

Star Mine Preliminary Assessment Report

Blaine County
State of Idaho



Department of Environmental Quality

December 2006

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

Star Mine
Preliminary Assessment Report
December 2006

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List of Acronyms

Acronym	Definition
303 (d)	Section of the Clean Water Act in Idaho
AMSL	Above mean sea level
ATV	All Terrain Vehicle (a.k.a. four-wheeler)
bgs	below ground surface
DEQ	Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
gpm	gallons per minute
PA	Preliminary Assessment
ppm	parts per million
TDL	Target Distance Limit
TMDL	Total Maximum Daily Loads
USBM	United States Bureau of Mines
USFS	United States Forest Service
USGS	US Geological Survey

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Section 1. Introduction

This document presents the results of the preliminary assessment (PA) of the Star Mine. 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 preliminary assessments at various mines within the Mineral Hill Mining District in Blaine County, Idaho.

The DEQ often receives complaints or information about sites that may be contaminated with hazardous waste. These sites can include abandoned mines, rural airfields that have served as bases for aerial spraying, old landfills, illegal dumps, and abandoned industrial facilities that have known or suspected releases.

In February 2002, DEQ initiated a Preliminary Assessment Program to evaluate and prioritize assessment of such potentially contaminated sites. Due to accessibility and funding considerations, priority is given to sites where potential contamination poses the most substantial threat to human health or the environment.

For additional information about the Preliminary Assessment Program, see the following:

http://www.deq.idaho.gov/waste/prog_issues/mining/pa_program.cfm

1.1 Overview

The Mineral Hill Mining District is located in the south-central part of Blaine County, west of the Big Wood River Valley near the towns of Hailey and Bellevue. There are multiple historic mining sites within the district, although this preliminary assessment addresses only one site within the Star Gulch sub-watershed.

The Star Mine is situated along Star Creek, a tributary to the Big Wood River, at approximately 6,000 to 6,500 feet above mean sea level (AMSL). The Star Mine exists on patented land at latitude 43.4799° N and longitude 114.3177° W, within Section 28 of Township 2N & Range 18E.

The general location of the mines is identified in Figure 1. The closest town to the mining site is Hailey, which is approximately two miles by air and four miles by road. Figure 2 shows the topography around the site, and Figure 3 presents an aerial view.

The former mines can be reached from Hailey by driving east along Croy Creek Road, then south along Colorado Gulch Road. The public has access to the mine on roads across U.S. Bureau of Land Management (BLM) lands, and there are no locked gates or posted signs in proximity to the mine site.

1.2 Historical Perspective

Ore was first discovered in 1864, and the boom days of the region were in 1880 to 1887. The total production has amounted to more than \$25,000,000, most of which came from lead-silver ore, with minor amounts from gold, copper and zinc ore

Umpleby, et al, 1930, p. 87-88

Discovery of the Minnie Moore mine in 1880 marked the beginning of the most prosperous era that the area enjoyed, but the years of greatest productivity came to an end within a decade...The discovery of more ore at the Minnie Moore in 1902 initiated another period of considerable productivity that lasted for several years. At the same time active work was carried on at the Croesus and other properties

Anderson, 1950, p. 9

The Star mine was “worked extensively in the early days and then intermittently until 1928-29” (ibid, p. 22). Later activity at the mine extended operations intermittently until 1968 (Worl & Lewis, 2001).

Ore mined in the early days was very rich. Much of it was reported to have averaged 40 to 60 per cent of lead and 40 to 120 ounces of silver to the ton, and numerous shipments were of far higher grade. Small lots containing as much as 2,000 ounces of silver to the ton were mined...Zinc is present in nearly all the ore. In most of the ore it is an abundant accessory...Gold is present in nearly all of the lead ore in amounts ranging from a few cents up to rarely \$5 to the ton...Little attention appears to be given to copper by mining men in the Big Wood River region, but much of the lead-silver ore contains more or less of this metal.

Umpleby, et al, 1930, pp. 87-88

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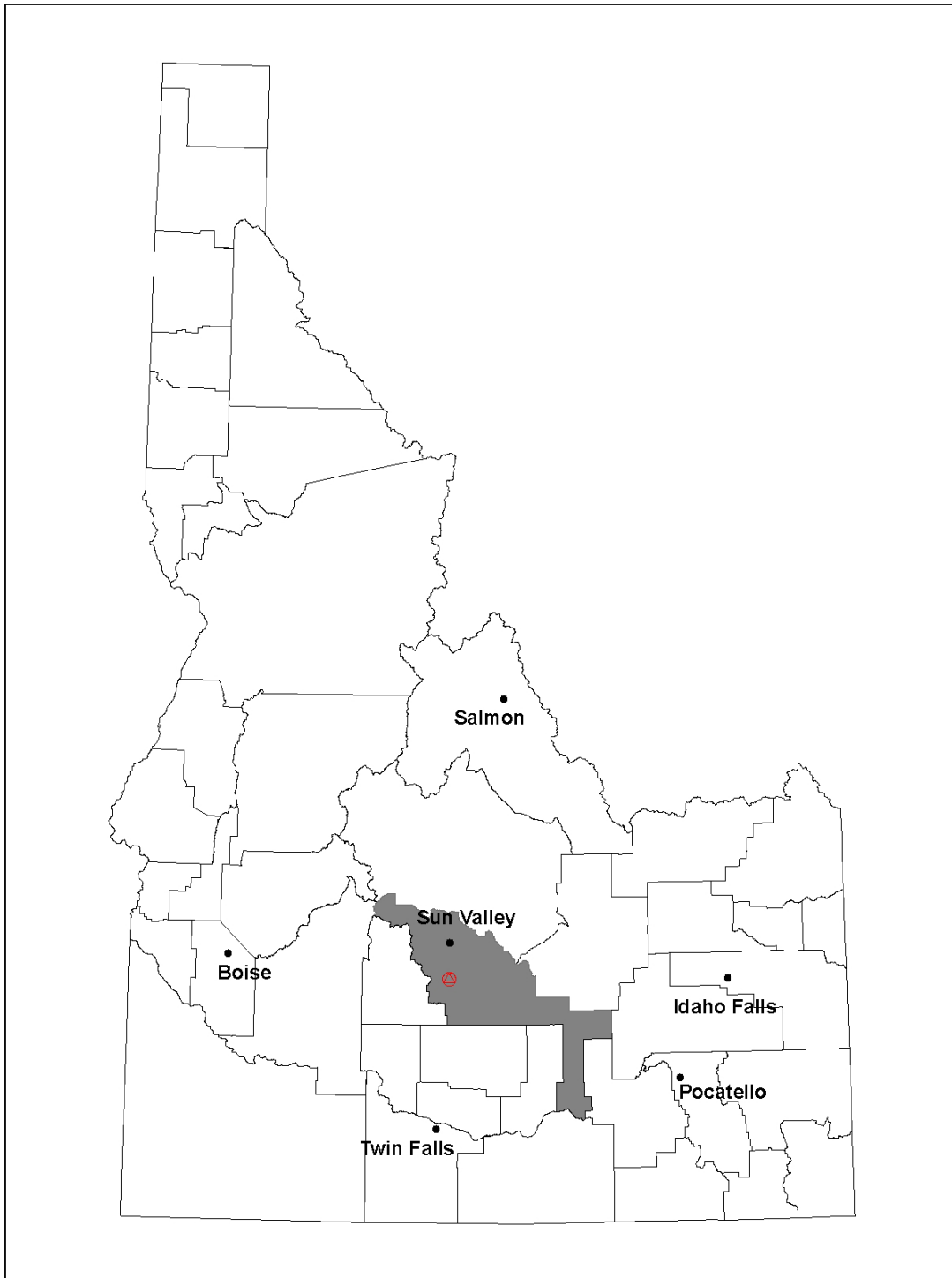


Figure 1. Location of the Star Mine within the state of Idaho.

