each reach using USEPA Rapid Bioassessment Protocol - Habitat Assessment Field Data Sheets for High Gradient Streams (Barbour 1999). Using this method, ten instream and riparian habitat parameters are each scored separately and then these individual habitat scores are summed to provide a habitat total score. The individual habitat parameter scores were used to differentiate habitat quality between stream reaches. Additional instream characterization was conducting with the Physical Characterization Field Data Sheet (Barbour 1999). The following habitat conditions were noted:

- Habitat total scores were 179, 170, 186, 182, 177, and 172 at stations NFSF-01, MFSF-01, MFSF-02, MFSF-03, and SFSR-02, respectively. This indicates the overall instream physical habitat conditions were optimal for all reaches.

- At NFSF-01, MFSF-01, and MFSF-02 the individual habitat parameter velocity/depth regime was rated as poor because only the fast/shallow regime was present, and the bank stability was rated as suboptimal due primarily to land/rock slides from the steep canyon walls and related high flow erosion.

- At MFSF-03 the individual habitat parameter velocity/depth regime was rated poor due to the presence of only fast/shallow conditions.

- At SFSR-02 the individual habitat parameter velocity/depth regime was rated marginal due to a lack of fast/deep and slow/deep conditions, respectively. The bank stability and vegetative protection parameters were both rated suboptimal at this station due primarily to high flow erosion and channel braiding in the vicinity of the station.

These habitat scores are more indicative of riffle habitat quality, and may not be correlated with pool habitat quality. Overall, MFSF-01 and MFSF-02 had quite similar riparian and instream conditions in a steep cascading bedrock/boulder/cobble dominated instream habitat, while NFSF-01, MFSF-03, and SFSR-02 were similar to each other with a less steep boulder/cobble/gravel dominated instream habitat. Conditions at SFSR-02 were slightly different than the others due to the erosional/braided channel features in the vicinity of the sampling reach. However, all stream reaches had some signs of unstable banks and channel structure. Large woody debris (LWD) density was high at all stations. Channel pattern was good with a sinuous channel at all stations.

To better understand pool conditions, the USEPA Rapid Bioassessment Protocol - Habitat Assessment Field Data Sheets for Low Gradient Streams (Barbour 1999) was completed at each pool sampling station. Most of the low gradient stream habitat parameters were rated as optimal or suboptimal except pool variability, which was rated as poor at all stations. This indicates that the pools are small, shallow, and not necessarily instream (i.e., are off-channel or along the side of the channel). Generally, the fine substrate at all stations was sand with minimal silt. The pool at station SFSR-02 contained a higher amount of organic material than the other stations.

No clear Site-related erosion features were noted in along the banks of the MFSF. However, the very steep (e.g., approximately 70 degree slope) drainage features near the Site showed extreme erosion potential with boulder strewn channels and large boulder, cobble, gravel, and sand alluvial fans between MFSF-01and MFSF-02. These drainages contain old mining debris such as rails, barrels, metal scraps, and lumber suggesting that upgradient Site-related activities have been disturbed by high flows down the drainages. Thus, these drainages could be pathways for Site related physical and chemical impacts to the MFSF.

No fish barriers were noted at or between the sample stream reaches. However, the Spada Lake dam is a barrier for anadromous fishes.

2.1.3. INVERTEBRATES

Sampling of benthic macroinvertebrates was conducted from each of the stream reaches using a D-ring kick net with 500 micrometer mesh. Samples were collected from both pool and riffle habitats. Three kick-net samples (i.e., jabs) from each pool or riffle sampling location were composited into one larger sample for a total area of approximately 0.6 square meters (m^2) sampled per habitat type per station. Samples were preserved with 90% ethanol and shipped to the laboratory. Laboratory enumeration was completed to the species level, when possible, for at least 300 individuals in each sample. The identified invertebrates are listed in Table B-1. Abundance, diversity, and several biological indices were examined for the invertebrates present in each pool and riffle sample, and qualitatively compared between stations. Pool data were only compared to other pool data and riffle data were only compared to other riffle data. No rare, threatened, or endangered (RTE) stream invertebrate species were indicated to be present during Washington Department of Fish and Wildlife (WA-DFW) and Washington Department of Natural Resources (WA-DNR) database searches for such species, nor were any identified during the survey.

The abundance and diversity data provide understanding of the number of individual invertebrates and the number of species, respectively, at each station. Differences in the abundance and diversity between stations can be used as potential indicators of instream habitat quality and potential chemical impact. The metals tolerance index was developed in Montana (Montana Department of Environmental Quality [MTDEQ], 1995) and is based upon a correlation of invertebrate species present in known metals contaminated streams versus those present in unpolluted streams. A higher metals tolerance index value indicates that a higher percentage of the invertebrate species present are known to be tolerant of the presence of metals contamination. The Shannon-Weaver index is a measure of the number of species (i.e., diversity) and the number of individuals within each species (i.e., evenness). A higher Shannon-Weaver index indicates more diversity and a lower likelihood of impacted invertebrate populations. The fine sediment biotic index is a measure of the number of species present that are tolerant of increased sediment in the stream substrate. A higher fine sediment biotic index indicates there are more sediment tolerant species present in the sample. The intolerant species index is a measure of how many pollution sensitive species are present in each sample. A lower number in intolerant species suggests the invertebrate population may be impacted.

The results of the benthic invertebrate investigation in pool habitats show that:

- The estimated numbers of all invertebrates were 183, 128, 219, 1860, and 355 at NFSF-01P, MFSF-01P, 02P, 03P, and SFSR-02P, respectively.

- Diptera (primarily Chironomidae) were the most abundant species at NFSF-01P, MFSF-01P, MFSF-03P, and SFSR-02P, but had similar numbers at NFSF-01P, MFSF-01P, and MFSF-02P, then increased notably at the two farthest downstream locations. Ephemeropteran, Plecopteran, and Trichopteran (i.e., EPT) species showed increasing numbers between NFSF-01P, MFSF-01P, and MFSF-02P, then were much fewer and similar at MFSF-03P and SFSR-02P. The first dominant taxon increased steadily between NFSF-01P, MFSF-01P, 02P, and 03P, then decreased to a moderately high level at SFSR-02P. These results are shown on Figure B-1.

- The overall pattern of species diversity was similar at NFSF-01P, MFSF-01P and 02P with the numbers of each species except EPT generally increasing a similar amount. The EPT species diversity increased more noticeably in proportion with the other species, across these three stations. The species diversity was similar between MFSF-03P and SFSR-02P except for a decrease in the number in EPT species (Figure B-2). The number of non-chironomid/non-oligochaete species was greater at MFSF-02P. Chironomids were the only species that increased consecutively across all stations.

- The composition of functional feeding groups varied only slightly between most stations with moderately increased gatherers and decreased shredders at MFSF-03P, and decreased gatherers and increased predators at SFSR-02P. Shredders also showed a moderately elevated level compared to the other stations at MFSF-01P (Figure B-3).

- The metals tolerance index decreased between NFSF-01P, MFSF-01P, and MFSF-02P, then increased consecutively at MFSF-03P and SFSR-02P. The Shannon-Weaver species diversity index (log e) was fairly consistent with a slight decrease at MFSF-03P. The numbers of intolerant (i.e. sensitive) species were low at NFSF-01P, increased notably at MFSF-01P and MFSF-02P, then decreased rapidly at MFSF-03P and SFSR-02P. These results are shown in Figure B-4.

The increased number of invertebrates with increasing distance downstream suggests the pool quality is increasing at each consecutive downstream station. This is generally consistent with field observations, but the much higher abundance at MFSF-03P is not clearly explained solely by habitat quality because the pool habitat quality at SFSR-02P appeared as good, or better, than that at MFSF-03P. One possible explanation for the lower than expected abundance at SFSR-02P is that this pool was in a smaller braided channel that may have been formed by high water during the preceding winter.

Similarity in the percentage of species present at NFSF-01P, MFSF-01P, and MFSF-02P (Figure B-1) confirms the similarity in habitat conditions at these to pool stations. The relatively low abundance of dipteran species (primarily chironomid) and higher percentage of EPT species at these stations compared to MFSF-03P and SFSR-02P likely reflects the smaller and more riffle like conditions that were present at upstream pool stations where the pools were present along the side of the channel and contained a higher percentage of coarse grained substrate than the farther downstream stations. These conditions are normal for the cascading, high gradient nature of the upstream stations. Decreasing percentages of oligochaetes across the stations also reflects increasing habitat quality. The only indicator that habitat quality is not increasing with downstream distance from the Site is the obvious increase in the percentage of the first dominant taxon at MFSF-03P, which is a potential indicator of decreased habitat quality.

As discussed in the preceding paragraph, the increasing diversity across NFSF-01P, MFSF-01P, and MFSF-02P are likely related to increased riffle-like conditions and increased habitat quality at these stations. The riffle characteristics are indicated by the increased diversity of non-chironomid/non-oligochaete and EPT species. At stations MFSF-03P and SFSR-02P, the species diversity stabilizes while the number of species that are most common in riffle habitats decrease, and the number of pool species increases. These trends likely reflect the increasing pool characteristics. The relatively high number of EPT species at MFSF-03P suggests this pool still contains some riffle characteristics.

