NATURAL RESOURCES

INACTIVE AND ABANDONED MINE LANDS: Spada Lake and Cecile Creek Watershed Analysis Units, Snohomish and Okanogan Counties, Washington

by Richard W. Phipps,
Donald T. McKay, Jr.,
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Contents

APPENDICES

FIGURES

TABLES

Inactive and Abandoned Mine Lands—Spada Lake and Cecile Creek Watershed Analysis Units, Snohomish and Okanogan Counties, Washington

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INTRODUCTION

Washington State contains more than 3,800 inactive and/or abandoned metal mines located on private, state, federal, and tribal lands (Fig. 1) (Huntting, 1956; U.S. Bureau of Mines, 1995). Most of these mines became inactive prior to the enactment of environmental laws requiring reclamation (Norman, 2000). Conditions at these sites are largely undocumented. Problems can include physical hazards, such as open shafts, collapsing adits, and derelict structures (Fig. 2). Less obvious problems may include substandard water quality, such as acid mine drainage (AMD) and metals transport to surface and ground water. Many mine openings now serve as critical habitat for bats and other wildlife (Tuttle and Taylor, 1994).

Previously in Washington State there has been no systematic database of inactive and abandoned metal mines (Norman, 2000). Previous work by the Department of Natural Resources (DNR) has had a distinctly commodity-oriented focus (Huntting, 1956; Derkey and others, 1990). Our current goal is to build a single database and geographic information system (GIS) coverage of major mines in the state—to be known as the Inactive and Abandoned Mine Land (IAML) inventory. Documentation will focus on physical characteristics and hazards (openings, structures, materials, and waste) and water-related issues (acid mine drainage and/or metals transport). Accurate location, current ownership, and land status information will be included. Acquisition of this information is a critical first step to determine if remedial or reclamation activities are warranted. Open-File Reports (OFRs) will provide written documentation on mines or groups of mines within specific mining districts or counties.

More than 3800 mineral properties have been located in the state during the last 100 years (Huntting, 1956). Many are undeveloped prospects of little economic importance. In considering the population to include in the IAML inventory, we have identified about 60 sites that meet one or more of the following criteria: (a) more than 2000 feet of underground development, (b) more than 10,000 tons of production, (c) location of a known mill site or smelter. This subset of sites includes only metal mines no longer in operation.

We have chosen to use the term *inactive* in the project's title in addition to the term *abandoned* because it more precisely describes the land-use situation regarding mining and avoids any political or legal implications of surrendering an interest to a property that may re-open with changes in economics, technology, or commodity importance.

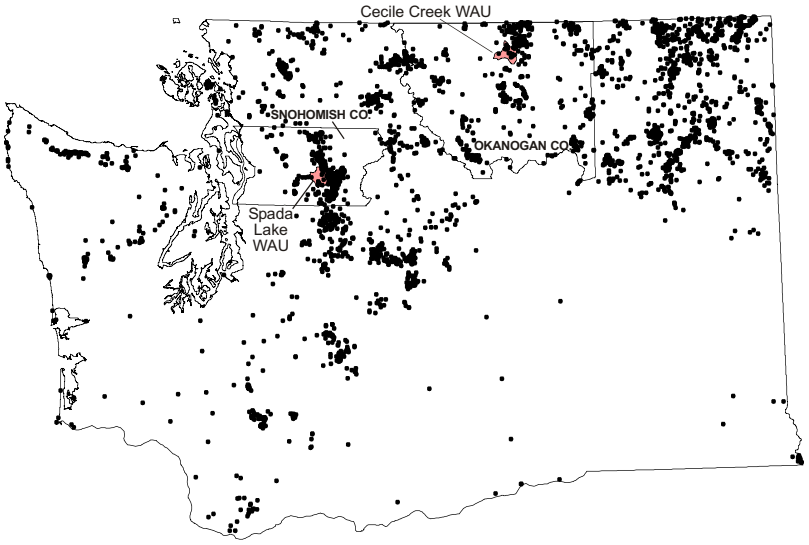

Figure 1. Distribution of inactive and abandoned mine lands sites in Washington (USBM, 1997). Shaded areas depict watershed analysis units (WAU) selected for this project.

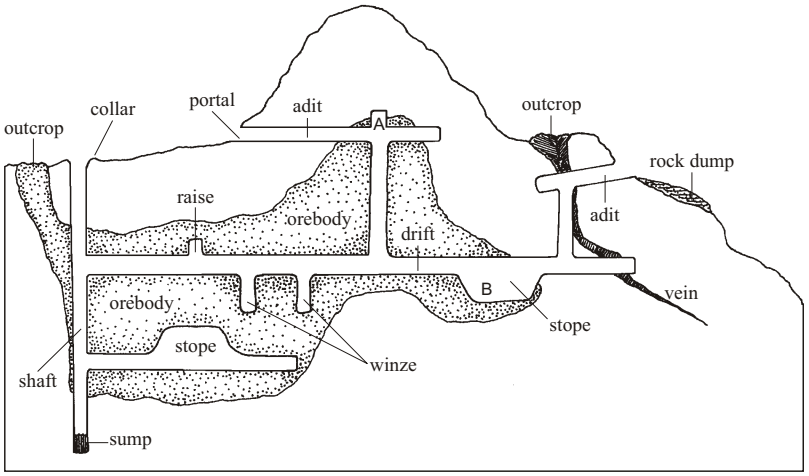

Figure 2. Typical underground features and terminology for a mine on a vein system (Tuttle and Taylor, 1994). [Reprinted with permission from *Bats and Mines*, Resource Publication No. 3; Bat Conservation International, Inc., PO Box 162603, Austin, Texas 78716; 512-327-9721; www.batcon.org.]