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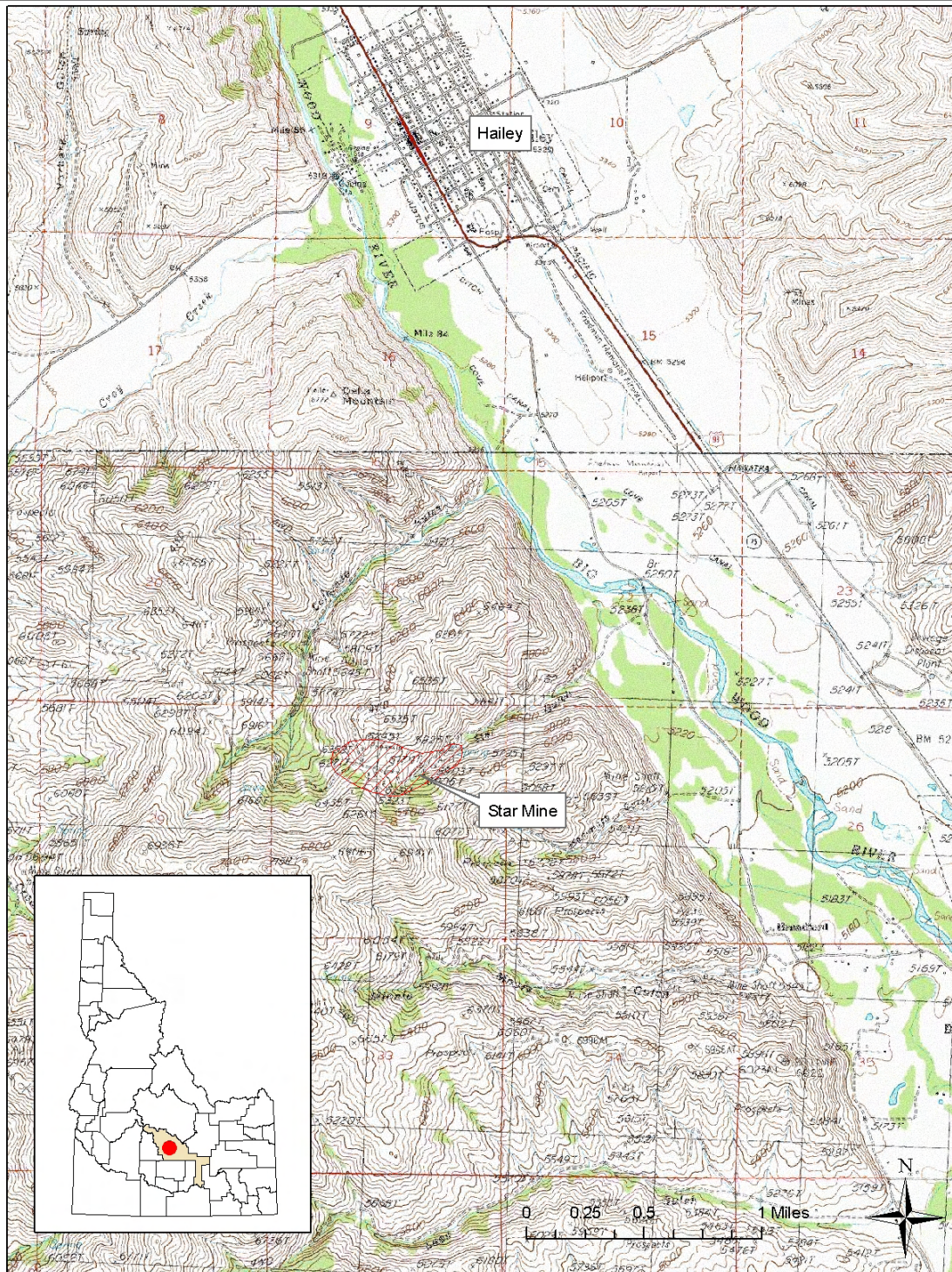


Figure 2. Topographic overview of the Star Mine area.

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Figure 3. Aerial photograph of the Star Mine area.

Section 2. Site Description, Operational History, and Waste Characteristics

Physical characteristics of the Star Mine site is presented in the following, along with the mines' operational histories and characteristics of the wastes that remain.

2.1 Ownership

The Star Mine property currently comprises the Hancock, Centre, Concordia, and Star Quartz patents. David Falk, et al. received a patent on the Star Quartz in 1882, which probably initiated mineral development in Star Gulch. David Falk and Alonzo Wolters, put up the Wood River Smelting Company plant at Hailey in 1881 (IDHistory, 1981).

Later, John Lemp and Nathan Falk were issued patents for the Concordia and Hancock in 1890 and the Centre in 1893. At a later date, John Lemp, Jr. assumed ownership of all four patents.

According to the Blaine County Tax Assessor, the owner of record is Lemp Development Company, Inc. Their mailing address is: 3745 23rd Street, Boulder, Colorado 80302. The site contact person is John Lemp, Jr., who can be reached at (303) 449-0907.

2.2 History, Ore and Production

Anderson (pp. 22-23) describes the early history of the mine:

The mine was worked extensively in the early days and then intermittently until 1928-29. The production is not known but is considerable. The property consists of three patented claims and the development includes seven tunnels at as many levels and an old shaft from which much of the early work was done. All the tunnels are caved, but the lower tunnels are known to possess lengths of over 2,000 feet. More recent exploratory work has been confined to bull-dozed cuts above and in line with the series of tunnels.

The mine is reported to have two veins about 90 feet apart of which one is known as the Hanging Wall vein and the other as the Footwall vein. These are in the diorite not far west of the contact between the diorite and the Milligen formation. Each vein is in a fissure also occupied by a light-colored 5- to 7-foot wide dike, either a bleached lamprophyric dike or a silicic porphyry. Ore is reported to occur on either of both sides of the dikes but not within. Between the sixth and seventh levels, the veins are reported to dip

70° - 80° NE. Where exposed in the surface, the vein appears to strike N. 70° - 80° E.

The Footwall, or the more southerly vein, is reported to have been the most productive and to have contained ore over a maximum thickness of 6 feet on the sixth and seventh levels. The ore is reported as “clean” and to form a continuous shoot not less than 200 feet long on the seventh level. A winze has been sunk on the seventh level, but as the winze was sunk vertically, it passed into the footwall of the vein and away from the ore. In the Hanging Wall vein, the ore shoots are reported to have been short and narrower, at no place being more than 4 feet wide.

The ore is composed largely of galena with lesser amounts of sphalerite, chalcopyrite, tetrahedrite, and pyrite associated with a little siderite and quartz. Shipments to the smelter in 1928 contained from 12 to 65 per cent lead, 0.13 to 0.65 per cent copper, 3 to 13 per cent zinc, and 44 to 140 ounces of silver per ton. In general, the silver content of the ore seems to depend more on the amount of copper than lead, which suggests that the silver is largely contained in tetrahedrite.

The ore is reported to show increase in zinc with depth, but otherwise there is no observable change in the character of the ore from the top to the bottom of the mine. Six feet of zinc ore is reported unmined on the sixth level.

Another vein is exposed a short distance east of the Star, extending from the bottom of the gulch to the crest of the ridge in a northerly direction. In places, the vein forms a ledge projecting above the surface. Whether this vein is on the Star property or not was not learned. The vein is in the black argillites of the Milligen formation and may be traced for some hundreds of feet by short tunnels, cuts, and ledge exposures. Locally, the vein measures 4 feet wide, dips 80° SW, and is contained between well-defined walls. The outcrop is stained by iron and manganese oxides, apparently formed by weathering of siderite



Figure 4. Aerial photograph of the Star Mine.

