BULLION MINE
PRELIMINARY ASSESSMENT AND SITE INVESTIGATION REPORT
SHOSHONE COUNTY, IDAHO

STATE OF IDAHO

DEPARTMENT OF ENVIRONMENTAL QUALITY

December 2004

Submitted to:
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101

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LIST OF ACRONYMS

Acronym	Definition
amsl	above mean sea level
bya	billion years ago
DEQ	Department of Environmental Quality
EPA	United States Environmental Protection Agency
FS	United States Department of Agriculture, Forest Service
gpm	gallons per minute
MCL	Maximum Contaminant Level
PPE	Probable Point of Entry
TDL	Target Distance Limit
TMDL	Total Maximum Daily Load

1 INTRODUCTION

The Department of Environmental Quality (DEQ) was contracted by Region 10 of the United States Environmental Protection Agency (EPA) to provide technical support for completion of a preliminary assessment (PA) and site investigation (SI) at the Bullion Mine, located in Shoshone County, Idaho. DEQ completed PA/SI activities in accordance with the objectives listed below.

1.1 SCOPE

Conducting the PA included reviewing existing site information, collecting receptor information within the site's range of influence, determining regional characteristics, and conducting a site visit. The SI expanded the scope of the review to include the collection of surface water, sediment, soil and ore samples to delineate sources of potential release(s) to the environment.

This document includes a discussion of site background information (Section 2), a discussion of the operational history and waste characteristics (Section 3), a discussion of the migration/exposure pathways and targets (Section 4), a summary and conclusion discussion (Section 5), applicable maps, tables and figures, and a list of pertinent references (Section 6).

1.2 OBJECTIVES

The specific objectives for the Bullion Mine sampling activities included the following:

- Determine the presence of hazardous constituents and contaminants in Bullion Creek
- Determine the impact of historic mining on surrounding soils and sediments
- Qualify and quantify sources of contaminants
- Evaluate human health and environmental targets affected by the historic mining operations

2 SITE BACKGROUND

This section specifies the site location, describes the site, provides a survey of previous investigative work, and summarizes the regulatory history of the Bullion Mine.

2.1 Site Location

Site Name:	Bullion Mine, Upper and Lower Workings
CERCLIS ID No.:	
Location:	Shoshone County, Idaho
Upper Workings	
Latitude:	47° 24' 26" N
Longitude:	115° 41' 48" W
Lower Workings	
Latitude:	47° 24' 05" N
Longitude:	115° 42' 05" W
Legal Description:	Section 21, Township 47N, Range 6E, Boise Meridian
Congressional District:	Idaho
Site Owner:	HF Magnuson & Company 413 Cedar St PO Box 469 Wallace, ID 83873-0469

2.2 Site Description

The Bullion Mine is an inactive gold and copper mine located in Shoshone County, Idaho (Figure 2-1). The Bullion Mine consists of two distinct workings: the upper working (Upper) lie on the north side of Forest Road (FR) 507, while the lower workings (Lower) lie approximately 0.25 miles south, below FR507. The Upper is located near the headwaters of an unnamed tributary of Bullion Creek while the Lower borders the north side of Bullion Creek. Both workings lie along the southeastern flank of the St. Joe Mountains near the Idaho-Montana border, within the St. Joe River drainage.

Traveling southwest on FR507 for approximately 0.5 miles, the lower workings are reached via an old haul road. The road's location is barely discernable, due to road construction and mature vegetation. The lower workings lie approximately 0.35 miles to the east.

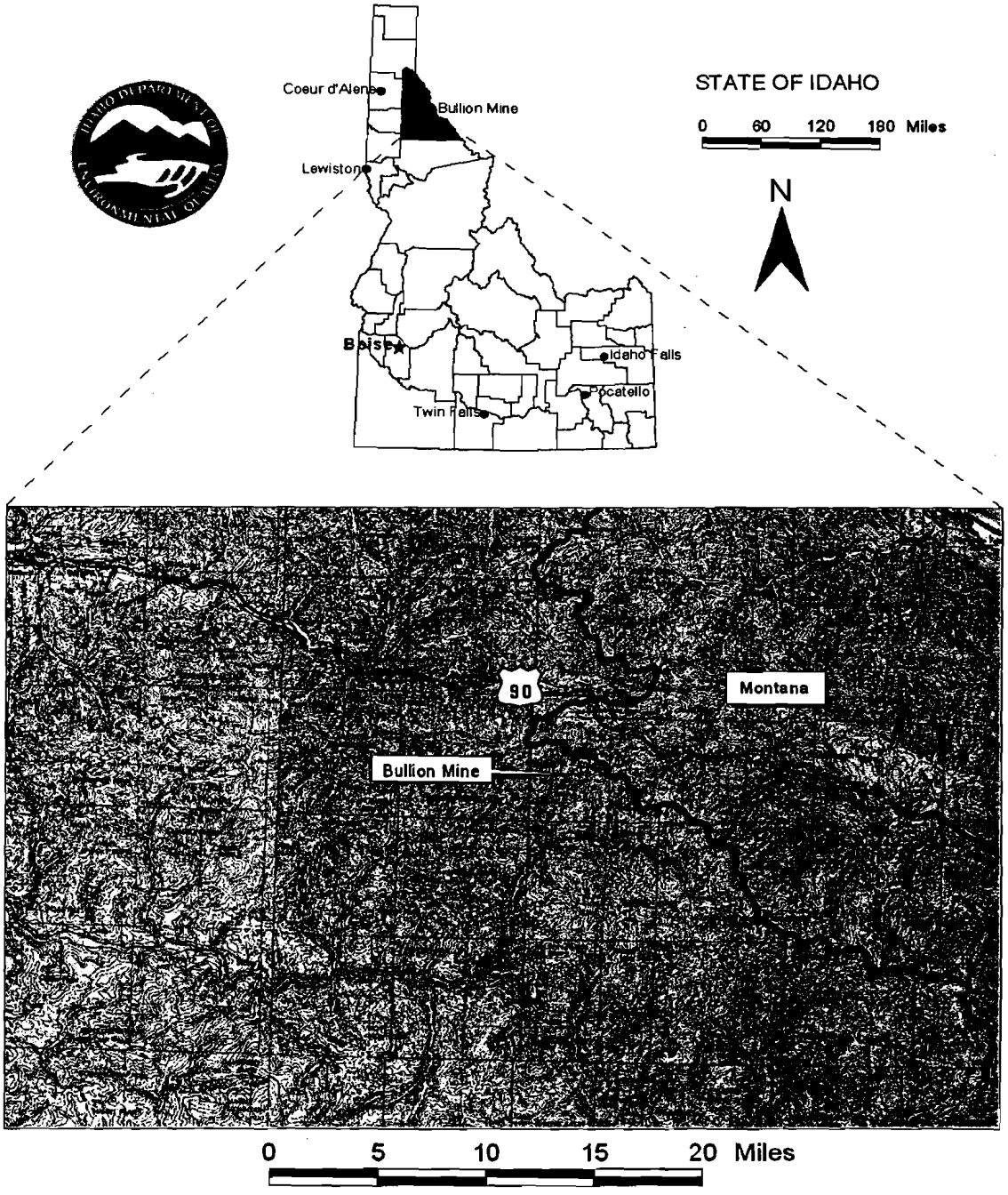

Figure 2-1. Map Showing Location of Bullion Mine.

The Bullion Mine can be best accessed from Taft, Montana. From the Taft exit on Interstate 90, turn west to the "T" intersection, then take a right-hand turn onto the frontage road. The paved road continues northwest, paralleling I-90 for 2.5 miles, and then curves southward, becoming FR445, an unimproved road. Bullion Pass lies approximately 2.25 miles ahead, marking the Idaho-Montana border.

The Upper lies nearly 1.0 mile beyond the divide, along the north side of FR507 at the apex of a sharp left-hand curve. The waste rock dump from Tunnel # 2 mantles the slope above the road, and an unnamed tributary drainage of Bullion Creek bisects the workings.

The Upper lies between elevations of 4,850 and 5,200 feet above mean sea level (amsl) and is located in the SE1/4 of the NE1/4, Section 21, T47 N, R6 E, on the Lookout Pass 7.5-minute quadrangle (Figure 2-2).

Though the entrance to the road is barely discernable from FR507, the pathway to the Lower is easily followed. Continuing downgrade, approximately 0.5 miles, a second unnamed tributary of Bullion Creek is encountered, as the road again curves to the left. There is adequate space for parking on the right-hand shoulder, as the old road is not suitable for vehicular traffic. From this point, walk approximately 150 feet east on FR507 to where the faint trace of the old road is visible along the right side of the road. (DEQ personnel partially cleared brush and deadfall along the course of the old road to the lower workings)

The Lower lies at an elevation of 4,560 feet amsl and is located in the SW1/4 of the SE1/4, Section 21, T47 N, R6 E, on the Lookout Pass 7.5-minute quadrangle (Figure 2-2).

Thick buck brush-like shrub (species unknown), mountain willow (*Salix eastwoodiae)* and immature lodgepole pines (P*inus contorta var. latifolia*) occupy the slopes and creek bottom adjacent to the Upper, whose slopes are dotted with springs and seeps, nourishing the dense vegetative cover. The Lower contains similar vegetation, though Western larch (*Larix occidentalis*) and Quaking aspen (*Populus tremuloides*) are also present. The St. Joe River drainage endured numerous wildfires between the late 1800s and early 1930s. The most notable conflagration occurring in 1910, when nearly 50 percent of the St. Joe Basin forests were consumed (IPNF, 2003) and the Bullion Mine was a scene of fire suppression activities during the 1910 firestorm, where eight fire fighters were killed. Subsequent fires re-burned these areas, creating large shrub fields, similar to those amid the Bullion workings.

