



**Site Inspection Report
Sunset Mine and Millsite
Mt. Baker – Snoqualmie National Forest**

July 2005



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

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USDA Forest Service
Mt. Baker-Snoqualmie National Forest

Site Location:

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Mt. Baker-Snoqualmie National Forest
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Cover Photo: Former mill foundation (upper left) and bridge upstream from Site in Trout Creek (lower right)

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EXECUTIVE SUMMARY

A Site Inspection (SI) was performed at the Sunset Mine and Millsite (Site), located in the Mt. Baker-Snoqualmie National Forest, near Index, Washington. The Site is an abandoned copper mine and consists of the foundation of the former mill, one open adit, two collapsed adits with associated waste dumps, two large open stopes, and one open ventilation raise. The Site is situated adjacent to Trout Creek, a tributary to the North Fork of the Skykomish River (NFSR), in Washington's northern Cascades. The SI was conducted to assess if the Site poses an immediate and potential threat to human health and the environment, and to collect sufficient information to support a decision regarding the need for further action. The SI consisted of the following tasks 1) background information research and file review, 2) onsite and offsite reconnaissance and ecological assessment, and 3) collection of soil, wasterock, plant tissue, surface water, pore water, sediment, and benthic macroinvertebrate samples. Based on the information gathered during these tasks, the results indicate the following:

Groundwater Pathway: The groundwater pathway is incomplete and further assessment is not recommended. Of the ten water wells located within the 4-mile radius of the Site, only one well is screened in the granite aquifer that is similar to the hydrogeology of the Site. Due to the location of this well (e.g., located over 2 miles southwest of the Site and outside of the Trout Creek watershed), Site impacts, if any, would be negligible on this well.

Surface Water Pathway: The surface water pathway is complete for both human and ecological receptors due to elevated concentrations of metals (primarily arsenic, copper and nickel) in stream sediments, surface water, and pore water and further assessment is warranted. Arsenic and copper concentrations in samples collected above the Site also exceed the lowest criteria indicating other potential metal sources upstream in Trout Creek. There are several rare, threatened and endangered (RTE) species (including Coho salmon and rainbow trout) known to inhabit Trout Creek and the NFSR. Results of the benthic macroinvertebrate sampling suggest little or no difference in invertebrate populations upstream, adjacent to and downstream 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. The wasterock piles contain elevated concentrations of metals (arsenic, chromium, chromium VI, copper, lead, manganese, mercury, nickel, silver, and zinc), which exceed numerous comparison criteria. Acid base accounting indicates that the soil and wasterock at the Site has the potential to produce acid rock drainage. However, none of the samples had toxicity characterization leaching procedure (TCLP) or synthetic precipitation leaching procedure results in excess of any TCLP disposal limit. Onsite vegetation does not appear to be impacted by mining activities associated with the Site. 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 impacted soil and wasterock is concentrated at the surface where human and ecological receptors could be exposed to particulate matter. Risks from the air pathway will be addressed when assessing the soil pathway.

Based on the information gathered as part of the SI and presented in this report, CES recommends performing an Engineering Evaluation / Cost Analysis (EECA) at the Site. As part of the EECA, a risk assessment should be performed to assess the human and ecological impacts, establish removal cleanup standards, and assess if a removal action is warranted. An additional aquatic sampling event should also be performed to evaluate water quality during low flow conditions in Trout Creek. Addressing the physical dangers (i.e., opened adits, caved stopes, etc.) should also be included as part of the EECA.

SITE INSPECTION DATA SUMMARY SHEET

Project Name: Sunset Mine and Millsite Site Inspection

Project Location: T 27 N, R 10 E, Section 1 **Latitude:** N47° 51' 26.8", **Longitude:** W121° 27' 43.6"

Nearest Surface Water Body: Trout Creek

Area of Disturbance: ~ 3 to 5 acres

SUMMARY OF ANALYTICAL/DOCUMENTED CONTAMINATION

Media	Sample Location	Flowrate/ Volume (cfs, gpm, or CY)	Contaminant	Highest Concentration	Lowest Criteria Eco – Ecological HH – Human Health	Background Concentration
Surface Water	SM-AS1	0.01 cfs	Arsenic Barium Copper Selenium	0.7 ug/L 11 ug/L 126 ug/L <1.0	0.018 ug/L – HH 4 ug/L - Eco 0.23 ug/L – Eco 0.39 ug/L – Eco	<0.4 ug/L 3 ug/L B < 1.0 ug/L <0.2 ug/L
	SM-AS2-1	NM	Arsenic Barium Copper Selenium	3.1 ug/L 18 ug/L 90.7 ug/L <1.0 ug/L	0.018 ug/L – HH 4 ug/L - Eco 0.23 ug/L – Eco 0.39 ug/L – Eco	<0.4 ug/L 3 B ug/L < 1.0 ug/L <0.2 ug/L
	SM-AS2-2	NM	Aluminum Arsenic Barium Copper Iron Lead Selenium	270 ug/L 3.3 ug/L 20 ug/L 212 ug/L 380 ug/L 2.8 ug/L <1.0 ug/L	87 ug/L - Eco 0.018 ug/L – HH 4 ug/L - Eco 0.23 ug/L - Eco 158 ug/L - Eco 0.11 ug/L – Eco 0.39 ug/L – Eco	50 B ug/L <0.4 ug/L 3 Bug/L <1.0 ug/L 20 B ug/L 0.4 B ug/L <0.2 ug/L
Pore Water	TC-PW-2	NA	Copper	1.6 B ug/L	0.23 ug/L - Eco	0.7 B ug/L
	TC-PW-3	NA	Copper	1.1 ug/L	0.23 ug/L - Eco	0.7 ug/L
Sediment	TC-SS-2	NA	Nickel	27.8 mg/kg	18 m/kg - Eco	17.4 mg/kg
Lower Wasterock Piles (WR-1, WR-2, and WR-3)	WR-1: SM-WR1, SM- WR8, SM-WR9, SM-S1, SM-S2, SM-S3	WR-1: 300 CY WR-2: 10 CY WR-3: 800 CY	Arsenic	1,150 mg/kg	1.6 mg/kg – HH	11 mg/kg
	WR-2: SM-WR2, SM- WR7		Arsenic V	109.8 mg/kg	10 mg/kg – Eco	11 mg/kg
			Chromium	59 mg/kg	0.4 mg/kg – Eco	14.7 mg/kg
Upper Wasterock Piles (WR-4, WR-5, and WR-6)	SM-WR4 SM-WR5 SM-WR6	WR-4: 60 CY WR-5: 300 CY WR-6: 500 CY	Chromium VI	103.6 B mg/kg	0.4 mg/kg – Eco	0.52 B mg/kg
			Copper	30,900 mg/kg	50 mg/kg – Eco	347.7 mg/kg
			Iron	226,000 mg/kg	100,000 mg/kg - Eco	16,000 mg/kg
			Lead	788 mg/kg	40.5 mg/kg – Eco	8.7 mg/kg
			Mercury	5.74 mg/kg	0.00051 mg/kg – Eco	0.06 B mg/kg
			Selenium	<100 / 20 mg/kg	0.21 mg/kg – Eco	1.1 mg/kg
			Silver	268 mg/kg	2 mg/kg – Eco	0.38 mg/kg
			Zinc	200 B mg/kg	8.5 mg/kg - Eco	103 mg/kg
Upper Wasterock Piles (WR-4, WR-5, and WR-6)	SM-WR4 SM-WR5 SM-WR6	WR-4: 60 CY WR-5: 300 CY WR-6: 500 CY	Aluminum	22,400 mg/kg	50 mg/kg – Eco	14,633 mg/kg
			Antimony	<800 / 7B mg/kg	5 mg/kg - Eco	0.23 B mg/kg
			Arsenic	133 mg/kg	1.6 mg/kg – HH	11 mg/kg
			Arsenic V	132.7 mg/kg	10 mg/kg – Eco	11 mg/kg
			Chromium	19 mg/kg	0.4 mg/kg – Eco	14.7 mg/kg
			Chromium VI	25.9 B mg/kg	0.4 mg/kg - Eco	0.52 B mg/kg
			Cobalt	26 B mg/kg	20 mg/kg – Eco	7.0 mg/kg
			Copper	883,000 mg/kg	50 mg/kg - Eco	347.7 mg/kg
			Lead	248 mg/kg	40.5 mg/kg - Eco	8.7 mg/kg
			Mercury	1.41 mg/kg	0.00051 mg/kg – Eco	0.06 B mg/kg
			Silver	11.3 mg/kg	2 mg/kg – Eco	0.38 mg/kg
			Vanadium	44.5 mg/kg	2 mg/kg – Eco	37.7 mg/kg
			Zinc	189 mg/kg	8.5 mg/kg - Eco	103 mg/kg

Notes: This table only lists sample concentrations that are at least 1.5 times higher than the lowest criteria and background concentration are listed. These exceedances are considered the major contaminants of concern (COCs) and not a complete list of all COCs.

Background water and sediment concentrations are the highest detected; background soil concentrations listed are the average of three samples. Unless otherwise shown: surface water = total recoverable metals; pore water = dissolved metals, and all sediment and solid media = total metals. ug/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 Sunset Mine and Millsite (Site). The SI was performed in accordance with the U.S. Environmental Protection Agency (EPA) publication, *Guidance for Performing Site Inspections under CERCLA* (EPA, 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 the Purchase Order #53-05K3-4-0005.

The primary 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 (EPA, 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, plant tissue, 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 12, 2004 (CES, 2004). 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 (WDNR) report on the Site (Wolff et al., 2002). During and 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). These changes are summarized in a letter to the USFS dated September 11, 2004 (Appendix A).

2.0 SITE DESCRIPTION AND OPERATIONAL HISTORY

The following sections give a specific description of the location and an operational history of the Site. Photographs of the Site and sampling locations are included in Appendix B. No regulatory removal actions have been undertaken at the Site. However, a regulatory inspection by WDNR was performed in 2002 (Wolff et al. 2002) and an APA was completed by the USFS in 2003. Results of the WDNR inspection and APA are discussed in Section 2.1.2. Historical maps, sketches and miscellaneous information are included in Appendix C.

2.1 Description and Location

The Site is located in the Mt. Baker-Snoqualmie National Forest, approximately 5 miles northeast of the town of Index (Plate 1). The Site lies adjacent to Trout Creek, a tributary of the North Fork of the Skykomish River (NFSR), and is located within the Index Mining District (Figure 1). According to the USGS 7 ½ Minute Quadrangle Map - Baring (USGS, 1982), the Site location is described as:

- Section 1, Township 27 North, Range 10 East of the Willamette Meridian
- Latitude - North 47° 51' 26.8"
- Longitude - West 121° 27' 43.6"
- Elevation: Mill Foundation - 1,370 feet above mean seal level (amsl)
 Caved East Slope - 1714 feet amsl

Figure 2 provides a general layout of the Site, including 2-foot contours and pertinent features. The Site is accessed from Index, by following County Route 63 northeast for 4.5 miles to the bridge over Trout Creek. Turn right immediately after the bridge and proceed southeast on Forest Service Road (FR) 6320 for approximately 1.5 miles to the Site. A high clearance four-wheel-drive vehicle is required on the FR 6320.

The Site consists of the concrete foundation of the former mill, one open adit (Adit 1), two collapsed adits (Adits 2 and 3) with associated wasterock piles, two large caved stopes (east and west), and one open ventilation raise. Mine workings are scattered upslope from the mill and can be reached by following the former road, which is now a hiking trail through thick vegetation.

Figure 2 shows the locations of the six wasterock piles at the Site. WR-1 is adjacent to the former mill and contains approximately 300 cubic yards (CY) of brown sand and silt. WR-2 consists of two small piles west of the foundation and totals approximately 10 CY of mostly reddish brown silt with some sand and scattered burnt wood fragments. The largest wasterock pile (WR-3) is located within the riparian zone adjacent to Trout Creek and contains approximately 800 CY of gray, gravel to silt size material with scattered wood fragments. WR-4 contains approximately 60 CY of dark brown sand and silt size material and is located on the slope below Adit 3. WR-5, located below the east stope and associated wood platform, contains approximately 300 CY of rust colored clay streaked with light gray and green, coarser material with more iron staining found below 6-inches below ground surface (BGS). WR-6, located below Adit 1, contains approximately 500 CY of rust colored, angular sandy silt and cobble size material with abundant organic material. No tailings were found at the Site; based on historic photos and records, it appears that the tailings were deposited in and adjacent to Trout Creek.

Water discharges from Adits 1 and 2. The Adit 1 drainage infiltrates into the ground approximately 50 feet from the portal. The discharge from Adit 2, the main haulage level, flows at a rate of 150 to 450 gallons per minute (gpm), depending on the season and recent precipitation (measured at 320 gpm during the SI field activities in June 2004), and flows over wasterock eventually discharging into Trout Creek.

The two open stopes (collapsed) and the ventilation raise are extreme physical hazards at the Site. Although warning signs are posted, there are no physical barriers to prevent access to the open caverns and vertical highwalls (50 to 100 feet) created by these features.

2.1.1 Operational History and Waste Characteristics

The following information is a chronological summary of the operational history of the Site and the estimated ore production gleaned from Toepfer (1953), Huntting (1956), and Wolff et al. (2002).

- 1897 Sunset outcrop discovered by Ezra and Arthur Egbert
- 1902-1935 Sunset Copper Co.
- 1935 The Sunset Syndicate Corporation leased the mine to workers
- 1941 to 1943 The mine and mill were operated by Kromona Mines Corporation of Seattle, WA.
- 1946 Index Mining Co. purchased the mine from Sunset Syndicate.
- 1955 Granore Co, (Grandby Resources , Mono Resources, and others) leased the property.
- 1985 USFS acquired property through a land exchange with Murray Pacific Corporation, a forest products company. The federal government owns and manages the surface estate, but the mineral estate at the Site remains outstanding.

The property includes 19 patented claims, 8 unpatented claims and various section subdivisions of deeded land totaling 960 acres. Historical photographs of the Site indicate that mill tailings (and/or wasterock) were deposited into and along the riparian zone of Trout Creek and most were likely washed away by seasonal high water. Historical mine maps are included in Appendix C.

Production occurred in 1902 to 1905, 1916 to 1920, 1923 to 1931, and 1935 to 1946. Total production amounted to 12,912,015 pounds of copper, 155,971 ounces of silver, 1,506 ounces of gold from 263,416 tons of crude ore (Toepfer, 1953). Production by year is shown in the table below.

Year	Crude ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Percent copper recovered per ton mined
1902-05	240	-	266	64,500	13.44
1906-15		-	-	-	-
1916	2,069	12	1,633	291,532	7.05
1917	2,703	4	535	149,313	2.76
1918	12,004	48	3,606	413,137	1.72
1919	12,645	74	6,401	530,164	2.10
1920	24,963	145	14,307	1,111,220	2.23
1921-22	-	-	-	-	-
1923	8,998	57	10,018	647,918	3.60
1924	14,280	94	8,563	799,575	2.80
1925	19,119	132	13,699	1,086,561	2.84
1926	25,283	188	18,379	1,346,466	2.66
1927	37,095	133	17,456	1,601,864	2.16
1928	27,891	110	10,887	1,088,163	1.95
1929	33,608	184	17,614	1,296,038	1.93
1930	27,809	94	9,277	1,143,408	2.06
1931	5,000 (?)	11	1,350	174,362	1.74 (?)
1932 to 34	-	-	-	-	-
1935	67	12	512	24,868	18.56
1936	1,483	13	1,246	92,935	3.13
1937	730	5	715	42,091	2.88
1938	1,050	9	1,035	82,990	3.95
1939	514	38	4,505	196,154	19.08
1940	868	38	4,268	199,300	11.48
1941	3,826	69	6,774	320,200	4.18
1942	938	21	1,381	95,800	5.11
1943	141	8	775	78,581	27.87
1944	29	3	271	11,519	19.86
1945	20	1	149	7,366	18.41
1946	43	3	349	16,000	18.60
1947-51	-	-	-	-	-

Notes: “-” = No data reported
 ? = Production records are estimates and unverified

2.1.2 Previous Investigations

In 2002, WDNR collected three water samples from the Site: one from the Adit 2 drainage, one upstream and one downstream from the Site in Trout Creek (Wolff et. al. 2002). The results indicated concentrations of copper exceeded the Washington State chronic level (11.4 micrograms per liter [$\mu\text{g/L}$]) for surface water in the three samples. Both Trout Creek samples also exceeded the EPA water quality criteria for human health for arsenic (5.6 $\mu\text{g/L}$). The downstream water sample had higher concentrations than the upstream sample for both metals. The flowrate in Trout Creek was estimated at approximately 20 cubic feet per second (cfs) during the WDNR sampling event. Analytical results are summarized in the table below.

**Surface Water Results from the WDNR report on Sunset Mine and Trout Creek
(Results in µg/L)**

Sample Location	pH	Cond	As	Cu	Pb	Zn
Adit 2 Drainage	5.9	133	<10	64	<10	33
Trout Creek, upstream of Site	5.5	22	11	26	<10	28
Trout Creek, downstream of Site	5.5	39	19	96	<10	27

Note: pH measured in standard units; Cond = conductivity in microseimans per square centimeter
As = arsenic; Cu = copper; Pb = lead; and Zn = zinc

In 2003, the USFS performed an APA, which consisted of collecting several samples from wasterock piles at the Site (USFS, 2003). A Niton XRF 700 Series, using *in situ* field screening methods, was utilized to help in the preliminary screening of the Site. Arsenic was the only element that exceeded EPA Region 9 Industrial Preliminary Remediation Goals (PRG) for soil with concentrations ranging from 47.8 milligrams per kilogram (mg/kg) to 290 mg/kg.

2.1.3 Climate

Climate data listed below were compiled from the Baring, Washington monitoring station (Western Regional Climate Center [WRCC], 2004) approximately 6 miles south of the Site at an elevation of 770 feet amsl. The Site, located approximately 600 feet higher in elevation than Baring, likely receives more total precipitation and has lower minimum and maximum temperatures.

- Total average precipitation is approximately 109 inches per year.
- The average minimum temperature of approximately 31° F occurs in January.
- The average maximum temperature of approximately 75° F occurs in July and August.

3.0 PATHWAYS AND ENVIRONMENTAL HAZARD ASSESSMENT

3.1 Groundwater Exposure Pathway

3.1.1 Targets

Targets are defined as receptors that are located within the target distance for a particular pathway. As outlined in the SI CERCLA guidance (EPA, 1992) the target distance for the groundwater pathway is four miles, and example targets are drinking water wells and wellhead protection areas. A review of the Washington Department of Ecology, Water Resources Department well log database indicates that there are ten water supply wells located within a 4-mile radius of the Site (See Plate 1). There are no known wellhead protection areas within a 4-mile radius of the Site.

3.1.2 Geologic Setting

Regional geologic information presented in this section was obtained from Orr and Orr (2002). Site-specific geology was compiled from Toepfer (1953), Hunting (1956), Derkey et. al. (1990) and Wolff et. al. (2002), as well as site-specific reconnaissance performed by a CES Washington Registered Geologist.

3.1.2.1 Regional Geology

The Site is located in the Olney Pass Terrane (Western Mélange Belt) within the North Cascades physiographic province. The North Cascades 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 feet 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 mélangé. The accreted terranes were intruded by Tertiary plutons and dotted with Quaternary age volcanoes.

3.1.2.2 Site Specific Mining Geology

The Sunset deposit lies entirely within the Index granodiorite batholith. Scattered, discontinuous dikes of aplite and basic composition intrude the homogenous mass. The ore occurs as lenticular masses in six roughly parallel shear zones (Wolff et. al., 2002). The vein structure is comprised of two sets of parallel fissures, intercepting, without crossing to form an oblique grid pattern. The veins strike north 60° west and due west and dip between 75° north and vertical (Toepfer, 1953).