2.3 General Geology

Numerous studies of the geology and mineral resources of the Wood River and adjacent areas have been made. Geologic studies have been conducted to investigate mineral deposits (Lindgren, 1900 & 1933; Umpleby et al, 1930; Anderson and Wagner, 1946; Anderson et al, 1950; Hall et al, 1978; Wavra and Hall, 1989; Link and Worl, 2001; Worl and Lewis, 2001); individual formations and units (Hall et al, 1974; Sandberg et al, 1975; Wavra and Hall, 1986; Worl and Johnson, 1995); quadrangles (Batchelder and Hall, 1978; Mitchell et al, 1991; Kiislgaard et al, 2001) and to compile regional information (Rember and Bennett, 1979).

The general geology of the area, depicted in Figure 5, was described by Anderson (1950, p2) who described the geology of the site:

The Hailey-Bellevue mineral best is underlain by a varied assemblage of sedimentary and igneous rocks, which, except for volcanics of mid-Tertiary age and some still younger unconsolidated sedimentary rocks, are all older than the ore deposits. The earlier rocks include fairly wide exposures of the

Milligen and Wood River formations-the host of so many of the ore deposits in the Wood River region-and also rather large intrusive bodies of diorite and quartz monzonitic rock which are regarded as outliers of the Idaho batholith. There is also a younger group of intrusive rocks which are of more pertinent interest because of their close association with the mineralization....In addition to the Milligen formation (Mississippian age) and the Wood River formation (Pennsylvanian age), the area contains some strata in and beneath a series of Tertiary volcanics (Oligocene) and much poorly consolidated and unconsolidated slope wash, terrace gravels, and stream alluvium of Quaternary age.

Anderson (p 7) went on to note that, "The folding within the area is comparatively simple and consequently faulting constitutes the outstanding feature."

2.4 Stratigraphy and Lithology

Anderson (p 7) noted the presence of the Milligen formation:

"The Milligen formation is present on both sides of the Big Wood River Valley and on the southwest slope of the high ridge between Big Wood River Valley and Rock Creek. In many places it lies in normal contact with the Wood River formation, though in some places it is in fault contact with the Wood River formation...In the southwest side of Big Wood River it is along a zone of complicated faulting and extensive mineralization.

The formation is comprised of an upper sequence of grayish calcareous shales with some purplish and buff shales and a few thin beds of impure limestone, while the lower sequence consists mainly of black carbonaceous shales and argillites with several discontinuous beds of dark gray and black limestone and locally thick lenses of light-colored sandstone and quartzite. The lower sequence of the Milligen formation is easily recognizable with its predominantly dark color and is the most important portion of the formation owing to its tendency to localize deformation and mineralization"

The area around Star Gulch is underlain by the Devonian Milligen formation, the Dollarhide and Wood River formations of Pennsylvanian and Permian age, and by intrusive granitic rocks of Cretaceous age. The Milligen formation is characterized by black argillite and phyllite, dark-colored calcareous sandstone and siltstone, and carbonaceous calcareous limestone (Worl, et al, 1991).

"The area of granite and diorite west of Bellevue contains many dikes, and the near-by sedimentary rocks contain a few sills...The dikes show a wide range in color and mineral composition. The rocks that resemble the diorite in composition are found in two sill-

like bodies-one 500 feet north of the Star shaft...” (Umpleby, et al, 1930, p. 214).

Anderson assigned the black-shale host rocks as belonging to the Milligen formation of Mississippian age, whereas later authors (Warva and Hall) assigned the rocks to Middle Pennsylvanian and Lower Permian Dollarhide while Link and Worl assigned the same rocks to the Middle Devonian Milligen. Regardless of the stratigraphic nomenclature, the mineralization apparently concentrated near intrusive bodies, along shear and fault zones.

2.5 Structure

Anderson (1950, p. 2) noted the following in regards to the structure of the rocks:

“The various rocks exhibit complex structural relationships. The Milligen and Wood River formations have been folded and greatly faulted with some of the faulting preceding and accompanying the intrusion of the different igneous rocks and some of it coming after intrusion, in part long after”

Umpleby, et al (1930, p. 217) noted a broad anticline southwest of the river:

Southwest of the river the beds dip generally westward at inclinations that largely range from 20° to 40°. It's thus clear that the sediments form a broad anticline, of which the crest almost coincides with the Big Wood River Valley...The underlying Milligen formations shows a wide range in local dip and strike...At the mouth of Star Gulch...these beds are locally crumpled or closely folded”

Link and Worl (2001, p. 12) mapped areas nearby the Minnie Moore mine in Colorado and Star Gulches. They noted the rocks of the Dollarhide Formation were located:

“on the west (upper) ends of Colorado and Star Gulches in a northward-widening band east of the Croesus stock. This is one of the few places where the Dollarhide and Milligen Formations are in contact. The exposed contact is sharp and linear, and beds are parallel across it. These features suggest that the contact is a sheared unconformity...A low-angle, shallow dipping, top-to-the-west normal fault cuts the upper parts of the Colorado Gulch. Between Colorado and Star Gulches, this fault cuts the Snoose vein in its footwall. The fault also cuts the ridge to the north of Colorado Gulch...”

Link and Worl (ibid, pp.18-19) also that ore occurs in fracture zones:

“In the Colorado and Star Gulches, ore is hosted by high-angle fracture systems that trend northwest and dip mostly southwest...A major low-angle top-to-the-northwest normal fault terminates the mineralized veins north of Star Gulch”

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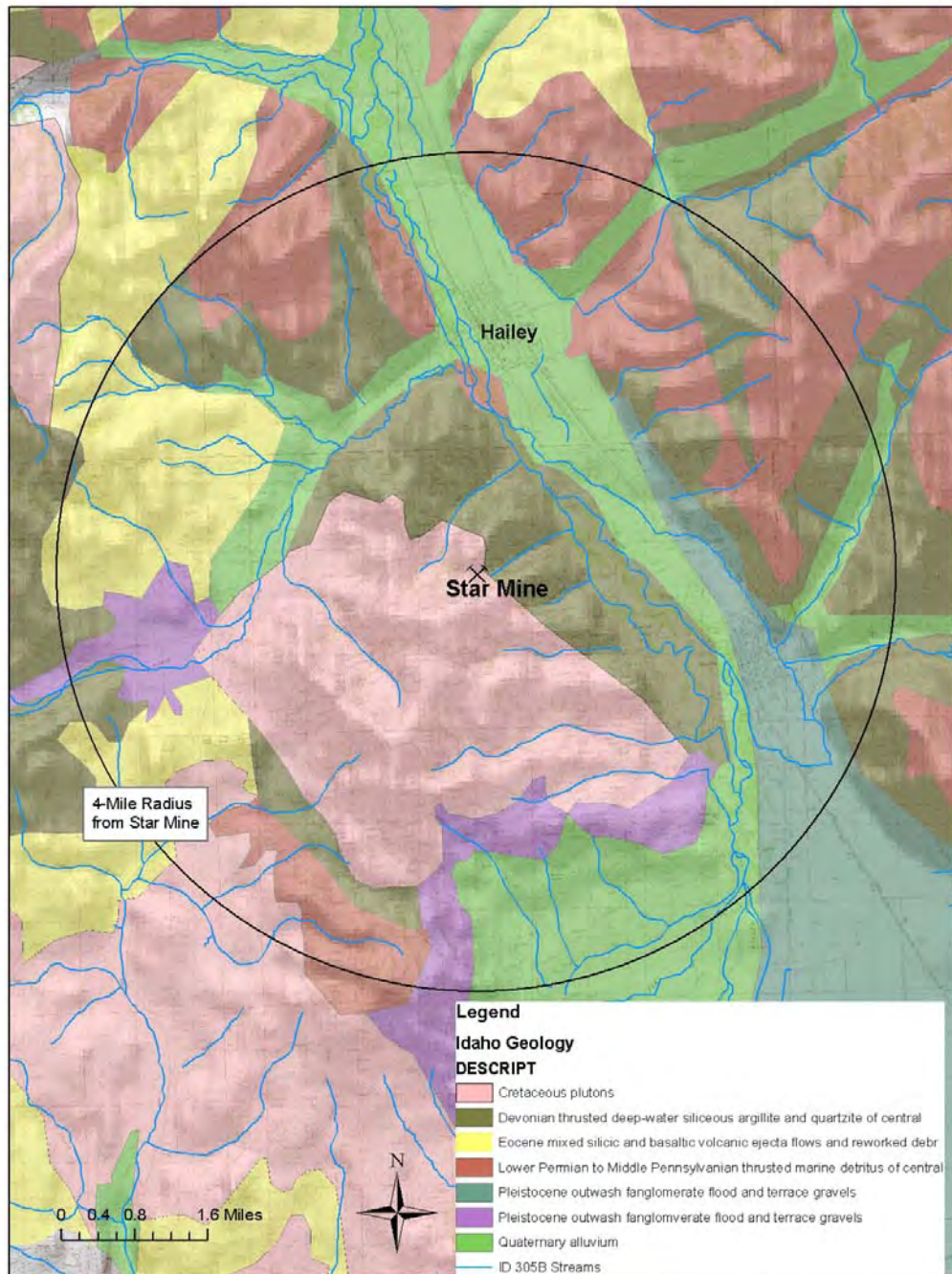