As shown in Figure B-3, the functional group composition shows a fairly similar pattern with an increase in the percentage of gatherers at MFSF-03P and an increase in predators at SFSR-02 compared to the other stations. The increase in gatherers and predators may reflect the increased chironomid abundance in the sandy pool at MFSF-03P and a pool with high organic material at SFSR-02P. The difference in foraging preferences are a reflection of the different chironomid species that inhabit the different substrates in these pool habitats. The higher percentage of different foraging strategies at SFSR-02 suggests this station provides more diverse pool habitat than MFSF-03P.

The Shannon-Weaver index (Figure B-4) is fairly consistent across all stations with slightly lower species diversity at MSFS-03P. The intolerant (i.e., sensitive) taxa index shows an increase in sensitive taxa at MFSF-02P compared to background stations, then a decline to at or below background conditions at stations MFSF-03P and SFSR-02P. This suggests increased habitat quality immediately downstream of Site activities but decreasing quality further downstream from the Site (below the confluence with the NFSF). Consistent with the intolerant taxa index, the metals tolerance index shows a decrease (albeit slight) at MFSF-02P. Regardless, the fairly consistent and low metals tolerance indices at all stations suggests that metals are not causing any impact in the MFSF nor the SFSR. Thus, differing instream pool habitat conditions are suggested as the likely causes of differing numbers and diversity of stream invertebrates within the sample pools.

Generally, pool habitats are representative of instream sediment quality. Conditions at MFSF-03P showed somewhat unexpected differences from the other stations. However, the benthic invertebrate survey results for pool habitats provide no clear evidence of (Site-related) chemical impact downstream of the Site, nor were any apparent Site-related physical alterations to the stream channel observed.

Results of the benthic invertebrate investigation in riffle habitats suggest that:

- The numbers of invertebrates were 64, 362, 684, 943, and 296 at stations NFSF-01R, MFSF-01R, MFSF-02R, MFSF-03R, and SFSR-02R, respectively.

- EPT species were the most abundant at all Stations but were somewhat lower than other stations at SFSR-02R. Diptera, chironomid, and Baetidae abundance were relatively consistent across all stations with a slight dip at MFSF-03R. The first dominant taxon varied somewhat across most stations, but was clearly highest at MFSF-03R. These findings are shown graphically in Figure B-5.

- Species diversity was lowest at NFSF-01P, and quite consistent across all the other stations as displayed in Figure B-6.

- The composition of functional feeding groups showed that scrapers were dominant at all Stations and that the distribution of feeding groups were similar across the stations but with the highest number of scrapers and the lowest number gatherers at MFSF-03R and relatively low numbers of scrapers at SFSR-02R. Figure B-7 shows the distributions of functional feeding groups at each riffle station.

- The intolerant species index was low at NFSF-01R, then increased and stayed relatively high at all other stations, with the highest index at MFSF-02R immediately downstream of the Site. The metals tolerance index and Shannon-Weaver species diversity index (log e) were both low and consistent across all stations (Figure B-8).

Generally, riffle habitats are representative of instream water quality but also reflect riffle habitat conditions. The increased first dominant taxon and different functional feeding groups at MFSF-03R, different species abundance and functional feeding groups at SFSR-02R, and the decreased species diversity at NFSF-01R suggest these three stations are somewhat different than the other stations. Differences at SFSR-02R are likely related to habitat conditions within the braided side channel that was sampled. Regardless, the consistency in other measures across all stations (especially immediately downstream of the Site) suggest good quality riffle habitat is present and that there are no apparent Site-related impacts in these riffle habitats.

Overall, the riffle invertebrate results suggest that conditions at MFSF-03 and NFSF-01, and possibly SFSR-02 are potentially different than at the other stations. However, there is no clear evidence that these differences are a result of Site-related chemical or physical impacts.

2.1.4. FISH

The presence of fish was documented by visual observation during the ecological survey and through contact with regional state and federal fisheries biologists. No fish were observed during the ecological survey. The dam that creates Spada Lake prohibits the presence of anadromous fish in the reaches investigated during this ecological survey. The resident species expected in the vicinity of the Site are cutthroat (*Oncorhynchus clarki*), rainbow (*Oncorhynchus mykiss*) trout, eastern brook trout (*Salvelinus fontinalis*), and brown bull head (*Ictalurus nebulosus*).

2.2. TERRESTRIAL ECOLOGICAL SURVEY

Terrestrial habitats and animals that are present or likely at, and surrounding, the Site were documented during the ecological survey and via communication information obtained from regional biologists. Two 30-minute bird surveys were also conducted. During the field investigation, the Site was inspected to determine the dominant vegetation communities and identify the dominant plant species (Cooke, 1997; Hitchcock and Cronquist, 1978; Niehaus and Ripper 1976, Pojar and Mackinnon, 1994; Little, 1980) within each of the communities. Qualitative surveys also were conducted at and surrounding the Site for the presence of mammal and terrestrial invertebrates. Lists of rare, threatened, or endangered (RTE) plants and animals likely or known to be present in the vicinity of the Site were obtained from the U.S. Forest Service (USFS), WA-DFW, and WA-DNR and are provided in Appendix B1.

2.2.2. PLANT COMMUNITIES/HABITAT

The Site is within the Cascades Mixed Forest-Coniferous Forest ecoregion (Bailey 1995). This ecoregion is characterized by warm summers and wet mild winters with average temperatures ranging from 2 to 10 degrees Celsius. Rainfall varies considerably with elevation across the ecoregion with 100 to 200 cm (40-75 inches) of precipitation per year estimated for the Kromona Mine area. Precipitation is common throughout the year, but a majority occurs in the fall, winter, and spring. Relative humidity is often high due to the proximity of this province to the Pacific Ocean. The dominant plant communities in this ecoregion may be Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), grand fir (*Abies grandis*), silver fir (*Abies amabilis*), or Sitka spruce (*Picea sitchensis*) forests at middle to low elevations. Western hemlock and silver fir are often the climax species.

The Site is primarily encompassed by a coniferous second growth forest. However the very steep slopes at the Site result in a considerable amount of rock fall, landslides, and erosion, resulting in numerous disturbed areas with successional vegetation. The major plant communities identified at and immediately surrounding the Site included the coniferous forest community, a riparian community, a naturally disturbed community (which is similar to the riparian community), and a mining disturbed community. In some areas it was difficult to determine naturally disturbed versus potentially mining disturbed communities. The terrestrial RTE plant species potentially present near the Site are listed in Table B-2. No listed RTE plants were observed during the site visit. However, the entire Site was not surveyed, so if remediation work is necessary, field surveys for particular species may be needed prior to any ground disturbance activity.

The forest community canopy layer was dominated by western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*). The primary shrub layer species included salmon berry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa*), and red huckleberry (*Vaccinium parvifolium*). The ground (herbaceous) layer included queen’s cup (*Clintonia uniflora*), sword fern (*Polystichum munitum*) and mosses (various sp.) with few other species present. These and other species observed in the forest community are listed in Table B-3.

The riparian community had a sparse to patchy canopy layer, primarily consisting of Sitka alder (*Alnus sinuata*) with some intermixed western red cedar and western hemlock. The shrub layer was dominated by salmonberry (*Rubus spectabilis*), Scouler’s willow (*Salix scouleriana*), and Devil’s club (*Oplopanax horridus*). The herbaceous layer was dominated by lady fern (*Pteridium aquilinum*), fireweed (*Epilobium angustifolium*), clasping twisted stalk (*Streptopus amplexifolius*), and rosy twisted stalk (*Streptopus roseus*). These and other species observed in the riparian community are listed in Table B-3.

The naturally disturbed community was diverse, varying from early successional species on large expanses of rockslides or landslides, to mid-successional species overlying landslide areas. The canopy species were limited to mid-successional areas and included western red cedar, Sitka alder, and red alder. The shrub layer included vine maple (*Acer circinatum*), salmonberry, Devil’s club, and red elderberry. The herbaceous layer varied between the successional stages, but included rosy twisted stalk (*Streptopus roseus*), lady fern (*Athyrium felix-femina*), Pacific bleeding heart (*Dicentra formosa*), stream violet (*Viola glabella*), and Indian hellebore (*Veratrum viride*).

The disturbed mine community encompassed both areas of the Site: the upper workings including the Main Adit and the lower Millsite area, as well as the network of roadways and excavated areas. Many of the excavated areas are quite similar to the mid-successional naturally disturbed communities, but contained more weedy species. The areas immediately surrounding the Site were primarily waste rock, gravelly soil, or compacted gravel roadways with early successional canopy and shrub layers, and a variable herbaceous layer including more colonizing and weedy species. The Millsite area canopy was dominated by red alder, western hemlock, and western red cedar. The shrub layer at the Millsite areas was absent, but other areas included mostly salmon berry and red elderberry. The herbaceous layer at the Millsite included fireweed, sedges and horsetail while the other disturbed areas included pacific bleeding heart, lady fern, stream violet, rosy twisted stalk, Cooley's hedgenettle, and false lily-of-the-valley. There is very little vegetation at the upper workings (Main Adit and upper tram terminal) and associated waste rock. The species observed in the disturbed mine community are listed in Table B-3.