The most prominent vein, the Sunset vein, has fracture zones that averages about 7 feet in width and attains locally a maximum of 15 feet. Chlorite alteration of varying intensity is present with the fracture zones and often penetrates the wall rock. Sericite alteration, although confined to the fracture zone, appears to be associated with the copper mineralization. Little or no post mineralization faulting has occurred (Toepfer, 1953).

Five production levels were developed at the Site. Levels 3, 4 and 5 are flooded and are drained by the main haulage tunnel (Adit 2) at least seasonally. Underground workings consisted of more than 12,000 feet of drifts, crosscuts and raises. The primary ore minerals at the Site are chalcopyrite, bornite, covellite, molybdenite, native silver, and native copper (Hunting, 1956). Gangue minerals include quartz, calcite, pyrite, marcasite, serpentine, talc, chlorite, and kaolinite (Derkey and others, 1990). The host rock for the mineralization is granodiorite and tonalite. Copper, gold and silver were the main commodities at the Site.

3.1.3 Hydrogeology

The Site is located within the Trout Creek sub-watershed of the NFSR watershed. As outlined above, there are ten water supply wells located within a 4-mile radius of the Site. A review of the well logs indicates the shallow geology in the vicinity of the NFSR consists mostly of alluvial deposits of sand and gravel with lenses of clay to depths up to 136 feet BGS. Most wells are shallow (less than 50 feet BGS) and do not encounter bedrock. Granite bedrock was encountered in only one well at 136 feet BGS. Copies of the well logs reviewed are available in the USFS Project File. None of the wells were observed or sampled during the SI field activities.

The hydrogeology in the vicinity of the Site is likely dominated by heterogeneous fracture flow within the granite aquifer. Evidence of this is the fact that the lower levels of the mine workings flooded in 1942 indicating a water bearing fracture(s) was encountered. The connection between the unconsolidated alluvial aquifer with the granite aquifer at the Site is unknown. During periods of high water table (winter and spring), the groundwater within the fractures may intercept (and discharge to) the alluvial aquifer and ultimately to streams. The Adit 1 drainage infiltrates into the ground approximately 50 feet from the portal. The drainage from Adit 2, the main haulage level, flows over wasterock eventually discharging into Trout Creek approximately 500 feet below the portal.

3.1.4 Groundwater Exposure Pathway Summary

Ten water wells are located within the 4-mile radius of the Site. Nine water wells obtain groundwater from the unconsolidated alluvial deposits associated with the NFSR; impacts from the Site on these wells are extremely unlikely. One water well is screened in the granite aquifer that is similar to the hydrogeology of the Site. However, due to the location of this well (e.g., located over 2 miles southwest of the Site and outside of the Trout Creek watershed), Site impacts, if any, would be negligible on this well. Based on this, the groundwater pathway is incomplete and no further assessment is warranted.

3.2 Surface Water Exposure Pathway

3.2.1 Targets

For the surface water pathway, the target distance has been defined as 15-miles, and example targets are surface water intakes, sensitive environments (i.e., wetlands), and aquatic organisms. However, because of the relative low flowrate of Trout Creek when compared to the flowrate of the NFSR (approximately 50 times the flow of Trout Creek), only targets above the confluence are considered targets.

3.2.1.1 Local Surface Water Use

Plate 1 shows the 1 and 4-mile radius from the Site. There are approximately 40 houses within a 4-mile radius of the Site, but all are located below the confluence of Trout Creek with the NFSR. It is not known whether the houses are permanent or seasonal residences (Stowe, 2004). Recreational use in the watershed is high. There are 22 active surface water rights within 4 miles downstream of the Site. Of these, 19 are located on the NFSR below the confluence with Trout Creek, 1 is located on Lewis Creek and 1 is a spring. 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.

3.2.1.2 Wetlands

Maps outlining designated wetland areas were prepared by the National Wetlands Inventory (NWI), a division of the U.S. Fish and Wildlife Service. The document was prepared primarily by analysis of high altitude aerial photographs. Wetlands were identified based on vegetation, visible hydrology, and geography in accordance with Classification of Wetlands and Deepwater Habitats of the United States (USDI, 1979). The following are considered “listed” on the NWI map (USFWS, 1994):

- Areas near the headwaters of Trout Creek down to the confluence with the Skykomish River are designated as Riverine, Upper Perennial, Open Water/Unknown Bottom, Intermittently Exposed/Permanent (R3OWZ);
- Areas located near the confluence of the Skykomish River and Trout Creek are identified as R3OWZ and Palustrine, Scrub-Shrub, Saturated/Semi-permanent/ Seasonal (PSSY); and
- Tom, Dick, and Harry Lakes, located approximately ½ mile south of the Site at an elevation of 3,340 feet amsl, are classified as Palustrine, Open Water/Unknown Bottom, and Intermittently Exposed/Permanent (POWZ).

3.2.1.3 Aquatic Ecological Survey

Aquatic surveys were conducted within three reaches of Trout Creek and one reach of the North Fork Skykomish River (NFSR) to assess the potential impacts of the Site on the instream habitat and benthic macroinvertebrate community, and to determine the presence of fish species. Refer to Appendix D for supplemental text, figures and tables regarding the survey. The rare, threatened, or endangered (RTE) species known or expected to inhabit the area surrounding the Site are also listed in Appendix D.

Overall instream physical habitat conditions (Barbour 1999) were rated as optimal for all reaches although there were suboptimal and poor ratings for some individual habitat parameters at different stations. Observations made during the survey suggest that the pool habitat quality was higher at TC-01P and TC-03P than at other stations. No RTE invertebrate species were identified during the survey.

The similar total number and types of species present at the pool stations along Trout Creek suggests that physical conditions are similar at all three stations (Figure D-2). A lower numbers of species present in the NFSR likely reflects differing habitat conditions. The low metals tolerance indices and consistent Shannon-Weaver and Margalef’s Richness indices also suggest there are no Site related impacts in pool habitats.

In riffle habitats, proceeding downstream along Trout Creek, an increasing percentage of Ephemeroptera, Plechoptera, and Trichoptera (EPT) species and similarities in invertebrate diversity and functional feeding groups across the four stations suggest there are consistent conditions at the three Trout Creek stations, with different (but not poor), conditions at NFSR-01R. The consistency expressed by the biological indices also supports this evidence. Thus, it does not appear that aquatic invertebrates in riffle habitats are being impacted by the Site.

No fish were noted in Trout Creek, but no barriers to fish passage were identified during the ecological survey. Through communications with regional biologists, the Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species Program (PHSP), and the Washington Natural Heritage Program (WNHP) it was documented that Coho salmon, winter-run steelhead, and resident rainbow trout are present in Trout Creek. In addition, fall chinook salmon, chum salmon, pink salmon, summer-run steelhead, and dolly varden/bull trout are known to inhabit the NFSR and may be found in portions of Trout Creek. Of these, Coho salmon, chinook salmon, rainbow trout, and bull trout are RTE species.

3.2.2 Hydrologic Setting

The Site is bordered on the south by Trout Creek (Plate 1). According to the USGS 7½ minute quadrangle maps (USGS, 1982) of the area, the Trout Creek watershed above the Site is approximately 9,200 acres or 14.4 square miles (Plate 1). Trout Creek originates approximately 6.3 miles above the Site and reaches the NFSR approximately 1.5 miles downstream from the Site. The NFSR flows west approximately 7 miles before reaching the confluence with the South Fork of the Skykomish River approximately 1.5 miles west of Index. At the time of the SI field activities, drainage from Adit 1 infiltrated approximately 50 feet from the portal, but likely fluctuates seasonally. Water was also observed flowing from Adit 2, across wasterock and past the former mill site at a rate of approximately 320 gpm (varies seasonally) for 500 feet before entering Trout Creek. Overland flow originating at the Site flows down the slope and across the wasterock piles and ultimately into Trout Creek.

High flowrates in Trout Creek and the NFSR during the SI field activities negated safely collecting flow measurements at several aquatic stations. However, flow was measured at TC-01 (upstream) at approximately 121 cfs (55,000 gpm) on June 22, 2004. Flow from the Adit 2 discharge was measured at approximately 0.71 cfs (320 gpm). The closest USGS gaging station (#12134500) is located on the Skykomish River approximately 15 miles downstream of the Site. According to USGS records, the mean average flowrate at this station on June 22, 2004 was approximately 6,300 cfs.

3.2.3 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 and 2, analytical results are tabulated in Tables 1, 2 and 3; the original laboratory reports are available in the USFS Project File. Changes to the sampling program made during the SI field activities after discussion and concurrence with the USFS representative are included in Appendix A. Photographs of selected sampling locations are included in Appendix B. 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 June 21 through June 25, 2004; the reader is referred to the FOP (CES, 2004) for sampling procedure, protocols and analysis.

A total of 12 water samples (8 surface water and 4 pore water) and 4 sediment samples were collected from Trout Creek, the NFSR, and Adits 1 and 2 during the SI field activities (Figures 1 and 2). Metals analyses, field parameters and wet chemistry results are presented in Tables 1, 2 and 3. The following table summarized the metal results for surface water, pore water, and sediment samples.

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

SAMPLE TYPE	TABLE / SAMPLE ID	METALS EXCEEDING ONE OR MORE COMPARISON CRITERIA	TRENDS OBSERVED AND COMMENTS
Surface Water	Table 1	Total recoverable metals (ug/L)	
Trout Creek (Background)	TC-SW1	Lead (0.4 B)	NA
In Trout Creek, adjacent to the Site	TC-SW-2	Arsenic (0.2 B) Copper (1.0 B)	Arsenic and copper were equal to or below background; both exceeded the lowest criteria.
In Trout Creek, immediately upstream from confluence with NFSR	TC-SW-3	Arsenic (0.2 B) Copper (0.8 B)	Arsenic and copper below background; both metals exceeded the lowest criteria.
In NFSR, upstream of confluence with Trout Creek (Background)	NFSR-SW-1	Arsenic (0.7) Barium (5 B) Copper (0.5 B)	Arsenic exceeds all Trout Creek samples and lowest criteria. Barium and copper exceed Trout Creek background and lowest criteria
In NFSR, downstream of confluence with Trout Creek	NFSR-SW-2	Arsenic (0.7) Barium (5B)	Arsenic exceeds all Trout Creek samples, is equal to background NFSR sample, and exceeds lowest criteria. Barium exceeds Trout Creek background and lowest criteria.
Adit 1 drainage just below portal	SM-AS1	Arsenic (0.7) Barium (11) Copper (126)	All metals exceed background, Trout Creek samples and lowest criteria (Al = 87, As = 0.018, As V = 3.1, Ba = 4, Cu = 1.0, Fe = 300, and Pb = 0.11).
Adit 2 drainage just below portal	SM-AS2-1	Arsenic (3.1) Barium (18) Copper (90.7)	
Adit 2 drainage 25 feet before entering Trout Creek	SM-AS2-2	Aluminum (270) Arsenic (3.3) Arsenic V (3.2) Barium (20) Copper (212) Iron (380) Lead (2.8)	
Pore Water	Table 2	Dissolved metals (ug/L)	All criteria listed are Ecological
Trout Creek (Background)	TC-PW-1	Arsenic (0.3 B) Copper (0.7)	NA
In Trout Creek, adjacent to the Site	TC-PW-2	Arsenic (0.2 B) Copper (1.6)	Total arsenic exceeds lowest criteria, but below background. Copper exceeds background and lowest criteria
In Trout Creek, immediately upstream from confluence with NFSR	TC-PW-3	Arsenic (0.2 B) Copper (1.1)	
In NFSR, upstream of confluence with Trout Creek (Background)	NRSR-PW-1	Arsenic (0.9) Barium (5 B) Copper (1.1)	Arsenic, barium and copper exceed background and lowest criteria
Sediment	Table 3	Total metals (mg/kg)	All criteria listed are Ecological
Trout Creek (Background)	TC-SS-1	Arsenic (7.7) Copper (83.6)	NA
In Trout Creek, adjacent to the Site	TC-SS-2	Arsenic (7.8) Copper (109) Nickel (27.8)	All metals exceed background and lowest criteria
In Trout Creek, immediately upstream from confluence with NFSR	TC-SS-3	Arsenic (7.2) Copper (102) Nickel (20.6)	Arsenic below background, but above lowest criteria. Copper and nickel above background and lowest criteria.
In NFSR, upstream of confluence with Trout Creek (Background)	NFSR-SS-1	Arsenic (35.4) Copper (44.8)	Arsenic above Trout Creek background, copper below Trout Creek background. Both above lowest criteria.

Notes: B = analyte detected between the MDL and the practical quantitation limit and is therefore estimated.
Metals that were not detected above the MDL, which is greater than the lowest criteria, are not listed.

3.2.4 Surface Water Exposure Pathway Summary

Based on the information presented in this section, metals (primarily arsenic and copper) have been released into Trout Creek from the Site, and appear to have slightly impacted stream sediments, surface water and pore water. However, there are numerous mines and prospects (mostly copper, gold and silver) above the Site within the Trout Creek watershed. The Non Pareil Mine, which also mined nickel, was located approximately 1.5 miles above the Site along Trout Creek (Northwest Underground Explorations, 1997) and is a potential source of the elevated metal concentrations in sediment. Differences between the metals concentrations detected in Trout Creek samples collected in 2002 (Wolff, et. al.) and this SI may be in part based on the large difference in

flowrates during the time of sample collection (20 cfs in May 2002 versus 120 cfs in June 2004). The additional flow, resulting from snowmelt and rain, may have diluted the samples resulting in lower detected concentrations.

Several species of salmon, including four RTE species, have been documented in Trout Creek and are known to inhabit the NFSR. Results from the benthic invertebrate survey for pool and riffle habitats indicate consistent conditions at the three Trout Creek stations indicating that Site impacts are not likely occurring in Trout Creek downstream of the Site.

Although upstream metal sources may be contributing to the elevated metals in surface water, pore water, and sediment, the surface water pathway is complete and further assessment is warranted. An additional sampling event is recommended during low flow conditions. The purpose of this event is to assess the concentrations of metals in surface water, pore water, and sediment during a period when snow melt and spring runoff is not diluting concentrations and to assess the potential impacts from upstream sources. Samples should be collected from the same Trout Creek stations for comparative purposes.

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 feet of the Site. Public use of the Site and vicinity is moderate, though public access records are not maintained. The Site is promoted in *Discovering Washington's Historic Mines* (Northwest Underground Explorations, 1997) and several hikers were encountered during SI activities at the upper workings. Access is currently not restricted by fencing; warning signs are posted at the entrance to the collapsed chasms and air shaft. In general, land uses in this area are limited to timber harvesting, firewood cutting, recreation (hiking, fishing, camping, hunting, etc.) and some minerals prospecting. The closest residence to the Site is located approximately 1.9 miles downstream of the Site, along the NFSR below the confluence with Trout Creek. As the area is unincorporated, it is unknown whether the residences are permanent or seasonal (Stowe, 2004).

3.3.1.2 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 with regional biologists. Lists of RTE plants and animals likely or known to be present in the vicinity of the Site were obtained from the USFS, the WDFW PHSP, and/or the WNHP (See Appendix D). Full results of the terrestrial ecological survey are provided in Appendix D.

The major plant communities identified at and surrounding the Site included mixed forest, riparian, and disturbed mine. The mixed forest community had a canopy layer dominated by red alder, vine maple, and western hemlock; primary shrub layer species including dull Oregon grape, red elderberry, and red huckleberry; and a ground (herbaceous) layer of sword fern and mosses with numerous other species present. The riparian community included a dense canopy layer of red alder, western red cedar, and western hemlock; a dense shrub layer dominated by Sitka willow, salmon berry, red elderberry, and Devil's club; and a dense herbaceous layer dominated by common horsetail, bracken fern, fireweed, and grasses. The disturbed mine areas were primarily wasterock, excavated gravelly soil or compacted gravel roadways with numerous colonizing and weedy species including successional canopy of red alder and young coniferous trees, a shrub layer of salmon berry, and sparse herbaceous layer including mostly fireweed. These and other species observed in the disturbed mine community are listed in Appendix D. The Site is immediately adjacent to and displaces portions of the riparian community. The vegetation within close proximity to the Site is clearly different from both these mixed forest and riparian communities. None of the identified plants are RTE species.

Invertebrates noted on and near the Site include black carpenter ants, common black ground beetles, butterflies, moths, black flies, yellow jackets, a centipede, a caterpillar, and spiders. These and other invertebrates expected at the Site are listed in Appendix D. None of these or other invertebrates in the vicinity of the Site are known RTE species.

Birds seen or heard at the Site included winter wren, Swainson's thrush, Stellar's jay, American robin, and Pacific slope flycatcher. These represent an assemblage common among mixed coniferous and deciduous forests in northwestern Washington. Pileated woodpeckers are expected in the vicinity of the Site and are a state candidate for listing as a threatened or endangered species. Marbled murrelets are known to nest within a few miles of the Site and are state and federally listed threatened species. Other RTE bird species that may inhabit the forest surrounding the Site are presented in Appendix D.

Game trails were not clearly present, but deer tracks and pellets were noted, suggesting that black-tailed deer are present near the Site. Black bear or mountain lion may also be present. Other mammals or mammal signs observed included Douglas' tree squirrel, mountain beaver, and a Townsend chipmunk. Townsend's big-eared bats, a state candidate species and federal species of concern, may inhabit caves or shafts in the vicinity of the Site. Other RTE mammal species that may inhabit the region are listed in Appendix D.

No reptiles or amphibians were found during the survey. Those expected or possible at the Site are listed include northern alligator lizards, common garter snake, long-toed salamander, cascades frog, red-legged frog, tailed frog, and pacific treefrog. The cascades frog, red-legged frog, tailed frog, western toad, and spotted frog are RTE species that may be found in the vicinity of the Site.

Overall, relatively few species were identified during this limited ecological survey. This is likely the result of there being only one dominant vegetation community: mature mixed forest. The wetland/riparian community is very small and thus does not support numerous other species that might be expected in a similar, but larger habitat. Of the invertebrates and wildlife documented or likely to inhabit the site, ground-dwelling invertebrates such as ants are the species most likely to be exposed to site-related contamination. Invertivorous species such as robins that forage frequently on invertebrates within or near the waste piles may also be relatively highly exposed to Site related contamination.

3.3.2 Site Inspection Analytical Results

The following sections present the background soil, wasterock, and vegetation tissue analytical results for the Site. Sample locations for soils, wasterock, and tissue samples are shown on Figures 1 and 2. Analytical results for background soils are tabulated in Table 4 and wasterock in Tables 5 and 6. Vegetation tissue results are tabulated in Table 7. The complete laboratory analytical results and a discussion of QA/QC procedures and results are available in the USFS Project File. Field activities were conducted from June 21 through 25, 2004; the reader is referred to the FOP (CES, 2004) for sampling procedure, protocols, and analyses.

The volume of the wasterock piles were estimated by measuring the base of the pile, height and slopes of sides and with the use of AutoCAD and the prismoidal formula. Based on these calculations, the total volume of wasterock and material at the Site is estimated at 1,970 CY (WR-1 = 300 CY, WR-2 = 10 CY, WR-3 = 800 CY, WR-4 = 60 CY, WR-5 = 300 CY, and WR-6 = 500 CY).

3.3.2.1 Background Soil, Site Soil, and Wasterock Metal / pH Chemistry Results

Background soil samples were collected from three locations above the Site to provide representative chemistry of undisturbed areas around the Site (Figure 2). A total of 17 wasterock and soil samples, including three background samples, were collected and submitted for laboratory analysis during the SI field activities. As outlined in the SOW, the USFS requested that samples be collected at various depths at each sampling location, including from native soil beneath the piles. However, because the access road to the Site

is in very poor condition, heavy equipment (i.e., drill rig or backhoe) could not be brought up to the Site. Therefore, CES attempted to penetrate the piles using a stainless steel hand auger and/or shovel, but due to the density and size of the wasterock, CES was only able to penetrate most wasterock piles to a depth of 1 foot.