Figure 5. Geologic map of the Star Mine area.

Section 3. Current and Potential Future Land Uses

Current land uses in the area include biking, hiking, horseback riding and off-road vehicle touring. The Star Mine is accessible from an unnamed and non-maintained road that branches from the Colorado Gulch road. During the course of the field work conducted, the DEQ site investigators observed hikers and mountain bikers traversing the Colorado Gulch road, and it is presumed that the adjacent Star Gulch road is similarly accessed.

3.1 Fish Species Observed

Fish presence/absence studies have not been conducted on Star Creek to confirm any fish species that may reside in this stream. Redband rainbow trout [*Oncorhynchus mykiss gairdneri*], mountainwhitefish [*Prosopium williamsoni*], wood river sculpin [*Cottus leiopomus*], and brook trout [*Salvelinus foninalis*] are present within the Big Wood River (IDFG, 2000).

3.2 No Apparent Wetlands

Official wetland surveys for the area could not be found, but aerial photographs as well as direct observation seem to indicate that the Star Creek valley contains no wetland areas.

3.3 Future Land Use

Future land use could potentially include some year-round and/or seasonal homes on the private parcels of property in the sub-basin, owing to its close proximity to the Hailey and Bellevue communities.

Section 4. Individual Site Overview and Waste Characteristics

DEQ conducted a site visit on July 11, 2006, which included a visual inspection of the Star Mine and collection of one (1) water sample and eight (8) soil and sediment samples from the sampling locations shown in Figure 6. The samples were designated as shown.

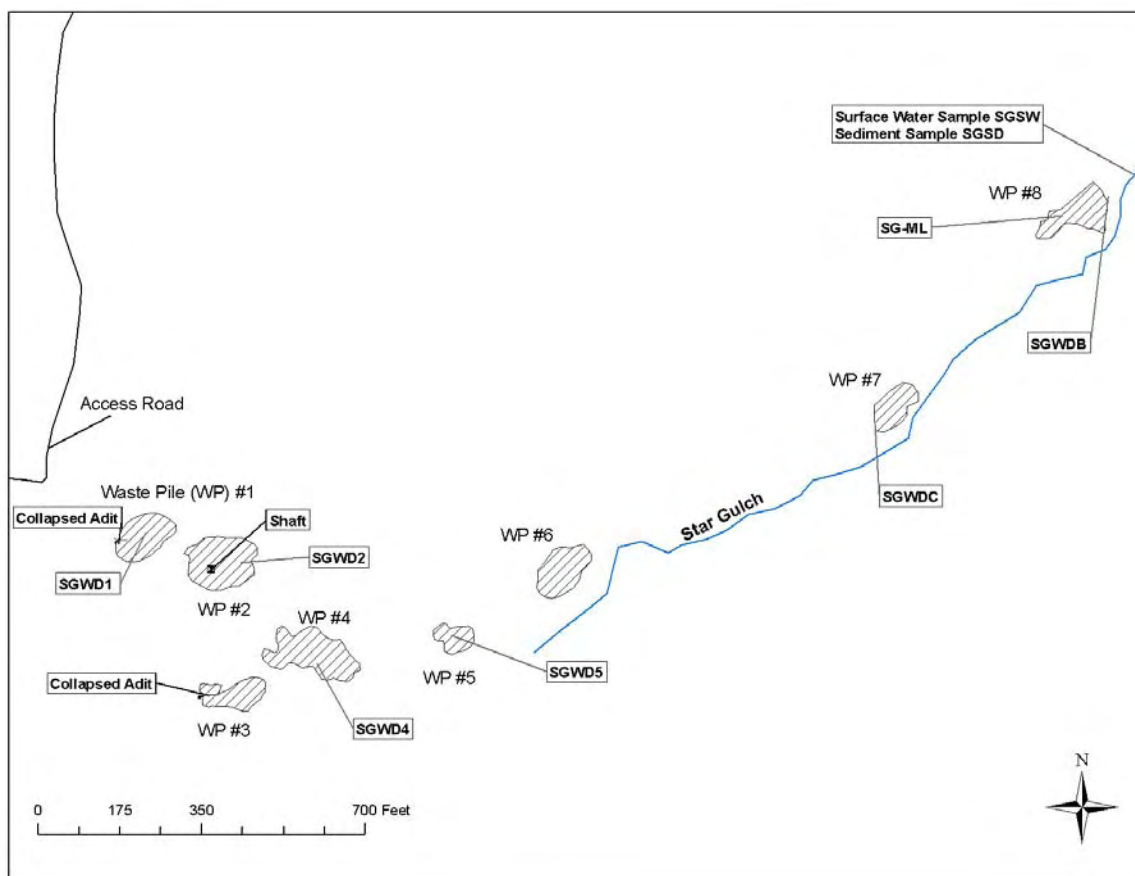


Figure 6. Small scale sketch of the Star Mine and environmental sampling locations.

4.1 Sampling Results

Table 1 and Table 2 present the results of the sampling. Boldface values in Table 1 are in excess of the Idaho Initial Default Target Levels (IDTLs) as described in the Idaho Risk Evaluation Manual (REM).

The water sample (SGSW) was collected from Star Creek approximately 150 feet downstream of all mining activity. A sediment sample (SGSD) was collected at the same time the water sample was collected. Results from these samples can be seen in Table 2.

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The stream and sediment sample location is down gradient of the mining activity and is considered to be the Point of Potential Exposure (PPE).

Table 1. July 2006 total soils analysis for Star Gulch, Blaine County, Idaho.