Hazard Note/Disclaimer: Inactive and abandoned mines can present hazards to life and limb. Hazards include, but are not limited to: unstable or hidden shafts and highwalls, unstable adit walls and ceilings, shafts covered by deteriorating timbers, deep pools of water, poisonous gases, depleted oxygen, dangerous chemicals, and unstable explosives. DGER personnel did not enter any mine openings during this reconnaissance.

Creation of the state-managed IAML database is a cooperative effort between DNR, the U.S. Forest Service (USFS), the U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (DOE). DNR's Division of Geology and Earth Resources (DGER) is the lead agency. To date, USFS contracts have been the principal source of funding, with other contributions coming from DNR and EPA.

METHODS

Although this is not the first IAML report published, it describes a project initiated during the field season of June through September of 2000. The project was to conduct an inventory and field inspections of abandoned mine sites in geographically dissimilar areas with notable mining histories. A statewide survey of major abandoned and inactive metal mines (Derkey and others, 1990) shows concentrations of historical mining activity throughout the Cascades and across most of northeastern Washington (Fig. 1). In western Washington, many of the known sites are clustered in Snohomish County, along the west-central portion of the Cascade Range (Sultan–Index area). In eastern Washington, a similar concentration is found in the highlands of Okanogan County (Loomis–Oroville area).

As we thought about the project, the need for a watershed approach became evident. Examining abandoned mine sites on a watershed basis allows for more efficient, effective, and objective reclamation planning. A watershed approach provides a detailed look at the condition of individual abandoned mine sites and helps pinpoint probable sources of metals transport. This approach also integrates well with watershed analysis work conducted by other agencies, wherein a watershed can be treated as a whole and action sites within any given watershed can then be prioritized.

Based on the locations of historical mining districts with respect to surface water and public lands, one watershed analysis unit (WAU) was selected in each of these areas. In Snohomish County, we selected the Spada Lake WAU, which includes portions of the old Sultan and Silverton mining districts, as well as the Spada Lake Reservoir, the municipal water supply for the city of Everett. In Okanogan County, we selected the Cecile Creek WAU, which includes portions of the old Palmer Mountain and Gold Hill mining districts, as well the Sinlahekin Wildlife Recreation Area, managed by the Washington Department of Fish and Wildlife (WDFW).

We divided our research for this project into literature review and field inspection. Our literature review built upon information about mineral occurrence and production at the mine sites from three databases:

- The Mineral Industry Location System (MILS) table of the Minerals Availability System (MAS), compiled by the U.S. Bureau of Mines (USBM, 1995). When the USBM closed in 1996, the database was transferred to the U.S. Geological Survey.
- An electronic version of *Inventory of Washington Minerals, Part II—Metallic Minerals* (Huntting, 1956)
- An electronic version of *Metal Mines of Washington—Preliminary Report* (Derkey and others, 1990)

These three databases were designed for researching mineral availability, so their utility was limited. While each database was valuable for certain information not available in the other databases, they each had their own shortcomings for the purposes of the project. For example, MAS/MILS is a fairly comprehensive list of mines, but some mine locations are inaccurate. Derkey and others (1990) has accurate locations, but lists only 541 of the larger mines (those with documented ore production in excess of $1000). Huntting (1956) is more comprehensive than Derkey and others (1990), but there is no information on newer mines. Also, because Huntting did not list latitude and longitude, his location data could not be entered directly into a GIS coverage to place sites on a map. Nevertheless, these databases provided a good foundation.

Plotting the mine coordinates from MAS/MILS and Derkey and others (1990) was our first step. We prepared maps showing the locations of documented mines relative to hydrologic features, transportation infrastructure, and public land ownership. These maps were compared to USGS and DNR quadrangle maps that displayed other features such as recreational facilities and significant structures. Mines within the chosen WAUs were identified, and the search for additional information sources on those mines commenced.

Literature review provided information about location, access routes, extent of underground workings and surface development, presence of acid-producing or -neutralizing minerals, potential for bat habitat, and proximity to water. Sites were prioritized for field inspection based on the extent of underground excavations, presence of multiple mine openings, and potential for acid mine drainage and metals transport to surface and ground water. We added to the sites identified through the databases when other mines in the study areas were identified elsewhere in literature or discovered during field inspections.

Field inspections were performed to verify locations, describe physical hazards, and identify water-quality problems. Because underground mine workings pose hazards such as unstable ceilings and floors, hidden shafts, poisonous gases, depleted oxygen, dangerous chemicals, and explosives, DNR staff were instructed not to enter any open mines. Details on underground workings were compiled through literature review, except to the extent that an observation could be made from outside the mine portal (for example, observing that an adit contained standing water and was collapsing near the portal). Therefore, all dimensions reported for underground workings observed during field visits are estimates.