Laboratory pH data indicates that background soil is slightly acidic with pHs ranging from 5.0 su to 5.5 su; Site soil and wasterock had a wide range of pH from strongly acidic and slightly alkaline (2.9 su to 7.4 su). The following tables summarized the metals results for background, soil, and wasterock samples at the Site. The table only outlines metals that exceeded at least one comparison criteria and the mean background, and provides a brief comment on any trends observed.

Summary of Background Soil, Site Soil, and Wasterock Metals Results

SAMPLE TYPE	TABLE / SAMPLE ID	METALS EXCEEDING AT LEAST ONE CRITERIA	METALS EXCEEDING ONE CRITERIA AND MEAN BACKGROUND	TRENDS OBSERVED AND COMMENTS
Background Soil	Table 4	Total metals (units in mg/kg)		
Above west stope, ventilation raise and east stope.	SM-BGS-1 SM-BGS-2 SM-BGS-3	Aluminum, arsenic, arsenic V, barium, chromium, copper, mercury, selenium, vanadium, and zinc	Not Applicable (NA)	NA
Wasterock	Table 5	Total metals (units in mg/kg)		
Lower Wasterock Piles (WR-1, WR-2, and WR-3)	SM-WR1 SM-WR8 SM-WR9 SM-S1 SM-S2 SM-S3 SM-WR2 SM-WR7 SM-WR3	Aluminum, arsenic, chromium, chromium VI, copper, iron, lead, manganese, mercury, selenium, silver, vanadium, and zinc	Aluminum (18,600), arsenic (1,150), chromium (59), chromium VI (103.6B), copper (30,900), iron (226,000), lead (788), manganese (1,190), mercury (5.74), selenium (20), silver (268), vanadium (41) and zinc (200 B).	Aluminum and vanadium similar to background, but above lowest criteria (50 and 2, respectively). All other metals exceed background and lowest criteria (Ag = 2, As = 1.6, Cr = 0.4, Cr VI = 19, Cu = 50, Fe = 100,000, Hg = 0.00051, Mn = 1,100, Pb = 40.5, Se = 0.21, and Zn = 8.5)
Upper Wasterock Piles (WR-4, WR-5, and WR-6)	SM-WR4 SM-WR5 SM-WR6	Aluminum, antimony arsenic, chromium, chromium VI, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc	Aluminum (22,400), antimony (7B), arsenic (133), chromium (19), chromium VI (25.9 B), cobalt (26 B), copper (883,000), lead (248), manganese (1,400), mercury (1.41), nickel (40), selenium (20), silver (11.3), vanadium (44.5) and zinc (189).	Chromium and vanadium similar to background, but above lowest criteria (0.4 and 2, respectively). All other metals exceed background and lowest criteria (Ag = 2, Al = 50, As = 1.6, Cr VI = 19, Co = 20, Cu = 50, Fe = 100,000, Hg = 0.00051, Mn = 1,100, Ni = 30, Pb = 40.5, Sb = 5, Se = 0.21, and Zn = 8.5)

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. chromium VI, etc.)

3.3.2.2 Wasterock Acid Base Accounting Results

Five wasterock samples were analyzed for static acid based accounting (ABA) using the Modified Sobek Method to evaluate the acid generating potential (AGP) and acid neutralization potential (ANP). As shown in Table 5, the acid base potential (ABP) ranged from +1 to -67 t CaCO₃/Kt (ABP units are presented as tons of calcium carbonate needed to neutralize a kiloton of waste) and the neutralization potential ratio (NPR) ranged from 0.13 to 1.07. ABP is the result of the ANP minus the AGP; a negative ABP indicates that the acid generating potential is greater than the acid neutralization potential. The NPR is the ratio of the ANP divided by the AGP; typically ratios < 1 are acid generating and ratios >3 are not acid generating. Based on these results, wasterock and soil at the Site has the potential to produce acid rock drainage (ARD).

3.3.2.3 Wasterock TCLP / SPLP Results

Five wasterock samples were submitted for the toxicity characterization leaching procedure (TCLP) and the synthetic precipitation leaching procedure (SPLP) for the eight Resource Conservation Recovery Act (RCRA) metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver). There are no applicable standards for SPLP; however, the results can be compared to RCRA TCLP disposal limits. None

of the samples had TCLP or SPLP results in excess of the TCLP standard (Table 6) and all were several orders of magnitude below the limits.

3.3.2.4 Plant Tissue Metals Results

Six vegetation samples were collected around the Site (Figure 2). Laboratory results are presented in Table 7. As the wasterock piles are not well vegetated, a reconnaissance was first performed to determine which species of plant was abundant and widespread enough for the sampling program, and one that would likely be foraged on by ecological receptors. Based on the reconnaissance, vine maple was selected. No stressed vegetation was observed during the SI field activities. Samples BG-V1, BG-V2, and BG-V3 were collected to represent background plant tissue concentrations at the same location as background soil sample locations (BGS-1, BGS-2, and BGS-3, respectively). Samples V1, V2, and V3 were collected to represent wasterock plant tissue concentrations with wasterock samples WR-6, WR-2, and AS-2, respectively.

Comparison criteria do not exist for plant tissue concentrations; however, they do exist for soil concentrations that are used to assess impacts to plant growth and the subsequent exposure to wildlife receptors that forage on plants. These criteria are shown on Tables 4 and 5. With the exception of one sample, results indicate that the concentrations of metals in plant tissue growing on the wasterock were generally similar to or less than background concentrations. Sample V2, collected behind the former mill foundation, had a lead concentration of 12.8 mg/kg, compared to the highest background concentration of 0.22 mg/kg. This area also had elevated lead concentration detected in soil samples.

3.3.3 Soil Exposure Pathway Summary

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. Nine metals are present at concentrations exceeding one or more comparison criteria in background soils. The following metals were detected in wasterock samples at concentrations exceeding both the mean background soil concentration and one or more comparison criteria: arsenic, chromium, chromium VI, copper, lead, manganese, mercury, nickel, silver, and zinc. All wasterock samples collected from the Site exceed the EPA Industrial PRG for arsenic at 1.6 mg/kg. In comparing wasterock concentrations to average background soil concentrations, arsenic, copper, lead, mercury and silver are the metals of concern. Results of the ABAs indicate the wasterock at the Site has the potential to produce ARD. None of the samples analyzed for SPLP or TCLP exceeded any of the TCLP limits.

Results of the vegetation sampling indicate that the concentrations of metals in vegetation growing on wasterock are generally similar to or less than background concentrations. Although there is slightly more copper, lead and manganese in vegetation growing on or near wasterock, and barium is slightly higher in background samples, the differences are minimal.

3.4 Air Exposure Pathway

3.4.1 Targets

The target distance for the air pathway has been defined as 1 and 4 miles from the Site. There are over 40 houses and cabins within 4 miles of the Site located on the NFSR below the confluence with Trout Creek approximately 600 feet lower in elevation. It is not known whether the houses are for year round residences or vacation homes, as the area is unincorporated. Neither the annual nor the summer wind direction is toward the nearest residences. Sensitive environments, including wetlands, which are located within 4 miles from the Site, are also outlined in Section 3.2.1.

3.4.2 Air Exposure Pathway Summary

Air samples were not collected as part of the field activities. Metals were released to the air during processing (i.e., crushing and sorting). However, processing is currently not occurring at the Site and has not occurred for over 50 years. The most likely air pathway is due to inhalation of particulate matter. As with soil exposure, this pathway is considered complete because metals impacted soil and wasterock 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. Therefore, further assessment of the air pathway is not recommended.

4.0 CONCLUSIONS

Groundwater Pathway

The groundwater pathway is incomplete and no further assessment is warranted. Although, the connection between the alluvial aquifer with the granite aquifer is unknown, the granite aquifer near the Site likely discharges groundwater to the contiguous alluvial aquifer and, ultimately, streams. Only one well within the 4-mile radius is screened in the granite aquifer. The elevation and location of the well (near the NFSR and not within the Trout Creek drainage) suggests a greater influence from the NFSR watershed and impacts from the Site, if any, are negligible.

Surface Water Pathway

The surface water pathway is complete for both human and ecological receptors due to elevated concentrations of metals (primarily arsenic, copper and nickel) in stream sediments, surface water, and pore water and further assessment is warranted. Arsenic and copper concentrations in samples collected above the Site also exceed the lowest criteria indicating other potential metal sources upstream in Trout Creek. There are several RTE species (including Coho salmon and rainbow trout) known to inhabit Trout Creek and the NFSR. Results of the benthic macroinvertebrate sampling suggest little or no difference in invertebrate populations upstream, adjacent to and downstream 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. The wasterock piles contain elevated concentrations of metals (arsenic, chromium, chromium VI, copper, lead, manganese, mercury, nickel, silver, and zinc), which exceed numerous comparison criteria. Acid base accounting indicates that the soil and wasterock at the Site has the potential to produce ARD. None of the samples had TCLP or SPLP results in excess of the TCLP standard. Onsite vegetation does not appear to be impacted by mining activities associated with the Site. 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 arsenic and copper impacted soil and waste material is concentrated at the surface where human and ecological receptors could be exposed to particulate matter. The most likely air pathway is due to inhalation of particulate matter. However, addressing and/or eliminating the soil exposure pathway will likely render the air exposure pathway incomplete. Therefore, further assessment of the air pathway is not recommended.

5.0 RECOMMENDATIONS

Based on the information gathered as part of the SI and presented in this report, CES recommends performing an Engineering Evaluation / Cost Analysis (EECA) at the Site. As part of the EECA, a risk assessment should be performed to assess the human and ecological impacts, establish removal cleanup standards, and assess if a removal action is warranted. An additional aquatic sampling event should also be performed to evaluate water quality during low flow conditions in Trout Creek and the NFSR. Addressing the physical dangers (i.e., opened adits, caved stopes, etc.) should also be included as part of the EECA.

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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**Table 1. Surface Water Analytical Results
Sunset Mine and Millsite Site Inspection, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington**

Sample ID.	Sample Date	Aluminum, TR	Antimony, TR	Arsenic III, TR	Arsenic V, TR	Arsenic Total, TR	Barium, TR	Beryllium, TR	Cadmium, TR	Calcium, TR	Chromium III, TR	Chromium VI, TR	Chromium, TR	Cobalt, TR	Copper, TR	Iron, TR	Lead, TR	Magnesium, TR	Manganese, TR	Mercury, TR	Nickel, TR	Potassium, TR	Selenium, TR	Silver, TR	Sodium, TR	Thallium, TR	Vanadium, TR	Zinc, TR
		Results in µg/L																										
TC-SW1	6/22/2004	50 B	< 0.4	0.059	< 0.4 C	< 0.4	3 B	< 2	< 0.2	1,800	< 10 C	< 1	< 10	< 10	< 1	20 B	0.4 B	300 B	< 5	0.000456	< 10	< 300	< 0.2	< 0.1	700 B	0.4 B	< 5	< 10
TC-SW2	6/22/2004	40 B	< 0.2	0.066	< 0.2 C	0.2 B	< 3	< 2	< 0.1	1,800	< 10 C	< 1	< 10	< 10	1 B	< 10	0.1 B	300 B	< 5	0.000373	< 10	< 300	< 0.1	< 0.1	600 B	< 0.1	< 5	< 10
TC-SW3	6/23/2004	< 30	< 0.2	0.083	< 0.2 C	0.2 B	< 3	< 2	< 0.1	1,800	< 10 C	< 1	< 10	< 10	0.8 B	10 B	< 0.1	300 B	< 5	0.000431	< 10	< 300	< 0.1	< 0.1	600 B	< 0.1	< 5	< 10
NFSR-SW1	6/23/2004	40 B	< 0.2	0.083	0.62 C	0.7 B	5 B	< 2	< 0.1	3,100	< 10 C	< 1	< 10	< 10	0.5 B	30 B	< 0.1	500 B	< 5	0.000431	< 10	400 B	< 0.1	< 0.1	1,600	< 0.1	< 5	< 10
NFSR-SW2	6/23/2004	50 B	< 0.2	0.081	0.62 C	0.7 B	5 B	< 2	< 0.1	2,500	< 10 C	< 1	< 10	< 10	1	20 B	< 0.1	500 B	< 5	0.00041	< 10	300 B	< 0.1	< 0.1	1,300	0.2 B	< 5	< 10
SM-AS1	6/22/2004	50 B	2.4	< 0.007	0.7 C	0.7 B	11	< 2	0.1 B	9,800	< 10 C	< 1	< 10	< 10	126	< 10	< 0.1	1,000 B	< 5	0.00384	< 10	400 B	< 1.0	< 0.05	1,400	< 0.05	< 5	< 10
SM-AS2-1	6/22/2004	< 30	0.5 B	0.03	3.1 C	3.1 C	18	< 2	0.1 B	20,400	< 10 C	< 1	< 10	< 10	90.7	10 B	< 0.1	2,500	< 5	0.00391	< 10	700 B	< 1.0	0.07 B	2,800	< 0.05	< 5	< 10
SM-AS2-2	6/22/2004	270	0.6 B	0.131	3.2 C	3.3 C	20	< 2	0.1 B	20,300	< 10 C	< 1	< 10	< 10	212	380	2.8	2,600	13 B	0.00604	< 10	800 B	< 1.0	0.26 B	2,700	< 0.05	< 5	< 10
Standards, corrected for hardness where applicable (used 7.2 mg/L as average in surface water samples)																												
Washington - Aquatic Life ¹		NS	NS	NS	NS	<u>190</u>	NS	NS	<u>0.14</u>	NS	<u>24.0</u>	10	NS	NS	<u>1.2</u>	NS	<u>0.11</u>	NS	NS	0.012	<u>27.5</u>	NS	5	NS	NS	NS	NS	<u>11.40</u>
Washington - Human Health ²		NS	14	NS	NS	0.018	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.14	610	NS	170	NS	NS	1.7	NS	NS
Washington Drinking Water Criteria ³		NS	6	NS	NS	10	2,000	4	5	NS	NS	NS	100	NS	1,300	300	15	NS	50	2	100	NS	50	100	20,000	2	NS	50,000
EPA - Aquatic Life ⁴		NS	NS	NS	NS	<u>150</u>	NS	NS	<u>0.04</u>	NS	<u>10</u>	<u>11</u>	NS	NS	<u>1.0</u>	NS	<u>0.11</u>	NS	NS	0.77	<u>5.6</u>	NS	5	NS	NS	NS	NS	<u>12.89</u>
EPA - Human Health ⁵		NS	5.6	NS	NS	0.018	NS	NS	NS	NS	NS	NS	100	NS	1,300	NS	NS	NS	NS	NS	610	NS	170	NS	NS	1.7	NS	7,400
ORNL - Surface Water PRGs ⁶		87	30	190	3.1	NS	4	0.66	1.1	NS	210	11	NS	23	12	1,000	3.20	NS	120	1.3	160	NS	0.39	0.36	NS	9	20	110

Sample ID.	Sample Date	Flow Rate (6-22-04)	Temperature (Field)	pH (Field)	pH (Lab)	Turbidity	Conductivity (Field)	Conductivity @ 25C (Lab)	Dissolved Oxygen (Field)	Oxygen Reduction Potential (Field)	Hardness as CaCO ₃ , TR	Residue, Filterable (TDS) @ 180	Residue, Non-Filterable (TSS) @ 105° C	Sulfate
		cfs	°C	su	su	NTU	µS/cm	µS/cm	mg/L	mV	mg/L	mg/L	mg/L	mg/L
TC-SW1	6/22/2004	120	9.1	6.32	6.8	44.3	20	16	14.08	185	6	< 10	< 5	< 10
TC-SW2	6/22/2004	NM	10.6	6.47	6.8	10.6	20	14	12.69	173	6	< 10	< 5	< 10
TC-SW3	6/23/2004	NM	16.9	6.13	6.8	16.9	20	14	14.09	191	6	< 10	< 5	< 10
NFSR-SW1	6/23/2004	NM	11.7	6.83	7.0	7.9	30	27	12.65	152	10	< 10	< 5	< 10
NFSR-SW2	6/23/2004	NM	11.8	6.78	7.0	12	30	22	12.47	157	8	< 10	< 5	< 10
SM-AS1	6/22/2004	0.01	8.0	6.75	7.3	51.7	70	60	13.40	279	29	30	< 5	10 B
SM-AS2-1	6/22/2004	0.71	7.5	7.32	7.6	119	130	124	13.61	169	61	70	< 5	20 B
SM-AS2-2	6/22/2004	NM	15.0	7.71	7.6	24	130	124	10.7	156	61	70	8 B	20 B
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
Washington - Human Health ²		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	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
EPA - Human Health ⁵		NS	NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	NS	NS

NOTES:

All analyses except arsenic III & mercury were conducted by ACZ Laboratories, Inc., Steamboat Springs, CO per EPA Method 200 series
 Arsenic III and mercury analyses were conducted by Brooks Rand, Seattle, WA per EPA Methods 1632 & 1631, respectively
 Arsenic V was calculated from difference between Arsenic, TR and Arsenic III
 Chromium VI was determined in the field using Hach Colormetric meter
 Chromium III was calculated from difference between Chromium, TR and Chromium VI
 mg/L = milligrams per liter
 µg/L = micrograms per liter
 su = standard units
 µS/cm = microsiemens per centimeter
 < value = analyte not detected above method detection limit (MDL)
 B = analyte detected between MDL and practical quantification limit (PQL)
 Bolded values indicate that the value exceeds one or more standard
 NM - Not Measured
 NA = Not analyzed
 TR = Total Recoverable Metals
 C = Calculated Value

STANDARD NOTES:

1 - State of Washington Aquatic Life criteria (WAC 173-201A), underline - corrected for hardness, *italics* - expressed as dissolved
 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), underline - corrected for hardness, *italics* - expressed as dissolved
 5 - EPA recommended ambient water quality criteria for protection of human consumption of water and fish (EPA, 2002 NTR)
 6 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)
 NS = No Standard

**Table 2. Pore Water Analytical Results
Sunset Mine and Millsite Site Inspection, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington**

Sample I.D.	Sample Date	Aluminum, Diss.	Antimony, Diss.	Arsenic III, Diss.	Arsenic V, Diss.	Arsenic Total, Diss.	Barium, Diss.	Beryllium, Diss.	Cadmium, Diss.	Calcium, Diss.	Chromium III, Diss.	Chromium VI, Diss.	Chromium, Diss.	Cobalt, Diss.	Copper, Diss.	Iron, Diss.	Lead, Diss.	Magnesium, Diss.	Manganese, Diss.	Mercury, Diss.	Nickel, Diss.	Potassium, Diss.	Selenium, Diss.	Silver, Diss.	Sodium, Diss.	Thallium, Diss.	Vanadium, Diss.	Zinc, Diss.	
		Results in µg/L																											
TC-PW1	6/22/2004	< 30	< 0.2	0.045	0.26 C	0.3 B	4 B	< 2	< 0.1	1,700	< 10	0.01 B	< 10	< 10	0.7 B	< 10	< 0.1	300 B	< 5	0.000414	< 10	< 300	< 0.1	< 0.05	700 B	< 0.05	< 5	< 10	
TC-PW2	6/22/2004	< 30	< 0.2	0.017 B	0.18 C	0.2 B	3 B	< 2	< 0.1	1,700	< 10	0.01 B	< 10	< 10	1.6 B	< 10	< 0.1	200 B	< 5	0.000606	< 10	< 300	< 0.1	< 0.05	700 B	< 0.05	< 5	< 10	
TC-PW3	6/23/2004	< 30	< 0.2	0.022 B	0.18 C	0.2 B	4 B	< 2	< 0.1	1,700	< 10	0.01 B	< 10	< 10	1.1 B	< 10	< 0.1	200 B	< 5	0.000519	< 10	< 300	< 0.1	< 0.05	700 B	< 0.05	< 5	< 10	
NFSR-PW1	6/23/2004	< 30	< 0.2	< 0.007	0.89 C	0.9	5 B	< 2	< 0.1	2,900	< 10	0.01 B	< 10	< 10	1.1 B	< 10	< 0.1	500 B	< 5	0.000681	< 10	< 300	< 0.1	< 0.05	1,700	< 0.05	< 5	< 10	
Standards, corrected for hardness where applicable (used 6 mg/L as average in pore water samples)																													
Washington - Aquatic Life ¹		NS	NS	NS	NS	190	NS	NS	0.13	NS	21	10	NS	NS	1.0	NS	0.11	NS	NS	0.012	23.5	NS	5	NS	NS	NS	NS	NS	9.64
EPA - Aquatic Life ²		87	NS	NS	NS	150	NS	NS	0.03	NS	8.6	11	NS	NS	0.8	NS	0.11	NS	NS	0.77	4.8	NS	5	NS	NS	NS	NS	NS	10.89
ORNL - Surface Water PRGs ³		87	30	190	3.1	NS	4	0.66	1.1	NS	210	11	NS	23	12	1,000	3.2	NS	120	1.3	160	NS	0.39	0.36	NS	9	20	110	