Analyte	Soil Sample SGWD1 (mg/kg)	Soil Sample SGWD2 (mg/kg)	Soil Sample SGWD4 (mg/kg)	Soil Sample SGWD5 (mg/kg)	Soil Sample SGWDB (mg/kg)	Soil Sample SGWDC (mg/kg)	Soil Sample SG-ML (mg/kg)	Idaho Initial Default Target Levels under REM (mg/kg)
Arsenic	133	129	190	89.1	95.6	1380	110	0.391
Barium	28	254	127	222	208	46.2	129	896
Cadmium	17.6	35.5	77.1	10	2.47	13.8	53	1.35
Chromium	29	135	77.1	166	77	46.6	39.4	2130
Lead	4160	1410	1770	647	57.8	1340	1260	49.6
Mercury	0.734	0.486	0.193	0.153	0.011	0.092	0.079	0.00509
Selenium	2.5	2.5	0.6	2.3	0.8	18.3	5.2	2.03
Silver	72.3	16.7	24.3	5.5	0.8	10.1	28.1	0.189

* Boldface types indicates value exceeds Idaho Initial Default Target Levels (IDTLs)

Table 2. Surface Water Sample Results from Star Creek, below the Star Mine.

Constituent of Concern	Star Creek Surface Water Result (mg/l)	Idaho Water Quality Standards for cold water biota ¹ (mg/L)	Star Creek Sediments Results (mg/kg)
Total Arsenic	0.062	0.36	42.5
Total Barium	0.04	NA	60
Total Cadmium	0.0012	0.0037	3.83
Total Chromium	0.006	0.550	28.1
Total Lead	<0.002	.065	38.1
Total Mercury	<0.0002	.0021	0.009
Total Selenium	0.012²	.0020	2
Total Silver	<0.002	.0034	0.3
Field Parameters			
pH	9.0 std. units		
Specific Conductance	470 µsiemen/cm		
Temperature	15.0 °C		
Dissolved Oxygen	10.70 mg/L		
Turbidity	290 NTU		

¹ Standards are based on a total hardness of 100 mg/L.

² Exceeds Idaho Water Quality Standards for cold water biota.

Table 1 shows that the soils collected from the waste piles exceed the IDTLs for arsenic, cadmium, lead, mercury, selenium, and silver. Table 2 shows that the water collected from Star Creek meets Idaho water quality standards with the exception of selenium. The water sampled is considered a good indication to the potential impacts to nearby surface water bodies due to the location of the samples collected.

4.2 Inspection Findings

DEQ also mapped the volume of the mine waste piles within the Star Gulch drainage at approximately 50,000 cubic yards (cy). The Star Mine waste piles are located above the flowing portion of Star Creek. The mine operated on the northeast side of Star Creek, on mostly open south-facing slopes, which allowed DEQ personnel the ability to make good observations and assessments. Associated with the mine are significant waste piles that can be seen throughout the upper portions of the drainage. All former structures at the site have been reduced to scattered rubble (Photo 1).



Photo 1. Remnants of a structure at the bottom of Star Gulch, looking east, down the drainage.

The Star Mine has eight significant waste piles that were inspected during the DEQ site visit (Photo 2). The waste piles were arbitrarily named Waste Pile #1 through Waste Pile #, 8 in the order in which they were mapped (Figure 6). The eight waste piles exist on steep slopes of approximately 15 percent.

4.2.1 Waste Pile #1

Waste Pile #1 is located on the eastern section of the mine property. This waste pile measured approximately 130 feet long, 60 feet wide, and 20 feet thick. Waste debris has slumped off the pile and built up along the pile's toe. The pile currently stretches from an old access road on the southern hillslope down to within approximately 100 feet of the next waste pile, Waste Pile #2. A caved adit was noted on the western side of this pile.



Photo 2. View looking east down Star Gulch. Multiple waste piles can be seen scattered throughout the drainage.

The Waste piles are composed of variable-sized grains, ranging from 3-5 mm in diameter to large boulders, with the majority of the material having a fairly uniform grain size. The

waste pile materials have weathered from a light gray to a reddish brown. Almost no vegetation has reclaimed the site except the occasional bunches of grass and sagebrush (Photo 2 and Photo 3).

Soil sample SGWD1 was collected at the top of Waste Pile #1, in various locations across the pile at approximately 2 inches deep. No surface water was visible anywhere on the waste pile or within the vicinity of the pile.

4.2.2 Waste Pile #2

Waste Pile #2 is located to the southeast of Waste Pile #1 on the same south-facing hillslope. It measures approximately 60 feet long, 100 feet wide, and 30 feet thick (Photo 3). An old road has been cross-cut through the waste pile that joins Waste Pile #1. The remnants of a shaft were seen in the central portion of this pile.



Photo 3. View of Waste Pile #2, looking south from Waste Pile #1.

Soil sample SGWD2 was collected on the top of Waste Pile #2. The sampling technique used to collect the sample was similar to the one used for Waste Pile #1: a composite sample across the top of the dump approximately 2 inches below the surface. No surface water was observed to be flowing on or across Waste Pile #2 during the site visit. The composition and color of Waste Pile #2 was very similar to that of Waste Pile #1. In addition, Waste Pile #2 also has not yet been reclaimed by a healthy stand of native vegetation.

4.2.3 Waste Pile #3

Waste Pile #3 is located approximately 200 feet due south of Waste Pile #2 and is the furthest most upgradient waste pile observed in Star Gulch. This pile measured approximately 140 feet long, 80 feet wide, and approximately 20 feet thick. Waste debris has slumped to the east down drainage. A caved adit was noted on the western edge of the pile. No visible water was observed that was associated with this pile. No samples were collected from this pile.

4.2.4 Waste Pile #4

Waste Pile #4 is located approximately 75 feet to the east and down drainage of Waste Pile #3. Waste Pile #4 appears to be composed of multiple smaller indistinguishable piles that have slumped together into one larger pile. The overall pile measured approximately 150 feet wide, 120 feet long, and approximately 25 feet thick. No adits or shafts were observed at this pile.

Soil sample SGWD4 was collected from a composite of the surface (top 2 inches) of waste pile. The composition and color of the dump was similar to that of the previous dumps investigated. No water was seen associated with this dump.

4.2.5 Waste Pile #5

Waste Pile #5 is located approximately 150 feet to the east and down drainage of Waste Pile #4. This waste pile measured approximately 90 feet long, 60 feet wide, and 20 feet deep. Soil sample SGWD5 was collected as a composite sample of the surface material of this dump. No visible water was seen associated with this dump.

4.2.6 Waste Pile #6

Waste Pile #6 is located approximately 150 feet to the east and down drainage of Waste Pile #5. This pile measured approximately 140 feet long, 90 feet wide, and 25 feet thick. Soil sample SGWDC was collected from this waste pile. No visible water was seen associated with this waste pile.

4.2.7 Waste Pile #7

Waste Pile #7 is located approximately 600 feet down drainage and to the east of Waste Pile #6. This pile measured approximately 120 feet long, 60 feet wide, and 20 feet thick. Soil sample SGWDC was collected from this waste pile. No visible water was seen associated with this waste pile.

4.2.8 Waste Pile #8

Waste Pile #8 is the furthest down-drainage waste pile observed in Star Gulch. This pile is located approximately 375 feet to the east of Waste Pile #6. This pile measured approximately 150 feet long, 90 feet wide, and 20 feet thick. Timbers, metal, and old concrete remnants were observed around this pile. Soil samples SGWDB and SG-ML

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were collected from this pile. No water was seen associated with this waste pile; however, Star Creek began flowing approximately 100 feet below the toe of this waste pile.

Section 5. Pathway and Environmental Hazard Assessment

Pathway and environmental hazards were assessed for groundwater, surface water, and soil/air exposure. The findings from these assessments are presented in the following.