The Mine and Millsite are not immediately adjacent to the MFSF riparian corridor. However, roadways associated with the Site travel along the creek in some areas. There were no areas where Site activities resulted in obvious physical impacts to the riparian community or the river. However, several drainages originated near Site-related activities and these drainages have contributed very large amounts of boulder, cobble, gravel, and sand to the upper reaches of the MFSF. The vegetation within close proximity to the mine adits, processing areas, and roadways is clearly different from the other communities. Compaction, soil types, and/or mine-related metals may be the cause of these differences. None of the identified plants were RTE species.

2.2.3. TERRESTRIAL INVERTEBRATES

Invertebrates noted on and near the mine included black carpenter ants (*Camponotus pennsylvanicus*), common black ground beetles (*Pterostichus* sp.), butterflies, moths, black flies (*Simulium* sp.), yellow jackets (*Vespula* sp.), and spiders (Order *Araneae*). The observed and expected invertebrates are listed in Table B-4. None of these or other invertebrates in the vicinity of the mine are known RTE species.

2.2.4. BIRDS

Birds seen or heard during the bird survey or during other field work at the site are listed in Table B-5. Heavy rains and thunder limited bird activity and the auditory identification of birds. As noted in Table B-2, northern flickers, northern goshawks, olive-sided flycatchers, pileated woodpeckers, and willow flycatchers are expected in the vicinity of the Site and are a rare, sensitive, indicator or candidate species. Marbled murrelets are known to nest within a few miles of the mine and are state and federally threatened species. The other RTE bird species listed in Table B-2 are possible inhabitants of the forest surrounding the mine, but are unlikely to forage regularly in the disturbed mine area.

2.2.5. MAMMALS

Game trails were not clearly present, but deer tracks were noted in the vicinity of the Site, suggesting that black-tailed deer (*Odocoileus hemionus columbianus*) are present near the Site. A black bear (*Ursus americanus*) was observed during travel to and from the Site. Other mammals or mammal signs observed included, Douglas' tree squirrel (*Tamiasciurus douglasii*), aplodontia (Mountain Beaver; *Aplodontia rufa*), and a Townsend chipmunk (*Eutamias townsendi*). Townsend's big-eared bats (*Plecotus townsendi*), a state candidate species and federal species of concern, may inhabit caves or mine shafts in the vicinity of the Site. Mammals that were observed, expected or possible at the Site are listed in Table B-6. Other RTE mammal species listed in Table B-2 may inhabit the region, but are unlikely or uncommon at the Site.

2.2.6. REPTILES AND AMPHIBIANS (HERPETILES)

Unidentified tadpoles and normal adult red-legged frogs were observed in pooled water surrounding the foundation of the former Millsite. No other amphibians or reptiles were observed during the survey. Those expected or possible at the Site are listed in Table B-7. The tailed frog (*Ascaphus truei*), western toad (*Bufo boreas*) and spotted frog (*Rana pretiosa*) are RTE species (Table B-2) that may be found in the vicinity of the Site.

3.0 CONCLUSIONS

Overall, mining, logging, and potentially other activities have attributed to physical disturbances to the natural environment on the hillside above the MFSF. The areas at and immediately surrounding the Site are still disturbed and contain disturbed successional plant communities. The habitat adjacent to the Site is also disturbed either by mining-related activities or due to the slides that occur on the steep slopes. Regardless, good quality terrestrial and instream habitats are present surrounding the Site. The mine-related physical disturbances do not obviously extend into the MFSF. The only apparent and potential areas of chemical effect for terrestrial species are on or near the waste material at the Site. Given the relatively small area of the waste material in comparison to the large undisturbed natural forest, the potential for terrestrial ecological effects is likely limited to individuals within the plant, invertebrate, and frog species that may reside in the disturbed areas and are rooted in or regularly exposed to the waste piles. Based on stream invertebrate enumeration results, no apparent instream effects were noted due to Site-related physical or chemical impacts.

4.0 RECOMMENDATIONS

Terrestrial ecological risk-based screening should be conducted to identify potential risks, if any, to terrestrial ecological receptors and determine contaminants of potential ecological concern (COPECs) in soil/waste piles, if any. While no apparent Site-related impacts were noted to stream invertebrates during this survey, an ecological risk assessment is warranted to determine the potential affects to fish and other aquatic/benthic species. Any identified COPECs in soil, surface water, or sediment should be examined with regard to the potential for bioaccumulation in terrestrial and aquatic food chains.

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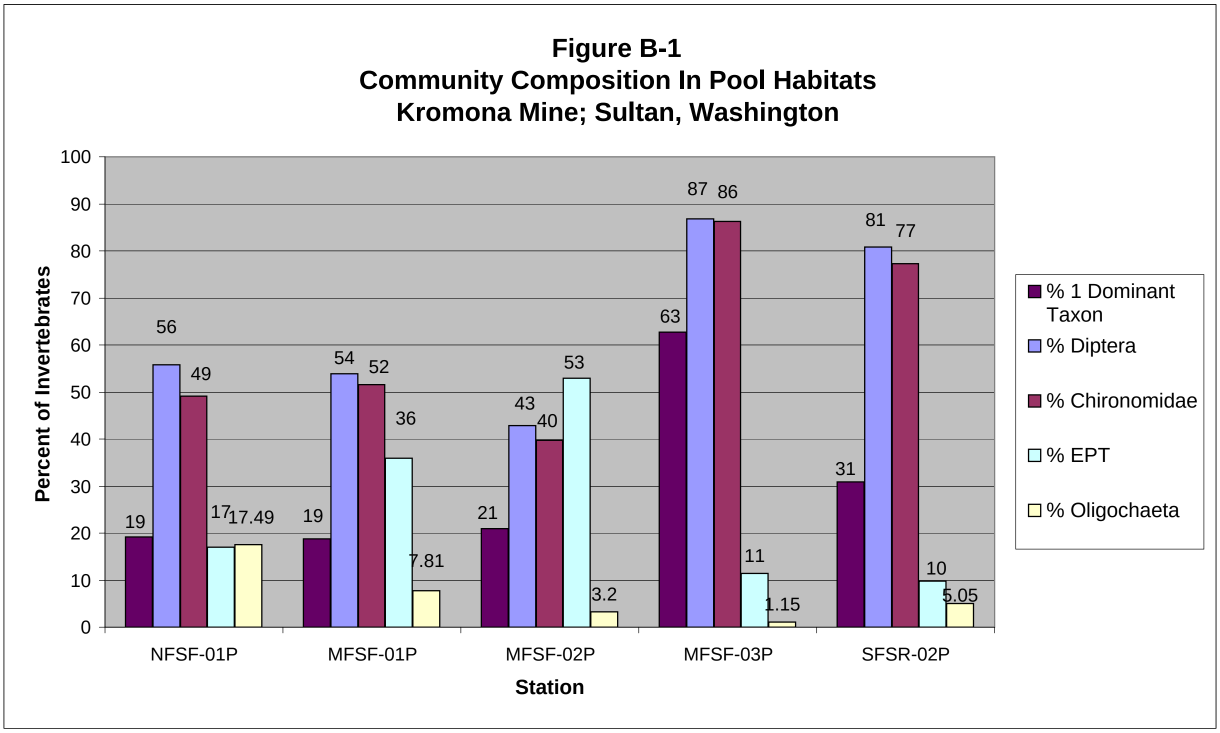


Figure B-1
Community Composition In Pool Habitats
Kromona Mine; Sultan, Washington
Percent of Invertebrates
Station
NFSF-01P
MFSF-01P
MFSF-02P
MFSF-03P
SFSR-02P
% 1 Dominant Taxon
% Diptera
% Chironomidae
% EPT
% Oligochaeta
19
56
49
17
17.49
54
52
36
7.81
21
43
40
53
3.2
63
87
86
11
1.15
31
81
77
10
5.05