Sample I.D.	Sample Date	Temperature (Field)	pH (Field)	pH (Lab)	Conductivity (Field)	Conductivity @ 25C (Lab)	Dissolved Oxygen (Field)	Oxygen Reduction Potential (Field)	Hardness as CaCO ₃ , TR	Residue, Filterable (TDS) @ 180	WAD Cyanide	WAD Cyanide	Sulfate
		°C	su	su	µS/cm	µS/cm	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L
TC-PW1	6/22/04	13.4	6.8	9.7	20	17	12	212	5 B	30		< 0.01	10 B
TC-PW2	6/22/04	12.4	6.6	7.7	20	21	11.8	170	5 B	< 10		< 0.01	< 10
TC-PW3	6/23/04	13.5	6.9	7.1	20	16	13.4	147	5 B	< 10		< 0.01	< 10
NFSR-PW1	6/23/04	13.0	7.0	7	30	27	11.8	153	9	30		NA	< 10
Standards													
Washington - Aquatic Life ¹		12	6.5-8.5	6.5-8.5	NS	NS	9.5	NS	NS	NS		NS	NS
Washington - Human Health ²		NS	NS	NS	NS	NS	NS	NS	NS	NS		NS	NS
Washington Drinking Water Criteria ³		NS	6.5-8.5	6.5-8.5	700	700	NS	NS	NS	500		NS	250
EPA - Aquatic Life ⁴		9-19	6.5-9	6.5-9	NS	NS	9.5	NS	NS	NS		NS	NS
EPA - Human Health ⁵		NS	5-9	5-9	NS	NS	NS	NS	NS	NS		NS	NS

NOTES:

All analyses except arsenic III & mercury were conducted by ACZ Laboratories, Inc., Steamboat Springs, CO per EPA Method 200 series
 Arsenic III and mercury analyses were conducted by Brooks Rand, Seattle, WA per EPA Methods 1632 & 1631, respectively
 Arsenic V was calculated from difference between Arsenic, TR and Arsenic III
 Chromium VI was determined in the field using Hach Colormetric meter
 Chromium III was calculated from difference between Chromium, TR and Chromium VI
 mg/L = milligrams per liter
 µg/L = micrograms per liter
 su = standard units
 µS/cm = microsiemens per centimeter
 < value = analyte not detected above method detection limit (MDL)
 B = analyte detected between MDL and practical quantification limit (PQL)
 Bolded values indicate that the value exceeds one or more standard
 NM - Not Measured
 NA = Not analyzed
 Diss. = Dissolved Metals
 C = Calculated Value

STANDARD NOTES:

1 - State of Washington Aquatic Life criteria (WAC 173-201A), underline - corrected for hardness, *italics* - expressed as dissolved
 2 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002), underline - corrected for hardness, *italics* - expressed as dissolved
 3 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)
 NS = No Standard

Table 3. Sediment Analytical Results
Sunset Mine and Millsite Site Inspection, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington

Sample ID	Sample Date	Aluminum, Total	Antimony, Total	Arsenic III, Inorganic	Arsenic V, Inorganic	Arsenic - Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total	WAD Cyanide
		mg/kg																									
TC-SS-1	6/22/2004	11,100	0.1 B	< 0.042	7.66 C	7.7	69.2	< 0.2	0.36	2,640	20	7	83.6	17,500	9.96	5,660	475	< 0.05	17.4	1,270	< 0.5	0.68	310	0.07 B	33.5	85	< 0.4
TC-SS-2	6/22/2004	11,800	0.3 B	< 0.038	7.76 C	7.8	79.9	< 0.2	0.26 B	2,600	22	9	109	21,300	6.4	7,780	548	< 0.05	27.8	1,500	< 0.5	0.14	260	0.07 B	40.7	92	< 0.4
TC-SS-3	6/22/2004	11,800	0.2 B	< 0.035	7.17 C	7.2	67.2	< 0.2	0.31	2,940	21	8	102	21,600	7.96	6,480	555	< 0.04	20.6	1,680	< 0.5	0.07 B	300	0.08 B	38.9	77	< 0.4
NFSR-SS-1	6/23/2004	10,800	0.5	0.017	35.4 C	35.4	43.7	< 0.2	0.36	2,910	18	8	44.8	19,300	10.30	6,230	286	< 0.04	16.7	1,090	< 0.5	0.1 B	300	0.06 B	39.2	73	NA
Standards																											
WA - Freshwater (under development) ¹		NS	0.6	NS	NS	51	NS	NS	1	NS	100	NS	830	NS	430	NS	NS	0.75	70	NS	NS	2.5	NS	NS	NS	160	NS
EPA - Freshwater TEL ²		NS	NS	NS	NS	5.9	NS	NS	0.596	NS	37.3	NS	35.7	NS	35	NS	NS	0.17	18	NS	NS	NS	NS	NS	NS	123.1	NS
EPA - Freshwater PEL ³		NS	NS	NS	NS	17	NS	NS	3.53	NS	90	NS	197	NS	91.3	NS	NS	0.486	35.9	NS	NS	NS	NS	NS	NS	315	NS
ORNL - Freshwater ⁴		NS	NS	NS	NS	42	NS	NS	4.2	NS	159	NS	77.7	NS	110	NS	NS	0.7	38.5	NS	NS	1.8	NS	NS	NS	270	NS

Sample ID	Sample Date	Total Organic Carbon		Size Fraction by Hydrometer			Solids (ACZ)	Solids (BR)	Texture Classification
				Clay	Sand	Silt			
TC-SS-1	6/22/2004	0.3 B	<0.1	97.5	2.5B	77.7	71.1	S	
TC-SS-2	6/22/2004	0.3 B	<0.1	97.5	5.0	87.8	78.7	S	
TC-SS-3	6/22/2004	0.4 B	<0.1	97.5	2.5	81.7	86.5	S	
NFSR-SS-1	6/23/2004	0.2 B	<0.1	100	2.5	79.1	81.1	S	

NOTES: Analysis (except As III) was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO, per EPA Method 6010/7000 series.
As III analyses conducted by Brooks Rand, Seattle, WA per EPA Methods 1632
mg/kg = milligrams per kilogram
< value = analyte not detected above listed Method Detection Limit (MDL)
B = analyte detected between MDL and Practical Quantification Limit (PQL)
MDL and PQL are not consistent among samples
Arsenic VI was calculated by subtracting Arsenic III from Total Arsenic
C = Calculated Value
S = Sand Texture

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

Table 4. Background Soil Analytical Results
Sunset Mine and Millsite Site Inspection, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington

Sample ID	Sample Date	Sample Depth (feet)	% Solids (ACZ)		pH	Aluminum, Total	Antimony, Total	Arsenic III, Total	Arsenic V, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Chromium III, Total	Chromium VI, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total	
			% Solids (ACZ)	% Solids (BR)																													
SM-BGS-1	6/21/2004	1	79.1	64.36	5.0	15,400	< 0.2	< 0.047	12.35 C	12.4	52.1	0.2 B	0.4 B	1,530	16	14,912 C	< 1.088 B	5 B	291	15,500	7.5	2,830	142	0.06 B	11.8	450	< 1	0.73	130	< 0.05	38	114	
SM-BGS-2	6/21/2004	1	89.0	72.6	5.5	16,900	0.1 B	0.062 B	7.54 C	7.6	143	< 0.2	0.52	2,490	17	16,036 C	< 0.964 B	10	121	18,800	5.62	6,650	247	< 0.04	18.1	720	< 0.5	0.11	170	< 0.03	43.4	126	
SM-BGS-3	6/21/2004	1	68.0	65.38	5.3	11,600	< 1	0.049 B	12.95 C	13	53.6	< 0.2	0.7 B	2,840	11	9.93 C	< 1.071 B	6	631	13,700	13.1	3,140	341	0.10 B	9	350	< 5	0.3 B	160	< 0.3	31.7	70	
Mean					5.3	14,633	0.23	0.045	10.95	11.0	83	0.13	0.54	2,287	14.7	13.63	0.52	7.0	347.7	16,000	8.7	4,207	243	0.060	13.0	507	1.1	0.38	153	0.06	37.7	103	
Standards																																	
WA - Method A Indust. Soil Cleanup Levels - Human Receptors ¹						NS	NS	NS	NS	20	NS	NS	2	NS	NS	2,000	19	NS	NS	NS	1,000	NS	NS	2	NS	NS	NS	NS	NS	NS	NS	NS	NS
WA - Ecological Receptors (p=plant, b=soil biota, w=wildlife) ²						50 p	5 p	7 w	10 p	NS	102 w	10 p	4 p	NS	42 bp	NS	NS	20 p	50 b	NS	50 p	NS	1,100 p	0.1 b	30 p	NS	0.3 w	2 p	NS	1 p	2 p	86 p	
EPA Indust. PRGs - Human Receptors ³						100,000	410	NS	NS	1.6	67,000	1,900	450	NS	450	100,000	64	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						NS	21 m	NS	NS	37 p	NS	NS	29 p	NS	5 p	NS	NS	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i
ORNL - Ecological Receptors ⁵						NS	5	NS	NS	9.9	283	10	4	NS	0.4	NS	NS	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5	

NOTES: Analysis (except As III and Cr VI) was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO using EPA Method 6000 Series & Method 7471.
As III and Cr VI analyses conducted by Brooks Rand, Seattle, WA per EPA Methods 1632 (As III) & 3060A/7196A (Cr VI)
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
Mean values calculated using value listed or 1/2 the MDL (if applicable).

STANDARD NOTES:
1 = Washington Department of Ecology MTCA (WAC 173-340) Industrial criteria, Table 745-1 (Ecology, 2001).
2 = Washington Department of Ecology MTCA (WAC 173-340) Industrial criteria, Table 749-3 (Ecology, 2001).
3 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2004).
4 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000)
5 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 1997
NS = Not standard

**Table 6. Waste Rock Synthetic Precipitation Leaching Procedure and Toxicity Characteristics Leach Procedure Results
Sunset Mine and Millsite Site Inspection, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington**

Sample ID	Sample Date	Sample Depth (feet)	SPLP Arsenic	TCLP Arsenic	SPLP Barium	TCLP Barium	SPLP Cadmium	TCLP Cadmium	SPLP Chromium	TCLP Chromium	SPLP Lead	TCLP Lead	SPLP Mercury	TCLP Mercury	SPLP Selenium	TCLP Selenium	SPLP Silver	TCLP Silver
			mg/L															
SM-S2	6/2/2004	0.5	< 0.04	< 0.04	0.007 B	0.366	< 0.005	< 0.005	< 0.01	< 0.01	< 0.04	0.04 B	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
SM-WR1-1	6/2/2004	0.5	< 0.04	< 0.04	0.013	0.431	< 0.005	0.009 B	< 0.01	< 0.01	< 0.04	0.33	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
SM-WR2-2	6/23/2004	0.5	< 0.04	< 0.04	0.035 B	0.05	< 0.005	< 0.005	< 0.01	< 0.01	< 0.04	< 0.04	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
SM-WR3-2	6/22/2004	3.0	< 0.04	< 0.04	0.006 B	0.14	< 0.005	0.006 B	< 0.01	< 0.01	< 0.04	< 0.04	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
SM-WR7	6/23/2004	0.5	< 0.04	< 0.04	0.083	0.061	< 0.005	< 0.005	< 0.01	< 0.01	0.13 B	0.14 B	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
Applicable Standards																		
RCRA TCLP Disposal Limits			5	5	100	100	1	1	5	5	5	5	0.2	0.2	1	1	5	5

NOTES: Analysis was conducted by ACZ Laboratories, Inc. in Steamboat Springs, CO.
mg/L = milligrams per liter
< value = analyte not detected above method detection limit (MDL)
B = analyte detected between method detection limit (MDL) and practical quantification limit (PQL)
NA = Not Analyzed.

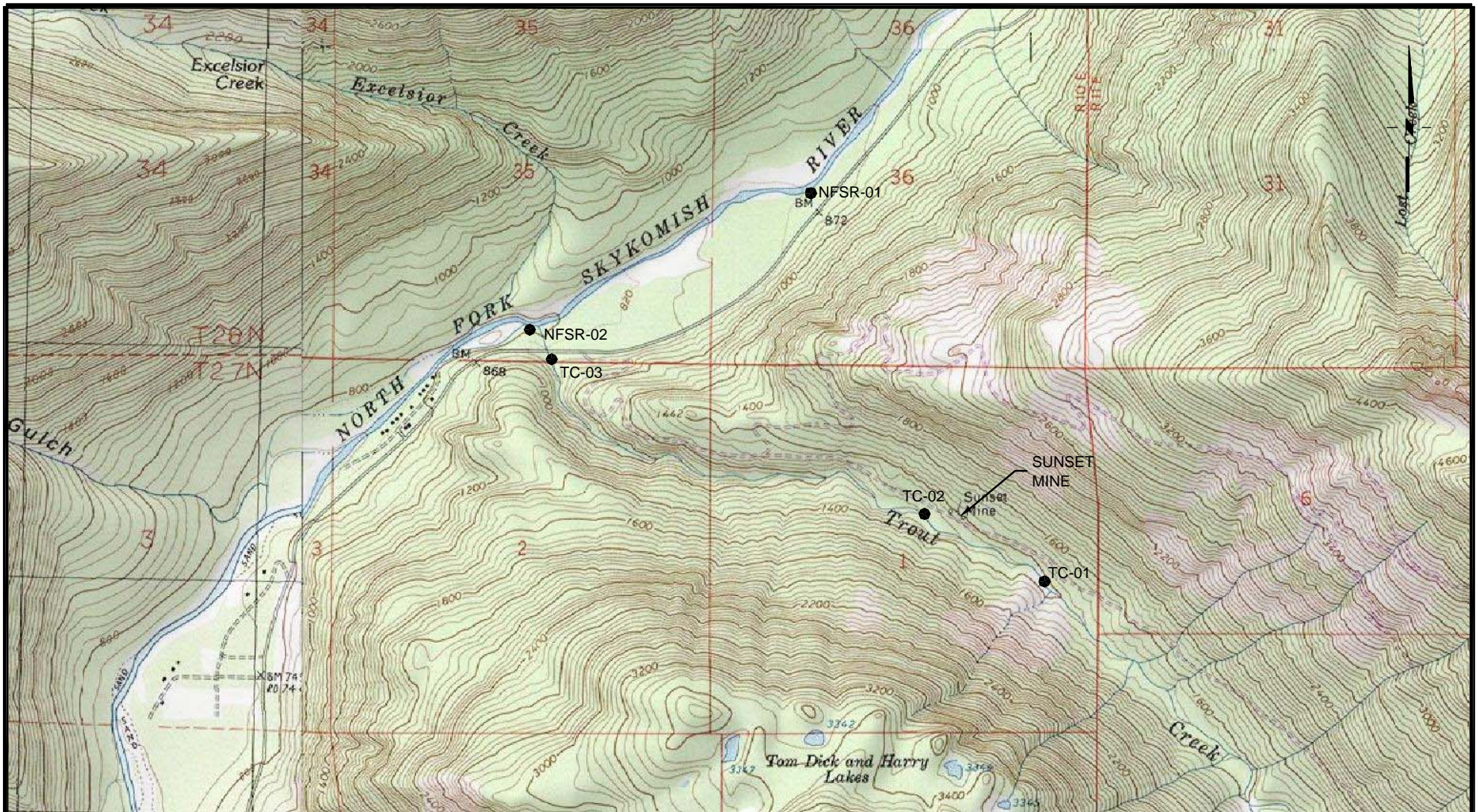
**Table 7. Vegetation Analytical Results
Sunset Mine and Millsite Site Inspection, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington**

Sample ID	Sample Date	Onsite (O) or Background (B)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
SM-BG-V1	06/21/04	B	23	< 0.1	< 0.3	33.1	< 0.2	30 B	10,000	< 1	< 1	8	78	0.13 B	2,720	647	< 0.09	< 1 B	12,100	< 0.5	< 0.03	< 30	0.09 B	< 0.5	57
SM-BG-V2	06/21/04	B	24	< 0.1	< 0.3 B	46.9	< 0.2	0.58	11,300	< 1	< 1	10	81	0.22 B	3,220	520.0	< 0.1	< 1	14,200	< 0.5	< 0.03	< 30	0.07 B	< 0.5	53
SM-BG-V3	06/21/04	B	22	< 0.1	< 0.3	38.4	< 0.2	0.22 B	11,400	< 1	< 1	10	71	0.22 B	3,240	248.0	< 0.1	1 B	12,900	< 0.5	< 0.03	< 30	0.03 B	< 0.5	52
SM-V1	06/21/04	O	20 B	< 0.05	< 0.1	22.5	< 0.2	0.11	12,200	< 1	< 1	15	72	0.09 B	2,930	610.0	< 0.1	1 B	10,800	< 0.5	< 0.01	< 30	< 0.01	< 0.5	58
SM-V2	06/22/04	O	18 B	0.3 B	< 0.3	25.3	< 0.2	0.1 B	9,970	< 1	< 1	13	53	12.8	2,060	328.0	< 0.09	< 1	7,750	< 0.5	< 0.03	< 30	< 0.03	< 0.5	55
SM-V3	06/22/04	O	16	< 0.1	< 0.3	14	< 0.2	0.23 B	8,030	< 1	< 1	12	61	0.66	2,480	848.0	< 0.1	< 1	10,100	< 0.5	< 0.03	< 30	< 0.03	< 0.5	40

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

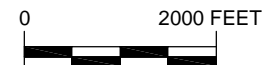
FIGURES

Figure 1. Aquatic and Background Sampling Locations
Figure 2. Site Layout and Sampling Locations