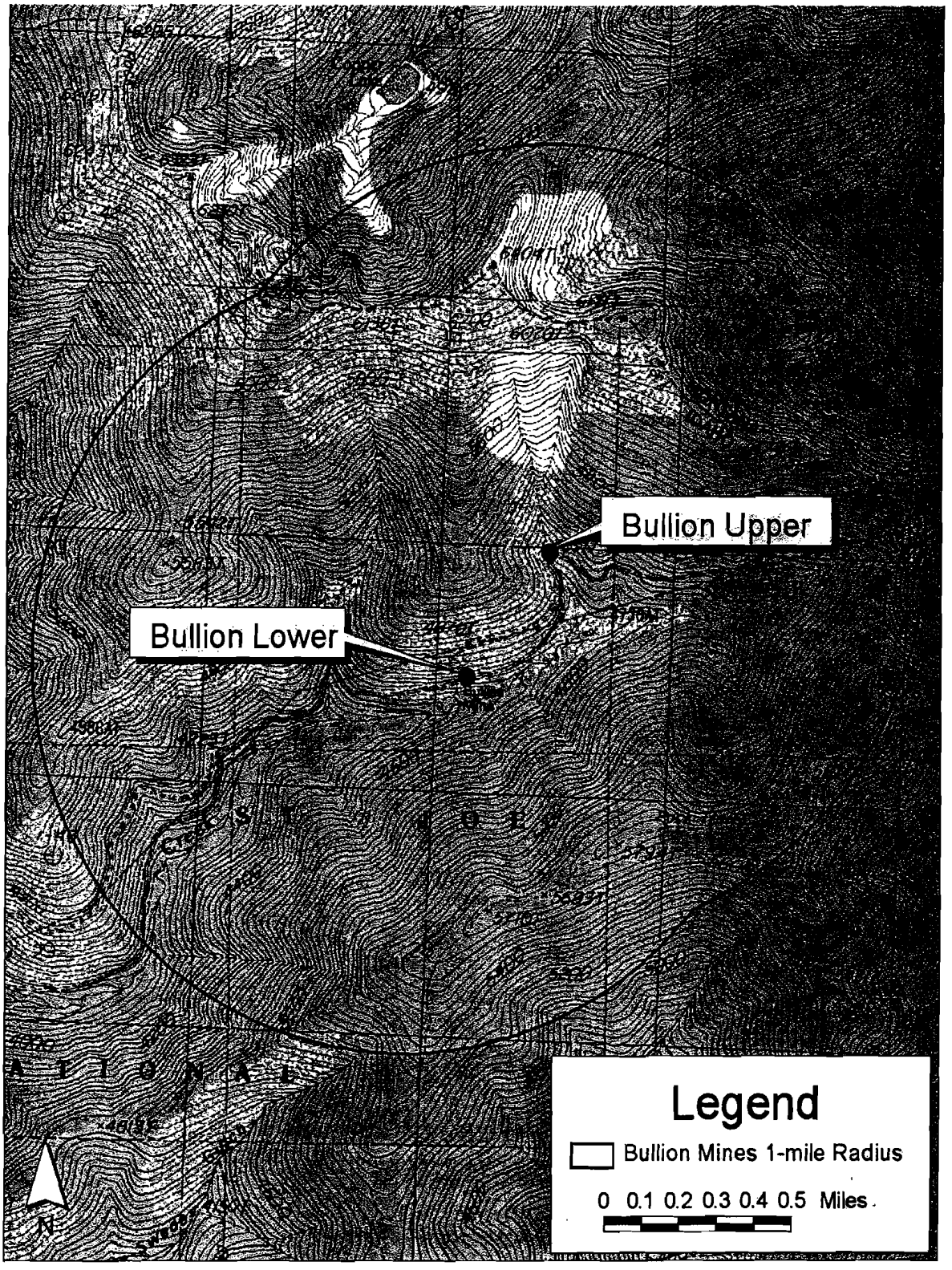

Figure 2-2. Bullion Upper and Bullion Lower 1-Mile Radius Map.

2.3 Previous Investigative Work

Previous investigative work has been conducted at the Bullion Mine. Geologists from the Idaho Geological Survey (IGS) conducted preliminary assessment activities in 1999, as part of an investigation of abandoned and inactive mines in Idaho located on U.S. Forest Service (USFS) lands (Kauffman, et al, 2003). At the time of these activities, the IGS presumed the Bullion Mine property to reside upon public land, managed by the USFS, rather than privately held patent land. The IGS report includes a historic literature search of the sites as well as fieldwork where specific mine workings were located and mapped. This report summarized information relative to the historic mineral production and geology of the mine and determined safety hazards and potential surface water impacts. Sample analysis of *adit* (mine entrance) water did not indicate the exceedance of water quality standards, nor was there any apparent significant leaching of any metals of interest. (Appendix D of this report contains a copy of the IGS report.)

2.4 Regulatory History

No regulatory action has occurred at the Bullion Mine or near the vicinity of the mine. No National Priority List Superfund sites are in the immediate vicinity of the Bullion Mine. The nearest Superfund site is Bunker Hill Mining & Metallurgical (IDD048340921), which is located in the Smelterville-Kellogg area, approximately 10 miles west-northwest from the site.

3 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

This section presents an operational history of the site, defines the characteristics of the waste, and describes previous source sampling efforts.

3.1 Operational History

The Bullion Mine was located from 1900 to 1903 and surveyed in 1903 (Sims, 1998). The Bullion Mining Co., Ltd. was incorporated in Idaho in 1902, capitalized with $1.0 million, and in 1907 increased capital stock to $1.5 million (The Mines Handbook, 1916). The major stockholders of the Bullion were J. H. Taylor, Secretary-Treasurer and Manager; William Squance, President.; R. A. Marshall, Vice President; Frank Taylor of Wallace; and John M. Klingman of Cleveland, Ohio (Norman, 1918).

In 1910, a devastating forest fire raged throughout the northwest and swept the through Bullion Creek drainage, destroying all of the structures and mine equipment. Sixty firefighters, led by S.M. Taylor, were surrounded by the fire and sought refuge in the Bullion Tunnel (presumably Tunnel No. 2). Unfortunately, eight men who were closest to the tunnel's entrance suffocated (Cohen and Miller, 1978).

In 1912, the Bullion Mine was restocked and back in operation, sending a trial shipment of ore to a smelter. According to The Mines Handbook (Weed, 1916):

> "A trial shipment of 24 tons to the East Helena smelter, Sept., 1912, showed 56% copper and 1 oz. silver per ton. Concentration

tests on 5.2% ore showed a 73% recovery. No production since 1912. Diamond drill work was done in 1913 and company plans driving lower tunnel 2,533' to intercept ore at depth of 430' in 1916."

In 1914, the Copper Chief Mining Company, which owned seven unpatented claims adjoining the Bullion, agreed to share the cost of completing a crosscut tunnel. The No. 3 Tunnel (Lower) was driven to reach the ore zones beneath the Upper workings and to provide access to the Copper Chief's ore as well. J.H. Taylor, who continued as Bullion's manager until 1945, managed this joint venture operation. The Mines Handbook (1918) reported:

> "Property: 16 claims, 2 patented, 320 acres...Property has a quartz vein of 4' to 20' width, with average of 6' to 12' and nearly vertical dip, carrying shoots of copper ore, 2'- 4' wide, mainly chalcopyrite. Concentrates estimated to average 19.8% copper, 3 oz silver, $2.40 gold, 28.5% iron and 4% silica per ton. Development: by shafts and 2 crosscut tunnels, one 200' vertically above the other. The upper one has 130' crosscut and 186' drift on vein. Lower tunnel cuts a 28' vein 350' from portal, with 4' of solid ore. Ore body proved from 35' upward by raise and downward by shaft. Equipment: includes steam power, a 12 h.p. hoist, Pelton wheel, and a 5-drill air compressor..."

The 1922 edition of the Mines Handbook further reported:

> "A 100-ton mill is contemplated. Company is operating jointly with the Copper Chief M & M Co., under same management." "Underground work continued until about 1922, when the three tunnels were 600 feet, 1,200 feet and 4,400 feet long, and the shaft was 100 feet deep. An additional thirteen claims were patented in late 1922 or early 1923...from 1926 to 1929, operations included raising from the No. 3 tunnel toward the upper workings. When work was discontinued, the raise was about 66 feet from connection with the No. 2 tunnel...In 1940, after the property had been idle for several years, the company noted that most of its (portable) equipment had been stolen" (Kauffman, 2003, p.148). During World War II, the Bullion Mining Company applied for government assistance through the DMEA Program, but was not granted assistance. "In 1949, the mine was said to have 12,080 feet of workings, including three tunnels (500 feet, 2,000 feet and 4,800 feet long), two shafts, and one raise. Despite later changes reported in the length of the workings, the Bullion appears to have been inactive since about 1930" (ibid, p. 148).

The Copper Chief M & M Company forfeited its corporate charter in 1942. On November 26, 1952, the Bullion Mining Company, Ltd. officially changed its name to delete "Limited." H. F. Magnuson became the major stockholder and president of the company in 2002 and continues to own the property (Shoshone County records).

3.2 Waste Characteristics

The Bullion Mine's ore was characterized as "largely spathic iron, with sufficient chalcopyrite, or sulfide copper, to make it desirable ore" (NW Mining Truth, 1917, p. 5). *Spathic* iron or siderite (iron carbonate) is also abundantly represented as *gangue* (worthless rock in which valuable minerals may be found) throughout many mines in the region. Three ore veins were encountered in Tunnel No. 3, including: "at a depth of 1200 feet, in a strongly-defined, well-mineralized vein...The Bullion No. 3 crosscut entered the vein at more than 3000 feet, intersecting it through the footwall and running 30 feet before reaching the hanging wall...Two other veins were crosscut earlier by the tunnel. The first was about 1000 feet from the portal and 12 feet wide, and the second about 2000 feet from the portal and 4 feet wide..." (ibid., p. 6). The No. 2 Tunnel was driven "more than 600 feet and attaining a vertical depth of over 500 feet. A strong east-and-west vein of copper ore, exceeding 20 feet in width, was opened... On the No. 2 dump and blocked out in the No. 2 workings is a substantial tonnage of shipping ore..." (ibid.).

The wastes generated from both the Upper and Lower operations are confined to waste rock. Though the Bullion Mining Company anticipated the construction of a mill to handle ore processing, no mill construction was ever realized. Ore excavated from mine operations was shipped offsite to mill and smelter facilities for processing. Waste rock dumps are associated with each tunnel, adit, and shaft. The Upper and Lower waste rock areas are described in Table 3-1.