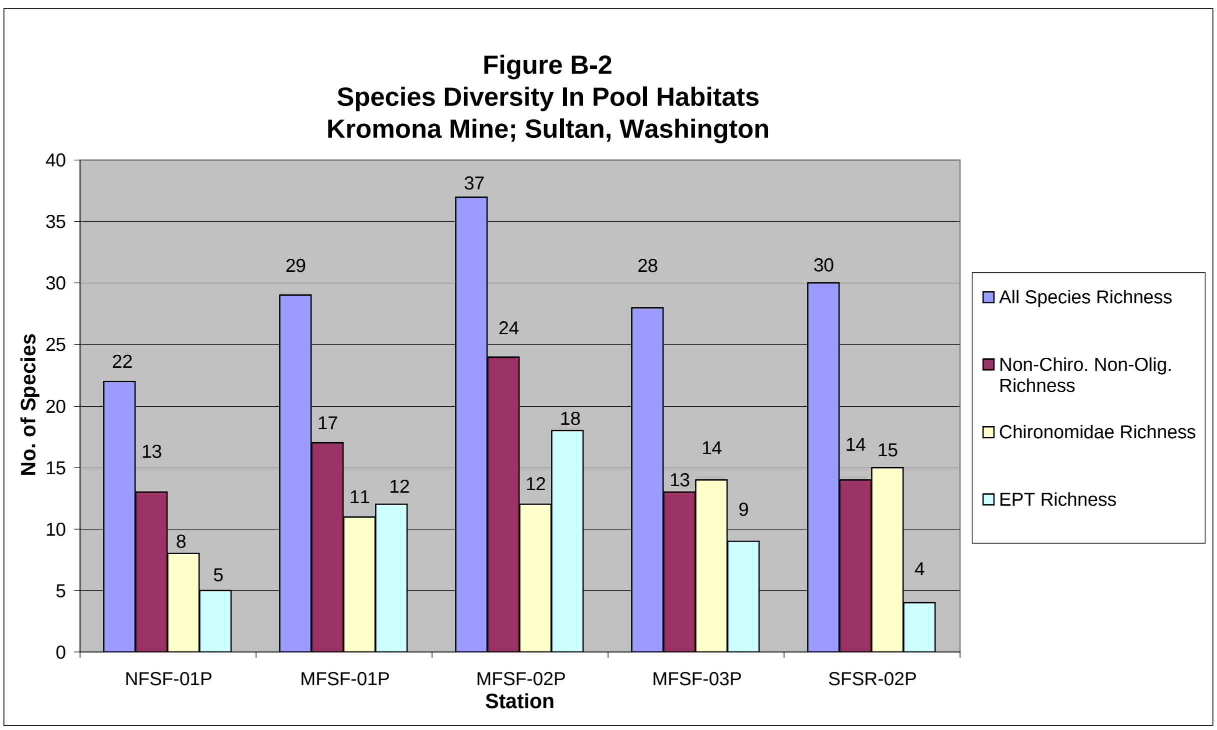


Figure B-2
Species Diversity In Pool Habitats
Kromona Mine; Sultan, Washington
No. of Species
Station
NFSF-01P
MFSF-01P
MFSF-02P
MFSF-03P
SFSR-02P
All Species Richness
Non-Chiro. Non-Olig. Richness
Chironomidae Richness
EPT Richness
22
13
8
5
29
17
11
12
37
24
12
18
28
13
14
9
30
14
15
4

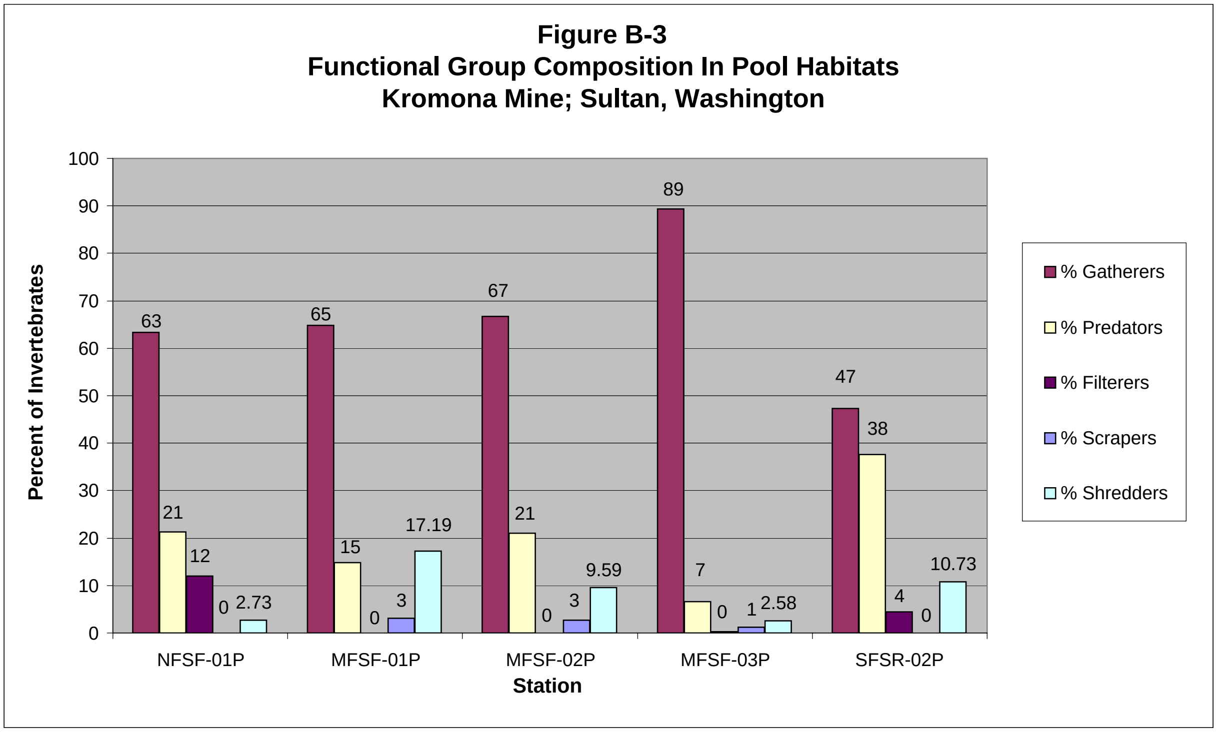


Figure B-3
Functional Group Composition In Pool Habitats
Kromona Mine; Sultan, Washington
Percent of Invertebrates
Station
NFSF-01P
MFSF-01P
MFSF-02P
MFSF-03P
SFSR-02P
% Gatherers
% Predators
% Filterers
% Scrapers
% Shredders
63
21
12
0
2.73
65
15
0
3
17.19
67
21
0
3
9.59
89
7
0
1
2.58
47
38
4
0
10.73

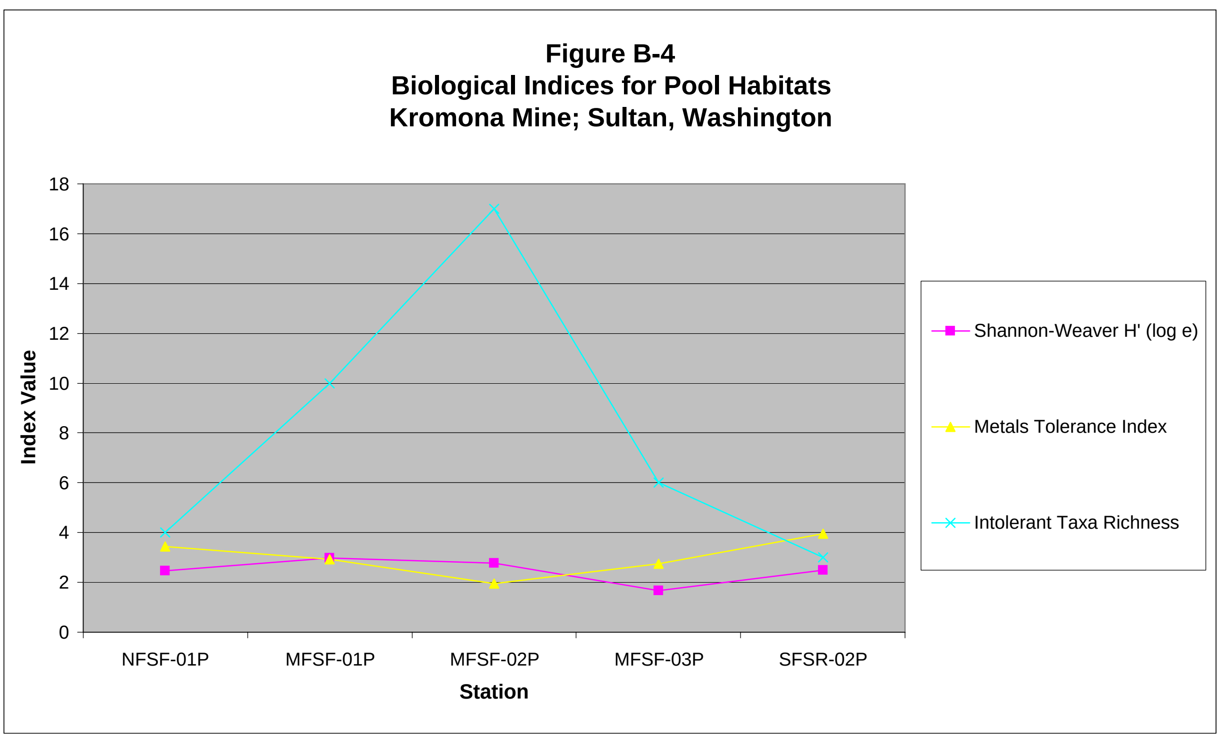


Figure B-4
Biological Indices for Pool Habitats
Kromona Mine; Sultan, Washington
Index Value
Station
NFSF-01P
MFSF-01P
MFSF-02P
MFSF-03P
SFSR-02P
Shannon-Weaver H' (log e)
Metals Tolerance Index
Intolerant Taxa Richness