EXPLANATION

● TC-01 Aquatic Sampling Station



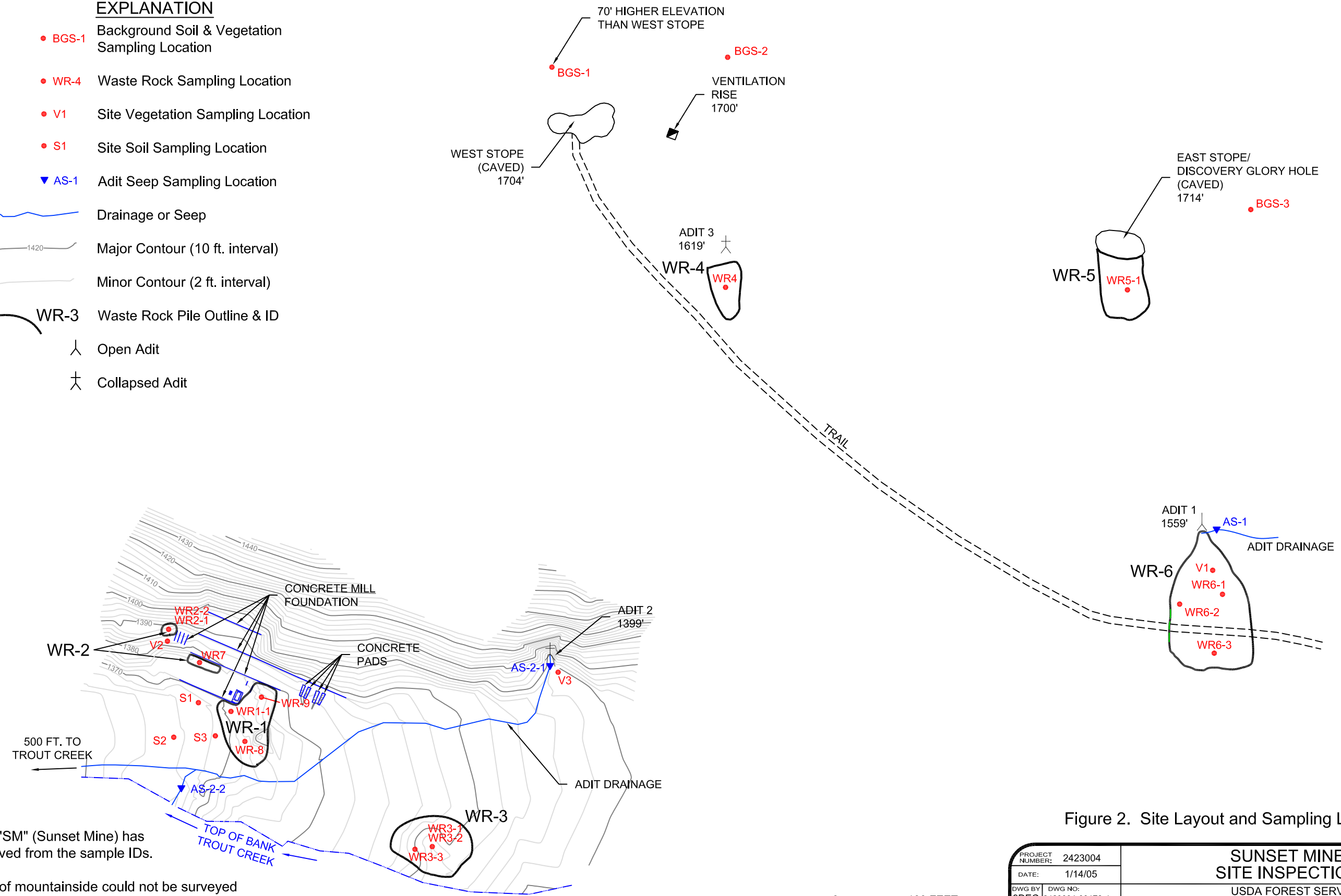
(SCALE & LOCATIONS ARE APPROXIMATE)

Figure 1. Aquatic and Background Sampling Locations

PROJECT NUMBER: 2423004	SUNSET MINE SITE INSPECTION
DATE: 1/7/05	
DWG. 8DEO DWG NO: 2423004-004P1.dwg	USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR INDEX, WASHINGTON
PROJECT MANAGER: 6DGW	CES CASCADE EARTH SCIENCES A Valmont Industries Company
REVISED:	

EXPLANATION

- BGS-1 Background Soil & Vegetation Sampling Location
- WR-4 Waste Rock Sampling Location
- V1 Site Vegetation Sampling Location
- S1 Site Soil Sampling Location
- ▼ AS-1 Adit Seep Sampling Location
- Drainage or Seep
- 1420— Major Contour (10 ft. interval)
- Minor Contour (2 ft. interval)
- WR-3 Waste Rock Pile Outline & ID
- ⋈ Open Adit
- ⋈ Collapsed Adit




NOTES:

- 1) The prefix "SM" (Sunset Mine) has been removed from the sample IDs.
- 2) Total area of mountainside could not be surveyed due to thick vegetation and steep terrain. Dimensions and elevations are estimated in field based on GPS readings.

(SOURCE: W&H PACIFIC SITE SURVEY, 2004)

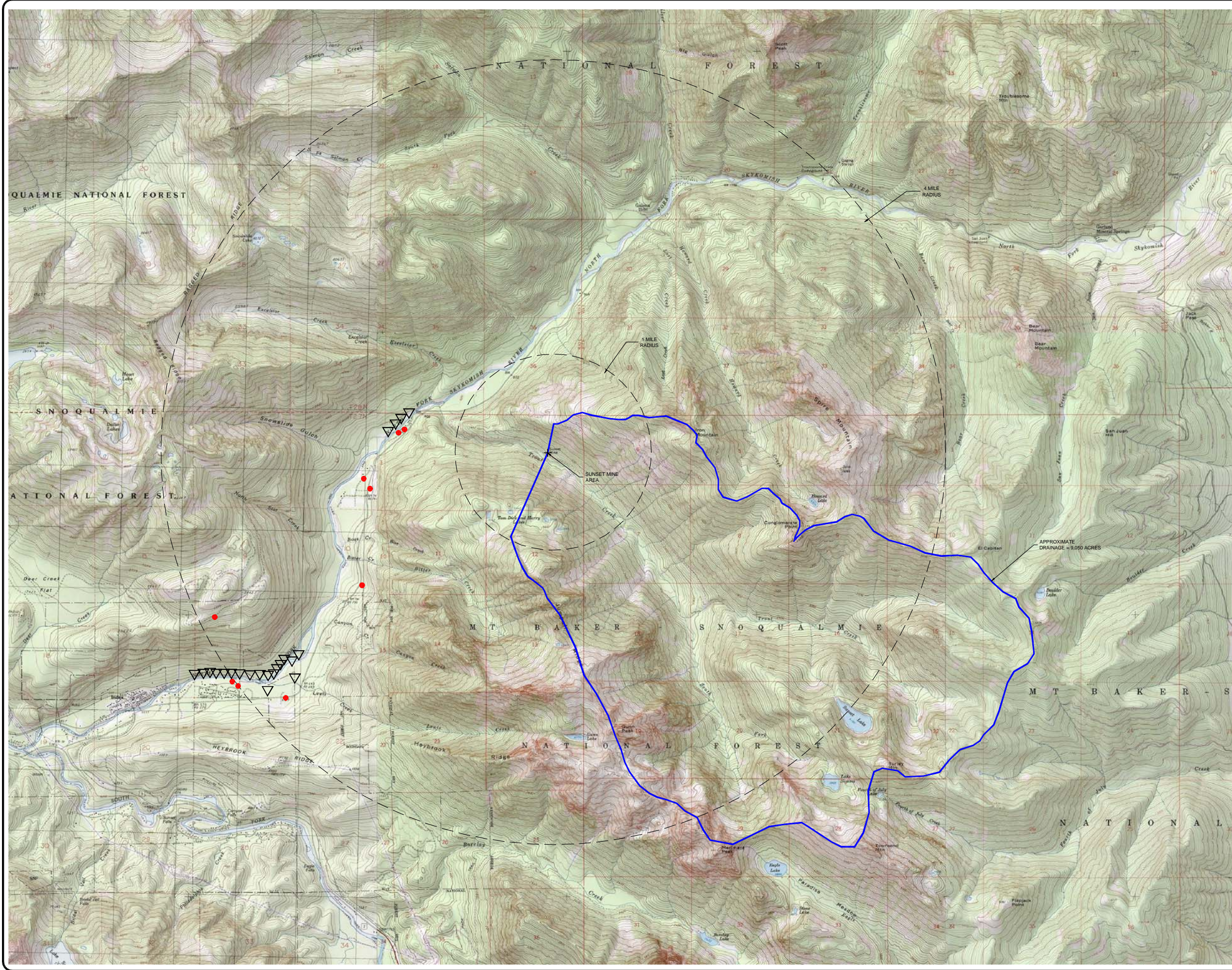






Figure 2. Site Layout and Sampling Locations

PROJECT NUMBER: 2423004	SUNSET MINE SITE INSPECTION USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR INDEX, WASHINGTON
DATE: 1/14/05	
DWG BY: 8DEO DWG NO: 2423004-004F2.dwg	
PROJECT MANAGER: 6DGW	
REVISED:	 CASCADE EARTH SCIENCES A Valmont Industries Company

PLATES

Plate 1 Sunset Mine Watershed Boundaries with 1- and 4-mile radii



- EXPLANATION**
-  Watershed Boundary
 -  Radius Surrounding Mine
 -  Water Well - Approximate Location
 -  Surface Water Rights Location

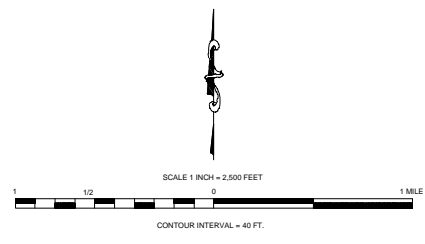



Plate 1. Sunset Mine Watershed Boundary with 1 and 4 Mile Radii

PROJECT: 2423004	SUNSET MINE SITE INSPECTION USDA FOREST SERVICE MT. BAKER / SNOQUALMIE NATIONAL FOREST NEAR INDEX, WASHINGTON
DATE: 1/7/05	
DWG. NO.: 620204-004P1.dwg	
REVISION: 6D/GW	
REVIEW:	
 CASCADE EARTH SCIENCES A Valmont Industries Company	

APPENDICES

- Appendix A** **Deviations from the Workplan**
- Appendix B** **Photographs**
- Appendix C.** **Mine Maps and Miscellaneous Information**
- Appendix D.** **Ecological Survey Tables and Figures**

Appendix A.

Deviations from the Workplan



August 15, 2004

Mr. Dennis Boles
Ochoco National Forest
3160 NE 3rd
Prineville, Oregon 97754

SUBJECT: CHANGES IN THE SUNSET MINE SAMPLING AND ANALYSIS PLAN

Dear Dennis:

The following changes were made to the Sampling and Analysis Plan (SAP) for the Sunset Mine Site Inspection. These changes were made after field observations and after discussions with the USFS.

- Clay mineralization was planned for all "pool" sediment samples. However, because of the substrate size (i.e., < 0.1% clay) discovered during field activities, this analysis was deemed unnecessary and removed from the analysis list.
- An unplanned surface water sample was collected from the seep discharging from Adit 1.
- Pore water samples were not collected from NFSR-02 due to the lack of a gravel or sandy substrate and depth of the water.
- The lack of fine grained material (i.e. < gravel) and depth of water at NFSR-02 prevented collection of sediment samples.
- Due to the high flow rate and large boulder substrate, flow rates could not safely be measured at TC-02, TC-03, NFSR-01 and NFSR-02.
- A backhoe or other large excavation equipment could not be transported to the Site because of the poor access road. Therefore, due to the cementation of the waste rock piles, samples could not be collected at depth except in WR-3.
- The thick vegetation at the Site, and narrowness of Trout Creek canyon prevented GPS locations to be accurate within 1 meter. The vegetation and steep slopes prevented surveying the upper working features (adits, stopes, waste rock piles).

Please contact me at (509) 921-0290 if you have any questions.

Regards,
CASCADE EARTH SCIENCES

Dustin G. Wasley, PE
Managing Engineer

Appendix B.
Photographs



Photograph 1: View southeast (upstream) at station TC-01 (CES 6-21-04)



Photograph 2: View downstream at station TC-01 (CES 6-21-04)



Photograph 3: View downstream at station TC-02 (CES 6-23-04)



Photograph 4: View upstream from station TC-03 (CES 6/23/04)



Photograph 5: View downstream from TC-03 at the confluence with the NFSR (CES 6/23/04)



Photograph 6: View east (upstream) at station NFSR-01 (CES 6-23-04)



Photograph 7: View upstream at station NFSR-02 and confluence with Trout Creek (CES 6-23-04)



Photograph 8: Infiltration of seep flowing from Adit 1 (CES 6-22-04)



Photograph 9: View east at Waste Rock Pile WP-6 below Adit 1 (CES 6-22-04)



Photograph 10: View north at Waste Rock Pile WP-6 below Adit 1 (CES 6-22-04)



Photograph 11: View of Adit 2 portal and seep (CES 6-22-04)



Photograph 12: Closeup of Adit 2 Portal (CES 6-22-04)



Photograph 13: View north at Waste Rock Pile WP-4 below Adit 3 (arrow) (CES 6-22-04)



Photograph 14: View west at entrance to Adit 3 (collapsed) (CES 6/22/04)



Photograph 15: View southeast to Discovery Glory Hole (east stope) (CES 6/22/04)



Photograph 16: View southeast at the caved west stope above Adit 3 (CES 6/22/04)



Photograph 17 View north at the ventilation rise above Adit 3 (CES 6/22/04)



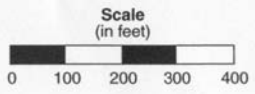
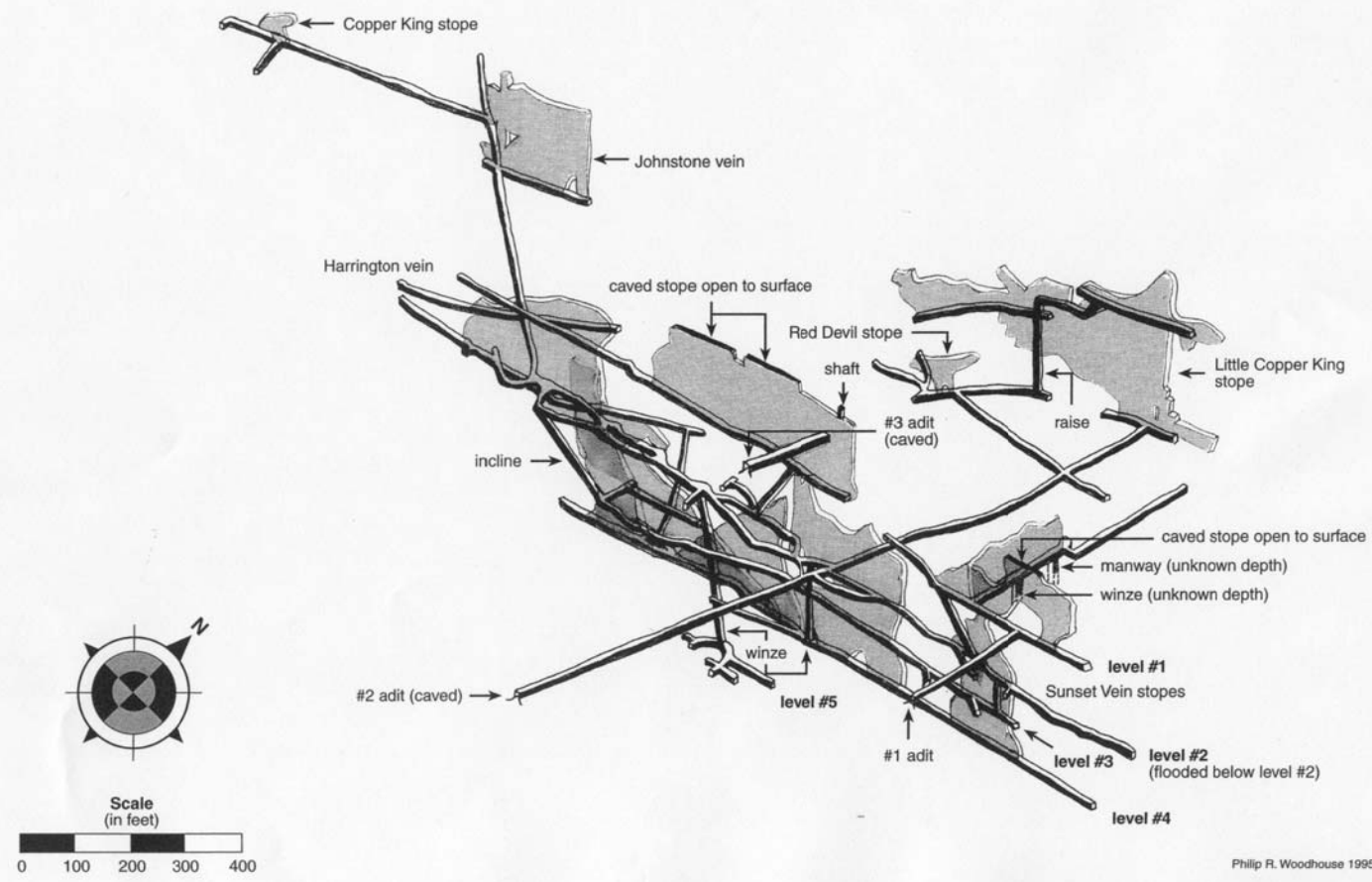
Photograph 24: View north at former mill foundation and sample SM-WR-8 (CES 6-22-04)

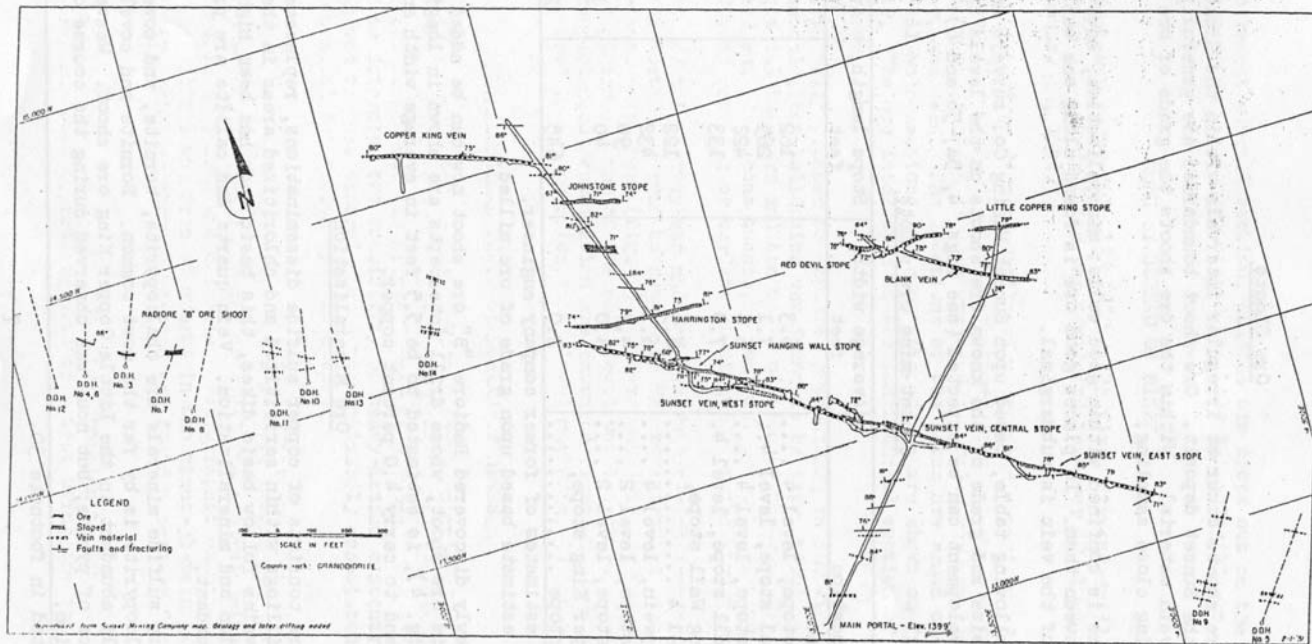
Appendix C.