Table 3-1. Waste Source Areas.

Workings	Waste Rock Location	Description	Dimensions (ft) (L x W x H)	Volume (feet) approx.
Upper	Tunnel No. 1	Adit dump	15 x 5 x 20	1,500
	Shaft No. 1	Shaft dump, overlaps adit dump	45 x 10 x 40	18,000
	Tunnel No. 2	Adit dump, modified by road construction	81 x 68 x 24	132,192
	Thornton Tunnel	Adit dump	11 x 8 x 3	264
Lower	Tunnel No. 3, north side of Bullion Creek	Adit dump and landing area	92 x 59 x 9	48,852
	South side of Bullion Creek	Largest adit dump, arc shaped due to blowout	238 x *19.5 x 25	116,025
	South side of Bullion Creek	Re-deposited dump material from blowout	Multiple lens shaped deposits	**25,920

*Average width across dump ** Calculated from dimension of blowout (72 x 18 x 20)

3.3 Previous Source Sampling Activities

The Bullion Mine was visited by John Kauffman of IGS on July 14, 1998. The IGS conducted a preliminary site investigation, which included limited sampling activities. Sampling locations are noted on the sketch diagrams of Figure 3-1 and Figure 3-2. Samples were collected from waste rocks dumps (red), surface water (blue) and sediment (yellow). Surface water samples results are listed in Table 3-2, while Table 3-3 includes the rock and sediment sample results.

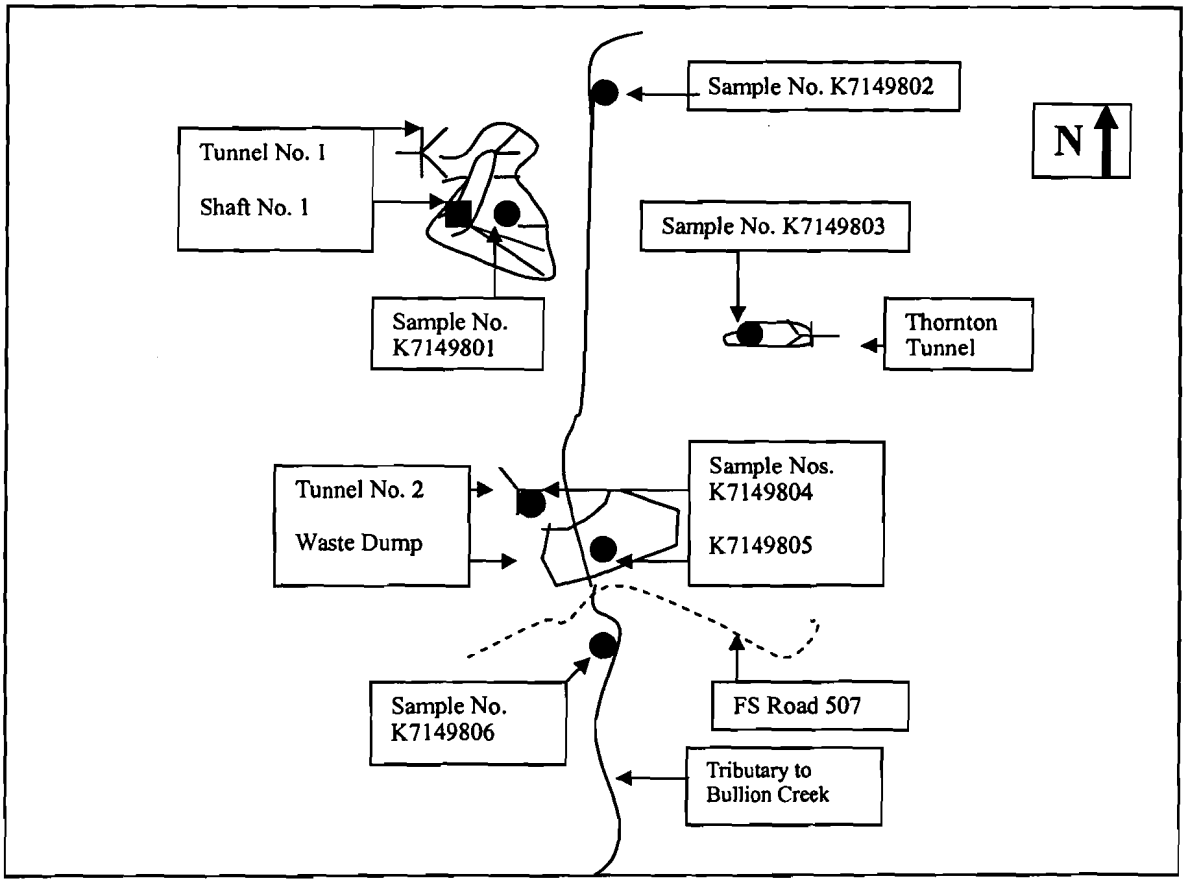

Figure 3-1. Upper Workings Diagram

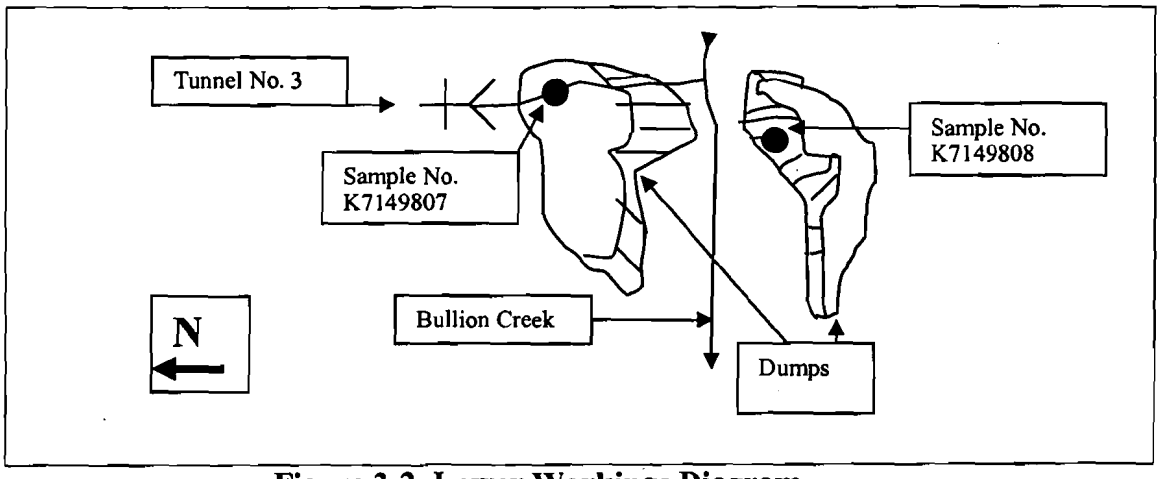

Figure 3-2. Lower Workings Diagram.

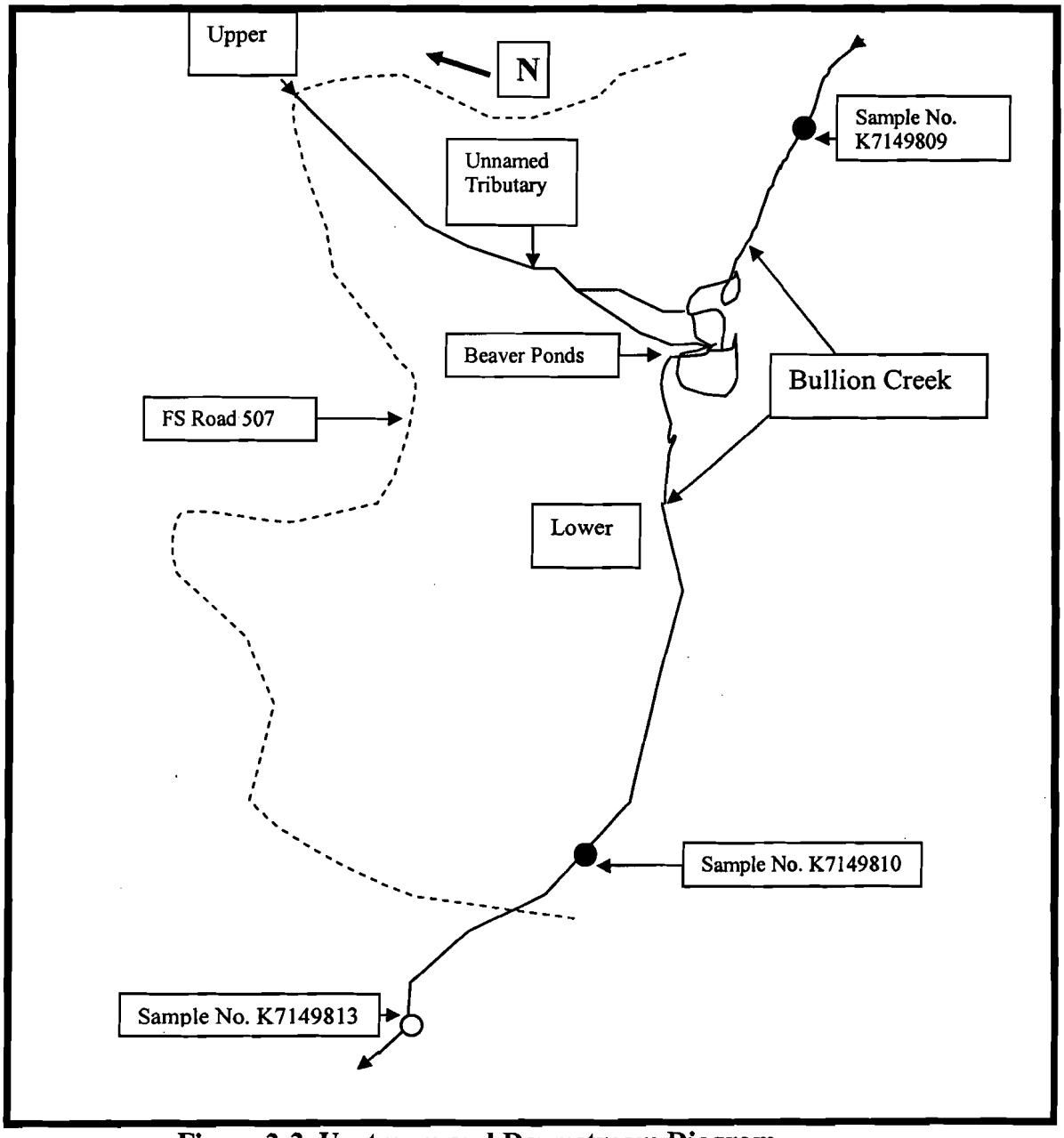

Figure 3-3. Upstream and Downstream Diagram.