5.1 Groundwater

Ground water flow is expected to primarily follow faults and brecciated zones within the country rock and have surface expressions as expressed as springs. In the Star Creek drainage, no springs were witnessed and none of the observed adits had water flowing from them. Densely vegetated portions of the hillsides indicate potential ground water discharge areas, however, due to the timing of the site visit, no distinct springs could be mapped.

Contributions to the aquifer in close proximity to the Star Mine will predominantly be as a direct result of precipitation or surface water. Star Creek is a perennial stream that flows into the Big Wood River. Annual precipitation for Hailey, Idaho, located approximately 2 miles to the northeast, is 16 inches, predominately during the winter months, with an average annual snowfall of 81 inches (WRCC, 2006).

Dry-season rainfall occurs almost exclusively in relatively short bursts, usually related to thunderstorm activity. It is expected that, except for flash flood-type events, almost all dry-season rainfall events would be completely absorbed by the soils and plants, without much, if any, contribution to the ground water. However, because the waste rock piles have limited soil, and exist adjacent to Star Creek, a higher percentage of this rainfall would be expected to drain into the stream.

According to Idaho Department of Water Resources July 2002 records, 338 private drinking water wells are reported to be located within a 4-mile radius of the site. Majority of these wells are located across the Big Wood River and closer to the nearby towns of Hailey and Bellevue. Ten (10) public drinking water systems are located within a 4-mile radius of the site (Figure 7). The nearest downgradient well is located approximately 0.9 miles from the mine site, with a static water level of 4 feet bgs, measured on October 19, 1997. Based on historical monitoring data for the public water systems associated with the cities of Hailey and Bellevue, metal contamination does not appear to be concern in the aquifer that supplies these systems (DEQ, 2006).

Sixty-five (65) irrigation wells were identified within a four-mile radius of the site (Figure 7), and the site is not located within a wellhead protection area (DEQ, 2003). There is no monitoring data available from these wells to determine if any impacts related to the mining site have occurred.

Due to the location of majority of the wells, however, it is unlikely that any impacts related to the mining activities will be detected in these wells (DEQ, 2006). The wells that are located downgradient of the mine site and are completed in the alluvial materials associated with the Big Wood River, drawing water from a separate aquifer than what is

directly below the mine site. Ground water impacts associated with this mine site would be a greater concern if more shallow wells were located closer to the site. Due to the current location of the nearby domestic wells with respect to the mine location, it appears these wells are a sufficient distance from the mine site to avoid any ground water impacts associated with this mine site.

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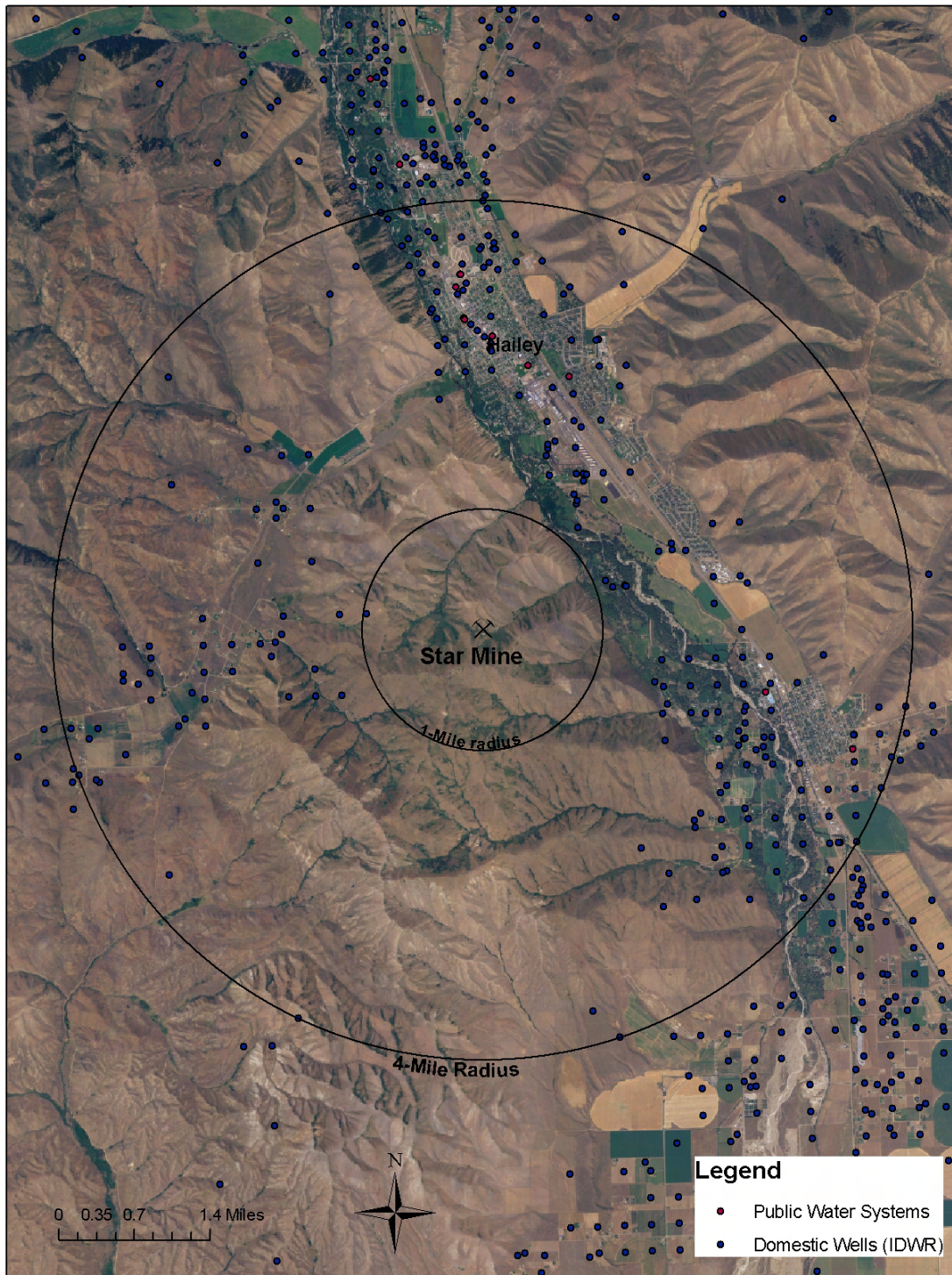


Figure 7. Domestic wells and Public Water System wells located with a four-mile radius of the Star Mine.

5.2 Surface Water

The Star Mine area drains eastward towards the south-flowing Big Wood River. Multiple potential *Probable Point of Entry* (PPE) points exist at the waste piles located at the Star Mine site. Overland flow across or in the vicinity of the waste piles would flow directly into Star Creek. Star Creek is not currently listed on the EPA §303(d) list of impaired streams, but the Big Wood River is currently listed for flow alteration, nutrients, and siltation.

Star Creek, a tributary of the Big Wood River, is the most immediate stream the Preliminary Assessment site could potentially impact. The majority of the mining activity in Star Gulch occurred upgradient from the flowing portion of Star Creek. The adits, shaft, and waste piles are located high in the Star Gulch drainage on the north side of the drainage.

Flowing water was observed in Star Creek only in the lower portion of the stream. The majority of this drainage did not experience any flowing surface water until water began to seep just below Waste Dump #8. From this point, the stream gained water and shortly formed a flowing water body. During the site visit, the flow rate of Star Creek was approximately five gallons per minute. It is unknown as to how much of Star Creek receives water during the wet seasons.

Commercial or subsistence fishing does not occur within the 15-mile downstream distance, but sport fishing does. As camping may occur in places along Star Creek, it is unlikely that fishing occurs in this stream. Redband rainbow trout [*Oncorhynchus mykiss gairdneri*], mountainwhitefish [*Prosopium williamsoni*], wood river sculpin [*Cottus leiopomus*], and brook trout [*Salvelinus foninalis*] are present within the Big Wood River (IDFG, 2000).