Figure B-5
Community Compostion In Riffle Habitats
Kromona Mine; Sultan, Washington

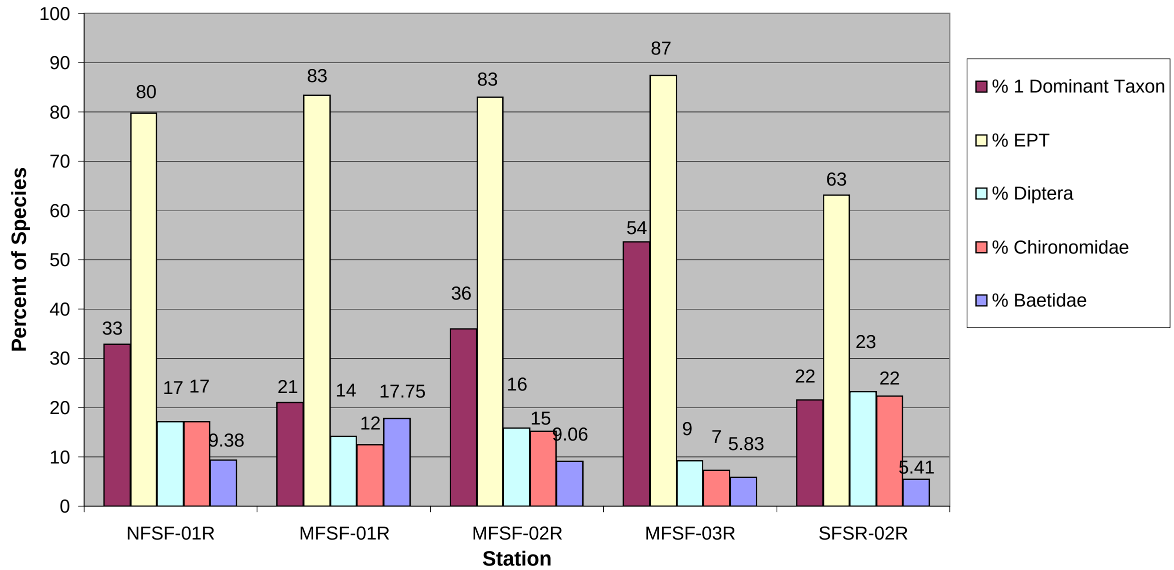
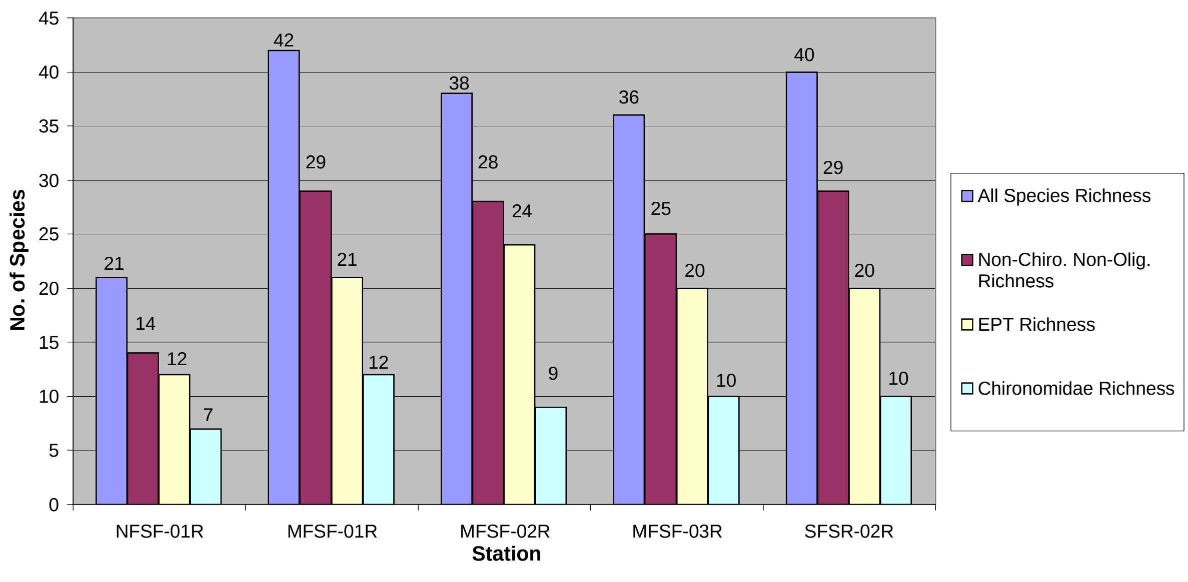


Figure B-6
Species Diversity In Riffle Habitats
Kromona Mine; Sultan, Washington



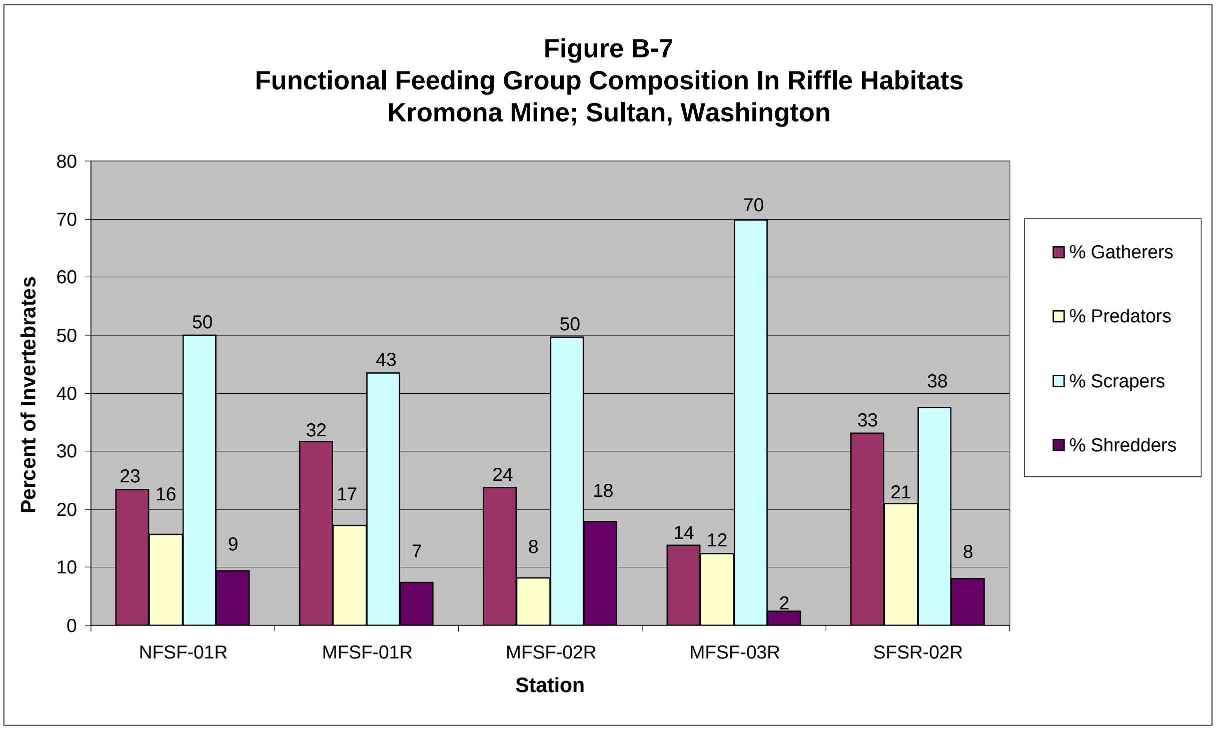


Figure B-7
Functional Feeding Group Composition In Riffle Habitats
Kromona Mine; Sultan, Washington
Percent of Invertebrates
Station
NFSF-01R
MFSF-01R
MFSF-02R
MFSF-03R
SFSR-02R
% Gatherers
% Predators
% Scrapers
% Shredders
23
16
50
9
32
17
43
7
24
8
50
18
14
12
70
2
33
21
38
8