Table 3-2. Adit and Surface Water Sample Analysis.

SAMPLE	REMARKS	*Al	*As	*Ba	*Be	*Cd	*Ca	*Cr	*Co	*Cu	*Fe	*Pb	*Mg
K7149802	Bullion--upper workings, upstream			0.002	0.0016	BDL	7.600	0.0082	BDL	BDL	0.079		2.2
K7149803	Bullion--upper workings, Adit 3, water			0.005	0.0003	BDL	7.400	BDL	0.010	BDL	0.360		2.2
K7149804	Bullion--upper workings, Adit 1, water			0.002	0.0003	BDL	11.000	BDL	0.008	BDL	BDL		5.8
K7149806	Bullion--upper workings, downstream			0.003	0.0016	BDL	9.100	0.0150	BDL	BDL	0.044		2.6
K7149807	Bullion--lower workings, Adit 1, water			0.010	0.0004	BDL	19.000	BDL	0.008	BDL	BDL		10.0
K7149809	Bullion--lower workings, upstream			0.004	0.0017	0.002	8.500	0.0085	BDL	BDL	BDL		1.4
K7149810	Bullion--lower workings, downstream			0.005	0.0016	BDL	12.000	0.0086	BDL	BDL	BDL		2.5

SAMPLE	REMARKS	*Mn	*Hg	*Mo	*Ni	*K	*P	*Ag	*Na	*S	*V	*Zn
K7149802	Bullion--upper workings, upstream	0.0039		BDL	BDL	0.86	NA	NA	1.500	NA	BDL	BDL
K7149803	Bullion--upper workings, Adit 3, water	0.0230		BDL	BDL	0.59	NA	NA	0.960	NA	BDL	0.0052
K7149804	Bullion--upper workings, Adit 1, water	0.0016		BDL	BDL	0.63	NA	NA	1.200	NA	BDL	0.0046
K7149806	Bullion--upper workings, downstream	0.0027		BDL	BDL	1.60	NA	NA	1.400	NA	BDL	BDL
K7149807	Bullion--lower workings, Adit 1, water	0.0018		BDL	BDL	0.83	NA	NA	2.500	NA	0.014	0.0068
K7149809	Bullion--lower workings, upstream	0.0014		BDL	BDL	0.63	NA	NA	1.500	NA	BDL	BDL
K7149810	Bullion--lower workings, downstream	0.0023		BDL	BDL	0.79	NA	NA	1.700	NA	BDL	BDL

* All units are mg/L

BDL – Below Detection Limit

NA – Not Applicable

Table 3-3. Stream Sediment & Waste Rock Sample Analysis.

SAMPLE	REMARKS	*Al	*As	*Ba	*Be	*Cd	*Ca	*Cr	*Co	*Cu	*Fe	*Pb	*Mg
K7149813	Bullion--lower workings, stream sediment, downstream	NA	130	170.0	0.770	2.70	2800	19.0	16.0	74.0	29000	73	12000
K7149801	Bullion--upper workings, Adit 2, dump	NA	470	23.0	0.300	8.80	130000	8.9	21.0	7200	200000	110	31000
K7149805	Bullion--upper workings, Adit 1, dump	NA	1100	71.0	0.480	6.70	91000	11.0	36.0	7200	130000	92	26000
K7149808	Bullion--lower workings, Adit 1, dump	NA	340	36.0	0.350	6.30	150000	7.6	20.0	1900	140000	66	37000

SAMPLE	REMARKS	*Mn	*Hg	*Mo	*Ni	*K	*P	*Ag	*Na	*S	*V	*Zn
K7149813	Bullion--lower workings, stream sediment, downstream	600	NA	13.0	24.0	6300	360	NA	160	240	NA	38.0
K7149801	Bullion--upper workings, Adit 2, dump	8200	NA	24.0	48.0	710	320	NA	320	7000	NA	140.0
K7149805	Bullion--upper workings, Adit 1, dump	5000	NA	20.0	47.0	2300	410	NA	260	7300	NA	110.0
K7149808	Bullion--lower workings, Adit 1, dump	6500	NA	19.0	37.0	1100	160	NA	300	4100	NA	45.0

SAMPLE	REMARKS	TCLP **As	TCLP **Cd	TCLP **Cr	TCLP **Pb	TCLP **Hg	TCLP **Se	TCLP **Ag	TCLP **Ba
K7149813	Bullion--lower workings, stream sediment, downstream	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
K7149801	Bullion--upper workings, Adit 2, dump	BDL	BDL	BDL	BDL	BDL	BDL	BDL	800
K7149805	Bullion--upper workings, Adit 1, dump	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1000
K7149808	Bullion--lower workings, Adit 1, dump	BDL	BDL	BDL	BDL	BDL	BDL	BDL	760

* All units are mg/kg

** All units are mg/L

BDL – Below Detection Limit

NA – Not Applicable

3.4 Previous Source Sample Analysis (IGS)

The arsenic soil concentrations were generally consistent with the DEQ analysis. The average residential risk associated with the arsenic in soils is approximately 1.6E-03. As this risk is based on prolonged exposure to humans, which appears unlikely at this site, this is likely an acceptable risk, if an on-site recreational exposure is considered.

There could be some potential exposures to aquatic life from cadmium concentrations at 2 µg/L. The water quality standard is 1 µg/L; however, the potential impacts are variable due to alkalinity, of which we have no data. It should be noted that cadmium only occurs in one sample upstream from the lower workings and, therefore, would not be considered a likely major impact.

The IGS data is difficult to evaluate for the following reasons:

- The report does not include detection limits; therefore, comparison to some of the surface water quality criteria is not possible. Some of the detections limits from other analyses exceed the aquatic life criteria.
- The report did not include arsenic compounds in the surface water assessment. Arsenic was the risk driver in the soil and waste rock.
- IGS did not perform an alkalinity test; therefore, we can not fully evaluate potential impacts to surface water for cadmium.

3.5 SI Source Sampling Activities

The Bullion Mine was visited by Brian Gaber, Robert Higdem, and Curtis Stoehr of DEQ on July 27-28, 2004 and September 1, 2004, during which times they collected solid and liquid phase samples according to the procedures detailed in the Sample Plan incorporated into the Project Plan (Appendix E). However, two water sampling field tests were not implemented, thus deviating from the Sample Plan. Water temperature and conductivity testing were not completed, due to equipment malfunction.

Samples were collected from waste rocks dumps (red), surface water (blue) and sediment (yellow), at the locations noted in Figure 3-4, Figure 3-5, and Figure 3-6. Surface water samples results are summarized in Section 4.2 (page 20) and listed in Table 4-1 (page 25). Rock and sediment sample results are summarized in Section 4.3 (page 26) and listed in Table 4-2 (page 27); Table 4-3 (page 28) includes TCLP sample results.

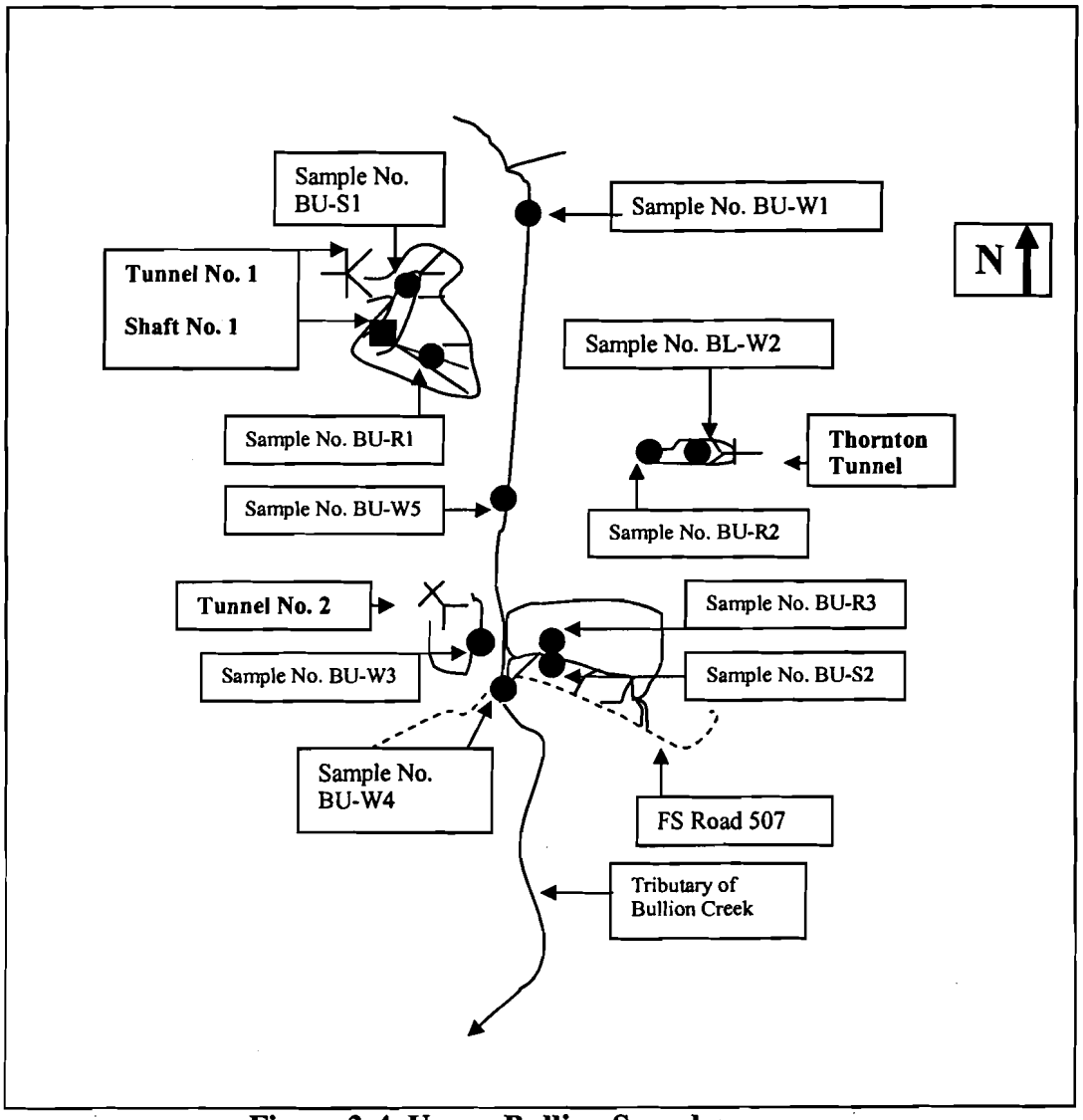

Figure 3-4. Upper Bullion Samples.