Mine Maps and Miscellaneous Information

Sunset Mine

(isometric projection)





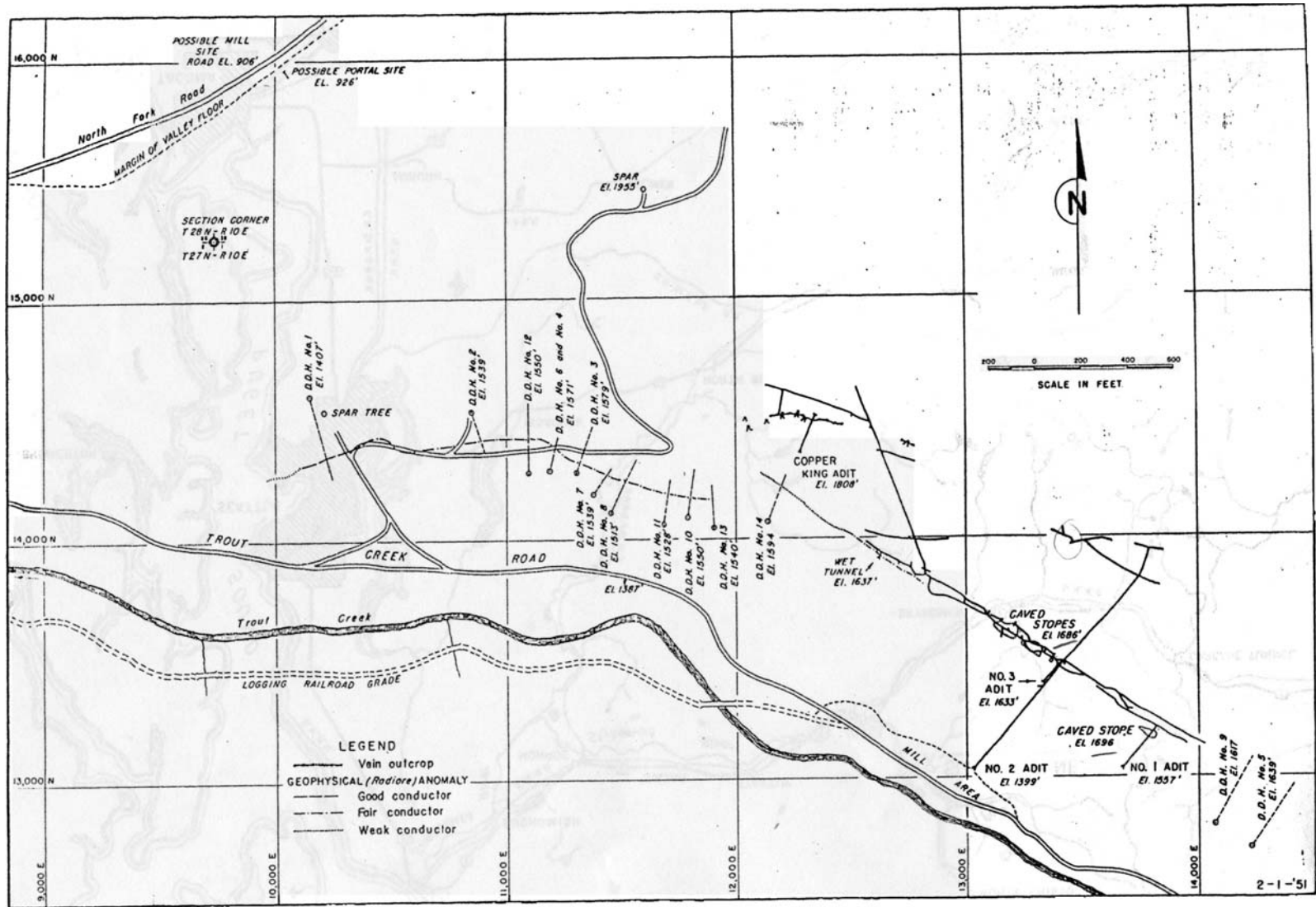


Figure 2. - Sunset mine area, Snohomish County, Wash.

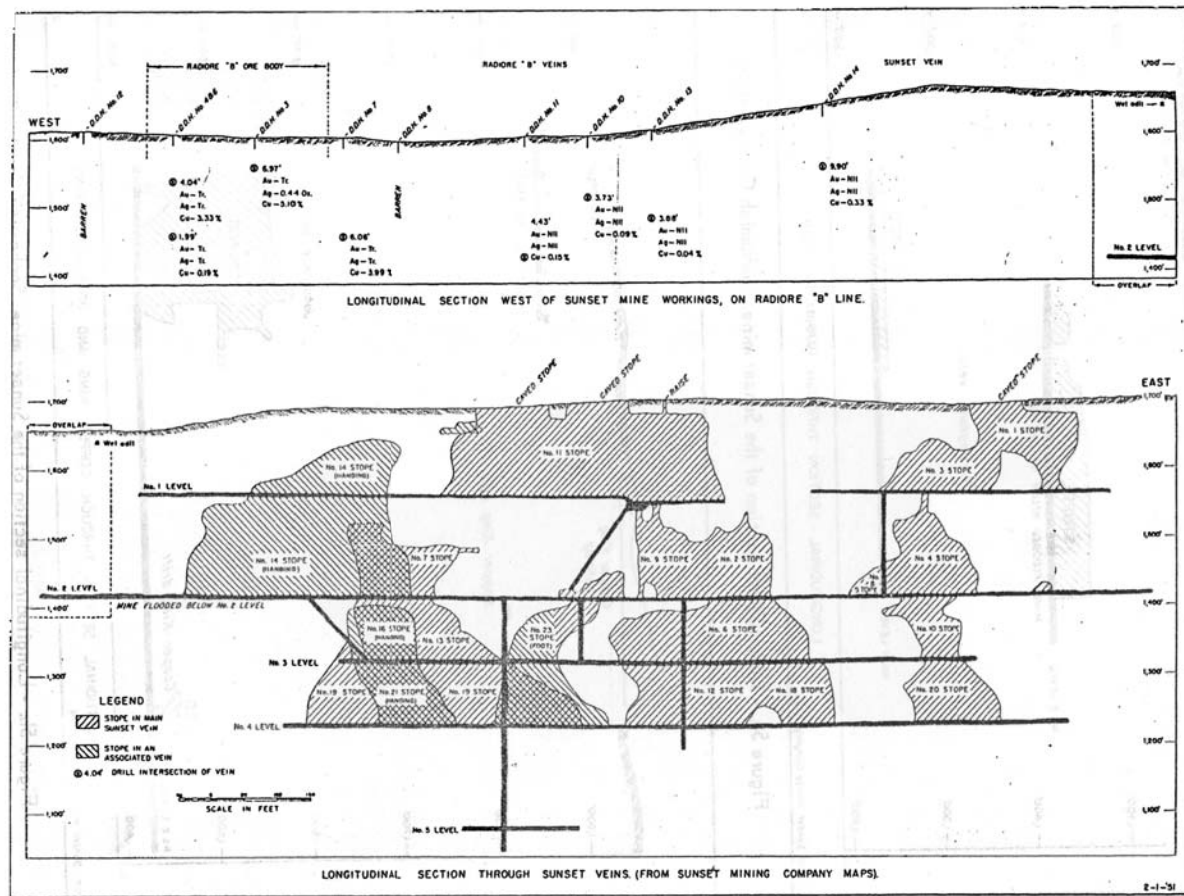


Figure 4. - Longitudinal section of the Sunset mine, Snohomish County, Wash.

Appendix D.

Ecological Survey Tables and Figures

AQUATIC ECOLOGICAL SURVEY

Aquatic surveys were conducted within Trout Creek and the NFSR to assess the potential impacts of the Site on the instream habitat benthic macroinvertebrate community and to determine the presence of fish species. Supplemental figures and tables associated with this section are included in Appendix D. In the vicinity of the Site, Trout Creek is a moderate sized third order stream (Armantrout 1998). Stream flow is perennial, with high and very high flow rates during significant rainfall and snowmelt events. At the time of the investigation (June 20 to 24, 2004), the flow was moderate, with gravel and cobble visible along the lower banks and boulders protruding from the water in midstream. The NFSR is approximately 1.5 miles downstream of the Site at approximately 600 feet lower elevation. It has approximately 50 times the volume of Trout Creek. There are no tributaries entering Trout Creek between the Site and the confluence with the NFSR.

Four stream reaches, each approximately 150 feet long, were established. One reach is upstream of the Site (TC-01), two are downstream of the Site on Trout Creek (TC-02 and TC-03), and one reference sampling reach in the NFSR upstream of the confluence of Trout Creek (NFSR-01). An attempt was made to establish a sampling station on the river, downstream of the confluence, but no shallow areas suitable for sampling could be located within 1 mile of the confluence. Invertebrate sampling was conducted in both riffle and pool habitats in each of the four selected 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). Additional instream characterization was conducted with the Physical Characterization Field Data Sheet (Barbour 1999). The following habitat conditions were noted:

- Habitat total scores were 168, 171, 166, and 191 (out of a possible 200) at TC-01, TC-02, TC-03, and NFSR-01, respectively. This indicates the overall instream physical habitat conditions were optimal for the all four reaches.
- At TC-01 and TC-02, the available cover and frequency of riffles were rated as suboptimal because of the cascading nature of the creek over a boulder and cobble substrate. The velocity/depth regime was rated as poor because only fast /shallow and fast/deep regimes were present.
- At TC-03, the available cover and velocity/depth regime were rated as marginal because of the cascading nature and boulder/cobble substrate/, and because only fast /shallow and fast/deep regimes were present. The frequency of riffles was rated as suboptimal.
- At NFSR-01, the velocity/depth regime was rated as marginal due to the lack of a slow/deep regime within the reach.

The habitat scores are more indicative of riffle habitat quality, and may not be correlated with pool habitat quality. Observations made during the survey suggest that the pool habitat quality was higher at TC-01P and TC-03P than at other stations. This was confirmed by observations made during the survey.

The instream conditions were generally similar for all three Trout Creek reaches, including a substrate with 60 to 80 percent boulder, 15 to 30 percent cobble, 5-10 percent gravel and, <1 to 5 percent sand. The NFSR reach was on a large side channel, off the main river, but still contained more and deeper water than the Trout Creek stations. The river substrate was comprised of approximately 75 percent cobble, 20 percent gravel, and less than 5 percent sand. All Trout Creek pool stations were along the bank, behind large current obstructions. The NFSR pool station was on the inside of a sharp corner along the bank. All the pools contained primarily sand, but compared to the NFSR pool, the Trout Creek pools were smaller, had more coarse sand, and had more gravel present in or very near the sampling location. The NFSR pool may have been subject to scouring during high water events.

Riparian conditions remained similar for all stations. At TC-01, TC-02, and TC-03, there were gravel roadways or other cleared and compacted areas within 65 feet of the right bank. An asphalt roadway was approximately 300 feet away from the left bank of the NFSR.

Sampling of benthic macroinvertebrates was conducted in each of the four stream reaches from both pool and riffle habitats. Three kick-net samples (i.e., jabs) from each pool and riffle sampling location were composited into one larger sample per habitat type per station. Laboratory enumeration was completed to the species level, when possible, for at least 300 individuals in each sample. 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. The invertebrates identified during the survey are shown in Table D-1. No rare, threatened, or endangered (RTE) invertebrate species were identified.

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

- The number of all invertebrates was 438, 213, 327, and 45 at TC-01P, TC-02P, TC-03P, and NFSR-01P, respectively.
- Diptera (primarily Chironomidae) and Ephemeroptera, Plecoptera, and Trichoptera (i.e., EPT) species were the most abundant invertebrates at all stations (Figure D-1). Chironomidae were the most abundant at TC-01P, TC-03P, and NFSR-01P. Chironomidae and EPT were nearly equally abundant at TC-02P. Oligochaeta species were few at all stations, but increased slightly at NFSR-01P. The dominant taxon was similar at TC-01P, TC-02P, and NFSR-01P, but higher at TC-03P.
- The overall number of different species (i.e., diversity) remained similar across the Trout Creek stations but decreased noticeably at NFSR-01P (Figure D-2). Chironomidae diversity decreased between TC-01P and TC-02P then increased slightly at TC-03P. In contrast, Non-Chironomidae/Non-Oligochaeta and EPT species increased between TC-01P and TC-02P, then decreased at TC-03P. All species decreased in number at NFSR-01P.
- The composition of functional groups varied across the four stations (Figure D-3). The percentage of clingers and gatherers were similarly high at TC-01P and TC-03P and similarly low at the other two stations. In direct contrast, shredder numbers were low at TC-01P and TC-03P, and higher at the other two stations. Generally, predator numbers decreased across the four stations, while the number of scrapers increased.
- The metals tolerance index was low and consistent across all stations (Figure D-4). The Shannon-Weaver species diversity index ($\log e$) and Margalef's Richness index were fairly consistent across the stations, with a slight dip in the Margalef's Richness at NFSR-01P. The fine sediment index increased dramatically between TC-01P and TC-02P then dropped slightly at the remaining stations. Similarly, the number of intolerant species increased between the first two stations, and then decreased slightly at the remaining stations.

The total number of invertebrates present in each sample and the invertebrate abundance data shown in Figure D-1 suggest higher quality pool habitat is present at TC-01P and TC-03P. This is consistent with the habitat quality ratings described earlier and field observations. The fact that EPT species abundance increased at TC-02P suggests that the habitat quality is trending toward riffle habitat, and also suggests that there is not a mine-related impact occurring at this station, located immediately downgradient of the Site. The increased percentage of the dominant taxon suggests that the invertebrate abundance is not well balanced at TC-03P. The reason for this potential imbalance is not clear; however, there is a bridge and asphalt roadway immediately upstream of TC-03P and a compacted parking/camping area immediately to the east, which may affect instream conditions.

The similar total number and types of species present at the pool stations along Trout Creek suggests that physical conditions are similar at all three stations (Figure D-2). The lower numbers of species present in the NFSR likely reflect the clearly differing habitat conditions. While there is some variation in overall numbers of each group between the stations, the distribution and diversity of the functional groups is similar at all stations (Figure D-3). The low metals tolerance indices and consistent Shannon-Weaver and Margalef's Richness indices shown in Figure D-4 suggest there are no mine-related impacts. The somewhat higher intolerant taxa index at TC-02P, immediately downstream of the Site also provides evidence that mine-related impacts are not occurring. Generally, pool habitats are representative of instream sediment quality. When compared to the upstream TC-01P, the benthic invertebrate survey results for pool habitats indicate that mine-related impacts are not occurring in Trout Creek downstream of the Site.

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

- The numbers of invertebrates were 648, 220, 430, and 181 (out of a possible 200) at TC-01R, TC-02R, TC-03R, and NFSR-01R, respectively.
- The abundance of EPT, Baetidae, and Ephemerilladae species increases across the four stations (Figure D-5). Chironomidae abundance was similar at TC-01R, TC-02R, and TC-03R then decreased noticeably at NFSR-01R. Oligochaeta abundance was highest at TC-01R then dropped to very low levels at the remaining stations. The dominant taxon was 22 percent or below at all stations with somewhat higher values at the downstream and NFSR stations.
- The number of species (i.e. diversity) was very similar at all three Trout Creek stations with a slight decrease on EPT species at TC-02P (Figure D-6). There were fewer of all species at NFSR-01R but the distribution of the species remained similar to those at the Trout Creek stations.
- The composition of functional groups was relatively similar at TC-01R, TC-02R, and TC-03R (Figure D-7). The percent shredders was higher at TC-03R than other stations. The percent clingers and scrapers was noticeably higher at NFSR-01R.
- The metals tolerance index was low and consistent, and the Shannon-Weaver species diversity index ($\log e$) was consistent, across all four stations (Figure D-8). Margalef's Richness index increased slightly at TC-02R, and then decreased consecutively at TC-03R and NFSR-01R. The number of intolerant taxa was similar at TC-01R, TC-02R, and TC-03R, and then decreased at NFSR-01R.

The lower total number of invertebrates at TC-02R suggests decreased habitat quality. This is contrary to the habitat rating scores. Regardless, an increasing percentage of EPT compared to the total number of invertebrates, and similarities in invertebrate diversity and functional feeding groups across the four stations suggest there are consistent conditions at the three Trout Creek stations, with different, but not poor, conditions at NFSR-01R. The consistency expressed by the indices shown in Figure D-8 also supports this evidence. Thus, when compared to conditions at the upstream TC-01R, it does not appear that aquatic invertebrates in riffle habitats are being impacted by mine-related influences.

The potential presence of fish was documented by visual observation during the ecological survey. No fish were noted in Trout Creek, but no barriers to fish passage were identified during the ecological survey, within the examined reaches. Through communications with regional biologists, the Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species Program (PHSP), and the Washington Natural Heritage Program (WNHP; See Appendix D) it was documented that coho salmon (*Oncorhynchus kisutch*), winter-run steelhead (*Oncorhynchus mykiss*), and resident rainbow trout (*Oncorhynchus mykiss*), are present in Trout Creek. In addition, fall Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), pink salmon (*Oncorhynchus gorbuscha*), summer-run steelhead, and dolly varden/bull trout (*Salvelinus confluentus*) are known to inhabit the NFSR and may be found in portions of Trout Creek. Of these, coho salmon, Chinook salmon, rainbow trout, and bull trout are RTE species as listed in Table D-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 with regional biologists. Four 30-minute bird surveys were also conducted. A majority of plants were identified across each major vegetative community present at and surrounding the Site (Hitchcock and Cronquist, 1990). Qualitative surveys were also conducted at and surrounding the Site for mammal and invertebrate presence and use. Lists of RTE plants and animals likely or known to be present in the vicinity of the Site were obtained from the USFS, the WDFW PHSP, and/or the WNHP (See Appendix D). The terrestrial RTE species potentially present within the area of the Site are listed in Table D-2. None of the listed RTE plants were observed during field activities. However, if a removal action is necessary, field surveys for particular species may be needed prior to any ground disturbance activity.

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 encompassed by mixed deciduous/coniferous second growth forest. The major plant communities identified at and surrounding the Site included a mixed forest community, a riparian community, and a disturbed mine community. The mixed forest community canopy layer is dominated by red alder (*Alnus rubra*), vine maple (*Acer circinatum*), and western hemlock (*Tsuga heterophylla*). The primary shrub layer species include dull Oregon grape (*Mahonia nervosa*), red elderberry (*Sambucus racemosa*), and red huckleberry (*Vaccinium parvifolium*). The ground (herbaceous) layer is predominantly sword fern (*Polystichum munitum*) and mosses (various sp.) with numerous other species present. These and other species observed in the forest community are listed in Table D-3.

The riparian community has a dense canopy layer, primarily consisting of red alder, western red cedar (*Thuja plicata*), and western hemlock. The shrub layer is also dense and dominated by Sitka willow (*Salix sitchensis*), salmon berry (*Rubus spectabilis*), red elderberry, and Devil's club (*Oplopanax horridus*). The dense herbaceous layer is dominated by common horsetail (*Equisetum arvense*), bracken fern (*Pteridium aquilinum*), fireweed (*Epilobium angustifolium*), and grasses (various sp.). These and other species observed in the wetland/riparian community are listed in Table D-3.

The disturbed mine areas are primarily waste rock, excavated gravelly soil or compacted gravel roadways. Numerous colonizing and weedy species are present, with successional canopy and shrub layers, and a sparse herbaceous layer. The canopy is dominated by red alder. Young coniferous trees were interspersed among the alder. The shrub layer includes mostly salmon berry, Sitka willow, and vine maple (*Acer circinatum*). The herbaceous layer is mostly fireweed. These and other species observed in the disturbed mine community are listed in Table D-3. The Site is immediately adjacent to and displaces portions of the riparian community. The vegetation within close proximity to the Site is clearly different from both these mixed forest and riparian communities. None of the identified plants are RTE species.