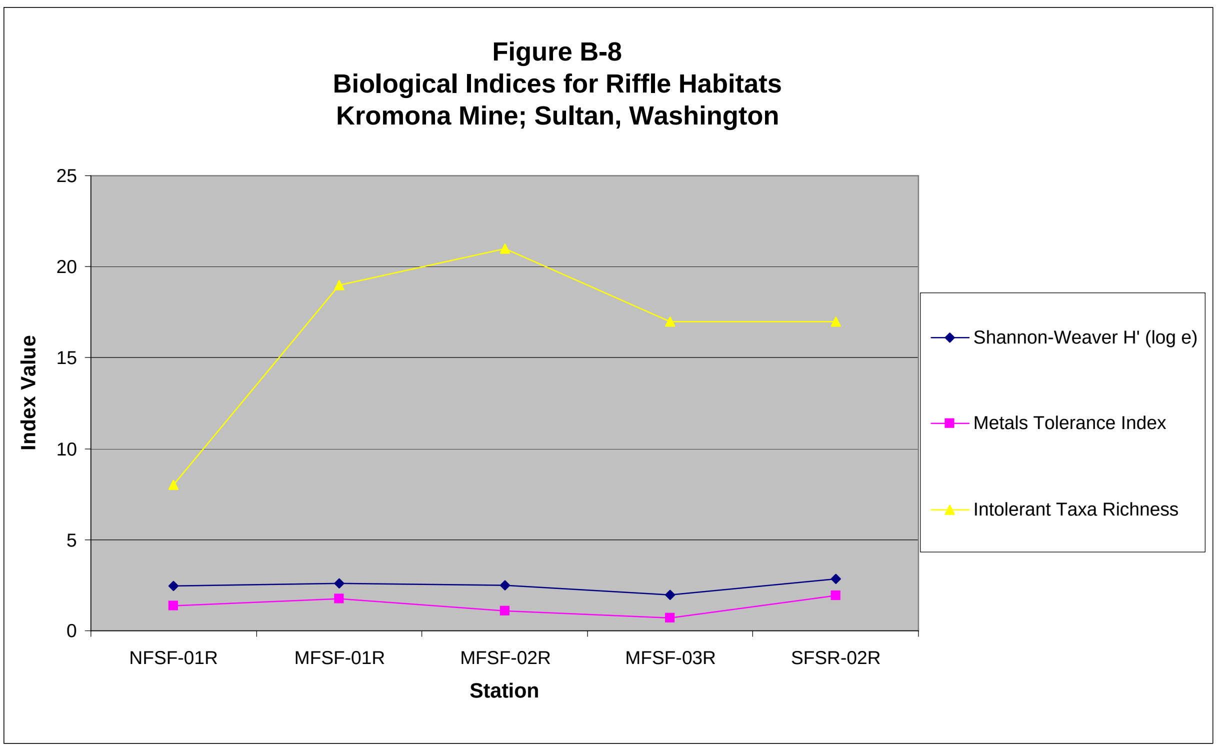


Figure B-8
Biological Indices for Riffle Habitats
Kromona Mine; Sultan, Washington
Index Value
Station
NFSF-01R
MFSF-01R
MFSF-02R
MFSF-03R
SFSR-02R
Shannon-Weaver H' (log e)
Metals Tolerance Index
Intolerant Taxa Richness

TABLE B-1
DOCUMENTED AQUATIC INVERTEBRATE SPECIES
KROMONA MINE
SULTAN, WASHINGTON

Taxonomic Group	Scientific Name	Taxonomic Group	Scientific Name
Ephemeroptera	Ameletus sp.	Diptera-Chironomidae (Continued)	Paraphaenocladius "n. sp."
	Baetis bicaudatus		Paratendipes sp.
	Baetis sp.		Parorthocladius sp.
	Baetis tricaudatus		Polypedilum sp.
	Cinygmula sp.		Pseudosmittia sp.
	Diphetor hageni		Rheocricotopus sp.
	Drunella coloradensis/flavilinea		Stempellinella sp.
	Drunella doddsi		Tanytarsus sp.
	Drunella spinifera		Thienemanniella sp.
	Epeorus deceptivus		Thienemannimyia gr. sp.
	Epeorus grandis		Tvetenia bavarica gr.
	Epeorus longimanus		Zavrelimyia sp.
	Epeorus sp.	Diptera	Bezzia/Palpomyia sp.
	Paraleptophlebia sp.		Clinocera sp.
	Rhithrogena sp.		Dicranota sp.
	Serratella sp.		Dolichopodidae
Plecoptera	Chloroperlidae		Empididae
	Despaxia augusta		Hesperoconopa sp.
	Doroneuria sp.		Hexatoma sp.
	Kathroperla sp.		Limnophila sp.
	Leuctridae		Molophilus sp.
	Malenka sp.		Oreogeton sp.
	Moselia infuscata		Pedicia sp.
	Paraleuctra sp.		Stilobezzia sp.
	Perlidae		Tipula sp.
	Perlodidae		Tipulidae
	Plumiperla sp.		Wiedemannia sp.
	Podmosta sp.	Trichoptera	Chyranda centralis
	Setvena sp.		Dolophilodes sp.
	Suwallia sp.		Ecclisocosmoecus scylla
	Sweltsa sp.		Ecclisomyia sp.
	Visoka cataractae		Lepidostoma sp.
	Yoraperla sp.		Limnephilidae
	Zapada columbiana		Neophylax sp.
	Zapada sp.		Neothremma sp.
Coleoptera	Lara sp.		Parapsyche elsis
	Oreodytes sp.		Polycentropus sp.
Diptera-Chironomidae	Boreochlus sp.		Rhyacophila betteni gr.
	Brillia sp.		Rhyacophila brunnea gr.
	Chaetocladius sp.		Rhyacophila hyalinata gr.
	Eukiefferiella brevicalcar gr.		Rhyacophila narvae
	Eukiefferiella gracei gr.		Rhyacophila pellisa/valuma
	Heleniella sp.		Rhyacophila sp.
	Heterotrissocladius marcidus gr.	Annelida	Oligochaeta
	Hydrobaenus sp.	Acari	Hygrobates sp.
	Krenosmittia sp.		Lebertia sp.
	Larsia sp.		Oribatei
	Limnophyes sp.		Protzia sp.
	Macropelopia sp.		Torrenticola sp.
	Micropsectra sp.		Wandesia sp.
	Pagastia sp.	Crustacea	Ostracoda
	Parachaetocladius sp.	Other Organisms	Nematoda
	Parametriocnemus sp.		Polycelis sp.

TABLE B-2
SUMMARY OF RARE, THREATENED, OR ENDANGERED SPECIES IN THE VICINITY
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Species Name	Washington State Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
AQUATIC INVERTEBRATES					
None					
FISH					
Rainbow trout	***Oncorhynchus Mykiss***	**Priority**			**Expected**
PLANTS					
Alaska Harebell	*Campanula lasiocarpa*	Sensitive			Possible
Black Lily	*Fritillaria camschatcensis*	Sensitive			Possible
Branching Montia	*Montia diffusa*	Sensitive			Possible
sedge, bristly	*Carex comosa*	Sensitive			Possible
Choris' Bog-orchid	*Platanthera chorisiana*	Threatened		Sensitive	Possible
Cooley's Buttercup	*Ranunculus cooleyae*	Sensitive			Possible
Creeping snowberry	*Gaultheria hispidula*	Sensitive			Possible
sedge, few-flowered	*Carex pauciflora*	Sensitive			Possible
Flat-leaved Bladderwort	*Utricularia intermedia*	Sensitive			Possible
Goblin's Gold	*Schistostega pennata*			Sensitive	Possible
oldgrowth specklebelly	*Pseudocyphellaria rainierensis*	Sensitive		Sensitive	Possible
sedge, long-styled	*Carex stylosa*	Sensitive		Sensitive	Possible
sedge, russet	*Carex saxatilis var. major*			Sensitive	Possible
Several-flowered sedge	*Carex pluriflora*	Sensitive			Possible
Shining flatsedge	*Cyperus bipartitus*	Sensitive			Possible
Small northern bog-orchid	*Platanthera obtusata*	Sensitive			Possible
Smoky mountain sedge	*Carex proposita*	Threatened			Possible
Spleenwort-leaved goldthread	*Coptis aspleniifolia*	Sensitive		Sensitive	Possible
boreal bedstraw	*Galium kamtschaticum*	Sensitive		Sensitive	Possible
Stalked moonwort	*Botrychium pedunculosum*	Sensitive	Concern		Possible
Tall agoseris	*Agoseris elata*	Sensitive		Sensitive	Possible
Treelike clubmoss	*Lycopodium dendroideum*	Sensitive			Possible
Water lobelia	*Lobelia dortmanna*	Threatened			Possible
Yellow mountain-avens	*Dryas drummondii*	Sensitive			Possible
TERRESTRIAL INVERTEBRATES					
None Identified					
REPTILES AND AMPHIBIANS (HERPETILES)					
Western toad	***Bufo boreas***	**Candidate**	**Concern**		**Expected**
Spotted frog	*Rana pretiosa*	Endangered	Candidate	Sensitive	Possible
tailed frog	*Ascaphus truei*	Sensitive		Sensitive	Possible
BIRDS					
Northern Flicker	***Colaptes auratus (Colaptes cafer)***			**MIS**	**Expected**
Northern goshawk	***Accipiter gentilis***	**Candidate**	**Concern**	**Sensitive**	**Expected**
olive-sided flycatcher	***Contopus borealis***		**Concern**		**Expected**
Pileated woodpecker	***Dryocopus pileatus***	**Candidate**		**MIS**	**Expected**
Willow flycatcher	***Empidonax traillii***		**Concern**		**Expected**
American peregrine falcon	*Falco peregrinus anatum*	Sensitive	Concern	Sensitive	Possible
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened	Sensitive	Possible
band-tailed pigeon	*Columba fasciata*		Concern	Sensitive	Possible
black-backed woodpecker	*Picoides arcticus*	Critical		Sensitive	Possible
golden eagle	*Aquila chrysaetos*	Candidate		Sensitive	Possible
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	Threatened		Possible
Olive-sided flycatcher	*Contopus borealis*		Concern		Possible
Spotted owl	*Strix occidentalis*	Endangered	Threatened	Sensitive	Possible
MAMMALS					
black-tailed deer	*Odocoileus hemionus*			MIS	Expected
Canada lynx	*Lynx canadensis*	Threatened	Threatened	Sensitive	Possible
fisher	*Martes pennanti*	Endangered	Concern	Sensitive	Possible
Gray wolf	*Canis Lupus*	Endangered	Threatened	Sensitive	Possible
long-eared myotis	*Myotis evotis*		Concern	Sensitive	Possible
long-legged myotis	*Myotis volans*		Concern	Sensitive	Possible
Mountain goat	*Oreamnos americanus*	Priority		MIS	Possible
pine marten	*Martes americana*			Sensitive	Possible
Townsend big-eared bat	*Plecotus townsendii townsendii*	Candidate	Concern	Sensitive	Possible
Townsend's big-eared bat	***Coryhorhinus townsendii***	**Candidate**	**Concern**		**Possible**
wolverine	*Gulo gulo luteus*		Concern	Sensitive	Possible