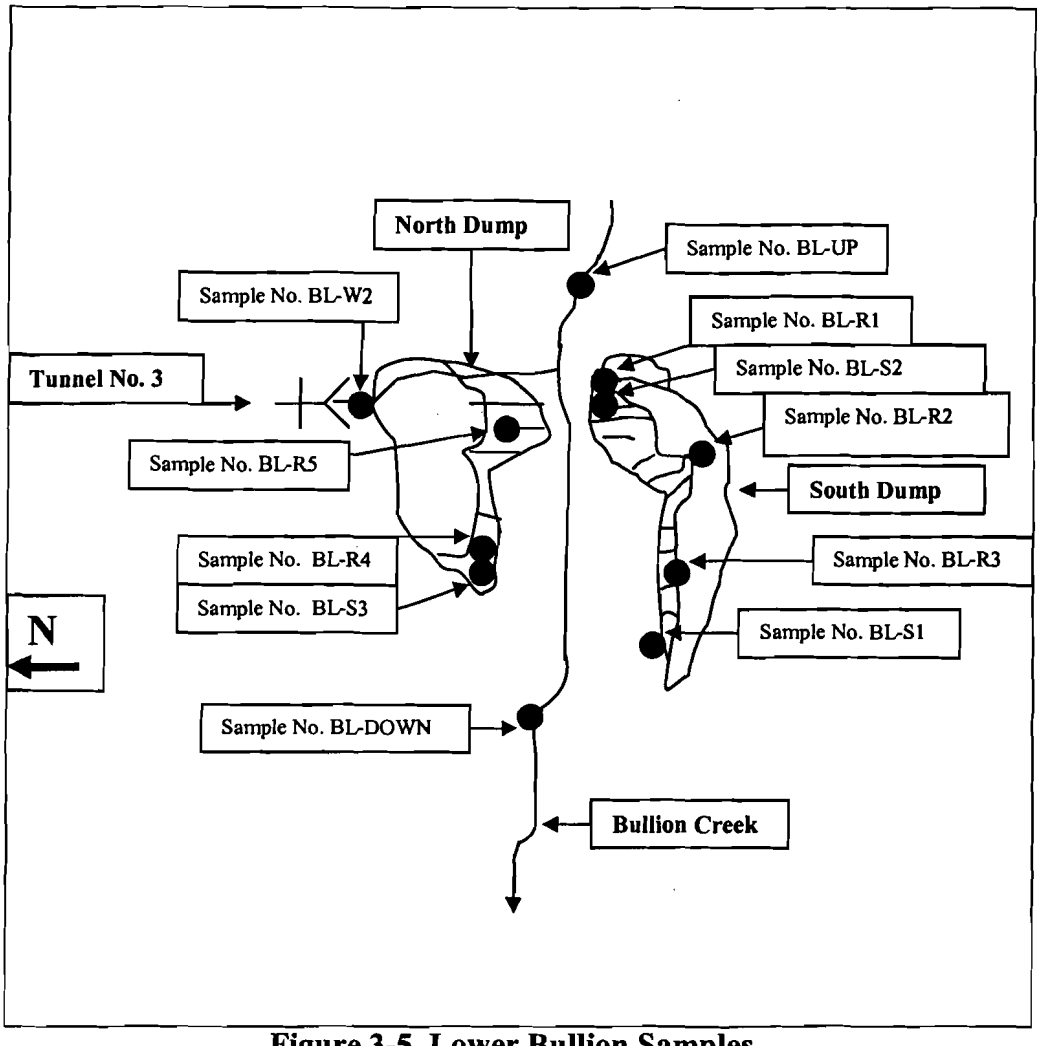

Figure 3-5. Lower Bullion Samples.

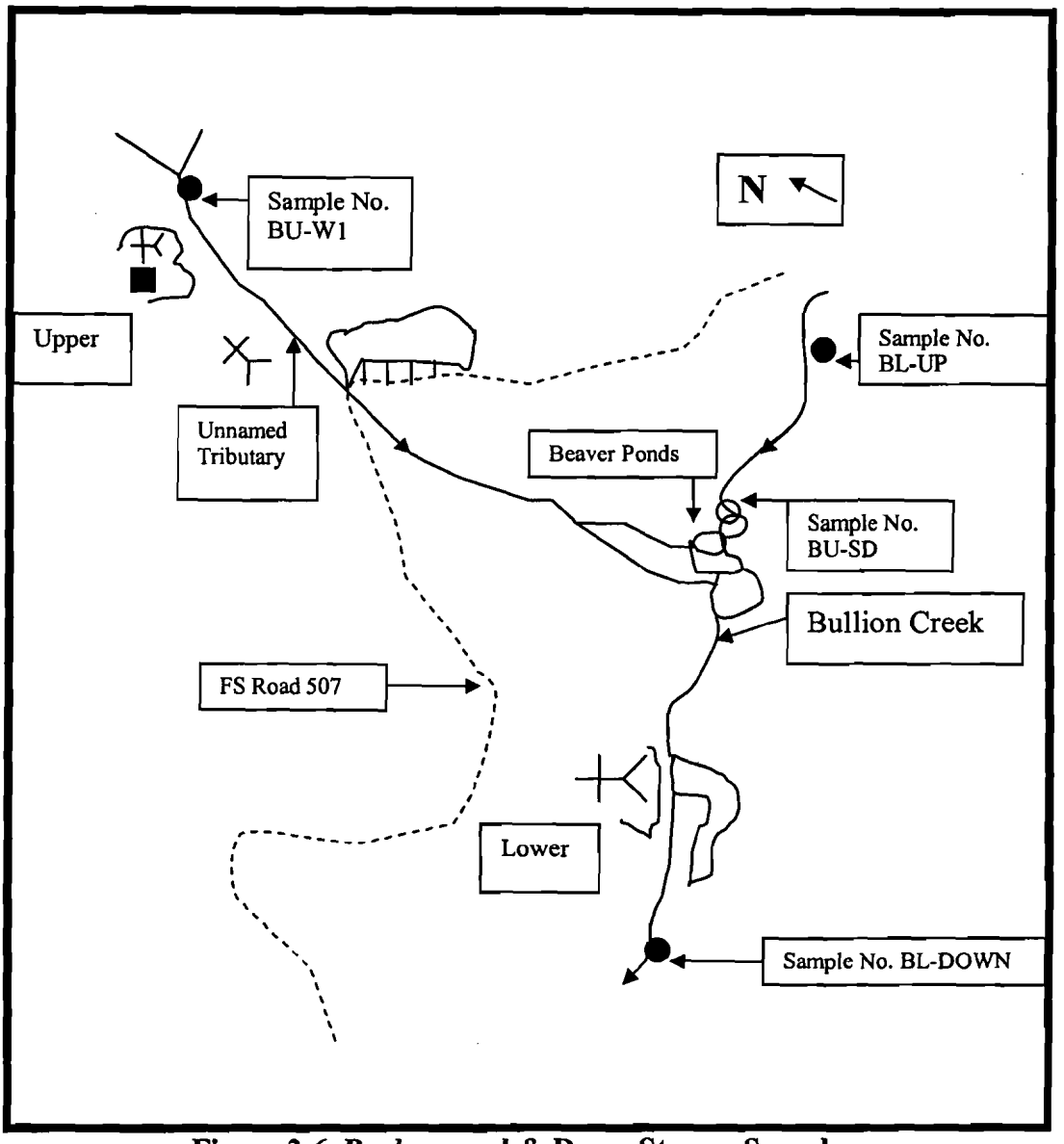

Figure 3-6. Background & Down Stream Samples.

3.6 SI Source Sample Analysis

Data from sampling of soils, waste rock, sediments and surface water at the Bullion Mine indicate potential risk to recreational users from soil ingestion. While average arsenic soil concentrations indicate an approximate risk of 2.2E-03 (using Region IX Preliminary Remediation Goals [PRGs] – residential scenario), one sample (BL-R4) on the south waste rock pile showed an approximate 1.5E-01 risk (see Table 4-2). This high arsenic concentration appears in only one sample and is not considered indicative of ambient site conditions.

Water quality analyses indicate arsenic is above the Maximum Contaminant Level (MCL), in the Tunnel #2 and Tunnel #3 discharge, by 5 µg/L and 1 µg/L, respectively (see Table 4-1). However, surface water is not above MCLs for metals in any of the Bullion Creek samples. The detection limits were not adequate to fully evaluate impacts from cadmium for aquatic life (detection limit 2 µg/l – regulatory limit 1 µg/l) and mercury (detection limit .200 µg/l – aquatic life criteria .012 µg/l). Additionally, the single hit of copper cannot be fully evaluated due the lack of alkalinity data.

4 MIGRATION/EXPOSURE PATHWAYS AND TARGETS

The following sections describe migration/exposure pathways and targets within the site's range of influence (Figure 4-1 and Figure 4-2).