Figure 8 depicts the drainage patterns of these water bodies as well as the 15-mile downstream *Target Distance Limit* (TDL) located on the Big Wood River.

There are no surface water intakes for drinking water or any type of industry within the 15-mile TDL.

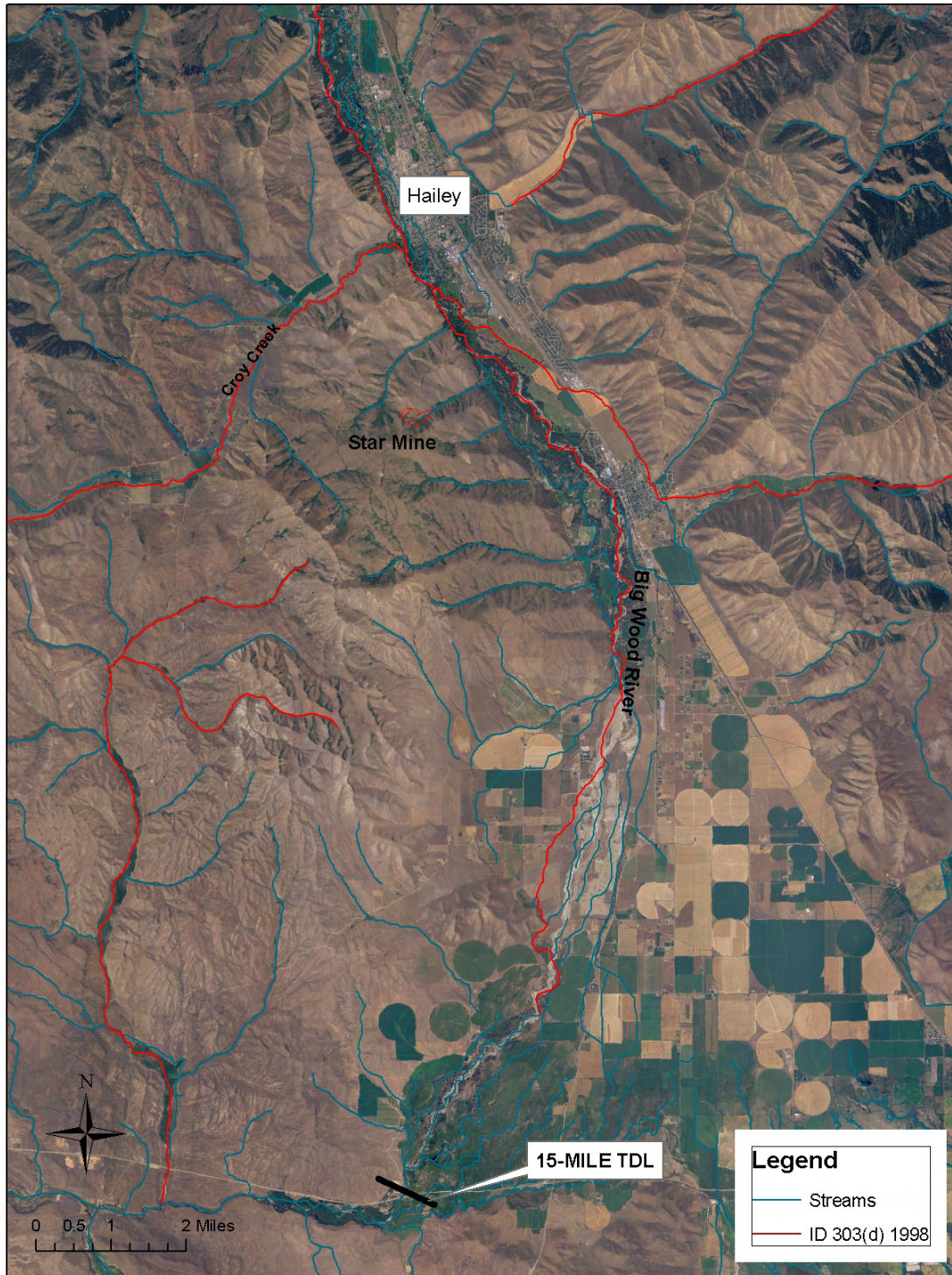


Figure 8. Surface water 15-mile Target Distance Limit from the Preliminary Assessment Site.

5.3 Soil Exposure and Air

Access to the mine site is not restricted or posted, and there were numerous indications of public use of the site for recreation. A spur road from the main access road to Colorado

Gulch allows public access to the site. Four-wheel drive vehicles may be able to drive down through Star Gulch on old abandoned roadways. Some signs indicating that private land are present and other signs warning of potential mining activity exist at the bottom of the drainage. Most of the private land access points in the lower drainage are posted with trespass information.

5.3.1 Potential Receptors

Potential receptors include local residents, hunters, anglers, cattlemen, trail riders (motorized and non-motorized), campers, and rarely, tourists. Cattle activity surrounding and within the mine site is minimal. Residents and outdoor enthusiasts remain the likeliest potential receptors, as they reside nearby or use surrounding land for recreational activities.

The land within a two (2) mile radius of the site is primarily BLM land, but minor amounts of private land exist. The parcels of land occupied by the mines and waste dumps are leased or owned by private parties.

5.3.2 Schools, Day-Care Facilities, Private Residences

There are no schools, day-care facilities, or private residences within 200 feet of the site, but BLM or Forest Service workers, in addition to the outdoor recreation enthusiasts, may occasionally be within 200 feet of the site.

5.3.3 Plant Species of Concern

Bugleg goldenweed was the only plant species of concern (F&G, 2002) within a 4-mile radius of the mining site (Figure 9). Animal species listed as a species of concern that are located within a 4-mile radius of the site include Gray Wolf, North American Wolverine, Western Toad, and Canadian Lynx (F&G, 2002).

5.3.4 Soil Sample Concentrations

Soil samples contained total arsenic concentrations ranging from 89 to 1,380 mg/kg. Barium concentrations ranged from 28 to 254 mg/kg. Cadmium concentrations from soil samples ranged from 2.47 to 77 mg/kg. Chromium concentrations ranged from 29 to 166 mg/kg. Lead concentrations ranged from 58 to 4,160 mg/kg. Mercury concentrations ranged from 0.01 to 0.7 mg/kg. Selenium concentrations ranged from 0.6 to 18.3 mg/kg. Silver concentrations ranged from 0.8 to 72.3 mg/kg. Analytical results can be seen in Table 1.

Because the mine workings begin at the top of the ridge in the watershed, background samples were not collected during this investigation, so it is difficult to analyze the elevated concentrations reported to a background level to determine the amount of impacts this mine has had on the surficial soils.

Relative to the Idaho *Initial Default Target Levels* (IDTLs) soil exposure at the mines is expected to be elevated for all receptors, due to the high concentrations measured in the soil samples. These IDTLs are risk-based target levels for certain chemicals that have

been developed by DEQ using conservative input parameters, a target acceptable risk of 10^{-6} , and a *Hazard Quotient* of 1. These values are designed to aid in the development of clean-up and remediation goals that would allow the closure of a site based on the risks associated with various receptors for specific media to be less than 10^{-6} .

If the IDTL is exceeded for any constituents, two options are available:

1. Adopt the IDTLs as the cleanup levels and develop a *Risk Management Plan* (RMP)
2. Perform a more detailed, site-specific evaluation, which includes developing site-specific background concentrations for comparative purposes.