Notes:

Bold indicates a rare, threatened, or endangered species observed or expected at or near the Site.

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

Underlined species names are linked to internet fact sheets

MIS = Management Indicator Species

TABLE B-3
OBSERVED PLANT SPECIES
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Habitat Type	Estimated Percent Cover	Oregon Status	Federal Status	U.S. Forest Service Status
TREES						
red alder	*Alnus rubra*	Disturbed - Mine	70			
western hemlock	*Tsuga heterophylla*	Disturbed - Mine	10			
western red cedar	*Thuja plicata*	Disturbed - Mine	10			
Pacific silver fir	*Abies amabilis*	Disturbed - Mine	5			
western red cedar	*Thuja plicata*	Disturbed - Natural	15			
Sitka alder	*Alnus sinuata*	Disturbed - Natural	10			
red alder	*Alnus rubra*	Disturbed - Natural	10			
western hemlock	*Tsuga heterophylla*	Disturbed - Natural	5			
western hemlock	*Tsuga heterophylla*	Forest	55			
western red cedar	*Thuja plicata*	Forest	40			
Sitka alder	*Alnus sinuata*	Riparian	30			
western hemlock	*Tsuga heterophylla*	Riparian	5			
western red cedar	*Thuja plicata*	Riparian	5			
SHRUBS						
salmonberry	*Rubus spectabilis*	Disturbed - Mine	50			
red elderberry	*Sambucus racemosa*	Disturbed - Mine	20			
Goats beard	*Aruncus dioicus*	Disturbed - Mine	5			
red huckleberry	*Vaccinium parvifolium*	Disturbed - Mine	5			
Scouler's willow	*Salix scouleriana*	Disturbed - Mine	5			
squaw currant	*Rosa pisocarpa*	Disturbed - Mine	5			
vine maple	*Acer circinatum*	Disturbed - Natural	30			
salmonberry	*Rubus spectabilis*	Disturbed - Natural	20			
Devil's club	*Oplopanax horridus*	Disturbed - Natural	10			
red elderberry	*Sambucus racemosa*	Disturbed - Natural	5			
salmonberry	*Rubus spectabilis*	Forest	10			
Devil's club	*Oplopanax horridus*	Forest	5			
salmonberry	*Rubus spectabilis*	Riparian	25			
Scouler's willow	*Salix scouleriana*	Riparian	20			
Devil's club	*Oplopanax horridus*	Riparian	10			
red elderberry	*Sambucus racemosa*	Riparian	5			
GROUNDCOVER						
Pacific bleeding heart	*Dicentra formosa*	Disturbed - Mine	65			
lady fern	*Athyrium felix-femina*	Disturbed - Mine	50			
stream violet	*Viola glabella*	Disturbed - Mine	25			
rosy twisted-stalk	*Streptopus roseus*	Disturbed - Mine	20			
Cooley's hedgenettle	*Stachys coolyei*	Disturbed - Mine	15			
false lilly-of-the-valley	*Maianthemum dilatatum*	Disturbed - Mine	10			
arrow-leaved groundsel	*Senecio triangularis*	Disturbed - Mine	5			
common horsetail	*Equisetum arvense*	Disturbed - Mine	5			
early blue violet	*Viola adunca*	Disturbed - Mine	5			
indian hellebore	Veratrum viride	Disturbed - Mine	5			
miner’s lettuce	*Claytonia perfoliata*	Disturbed - Mine	5			
sedges	Carex sp.	Disturbed - Mine	5			
Star-flowered Solomon's Seal	*Smilacina stellata*	Disturbed - Mine	5			
sweet-scented bedstraw	*Galium triflorum*	Disturbed - Mine	5			
western trillium	*Trillium ovatum*	Disturbed - Mine	5			
fireweed	*Epilbium angustifolium*	Disturbed - Mine	5			
thistle, Canada	*Cirsium arvense*	Disturbed - Mine	5			
rosy twisted-stalk	*Streptopus roseus*	Disturbed - Natural	70			
lady fern	*Athyrium felix-femina*	Disturbed - Natural	20			
Pacific bleeding heart	*Dicentra formosa*	Disturbed - Natural	15			
stream violet	*Viola glabella*	Disturbed - Natural	10			
indian hellebore	*Veratrum viride*	Disturbed - Natural	10			
early blue violet	*Viola adunca*	Disturbed - Natural	5			
miner’s lettuce	*Claytonia perfoliata*	Disturbed - Natural	5			

TABLE B-3
OBSERVED PLANT SPECIES
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Habitat Type	Estimated Percent Cover	Oregon Status	Federal Status	U.S. Forest Service Status
western trillium	*Trillium ovatum*	Disturbed - Natural	5			
Pacific bleeding heart	*Dicentra formosa*	Disturbed - Natural	5			
sword fern	*Polystichum munitum*	Forest	10			
queen’s cup	*Clintonia uniflora*	Forest	5			
lady fern	*Athyrium felix-femina*	Riparian	25			
fireweed	*Epilbium angustifolium*	Riparian	20			
clasping twisted stalk	*Streptopus amplexifolius*	Riparian	10			
rosy twisted-stalk	*Streptopus roseus*	Riparian	10			
Cooley's hedgenettle	*Stachys coolyei*	Riparian	5			
grasses	Various species	Riparian	5			
maidenhair fern	*Adiantum pedatum*	Riparian	5			
oak fern	*Gymnocarpium dryopteris*	Riparian	5			
rusty (Alaska) saxifrage	*Saxifraga ferruginea*	Riparian	5			
Star-flowered Solomon's Seal	*Smilacina stellata*	Riparian	5			
stream violet	*Viola glabella*	Riparian	5			
sweet-scented bedstraw	*Galium triflorum*	Riparian	5			
MOSSES						
moss	Various sp.	Disturbed - Mine	50			
moss	Various sp.	Disturbed - Natural	40			
moss	Various sp.	Forest	40			
moss	Various sp.	Riparian	30			
LICHENS						
Lichen	Various sp.	Disturbed - Mine	5			
Lichen	Various sp.	Disturbed - Natural	5			
Lichen	Various sp.	Forest	5			

Notes:

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

TABLE B-4
TERRESTRIAL INVERTEBRATES
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Federal Status	State Status	U.S. Forest Service Status	Observed/ Expected/ Possible
bees	Order *Hymenoptera*				Observed
black carpenter ants	*Camponotus pennsylvanicus*				Observed
black flies	*Simulium* sp.				Observed
mosquitos	Family *Culicidae*				Observed
butterflies and moths	Order *Lepidoptera*				Observed
spiders	Order *Araneae*				Observed
horse and deer flies	Family Tabanidae				Expected
midges	Family Chironomidae				Expected
robber flies	Family Asilidae				Expected
wasps	Order *Hymenoptera*				Expected
yellow jackets	*Vespula* sp.				Expected
alderflies	*Sialis* sp.				Expected
centipedes	Order *Chilopoda*				Expected
common black ground beetle	*Pterostichus* sp.				Expected
grasshoppers and crickets	Order *Orthoptera*				Expected
mayflies	Order *Ephemeroptera*				Expected

Notes:

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TABLE B-5
DOCUMENTED OR EXPECTED BIRDS
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Washington Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
American kestrel	*Falco sparverius*				Observed
black-capped chickadee	*Parus atricapillus*				Observed
northwestern crow	*Corvus caurinus*				Observed
ruffed grouse	*Bonasa umbellus*				Observed
Steller's jay	*Cyanocitta stelleri*				Observed
winter wren	*Troglodytes troglodytes*				Observed
American crow	*Corvus brachyrhynchos*				Expected
American dipper	*Cinclus mexicanus*				Expected
Audubon’s warbler	*Dendroica auduboni*				Expected
band-tailed pigeon	***Columba fasciata***		**Concern**	**Sensitive**	**Expected**
barred owl	*Strix varia*				Expected
blue grouse	*Dendragapus obscurus*				Expected
brown creeper	*Certhia familiaris*				Expected
cedar waxwing	*Bombycilla cedrorum*				Expected
dark-eyed junco (slate-colored)	*Junco hyemalis*				Expected
downy woodpecker	*Picoides pubescens (Dendrocopos pubescens)*				Expected
evening grosbeak	*Hesperiphona vespertina*				Expected
fox sparrow	*Passerella iliaca*				Expected
great horned owl	*Bubo virginianus*				Expected
hairy woodpecker	*Picoides villosus (Dendrocopos villosus)*				Expected
Hammond's flycatcher	*Empidonax hammondii*				Expected
northern flicker	***Colaptes auratus (Colaptes cafer)***			**MIS**	**Expected**
olive-sided flycatcher	***Contopus borealis***		**Concern**		**Expected**
pileated woodpecker	***Dryocopus pileatus***	**Candidate**		**MIS**	**Expected**
pine grosbeak	*Pinicola enucleator*				Expected
pine siskin	*Carduelis pinus (Spinus pinus)*				Expected
red crossbill	*Loxia curvirostra*				Expected
red-breasted nuthatch	*Sitta canadensis*				Expected
red-tailed hawk	*Buteo jamaicensis*				Expected
ruby-crowned kinglet	*Regulus calendula*				Expected
rufous hummingbird	*Selasphorus rufus*				Expected
saw-whet owl	*Aegolius acadicus*				Expected
sharp-shinned hawk	*Accipiter striatus*				Expected
song sparrow	*Melospiza melodia*				Expected
spotted towhee	*Pipilo erythrophthalmus*				Expected
Swainson's thrush	*Catharus ustulata (Hylocichla ustulata)*				Expected
varied thrush	*Ixoreus naevius*				Expected
warbling vireo	*Vireo gilvus*				Expected
western tanager	*Piranga ludoviciana*				Expected
western wood pewee	*Contopus sordidulus*				Expected
white-winged crossbill	*Loxia leucoptera*				Expected
willow flycatcher (Traill's flycatcher)	*Empidonax traillii*		**Concern**	**Sensitive**	**Expected**
yellow-bellied sapsucker	*Sphyrapicus varius*				Expected
yellow-rumped warbler	*Dendroica coronata*				Expected
bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened	Sensitive	Possible
belted kingfisher	*Megaceryle alcyon*				Possible
black-headed grosbeak	*Pheucticus melanocephalus*				Possible
blue jay	*Cyanocitta cristata*				Possible
Calliope hummingbird	*Stellula calliope*				Possible
common nighthawk	*Chordeiles minor*				Possible
Cooper's hawk	*Accipiter cooperii*				Possible
dusky flycatcher (Wright's flycatcher)	*Empidonax oberholseri*				Possible
flammulated owl	*Otus Flammeolus*	Candidate			Possible
great gray owl	*Strix nebulosa*				Possible
hermit thrush	*Catharus guttatus (Hylochichla guttata)*				Possible
MacGillivray's warbler	*Oporornis tolmiei*				Possible
marbled murrelet	*Brachyramphus marmoratus*	Threatened	Threatened	Sensitive	Possible
mountain bluebird	*Sialia currucoides*				Possible
peregrine falcon	*Falco peregrinus anatum*		Concern	Sensitive	Possible

TABLE B-5
DOCUMENTED OR EXPECTED BIRDS
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Washington Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
purple finch	*Carpodacus purpureus*				Possible
red-breasted sapsucker	*Sphyrapicus ruber*				Possible
spotted owl	*Strix occidentalis*	Endangered	Threatened		Possible
three-toed woodpecker	*Picoides tridactylus*			Sensitive	Possible
Townsend's solitaire	*Myadestes townsendi*				Possible
Townsend's warbler	*Dendroica townsendi*				Possible
turkey vulture	*Cathartes aura*				Possible
western bluebird	*Sialia mexicana*				Possible
western flycatcher	*Empidonax difficilis*				Possible
Williamson's sapsucker	*Sphyrapicus thyroideus*				Possible

Notes:

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TABLE B-6
DOCUMENTED OR EXPECTED MAMMALS
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Washington Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
aplodontia (mountain beaver)	*Aplodontia rufa*				Observed
Columbia blacktailed deer	***Odocoileus hemionus columbianus***	**Priority**			**Observed**
douglas squirrel (chickaree)	*Tamiasciurus douglasi*				Observed
black bear	*Ursus americanus*				Observed
bobcat	*Lynx rufus*				Expected
cougar (mountain lion)	*Felis concolor*				Expected
coyote	*Canis latrans*				Expected
deer mouse	*Peromyscus maniculatus*				Expected
dusky shrew	*Sorex obscurus*				Expected
Keen's myotis	***Myotis keenii***	**Candidate**			**Expected**
longtail weasel	*Mustela frenata*				Expected
masked shrew	*Sorex cinereus*				Expected
mink	*Mustela vision*				Expected
mountain vole	*Microtus montanus*				Expected
northern flying squirrel	*Glaucomys sabrinus*				Expected
northern water shrew	*Sorex palustris*				Expected
opossum	*Didelphis marsupialis*				Expected
porcupine	*Erethizon dorsatum*				Expected
raccoon	*Procyon lotor*				Expected
red fox	*Vulpes fulva*				Expected
Townsend big-eared bat	***Plecotus townsendii townsendii***	**Candidate**	**Concern**	**Sensitive**	**Expected**
Townsend's chipmunk	*Eutamias townsendi*				Expected
badger	*Taxidea taxus*				Possible
beaver	*Castor canadensis*				Possible
big brown bat	***Eptisicus fuscus***			**Sensitive**	**Possible**
boreal redback vole	*Clethrionomys gapperi*				Possible
California myotis	*Myotis californicus*				Possible
Canada lynx	***Lynx canadensis***	**Threatened**	**Threatened**	**Sensitive**	**Possible**
fisher	*Martes pennanti*	Endangered	Concern	Sensitive	Possible
fringed myotis	*Myotis thysanodes*	Vulnerable	Concern	Sensitive	Possible
gray wolf	*Canis lupus*		Threatened	Sensitive	Possible
hoary bat	*Felis concolor*				Possible
little brown myotis	*Myotis lucifugus*			Sensitive	Possible
marten	*Martes americana*			Sensitive	Possible
pallid bat	*Antozous pallidus*	Vulnerable	Concern	Sensitive	Possible
Preble's shrew	***Sorex preblei***	**Concern**		**Sensitive**	**Possible**
red bat	*Lasiurus borealis*				Possible
shorttail weasel (ermine)	*Mustela erminea*				Possible
silver-haired bat	*Lasionycteris noctivagans*			Sensitive	Possible
small-footed myotis	*Myotis leibii*		Concern		Possible
spotted skunk	*Spilogale putorius*				Possible
striped skunk	*Mephitis mephitis*				Possible
Townsend big-eared bat	*Plecotus townsendii townsendii*	Candidate	Concern	Sensitive	Possible
Trowbridge's shrew	*Sorex trowbridgei*				Possible
vagrant shrew	*Sorex vagrans*				Possible
wolverine	*Gulo gulo luteus*		Concern	Sensitive	Possible
yellow-bellied marmot	*Marmota flaviventris*				Possible
yuma myotis	*Myotis yumanensis*		Concern		Possible

Notes:

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TABLE B-7
DOCUMENTED OR EXPECTED AMPHIBIANS AND REPTILES
KROMONA MINE
SULTAN, WASHINGTON

Common Name	Scientific Name	Federal Status	Washington Status	Oregon Status	U.S. Forest Service Status	Observed/ Expected/ Possible
AMPHIBIANS						
Cascades frog	***Rana cascadae***				**Sensitive**	**Expected**
long-toed salamander	*Ambystoma macrodactylum*					Expected
northwestern salamander	*Ambystoma gracile*					Expected
Pacific giant salamander	*Dicamptodon tenebrosus*					Expected
Pacific treefrog	*Hyla regilla*					Expected
rough-skinned newt	*Taricha granulosa*					Expected
tailed frog	***Ascaphus montanus***	**Concern**				**Expected**
western red-backed salamander	*Plethodon vehicullum*					Expected
western toad	***Bufo boreas***	**Concern**	**Candidate**	**Vulnerable/Rare**		**Expected**
red-legged frog	***Rana aurora***				**Sensitive**	**Observed**
Columbia spotted frog	*Rana luteiventris*			Candidate/ Imperiled	Sensitive	Possible
ensatina	*Ensatina eschscholtzii*					Possible
Larch Mountain salamander	*Plethodon larselii*				Sensitive	Possible
Van Dyke's salamander	*Plethodon vandykei*					Possible
REPTILES						
common garter snake	*Thamnophis sirtalis*					Expected
rubber boa	*Charina bottae*					Possible
northern alligator lizard	*Gerrhonotus coeruleus*					Expected
northwestern garter snake	*Thamnophis ordinoides*					Possible

Notes:

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