4.1 GROUND WATER MIGRATION PATHWAY

This section describes the ground water migration pathway, addressing geology, hydrology, drinking water systems, and climate.

4.1.1 Geology

Rocks of the Belt series, known as the "Supergroup," underlie the Bullion Creek drainage. The Upper and Lower were wholly developed within the Wallace formation, which dates to the pre-Cambrian era (1.4 bya – 0.85 bya). "The entire formation bears evidence of shallow water deposition; the more shaly facies are mud cracked, while the sandy facies are ripple marked" (Wagner, 1949, p. 12). The mud cracks are distinctly typical of the shales and slates of the lower member of the formation. The formation consists of mostly thin-bedded calcareous sediments. "The rocks contain carbonates of magnesium and iron as well as of calcium, but the calcium seems the most abundant. The formation comprises three members which are fairly distinct in general character, but which grade into one another... The lowest member is characterized by the prevailing green color of its rocks....Higher in the formation the proportion of limy material is greater, as is indicated by the yellow color assumed by the rocks when weathered; numerous bands of whitish calcareous sandstone and a few strata of blue and white argillite make their appearance. The part of the formation in which the green color is strongly preponderant constitutes what may conveniently be called the "lower member" (Calkins and Jones, 1912, pp. 13 and 14). The lower member of the Wallace formation is represented throughout the Bullion workings.

Igneous rocks, in the form of diabase sills, distinguished by their intrusion parallel to the bedding of the rock, are also represented in the Bullion workings. The Wishards diabase is known to exist throughout the middle member of the Wallace formation, and thinner, less evident sills, are found between the middle and lower members. This diabase zone extends from Placer Creek near the town of Wallace, southeastward for a distance of nearly 30 miles into the upper St. Joe River drainage (Umpleby and Jones, 1923). Though apparently misidentified as a "dike or dyke" (cross-cutting the bedding), the occurrence of diabase was noted in Tunnel No. 3, "At a point about 2390 feet from the portal a diabase dyke 170 feet thick was encountered" (NW Mining Truth, 1917, p. 5).

Structurally, the Belt series forms a "broad anticlinal arch" in the upper St. Joe drainage, where the once horizontal beds often exceed dips of 45° (Umpleby and Jones, 1923, p. 11). The Placer Creek fault zone extends eastward through the northern portion of the

Bullion Creek drainage and may be represented in both the Upper and Lower workings. Localized "step" faults were identified in the No. 2 Tunnel's workings, where the vein was offset by more than 175 feet (NW Mining Truth, 1917).

4.1.2 Hydrologic Setting

Historically, the Upper workings (Tunnel No. 1 and shaft) received continuous ground water infiltration, which halted development. Initially, Tunnel No. 2 was driven to provide drainage, but the subsequent development of a second shaft ceased at a depth of 50 feet, when water infiltration was not stopped (Kauffman, 2003). During the 2004 site visit, DEQ noted numerous seeps and/or springs emanating from the hillside among the workings. Likewise, the Lower workings (Tunnel No. 3), though not directly connected to the Upper, produces perennial ground water discharge.

The Bullion Creek drainage and surrounding area is devoid of wells, so ground water data is unavailable. Consequently, ground water is expected to follow preferential pathways along bedding planes and be controlled by faults and fractures, locally.

4.1.3 Drinking Water Systems

Two (2) public drinking water wells are located within a 4-mile radius of the Bullion. The wells are located at the Dena Mora Eastbound and Westbound Rest Stops on Interstate 90, near Saltese, Montana, and lie 3.29 miles northeast from the Bullion. The wells, which serve non-resident, transient populations of 500 persons (each) from May 1st to October 30th, are closed during the winter months. The wells are developed in gravely clay alluvium and there is a likely hydrological connection with the St. Regis River (Miller, 2001). However, the wells are noted to be structurally up-gradient from the Bullion, owing to displacement along the Placer Creek fault zone. A private drinking water system, located approximately 3.49 miles north-northeast of the Bullion, is actually a spring. This spring is a non-community source, located adjacent to the Lookout Pass Ski Area in Idaho, serving three (3) connections and a non-transient population of 133 persons (DEQ, 2004).

4.1.4 Climate Summary

No precipitation data is available for the Bullion. Therefore, precipitation data from the Avery Ranger Station No. 2 that was maintained from 11/1/1968 to 9/30/2004 was used. This site is located 13 miles south-southeast and at an elevation of 2780 feet amsl. The mean annual precipitation is 37.78 inches, and the 100-year, 24-hour event is 2.80 inches, which occurred on December 2, 1977 (WRCC, 2004).

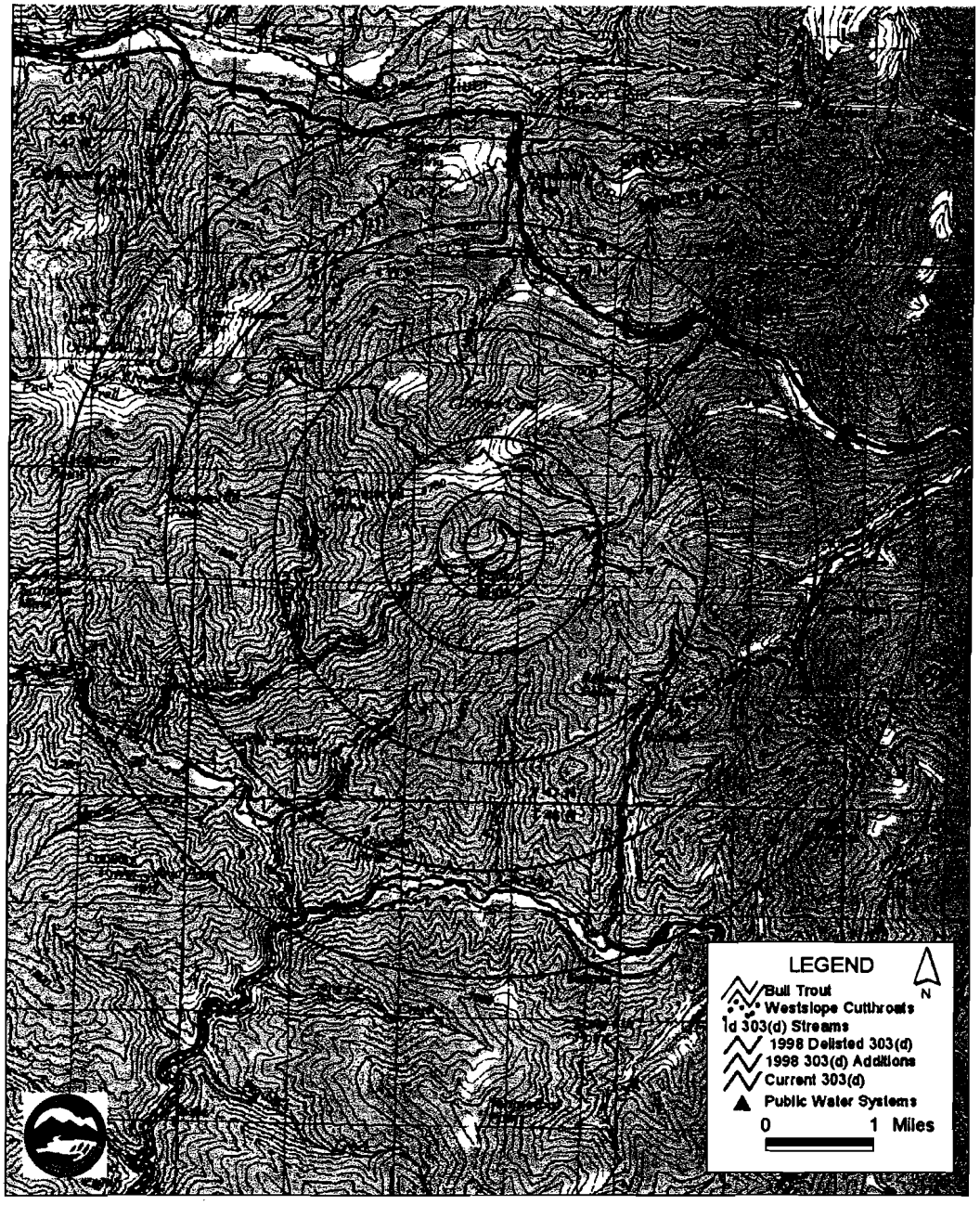

Figure 4-1. Bullion Mine 4-Mile Radius Map.

4.2 SURFACE WATER MIGRATION PATHWAY

This section describes the surface water migration pathway, including the hydrologic setting, in-water segment, target species, and source sample analysis.

4.2.1 Hydrologic Setting

Tunnel No. 3 (Lower) was driven entirely within the lower member of the Wallace formation. These rocks are mostly thin-bedded calcareous sediments, forming shale and slates. The beds are folded with dips exceeding 45°. Excavation of Tunnel No. 3, which lies approximately 30 vertical feet above and north of Bullion Creek, produced a large waste rock dump that resides within the floodplain of Bullion Creek. The creek bisects the dump. Historical accounts do not indicate that the dump was extended to dam the creek (i.e., power generation). Kauffman (2003, p. 158) suggested that the dump was "extended continuously across Bullion Creek". However, DEQ noted that the north face of the southern portion of the dump contains piling remnants, suggesting that a trestle once linked two separate dump areas.