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

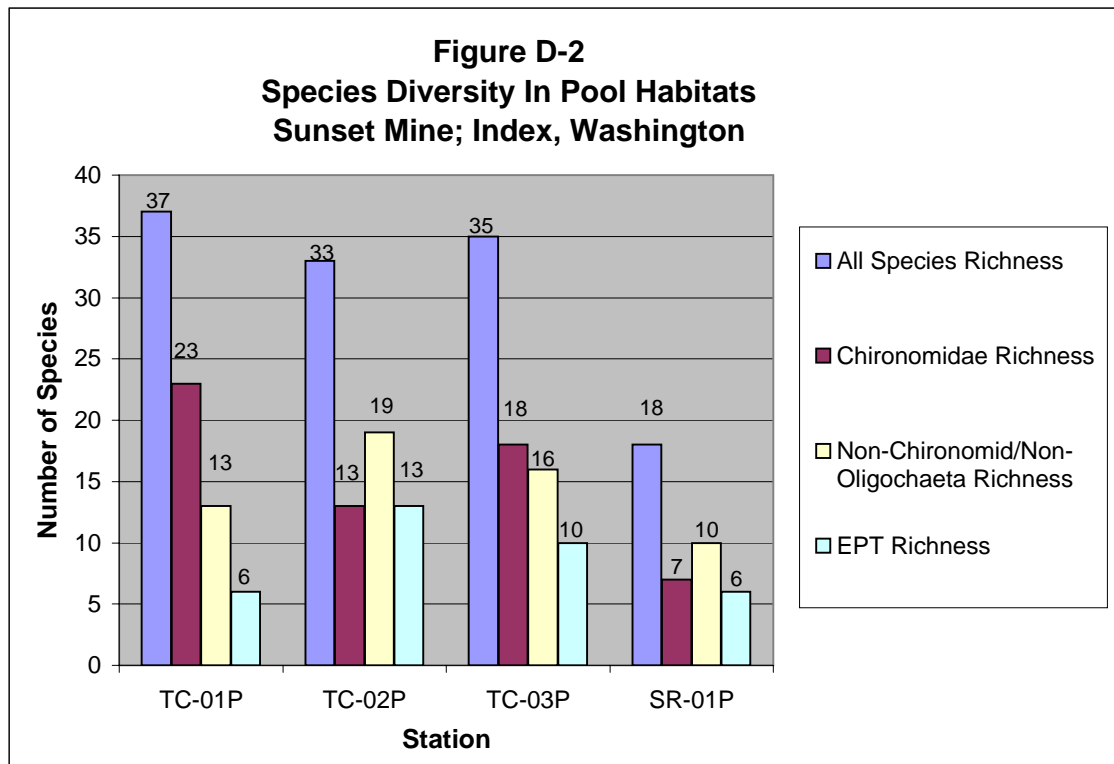
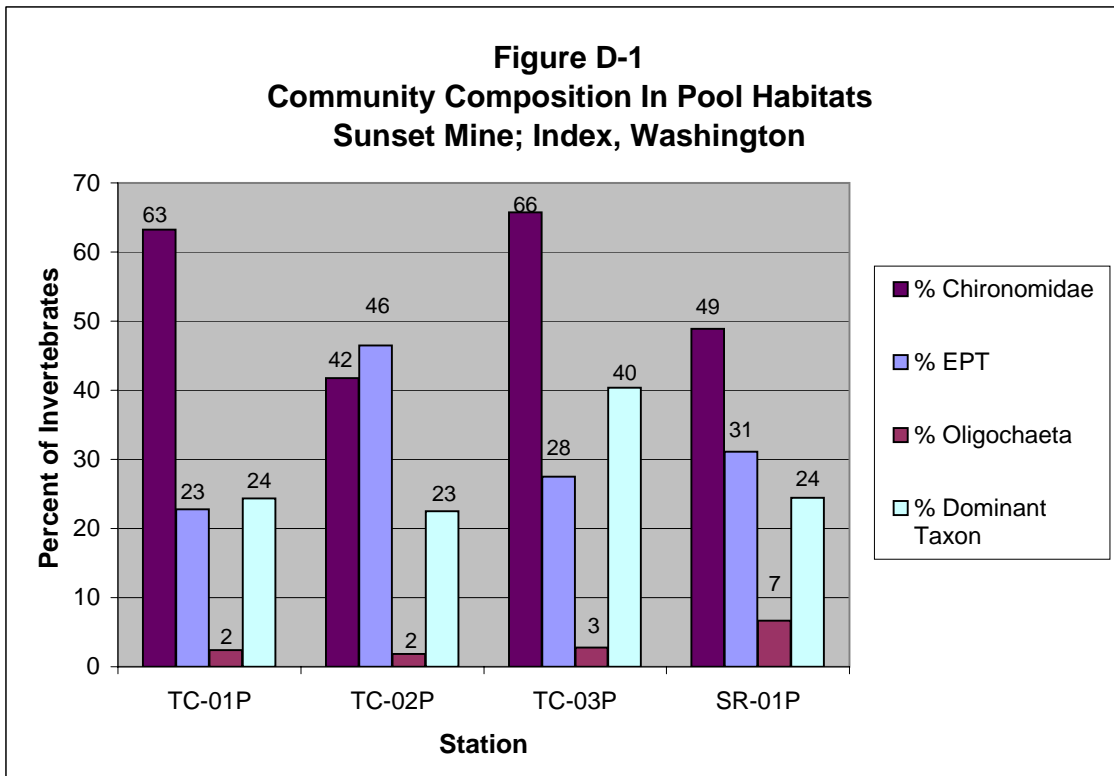
Birds seen or heard during the bird survey or during other field work at the Site are listed in Table D-5. A majority of these birds were identified by their song or call and were outside of the 30 m survey circle, which include winter wren (*Troglodytes troglodytes*), Swainson's thrush (*Catharus ustulata*), Stellar's jay (*Cyanocitta stelleri*), American robin (*Turdus migratorius*), and a Pacific slope flycatcher (*Empidonax difficilis*). These represent an assemblage common among mixed coniferous and deciduous forests in

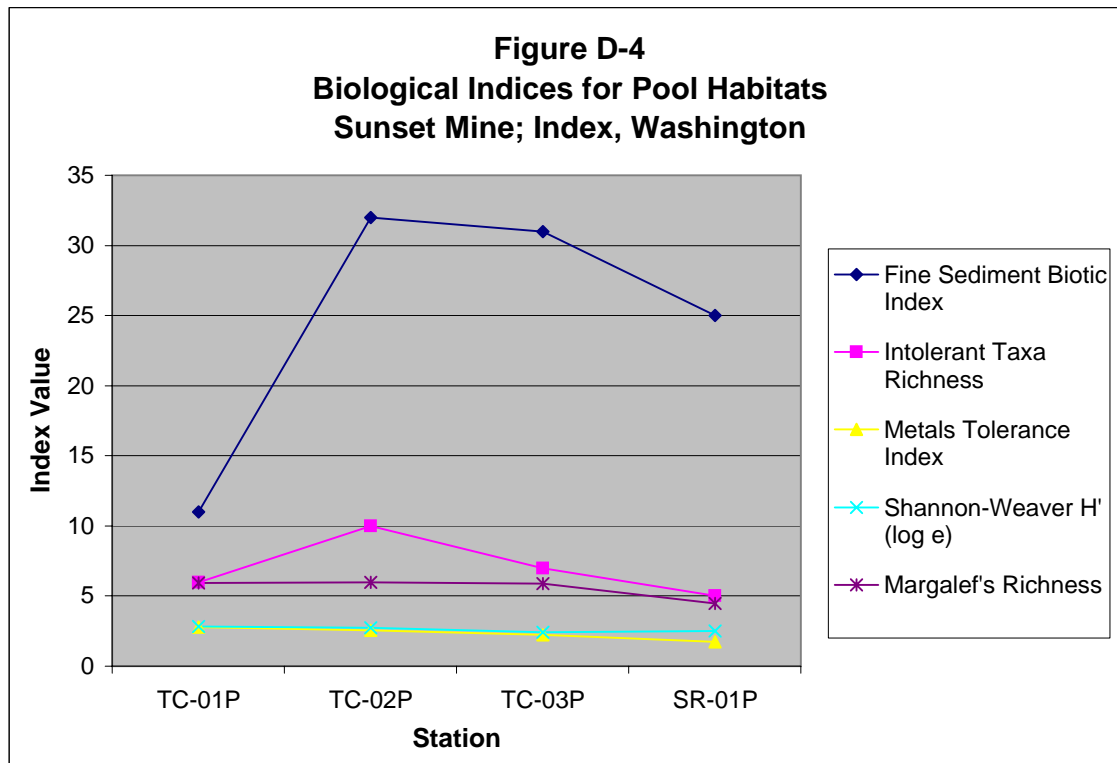
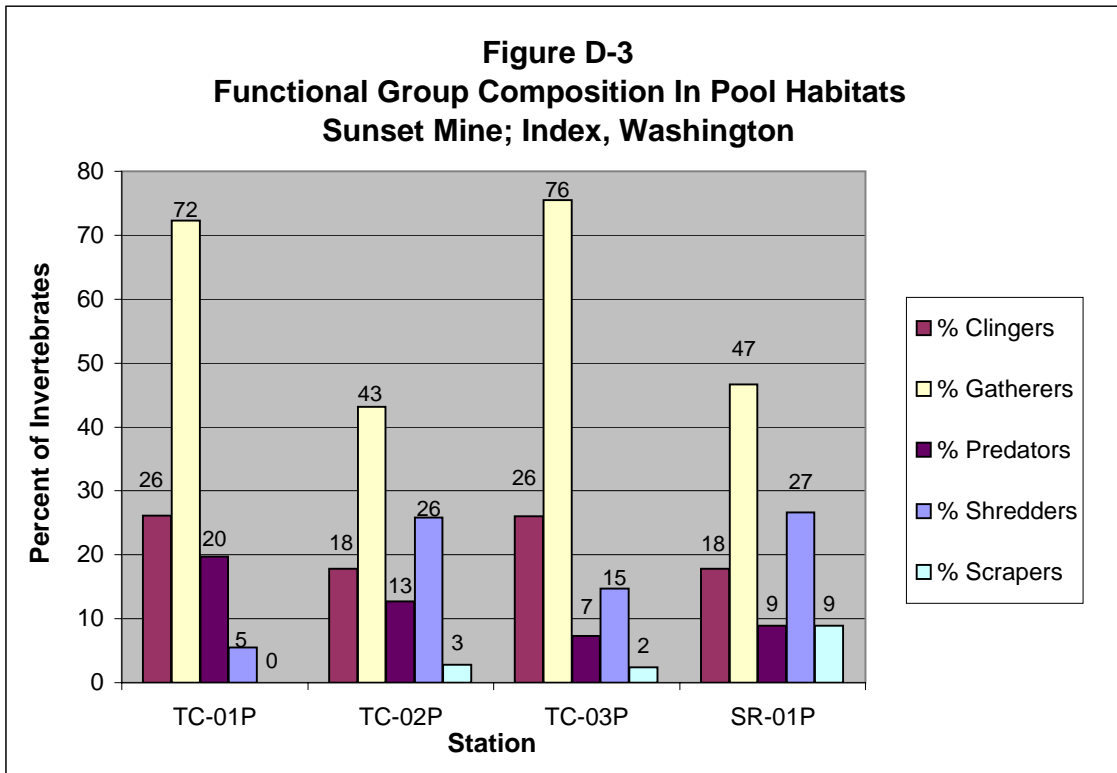
northwestern Washington. As noted in Table D-1, pileated woodpeckers are expected in the vicinity of the Site and are a state candidate for listing as a threatened or endangered species. Marbled murrelets are known to nest within a few miles of the Site and are state and federally listed threatened species. The other RTE bird species listed in Table D-1 may inhabit the forest surrounding the Site, but are unlikely to forage regularly in the disturbed mine area.

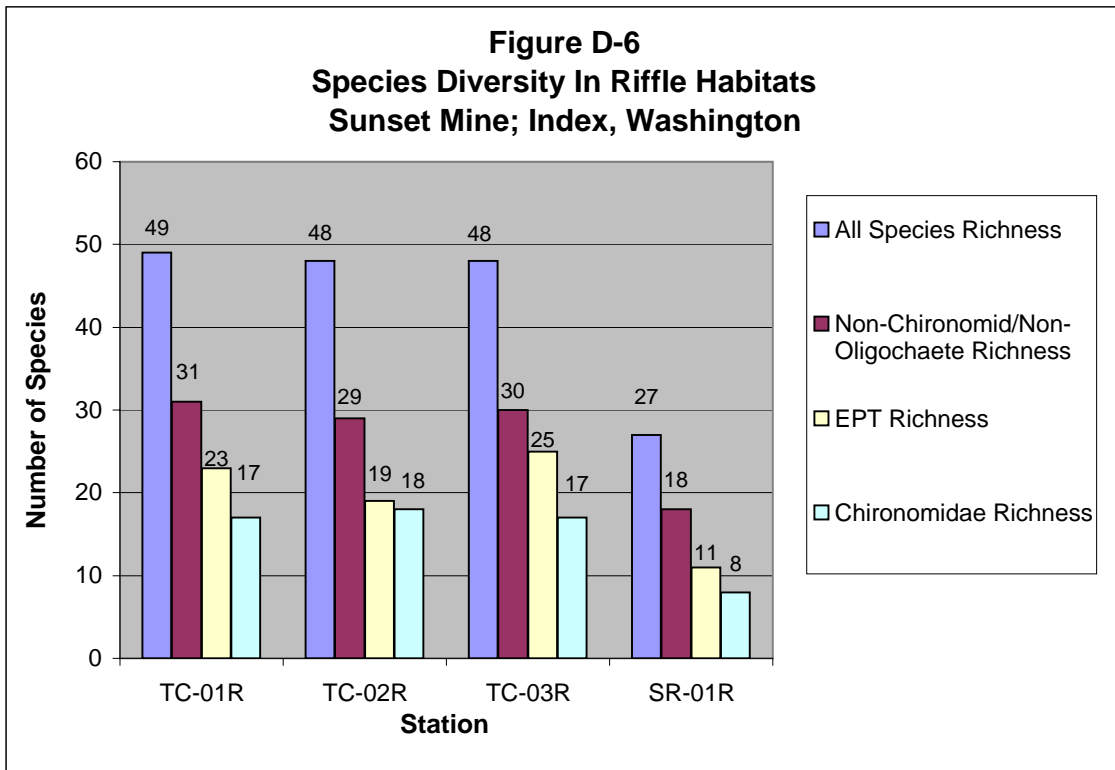
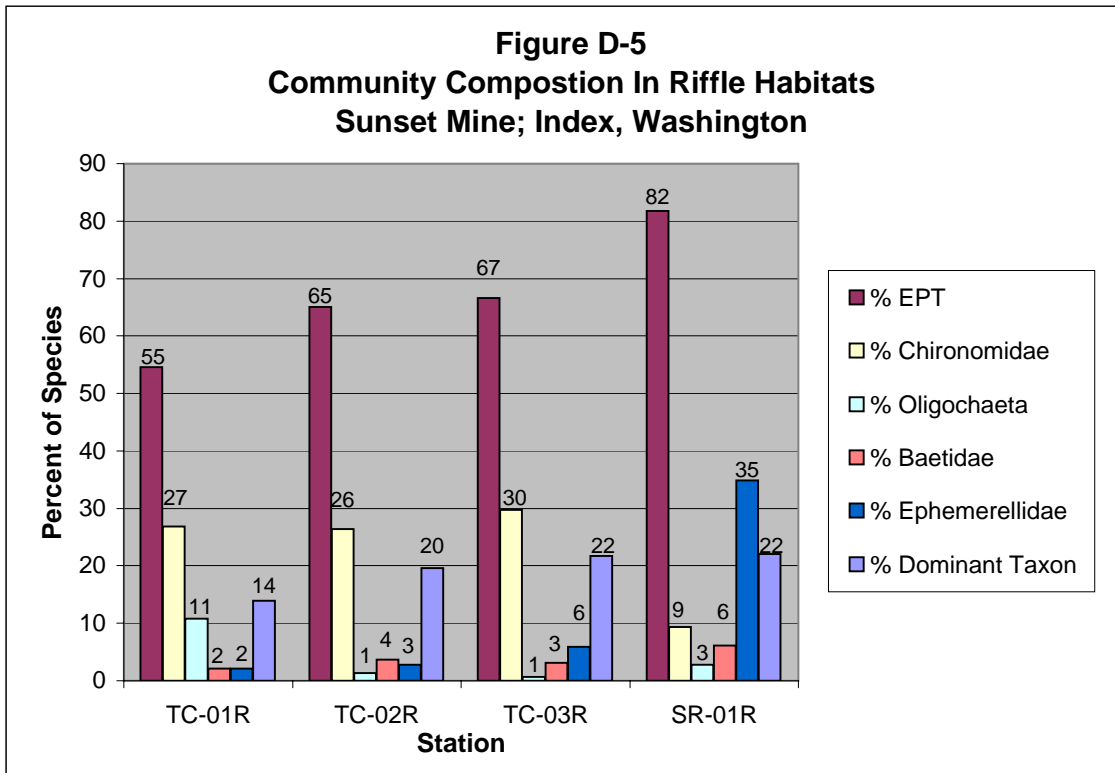
Game trails were not clearly present, but deer tracks and pellets were noted, suggesting that black-tailed deer (*Odocoileus hemionus columbianus*) are present near the Site. Black bear (*Ursus americanus*) or mountain lion (*Felis concolor*) may be present in the area surrounding the Site. Other mammals 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 shafts in the vicinity of the Site. Mammals that were observed, expected or possible at the Site are listed in Table D-6. Other RTE mammal species listed in Table D-1 may inhabit the region, but are unlikely or uncommon at the Site.

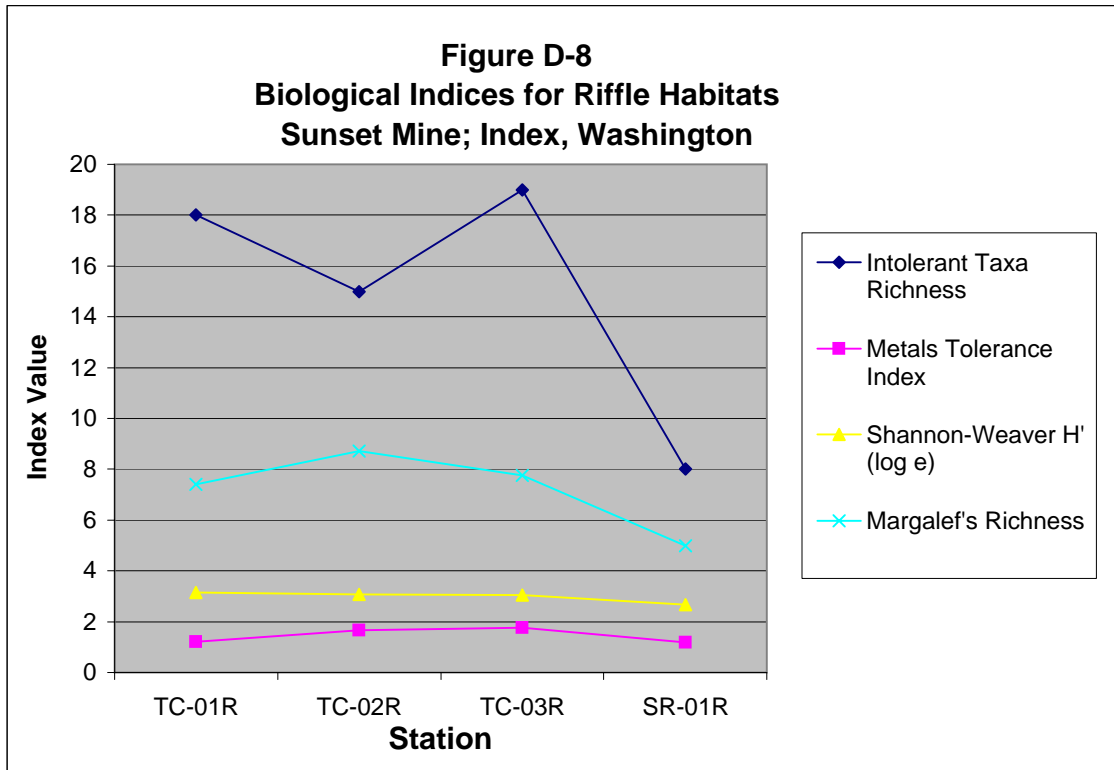
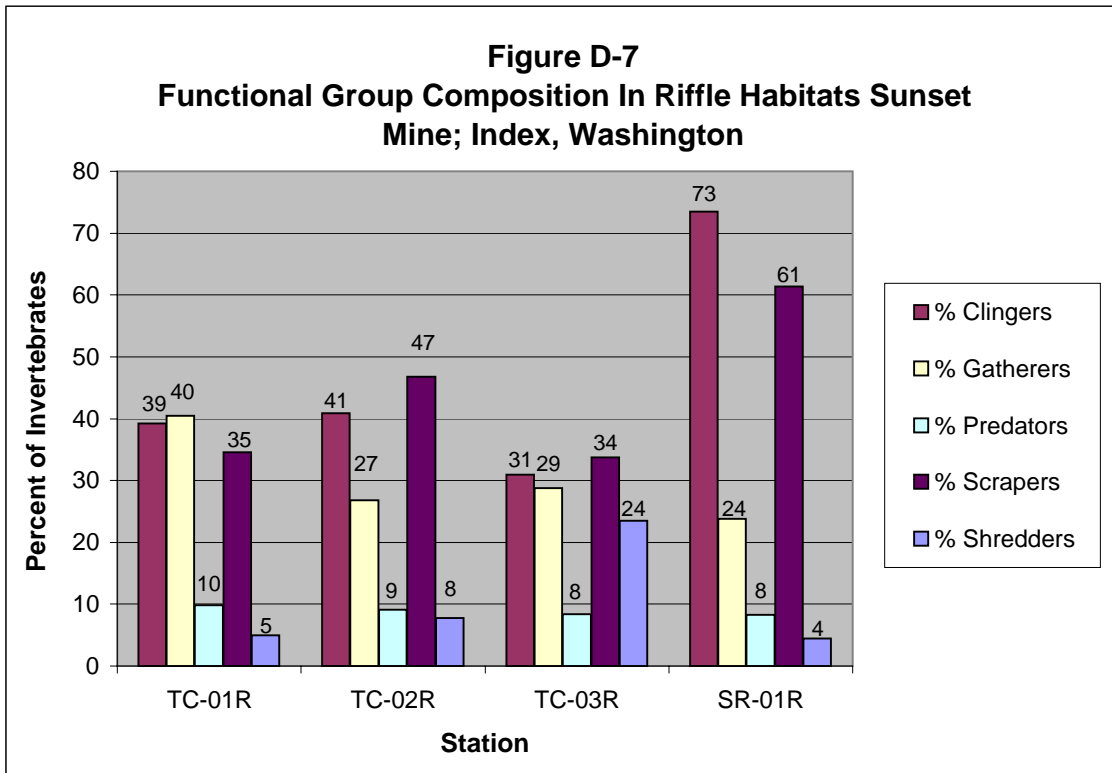
No reptiles or amphibians were found during the survey. Those expected or possible at the Site are listed in Table D-7 and include northern alligator lizards (*Elgaria coerulea*), common garter snake (*Thamnophis sirtalis*), long-toed salamander (*Ambystoma macrodactylum*), cascades frog (*Rana cascadae*), red-legged frog (*Rana aurora*), tailed frog (*Ascaphus montanus*), and pacific treefrog (*Pseudacris regilla*). The cascades frog, red-legged frog, tailed frog, western toad (*Bufo boreas*) and spotted frog (*Rana pretiosa*) are RTE species (Table D-1) that may be found in the vicinity of the Site.