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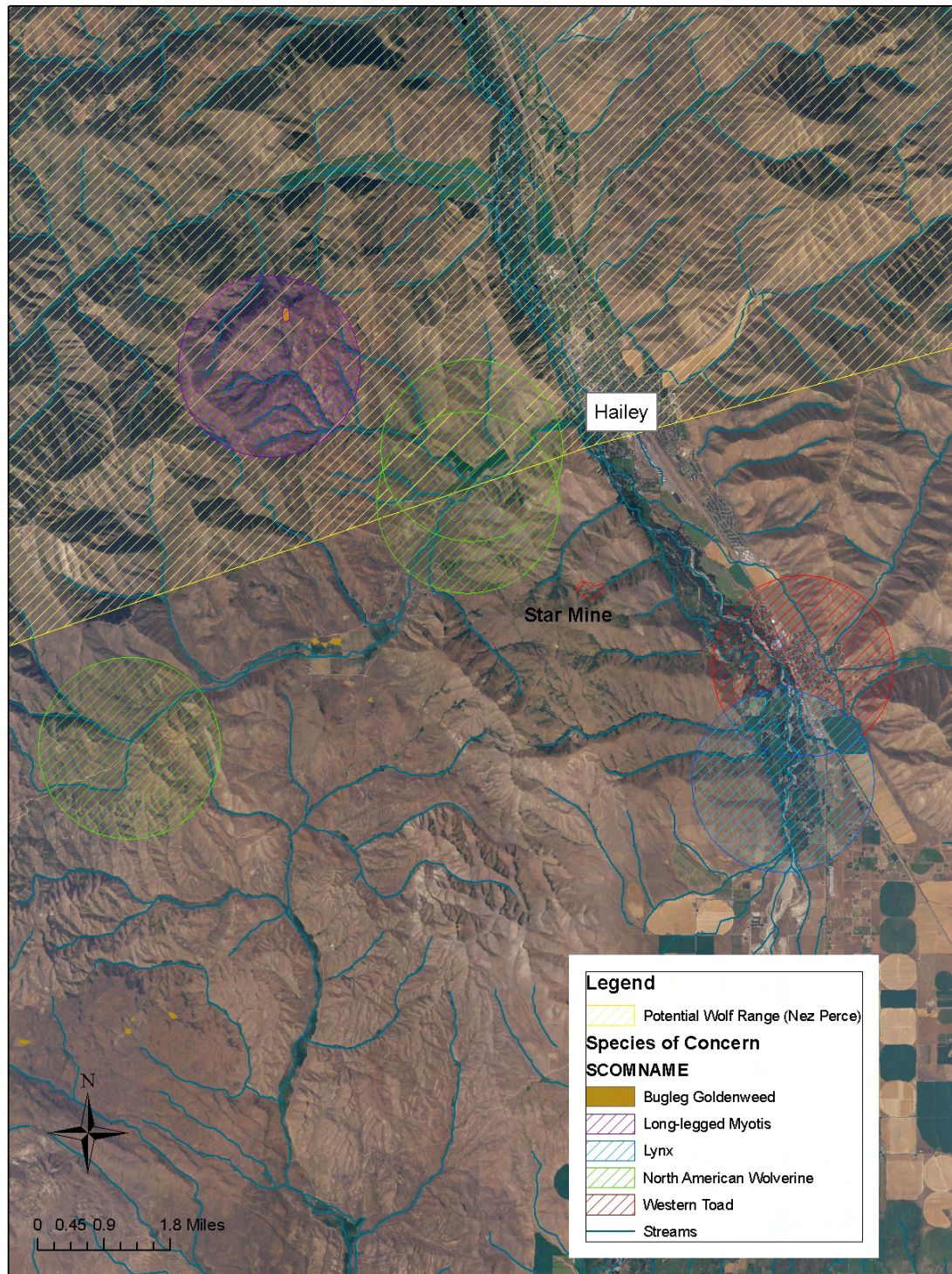


Figure 9. Sensitive species identified in the vicinity of the Preliminary Assessment Site.

Section 6. Summary and Conclusions

The Star Mine operated extensively in the 1880s, intermittently until 1928-29, and lastly until 1968. Though no production was recorded, shipments to the smelter in 1928 contained from 12 to 65 percent lead, 0.13 to 0.65 percent copper, 3 to 13 per cent zinc, and 44 to 140 ounces of silver per ton.

Most structures relating to mining activity have fallen, burned or been covered. Waste rock piles, remnants of historic structures, and the remains of a few collapsed adits can be seen in the area. No adits remain open and human activity in the area appears to be limited. Soil samples taken from the waste piles at the Star Mine contained elevated concentrations of metals. A water sample collected in this drainage showed no significant signs of overall water quality degradation.

6.1 Presence of Wetlands

Based on official wetland surveys and aerial photographs of the area, no wetlands exist near the site or within the 15-mile TDL. Therefore, potential impacts to wetland areas associated with this mine site can be neglected.

6.2 Impacts on Water Quality

The surface water sample (sample SGSW in Table 2) showed that the water quality in Star Creek appears to be within standards for aquatic life with the exception of selenium. However, the selenium concentrations measured in Star Creek are only slightly elevated with respect to the Idaho Water Quality Standards, indicating this selenium issue in the surface water may not be significant enough to warrant additional work. Moreover, it appears that human activity in Star Gulch is minimal, further justifying the basis for no further action.

Surface water samples were not collected from the Big Wood River downstream of the confluence with Colorado Creek to determine the impacts (if any) that could occur in the Big Wood River. The receptors of greatest concern are game fish, as they are exposed to the water that showed elevated metal concentrations and may later be consumed by humans.

Ground water impacts related to the mine site are currently unknown. However, monitoring data associated with the public water systems located near the cities of Hailey and Bellevue indicates no metal contamination exists within the producing aquifers for each system. The location and distribution of private domestic wells with respect to the mine site suggest impacts related to the mine site may be insignificant, but this suggestion cannot be verified due to a lack of analytical data.

6.3 Potential Exposure for Wildlife and Vegetation

Potential exposure of wildlife and vegetation waste to rock piles from the site is present. The high salinity of the waste piles may entice local wildlife to consume it due to the high salt content. In addition, the native plant species may bio-accumulate high concentrations of metals that may be consumed by the local wildlife. The wildlife that may be exposed to elevated concentrations of metal (via water, soil, or plant material) may be harvested and consumed by humans.

6.4 Potential Exposure for Humans

Human activity around the mine site is minimal, based on the observations during the site visit. There was very little evidence of recent human activity in Star Gulch during the site visit. Mountain bikers, hikers, hunters, snow mobile operators, off-road four wheeling enthusiasts, and various other outdoor recreation enthusiasts may potentially frequent the area as access is not restricted.

Although the waste piles have been shown to have high metal concentrations, exposure for humans to the elevated metal concentrations is low due to a lack of human activity near the site. Fugitive dust and direct contact with the waste piles are the two main mechanisms through which humans could be exposed to the metal concentrations at the site. These sources do not appear to be substantial enough to warrant any further investigations of this site.

6.5 Recommendations

Overall, the soil samples collected from the site show elevated metal concentrations with respect to Idaho's Initial Default Target Levels. The samples that indicated high metal concentrations were collected in areas that are accessible to human activity, but these areas do not appear to be a significant issue due to the lack of recent human activity in the area. Therefore, with respect to the elevated metal concentrations in the soil and water collected, additional work is not warranted.

Water quality within Star Creek appears to be within the criteria for the Idaho Water Quality Standards for cold water biota with the exception of selenium. Assuming no additional impacts related to this mine site exist below the PPE sample location, no additional work is warranted based on the water quality data presented.

DEQ recommends no further action be taken on this site based on the data presented in this report and the observations made in the field during the site visit.

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