The Upper workings lie in the upper reaches of a south facing draw, approximately 0.5 miles north of the Lower. Through the draw flows an unnamed tributary to Bullion Creek. The hillside is covered with dense brush, moss and grasses that are watered by numerous seeps and springs emanating nearby. IGS (Kauffman, 2003) identified an open adit (Tunnel No. 2) and a shaft (Shaft No. 1) as serious safety hazards. Recent bulldozer activity had carved a "gash" in the hillside southwest from Tunnel No. 2; the excavated material was used to cover the portal and block access to the adit, and the toe of the adit cover was noted to discharge ground water at an approximate rate of 2.0 gallons per minute. Additional bulldozer activity was evident near Tunnel No. 1 and Shaft No. 1, which had been blocked and covered. The upper portion of the waste rock dump of Tunnel No. 2 showed evidence of bulldozer activity, as well. The Thornton Tunnel lies on the east side of the tributary and discharges a minor flow (< 1 gallon per minute) to the hillside. Two large seeps or springs were identified uphill of the Tunnel No. 2 dump. One, flowing at an approximate rate of 1.5 gallons per minute, traversed the upper portion of the dump, infiltrated into the slope about 15 feet above the road, and discharged to the stream at the dump's western margin. The second, flowing at an approximate rate of 1.0 gallons per minute, flowed along the eastern perimeter of the dump, continued across its toe, and discharged to the stream, approximately five (5) feet above the road. Kauffman (2003) reported that the stream had carved a channel through the dump, but due to the recent bulldozing, this assessment was not verified. The multitude of seeps and springs coupled with snow pack runoff will gradually reduce the volume of the dump toward the lower reaches of the draw.

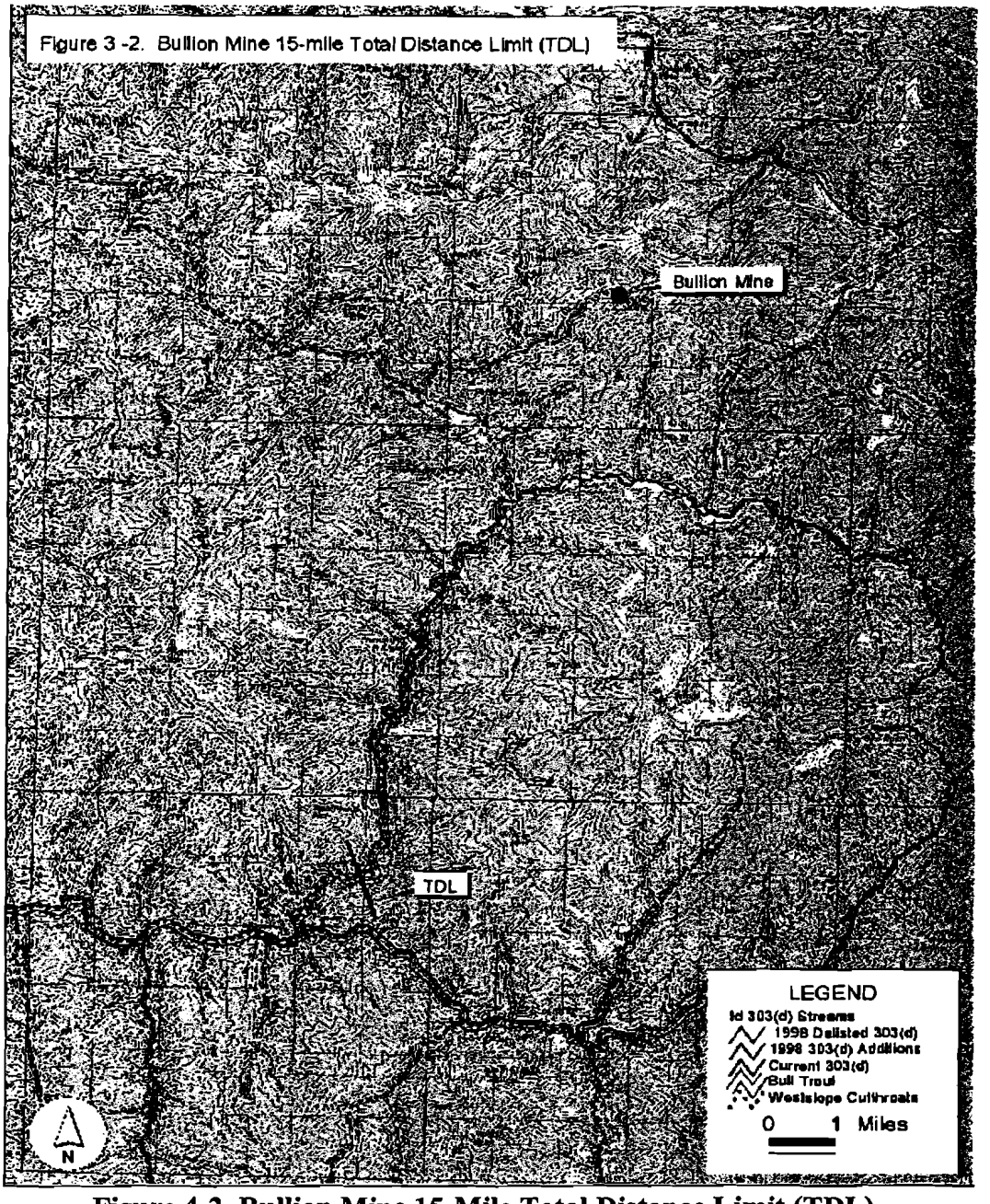

Figure 4-2. Bullion Mine 15-Mile Total Distance Limit (TDL).

4.2.2 In-water Segment

The distance of overland flow of ground water, draining from Tunnel No. 3 to the Probable Point of Entry (PPE) into Bullion Creek, is estimated at 125 feet. An exact measurement was not possible due to the extremely dense vegetation.

From the PPE, Bullion Creek flows southwest, approximately 0.5 miles, where it is joined by a southward flowing unnamed tributary; at 1.8 miles Wonderful Creek joins from the north; and at 2.55 miles another southward flowing unnamed tributary joins. Bullion Creek continues its southwest flow and joins the southeastward flowing North Fork St. Joe River at 3.48 miles. At 4.40 miles the North Fork St. Joe River is joined by the northeast flowing Mozier Creek; at 5.63 miles by the southwest flowing Lucky Swede Creek; and at 6.78 miles by the west flowing Loop Creek.

From its convergence with Loop Creek, the North Fork St. Joe River flows south-southwest. At 7.25 miles the North Fork St. Joe River is joined by the west flowing Long Creek; at 8.45 miles by the west-northwest flowing Big Dick Creek; at 8.6 miles by the southeast flowing Rye Creek; at 9.75 miles by the southeast flowing Kyle Creek; at 10.75 miles by the west flowing Molor Creek; at 11 miles by the east flowing Hammond Creek; at 11.75 miles from the west flowing Squaw Creek; at 12 miles by the east flowing Stetson Creek; at 13.85 miles by the southwest flowing Miller Creek; at 14.35 miles by the west-southwest flowing Nelson Creek; and by several unnamed tributaries to the border of the 15-mile TDL (Figure 4).

4.2.3 Target Species

Known to populate the North Fork St. Joe River are the bull trout (*Salvelinus confluentus*), listed as a threatened species, and the Westslope cutthroat (Oncorhynchus clarki lewisi), listed as a specie of concern (IF&G, 2004).

Commercial and subsistence fishing are not conducted within the surface water Target Distance Limit (TDL). Sport fishing may occur along Bullion Creek in its many beaver ponds, though direct evidence of this was not observed. Empirical data suggests the majority of sport fishing is contained to the larger tributaries of the North Fork St. Joe River, including Loop Creek and Squaw Creek. Fish catch data could not be determined.

The use of surface water for watering of livestock and irrigation appears to be non-existent within the TDL. Large indigenous mammals (deer, elk, bear, etc.) are presumed to be present in the area and would utilize the water from Bullion Creek and the North Fork St. Joe River.

The North Fork St. Joe River within the TDL has been designated by DEQ, under the Total Maximum Daily Load (TMDL) program, as a 303(d) listed stream for the pollutant of concern of temperature. It does not appear the former mining activity associated with the Bullion Mine has any impact on this pollutant of concern.

4.2.4 Source Sample Analysis

Small exceedance of MCLs (arsenic) for surface water flowing from the adits near the tunnel entrances are not perceived as a major impact because down-gradient concentrations in Bullion Creek are below MCLs. Full impacts to aquatic life cannot be fully evaluated due to high detections limits for cadmium and mercury and lack of alkalinity data for copper and cadmium. However, it does not appear that small exceedance of the aquatic life criteria from the Bullion Mine will adversely impact down-gradient receptors.

Table 4-1. Water Samples

Water Sample ID	Specific Location	* Ag	* As	* Ba	* Cd	* Cr	* Pb
BL-DOWN	Bullion Creek downstream from all workings	<0.0050	<0.010	0.0044	<0.0020	<0.0060	<0.0050
BL-W2	Bullion Lower - tunnel #3 discharge	<0.0050	0.011	0.0108	<0.0020	<0.0060	<0.0050
BL-W3	Bullion Lower - 40 yds upstream from waste rock piles	<0.0050	<0.010	0.0047	<0.0020	<0.0060	<0.0050
BU-W1	Bullion Upper - upstream from all workings	<0.0050	<0.010	0.0216	<0.0020	<0.0060	<0.0050
BU-W2	Bullion Upper - adit #3 discharge	<0.0050	<0.010	0.002	<0.0020	<0.0060	<0.0050
BU-W3	Bullion Upper - tunnel #2 discharge	<0.0050	0.015	0.0409	<0.0020	<0.0060	<0.0086
BU-W4	Bullion Upper - Bullion Creek directly below FS Road 507	<0.0050	<0.010	0.0033	<0.0020	<0.0060	<0.0050
BU-W5	Bullion Upper - below adits 2 & 3, above adit 1	<0.0050	<0.010	0.0027	<0.0020	<0.0060	<0.0050
BU-UP	Bullion Upper - from Bullion Creek above beaver ponds	<0.0050	<0.010	0.0051	<0.0020	<0.0060	<0.0050
BL-UP	Bullion Lower - Directly upstream of Lower Bullion Mine	N/A	N/A	N/A	N/A	N/A	N/A
BVR-W1	Bullion Creek at beaver ponds	N/A	N/A	N/A	N/A	N/A	N/A