Overall, relatively few species were identified during this limited ecological survey. This is likely the result of there being only one dominant vegetation community: mature forest. The wetland/riparian community is very small and thus does not support numerous other species that might be expected in a similar, but larger habitat. Of the invertebrates and wildlife documented or likely to inhabit the site, ground-dwelling invertebrates such as ants are the species most likely to be exposed to site-related contamination. Invertivorous species that forage frequently on invertebrates within or near the waste piles may also be relatively highly exposed to Site-related contamination.









**TABLE D-1
DOCUMENTED AQUATIC INVERTEBRATE SPECIES
SUNSET MINE
INDEX, WASHINGTON**

Taxonomic Group	Scientific Name	Taxonomic Group	Scientific Name
Ephemeroptera	Ameletus sp.	Diptera-Chironomidae (continued)	Microtendipes rydalensis gr.
	Baetidae		Orthocladius Complex
	Baetis tricaudatus		Orthocladius sp.
	Caudatella jacobi		Pagastia sp.
	Cinygmula sp.		Parachaetocladius sp.
	Drunella coloradensis/flavilinea		Parametricnemus sp.
	Drunella doddsi		Paraphaenocladius "n. sp."
	Epeorus deceptivus		Paraphaenocladius sp.
	Epeorus longimanus		Paratendipes sp.
	Epeorus sp.		Parorthocladius sp.
	Ephemerella inermis/infrequens		Polypedilum sp.
	Paraleptophlebia sp.		Pseudodiamesa sp.
	Rhithrogena sp.		Psilometricnemus sp.
	Serratella sp.		Rheocricotopus sp.
	Serratella tibialis		Rheosmittia sp.
Plecoptera	Calineuria californica	Rheotanytarsus sp.	
	Capniidae	Stempellinella sp.	
	Chloroperlidae	Stilocladius sp.	
	Doroneuria sp.	Thienemannimyia gr. sp.	
	Leuctridae	Tvetenia bavarica gr.	
	Malenka sp.	Zavrelimyia sp.	
	Moselia infuscata	Diptera	Bezzia/Palpomyia sp.
	Perlodidae		Chelifera sp.
	Plecoptera		Clinocera sp.
	Plumiperla sp.		Dicranota sp.
	Pteronarcys sp.		Hexatoma sp.
	Visoka cataractae		Limnophila sp.
	Zapada cinctipes		Oreogeton sp.
	Zapada columbiana		Prosimulium sp.
	Zapada oregonensis gr.		Rhabdomastix fascigera gr.
Zapada sp.	Simulium sp.		
Coleoptera	Narpus sp.		Wiedemannia sp.
	Oreodytes sp.		Arctopsychinae
	Sanfillipodytes sp.		Chyranda centralis
	Zaitzevia sp.		Dicosmoecus sp.
Diptera-Chironomidae	Brillia sp.		Trichoptera
	Chaetocladius sp.	Ecclisocosmoecus scylla	
	Corynoneura sp.	Lepidostoma sp.	
	Cricotopus sp.	Limnephilidae	
	Eukiefferiella brevicar gr.	Neophylax sp.	
	Eukiefferiella claripennis gr.	Pedomoecus sierra	
	Eukiefferiella cyanea gr.	Rhyacophila angelita gr.	
	Eukiefferiella gracei gr.	Rhyacophila brunnea gr.	
	Eukiefferiella sp.	Rhyacophila pellisa/valuma	
	Eukiefferiella tirolensis	Rhyacophila sp.	
	Euryhapsis sp.	Trichoptera	
	Heleniella sp.	Annelida Oligochaeta	
	Heterotrissocladius marcidus gr.	Acari Acari	
	Krenosmittia sp.	Crustacea Ostracoda	
	Larsia sp.	Other Organisms Nematoda	
	Micropsectra sp.	Polycelis sp.	

**TABLE D-2
SUMMARY OF RARE, THREATENED, OR ENDANGERED SPECIES IN THE VICINITY
SUNSET MINE
INDEX, WASHINGTON**

Common Name	Species Name	State Status	Federal Status	U.S. Forest Service Status	Observed/Expected/Possible
AQUATIC INVERTEBRATES					
None					
FISH					
Coho salmon (Puget Sound)	<i>Oncorhynchus kisutch</i>		Concern		Expected
Rainbow Trout	<i>Oncorhynchus Mykiss</i>	Priority			Expected
Bull trout (Coastal/Puget Sound)	<i>Salvelinus confluentus</i>	Candidate	Threatened		Possible
Chinook salmon (Puget Sound)	<i>Oncorhynchus tshawytscha</i>	Candidate	Threatened		Possible
PLANTS					
Alaska Harebell	<i>Campanula lasiocarpa</i>	Sensitive			Possible
Alaska Harebell	<i>Campanula lasiocarpa</i>	Sensitive			Possible
Black Lily	<i>Fritillaria camschatcensis</i>	Sensitive			Possible
Black Lily	<i>Fritillaria camschatcensis</i>	Sensitive			Possible
Branching Montia	<i>Montia diffusa</i>	Sensitive			Possible
Branching Montia	<i>Montia diffusa</i>	Sensitive			Possible
Bristly Sedge	<i>Carex comosa</i>	Sensitive			Possible
Choris' Bog-orchid	<i>Platanthera chorisiana</i>	Threatened			Possible
Cooley's Buttercup	<i>Ranunculus cooleyae</i>	Sensitive			Possible
Creeping Snowberry	<i>Gaultheria hispida</i>	Sensitive			Possible
Few-flowered Sedge	<i>Carex pauciflora</i>	Sensitive			Possible
Flat-leaved Bladderwort	<i>Utricularia intermedia</i>	Sensitive			Possible
Long-styled Sedge	<i>Carex stylosa</i>	Sensitive			Possible
Several-flowered Sedge	<i>Carex pluriflora</i>	Sensitive			Possible
Smoky Mountain Sedge	<i>Carex proposita</i>	Threatened			Possible
Spleenwort-leaved Goldthread	<i>Coptis aspleniifolia</i>	Sensitive			Possible
Stalked Moonwort	<i>Botrychium pedunculatum</i>	Sensitive	Concern		Possible
Tall Agoseris	<i>Agoseris elata</i>	Sensitive			Possible
Treelike Clubmoss	<i>Lycopodium dendroideum</i>	Sensitive			Possible
TERRESTRIAL INVERTEBRATES					
None Identified					
REPTILES AND AMPHIBIANS (HERPETILES)					
Rocky Mountain Tailed Frog	<i>Ascaphus montanus</i>	Candidate			Expected
Western toad	<i>Bufo boreas</i>	Candidate	Concern		Expected
Spotted frog	<i>Rana pretiosa</i>	Endangered	Candidate	Sensitive	Possible
BIRDS					
Bald eagle	<i>HALIAEETUS LEUCOCEPHALUS</i>	Threatened	Threatened		Possible
Marbled murrelet	<i>Brachyramphus marmoratus</i>	Threatened	Threatened		Expected
Northern goshawk	<i>Accipiter gentilis</i>	Candidate	Concern	Sensitive	Expected
Olive-sided flycatcher	<i>Contopus borealis</i>		Concern		Expected
Pileated woodpecker	<i>Dryocopus pileatus</i>	Candidate			Expected
Willow flycatcher	<i>Empidonax traillii</i>		Concern		Expected
Black-backed woodpecker	<i>Picoides arcticus</i>	Candidate			Possible
Golden eagle	<i>Aquila chrysaetos</i>	Candidate			Possible
Harlequin duck	<i>Histrionicus histrionicus</i>	Priority			Possible
Merlin	<i>Falco columbarius</i>	Candidate			Possible
Peregrine falcon	<i>Falco peregrinus</i>	Sensitive	Concern	Sensitive	Possible
Spotted owl	<i>Strix occidentalis</i>	Endangered	Threatened		Possible
MAMMALS					
Columbia black-tailed deer	<i>Odocoileus hemionus columbianus</i>	Priority			Expected
Fisher	<i>Martes pennanti</i>	Endangered	Concern	Sensitive	Expected
Keen's myotis	<i>Myotis keenii</i>	Candidate			Possible
Canada Lynx	<i>Lynx canadensis</i>	Threatened	Threatened	Sensitive	Possible
Pacific Townsend's big-eared bat	<i>Corynorhinus townsendii townsendii</i>	Candidate	Concern		Possible
Roosevelt elk	<i>Cervus elaphus roosevelti</i>	Priority			
Yuma myotis	<i>Myotis yumanensis</i>	none	Concern		Possible
Grizzly bear	<i>Ursus arctos</i>	Endangered	Threatened	Sensitive	Possible
Wolverine	<i>Gulo gulo</i>	Candidate	Concern		Possible

Notes:

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

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

**TABLE D-3
OBSERVED PLANT SPECIES
SUNSET MINE
INDEX, WASHINGTON**

Common Name	Scientific Name	Habitat Type	Percent Cover	Federal Status	State Status	U.S. Forest Service Status
TREES						
red alder	<i>Alnus rubra</i>	Disturbed	70			
western hemlock	<i>Tsuga heterophylla</i>	Disturbed	10			
big leaf maple	<i>Acer macrophyllum</i>	Disturbed	5			
Douglas fir	<i>Pseudotsuga menziesii</i>	Disturbed	5			
western red cedar	<i>Thuja plicata</i>	Disturbed	5			
red alder	<i>Alnus rubra</i>	Mixed Forest	80			
western hemlock	<i>Tsuga heterophylla</i>	Mixed Forest	15			
big leaf maple	<i>Acer macrophyllum</i>	Mixed Forest	5			
Douglas fir	<i>Pseudotsuga menziesii</i>	Mixed Forest	5			
western red cedar	<i>Thuja plicata</i>	Mixed Forest	5			
red alder	<i>Alnus rubra</i>	Riparian	40			
western hemlock	<i>Tsuga heterophylla</i>	Riparian	5			
western red cedar	<i>Thuja plicata</i>	Riparian	5			
SHRUBS						
salmonberry	<i>Rubus spectabilis</i>	Disturbed	60			
Sitka willow	<i>Salix sitchensis</i>	Disturbed	8			
vine maple	<i>Acer circinatum</i>	Disturbed	8			
vine maple	<i>Acer circinatum</i>	Mixed Forest	30			
dull Oregon grape	<i>Mahonia nervosa</i>	Mixed Forest	15			
big leaf maple	<i>Acer macrophyllum</i>	Mixed Forest	5			
false azalea (fool's huckleberry)	<i>Menziesia ferruginea</i>	Mixed Forest	5			
red elderberry	<i>Sambucus racemosa</i>	Mixed Forest	5			
red huckleberry	<i>Vaccinium parvifolium</i>	Mixed Forest	5			
salal	<i>Gaultheria shallon</i>	Mixed Forest	5			
thimbleberry	<i>Rubus parviflorus</i>	Mixed Forest	5			
trailing blackberry	<i>Rubus usiinus</i>	Mixed Forest	5			
Sitka willow	<i>Salix sitchensis</i>	Riparian	40			
salmonberry	<i>Rubus spectabilis</i>	Riparian	20			
Devil's club	<i>Oplopanax horridus</i>	Riparian	5			
red elderberry	<i>Sambucus racemosa</i>	Riparian	5			
GROUNDCOVER						
bleeding heart	<i>Dicentra formosa</i>	Disturbed	5			
fireweed	<i>Epilbium angustifolium</i>	Disturbed	5			
rusty saxifrage	<i>Saxifraga ferruginea</i>	Disturbed	5			
sword fern	<i>Polystichum munitum</i>	Mixed Forest	75			
bleeding heart	<i>Dicentra formosa</i>	Mixed Forest	5			
fringecup	<i>Tellima grandiflora</i>	Mixed Forest	5			
licorice fern	<i>Polypodium glycyrrhiza</i>	Mixed Forest	5			
maidenhair fern	<i>Adiantum pedatum</i>	Mixed Forest	5			
sweet-scented bedstraw	<i>Galium triflorum</i>	Mixed Forest	5			
Siberian miners-lettuce	<i>Montia siberica</i>	Mixed Forest	5			
western trillium	<i>Trillium ovatum</i>	Mixed Forest	5			
wild ginger	<i>Asarum caudatum</i>	Mixed Forest	5			
common horsetail	<i>Equisetum arvense</i>	Riparian	8			
grasses	Various species	Riparian	8			
bleeding heart	<i>Dicentra formosa</i>	Riparian	5			
bracken fern	<i>Pteridium aquilinum</i>	Riparian	5			
fireweed	<i>Epilbium angustifolium</i>	Riparian	5			
fringecup	<i>Tellima grandiflora</i>	Riparian	5			
rusty saxifrage	<i>Saxifraga ferruginea</i>	Riparian	5			
Siberian miners-lettuce	<i>Montia siberica</i>	Riparian	5			
sword fern	<i>Polystichum munitum</i>	Riparian	5			
MOSESSES						
moss	Various sp.	Mixed Forest	50			
moss	Various sp.	Riparian	30			
LICHENS						
None Identified						

Notes:

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

TABLE D-4
DOCUMENTED OR EXPECTED TERRESTRIAL INVERTEBRATES
SUNSET MINE
INDEX, WASHINGTON

Common Name	Scientific Name	Federal Status	State Status	U.S. Forest Service Status	Observed/Expected/Possible
black carpenter ants	<i>Camponotus pennsylvanicus</i>				Observed
centipedes	Order <i>Chilopoda</i>				Observed
common black ground beetle	<i>Pterostichus</i> sp.				Observed
black flies	<i>Simulium</i> sp.				Observed
spiders	Order <i>Araneae</i>				Observed
yellow jackets	<i>Vespula</i> sp.				Observed
alderflies	<i>Sialis</i> sp.				Expected
banana slug	<i>Ariolimax columbianus</i>				Expected
mayflies	Order <i>Ephemeroptera</i>				Expected
black-foot tightcoil snail	<i>Pristiloma chirstenella</i>				Expected

Notes:

Bold indicates regulated or managed species observed, expected, or possible at the site.

Blank status indicates no listing was available for the species.

TABLE D-5
DOCUMENTED OR EXPECTED
BIRDS
SUNSET MINE
INDEX, WASHINGTON

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

Notes:

Bold indicates regulated or managed species observed, expected, or possible at the site.

Blank status indicates no listing was available for the species.

**TABLE D-6
DOCUMENTED OR EXPECTED
MAMMALS
SUNSET MINE
INDEX, WASHINGTON**

Scientific Name	State Status	Federal Status	U.S. Forest Service Status	Observed/Expected/Possible
<i>Apodontia rufa</i>				Observed
<i>Odocoileus hemionus columbianus</i>				Observed
<i>Tamiasciurus douglasi</i>				Observed
<i>Eutamias townsendi</i>				Observed
<i>Ursus americanus</i>				Expected
<i>Odocoileus hemionus columbianus</i>	Priority			Expected
<i>Canis latrans</i>				Expected
<i>Peromyscus maniculatus</i>				Expected
<i>Sorex obscurus</i>				Expected
<i>Martes pennanti</i>	Endangered	Concern	Sensitive	Expected
<i>Mustela frenata</i>				Expected
<i>Martes americana</i>	Critical		Sensitive	Expected
<i>Mustela vision</i>				Expected
<i>Felis concolor</i>				Expected
<i>Erethizon dorsatum</i>				Expected
<i>Procyon lotor</i>				Expected
<i>Lepus americanus</i>				Expected
<i>Coryhorhinus townsendii</i>	Critical	Concern	Sensitive	Expected
<i>Eptisicus fuscus</i>			Sensitive	Possible
<i>Clethrionomys gapperi</i>				Possible
<i>Myotis californicus</i>				Possible
<i>Lynx canadensis</i>	Threatened	Threatened	Sensitive	Possible
<i>Martes pennanti</i>	Critical	Concern	Sensitive	Possible
<i>Myotis thysanodes</i>	Vulnerable	Concern	Sensitive	Possible
<i>Canis lupus</i>		Threatened		Possible
<i>Ursus arctos</i>		Threatened		Possible
<i>Felis concolor</i>				Possible
<i>Myotis keenii</i>	Candidate			Possible
<i>Myotis lucifugus</i>			Sensitive	Possible
<i>Sorex cinereus</i>				Possible
<i>Sylvilagus nuttalli</i>				Possible
<i>Glaucomys sabrinus</i>				Possible
<i>Sorex palustris</i>				Possible
<i>Didelphis marsupialis</i>				Possible
<i>Coryhorhinus townsendii townsendii</i>	Candidate	Concern	Sensitive	Possible
<i>Antozous pallidus</i>	Vulnerable			Possible
<i>Sorex preblei</i>	Concern		Sensitive	Possible
<i>Vulpes fulva</i>				Possible
<i>Tamiasciurus hudsonicus</i>				Possible
<i>Mustela erminea</i>				Possible
<i>Lasionycteris noctivagans</i>			Sensitive	Possible
<i>Myotis leibii</i>		Concern		Possible
<i>Sorex trowbridgei</i>				Possible
<i>Sorex vagrans</i>				Possible
<i>Gulo gulo luteus</i>		Concern	Sensitive	Possible
<i>Myotis yumanensis</i>		Concern		Possible

observed, expected, or possible at the site.
e for the species.

**TABLE D-7
DOCUMENTED OR EXPECTED
AMPHIBIANS, REPTILES, AND INVERTEBRATES
SUNSET MINE
INDEX, WASHINGTON**

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

Notes:

Bold indicates regulated or managed species observed, expected, or possible at the site.

Blank status indicates no listing was available for the species.