Water Sample ID	Specific Location	* Se	* Hg	* Cu	* Zn	pH
BL-DOWN	Bullion Creek downstream from all workings	<0.010	<0.00020	<0.0030	<0.0050	7.85
BL-W2	Bullion Lower - tunnel #3 discharge	<0.010	<0.00020	N/A	N/A	N/A
BL-W3	Bullion Lower - 40 yards upstream from waste rock piles	<0.010	<0.00020	N/A	N/A	N/A
BU-W1	Bullion Upper - upstream from all workings	<0.010	<0.00020	<0.0030	<0.0050	7.81
BU-W2	Bullion Upper - adit #3 discharge	<0.010	<0.00020	<0.0030	<0.0050	7.78
BU-W3	Bullion Upper - tunnel #2 discharge	<0.010	<0.00020	0.0079	0.0174	8.01
BU-W4	Bullion Upper - Bullion Creek directly below FS Road 507	<0.010	<0.00020	<0.0030	<0.0050	7.89
BU-W5	Bullion Upper - below adits 2 & 3, above adit 1	<0.010	<0.00020	N/A	N/A	N/A
BU-UP	Bullion Upper - from Bullion Creek above beaver ponds	<0.010	<0.00020	<0.0030	<0.0050	7.86
BL-UP	Bullion Lower - Directly upstream of Lower Bullion Mine	N/A	N/A	<0.0030	<0.0050	7.97
BVR-W1	Bullion Creek at beaver ponds	N/A	N/A	<0.0030	0.0079	7.94

*** Units – mg/L** *** N/A – Not Applicable**

4.3 SOIL EXPOSURE PATHWAY

No private residences exist within one mile of the Bullion Mine, nor are there any schools or daycare facilities within 200 feet. Receptors in the area have been identified as seasonal recreationists, including occasional tourists, hikers, campers, hunters and snowmobilers. The only commerce in the area is the occasional timber harvesting operation, though none are likely near the sparsely forested Bullion property.

4.3.1 Source Sample Analysis

Soil samples were collected at a depth of one (1) foot below ground surface. Although risk for arsenic through ingestion of soils is greater than 1E-04, according to region IX PRGs, it is anticipated exposures to humans at the site will be short. Therefore, except for the potential acute exposure as identified in sample BL-R3 (see Table 4-2), the long-term exposure scenario to humans should be acceptable. According to BLM's *Risk Management Criteria for Metals at BLM Mining Sites*, (Ford, 1996), residual arsenic concentrations at the site could impact wildlife in the area through continuing grazing or browsing activities. Observations at the site identified thick native brush and Lodge Pole pine as the dominant vegetation type. Areas not covered in thick brush were void of grasses and shrubbery suitable for forage, indicating this is not prime habitat for long term exposure. While the area by the beaver ponds was very lush for foraging, arsenic concentrations were below risk criteria.

Table 4-2. Soil and Sediment Samples.

Soil Sample ID	Specific Location	Ag*	As*	Ba*	Cd*	Cr*
BL-S1	Bullion Lower - soil from south pile	<2.5	370	90.7	<1.0	4
BL-S2	Bullion Lower - soil from south pile	<2.5	290	49.7	<1.0	<3.0
BL-S3	Bullion Lower - soil from north waste rock pile	<2.5	171	26.9	<1.0	<3.0
BL-R1	Bullion Lower - North face of South waste rock pile	<2.5	3110	15.6	<1.0	<3.0
BL-R2	Bullion Lower - Middle-top of South waste rock pile	<2.5	1520	25.6	<1.0	<3.0
BL-R3	Bullion Lower - West face of South waste rock pile	70.3	59400	9.7	6.5	<6.0
BL-R4	Bullion Lower - West face of North waste rock pile	<2.5	245	94.6	<1.0	4.6
BL-R5	Bullion Lower - North waste rock pile	<2.5	186	28	<1.0	<3.0
BU-S1	Bullion Upper - Adit #2	<2.5	283	20.6	<1.0	<3.0
BU-S2	Bullion Upper - Dump face of Adit #1	<2.5	141	17.3	<1.0	<3.0
BU-SD	Bullion Upper - at edge of Beaver pond #4	<0.5	3.3	12.6	<0.2	3.32
BU-R1	Bullion Upper - Adit #2	<2.5	1280	18.9	<1.0	<3.0
BU-R2	Bullion Upper - Adit #3	<0.5	18	64.1	<0.2	8.62
BU-R3	Bullion Upper - Dump face of Adit #1	<2.5	424	19.4	<1.0	<3.0

Soil Sample ID	Specific Location	Pb*	Se*	Hg*	% Sol 999
BL-S1	Bullion Lower - soil from south pile	17.3	<5.0	0.388	99.8%
BL-S2	Bullion Lower - soil from south pile	68.3	<5.0	0.333	99.7%
BL-S3	Bullion Lower - soil from north waste rock pile	20.3	<5.0	0.318	98.6%
BL-R1	Bullion Lower - North face of South waste rock pile	245	<5.0	0.433	99.8%
BL-R2	Bullion Lower - Middle-top of South waste rock pile	24.5	<5.0	0.462	99.7%
BL-R3	Bullion Lower - West face of South waste rock pile	64.4	23	1.73	99.7%
BL-R4	Bullion Lower - West face of North waste rock pile	13.8	<5.0	0.508	99.6%
BL-R5	Bullion Lower - North waste rock pile	20	6	0.475	99.8%
BU-S1	Bullion Upper - Adit #2	41.3	<5.0	0.277	99.5%
BU-S2	Bullion Upper - Dump face of Adit #1	16.4	<5.0	0.935	98.3%
BU-SD	Bullion Upper - at edge of Beaver pond #4	2.67	1	<0.0330	18.4%
BU-R1	Bullion Upper - Adit #2	59.1	<5.0	0.413	99.7%
BU-R2	Bullion Upper - Adit #3	15.3	<1.0	0.085	99.7%
BU-R3	Bullion Upper - Dump face of Adit #1	18	<5.0	1.36	99.5%

*** All units are mg/kg**

Table 4-3. Soil TCLP Samples.

Soil Sample ID	Specific Location	*Ag	*As	*Ba	*Cd	*Cr
BL-S1	Bullion Lower - soil from south pile	<0.0050	<0.010	0.0293	<0.0020	<0.0060
BL-S2	Bullion Lower - soil from south pile	<0.0050	<0.010	0.0358	<0.0020	<0.0060
BL-S3	Bullion Lower - soil from north waste rock pile	<0.0050	<0.010	0.0275	<0.0020	<0.0060
BU-S1	Bullion Upper - Adit #2	<0.0050	<0.010	0.0092	<0.0020	<0.0060
BU-S2	Bullion Upper - Dump face of Adit #1	<0.0050	<0.010	0.0062	<0.0020	<0.0060

Soil Sample ID	Specific Location	*Pb	*Se	*Hg
BL-S1	Bullion Lower - soil from south pile	<0.0050	0.015	<0.00020
BL-S2	Bullion Lower - soil from south pile	<0.0050	<0.010	<0.00020
BL-S3	Bullion Lower - soil from north waste rock pile	<0.0050	<0.010	<0.00020
BU-S1	Bullion Upper - Adit #2	<0.0050	<0.010	<0.00020
BU-S2	Bullion Upper - Dump face of Adit #1	<0.0050	0.017	<0.00020

*** All units are mg/kg**

4.4 AIR MIGRATION PATHWAY

There are not any permanent residents living within 4 miles of the Bullion Mine. Two (2) public drinking water wells are located within a 4-mile radius; the wells are located at the Dena Mora Eastbound and Westbound Rest Stops on Interstate 90 near Saltese, Montana and lie 3.29 miles northeast from the mine. The rest areas serve non-resident, transient populations of 500 persons (each) from May 1st to October 30th, but the rest stops are closed during the winter months.

No previous air sampling activities were conducted at the Bullion Mine, nor did DEQ conduct any. The lack of potential receptors, coupled with apparent stability of the source areas, precluded the need to conduct sampling.

The waste rock dump located adjacent to Tunnel No. 3 is situated in a riparian zone and is typically not susceptible to strong wind flow. The soils are lightly compacted and provide an adequate rooting medium for the establishment of pines and an under-story of dense brush. The waste dumps are becoming overgrown with annual and perennial vegetation. The waste rock dump associated with Tunnel No. 2 was partially compacted into the FS Road 507 roadbed. The top portion of the dump is heavily covered with brush, while the lower, south-facing slope is barren. The co-joined waste dump from Tunnel No. 1 and Shaft No. 1 is more densely covered with brush. However, due to the limited vehicle traffic combined with the vegetative cover, the potential for aerial dispersal from the waste dumps appears to be very low.

5 SUMMARY AND CONCLUSION

The Bullion Mine is an inactive gold and copper mine located along the southeastern flank of the St Joe Mountains, near the Idaho-Montana border, within the St Joe River drainage. The Bullion consists of two distinct workings: the Upper, located near the headwaters of an unnamed tributary of Bullion Creek, and the Lower, located near the north side of Bullion Creek. The wastes generated from both the Upper and Lower operations are confined to waste rock. The mine was said to have 12,080 feet of workings, including three tunnels (500 feet, 2,000 feet and 4,800 feet long), two shafts, and one raise.

The principal exposure pathways are surface water and soil. Seeps, springs and ground water drainage from underground workings percolate through waste rock material into the surface water, Bullion Creek. The average residential risk associated with the arsenic in soils is approximately 1.6E-03. As this risk is based on prolonged exposure to humans, which appears unlikely at this site, this risk is likely acceptable if an on-site recreational exposure is considered.

Data from sampling of soils, waste rock, sediments and surface water at the Bullion Mine indicate potential risk to recreational users from soil ingestion. While average arsenic soil concentrations indicate an approximate risk of 2.2E-03 (using Region IX PRGs – residential scenario), one sample on the south waste rock pile showed an approximate 1.5E-01 risk. This high arsenic concentration appears in only one sample and is not considered indicative of ambient site conditions.

Water quality analyses indicate arsenic is above the MCL in the Tunnel #2 and Tunnel #3 discharge by 5 µg/L and 1 µg/L, respectively. However, surface water is not above MCLs for metals in any of the Bullion Creek samples. The North Fork St. Joe River within the TDL has been designated by DEQ as a 303(d) listed stream for the pollutant of concern, which is temperature. It does not appear the former mining activity associated with the Bullion Mine has any impact on the temperature of Bullion Creek (this pollutant of concern).

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