A few sites were relatively close to existing roads or trails. Most sites required significant overland hikes. We reached some of the sites by helicopter. The amount of time spent at any given mine depended upon the complexity of the mining operation (a single feature or a complex of several remote features) and ranged between 15 minutes and 4 hours. At each site, we recorded observations through use of a form (Appendix A), field sketches, digital photography, and a handheld global positioning system (GPS) unit.

Mine openings can provide critical habitat for bats (Tuttle and Taylor, 1994). While at the mine portals, we also recorded observations related to the potential for bat habitat, such as portal aspect, air flow, temperature difference inside and outside of the portal, and presence of multiple mine openings at different elevations. Our field inspection forms were modified from the U.S. Bureau of Mines "AML Inventory Form" (USBM, 1994) (Appendix A). This form is commonly recognized by other land management agencies and is compatible with previous inventory work done by others (for example, Okanogan County Health District, 1994). One field inspection form was completed for each mine site.

Identifying sites with water quality problems was usually done by site inspection rather than literature research: Water quality was assessed by the following criteria—presence of wa-

ter on or within mine workings, waste rock or mill tailings, and pathways and chemical characteristics, including pH, conductivity, and metals content.

- Is water present within the mine workings, waste rock, or mill tailings?
- Where is the water going? Is it flowing to other surface waters or infiltrating back into soil?
- What are the chemical characteristics (pH, conductivity, metals content) of the water?

If water and/or sediment was present, we made field tests and collected samples for analysis at the contract laboratory, Sound Analytical Services, in Fife, Washington. Although we varied field tests at some sites to reflect geologic conditions (for example, specific metals known to be present at one site but not others), the primary analytes were arsenic, copper, iron, lead, zinc, mercury, and sulfate (Table 1). Conductivity and pH were also recorded.

We used the following equipment:

- handheld GPS unit (accuracy 20–50 feet, depending upon satellite availability, surrounding topography and timber canopy closure)
- field test kits (typically test strips or titration kits) for iron, copper, zinc, lead, sulfate
- digital pH meter and litmus paper
- digital conductivity meter
- water and sediment containers supplied by the contract laboratory (water samples for metals analysis were collected in preserved sample containers; others were unpreserved)
- digital and analog thermometers (centigrade)
- barometric altimeter
- digital camera
- binoculars
- headlamps and high-powered flashlight

Table 1. Washington State Water Quality Standards. Metal concentrations are g/L, uncorrected for hardness; hardness is in mg/L. – – –, no data

Type of standards (applicable Washington Administrative Code)	Arsenic	Copper	Lead	Zinc	Hardness
Surface water standards (WAC 173-201A, Standard for aquatic life in surface freshwater, chronic level maximums at 100 mg/L hardness)	190	11.4	2.5	104	100
Ground water standards (WAC 246-290, Washington State Department of Health, standards for ground water, domestic consumption)	50.0	1300	15	5000	– – –

Spada Lake Watershed, Snohomish County, Washington

SUMMARY

Geography

The Spada Lake watershed analysis unit (WAU) (Fig. 3) encompasses approximately 44,300 acres (69.2 mi^2) in the upper reaches of the Sultan River basin in Snohomish County. The rugged, high-elevation ridges and peaks of the Cascade Range rim the northern, eastern, and southern flanks of the WAU (Fig. 4), ultimately directing all surface water flow westward toward Spada Lake and Culmback Dam. The primary drainages contributing to Spada Lake are (north to south)—Williamson Creek, North Fork Sultan River, Elk Creek, and South Fork Sultan River.

Climate

The area has a temperate marine climate, receiving between 80 and 140 inches of precipitation per year. The precipitation is strongly influenced by the Cascade Range front on the east side of the WAU, so it is not evenly distributed. The lowest annual precipitation occurs near Culmback Dam on the western end of Spada Lake (elevation ~1,500 feet msl) and falls primarily as rain. The greatest annual precipitation falls primarily as snow near Big Four and the Sheep Gap Mountains (elevation ~6,000 feet msl).

Vegetation

Vegetative cover is primarily conifer forest, mostly split between very mature and immature (harvested and reforested within the last few decades). Dense underbrush (devils club, vine maple) dominates valley floors and peripheral drainages.

Land Ownership

Land ownership (Fig. 5) is mostly public. The State of Washington owns approximately 60 percent of the land, managed as either commercial forest land (fiduciary trust) or as Natural Resource Conservation Areas for preservation and recreation. The U.S. Forest Service manages approximately 20 percent of the WAU, primarily for recreation purposes. Approximately 15 percent of the area—the land immediately surrounding Spada Lake reservoir and extending upstream along the lower reaches of Williamson Creek—is managed as municipal watershed. The remaining land (<5%) became privately owned through the patenting of mine claims many years ago. Two such privately owned areas are the group of claims in the northernmost portion of the WAU (including the "45" and Little Chief mine sites) and a smaller group of claims at

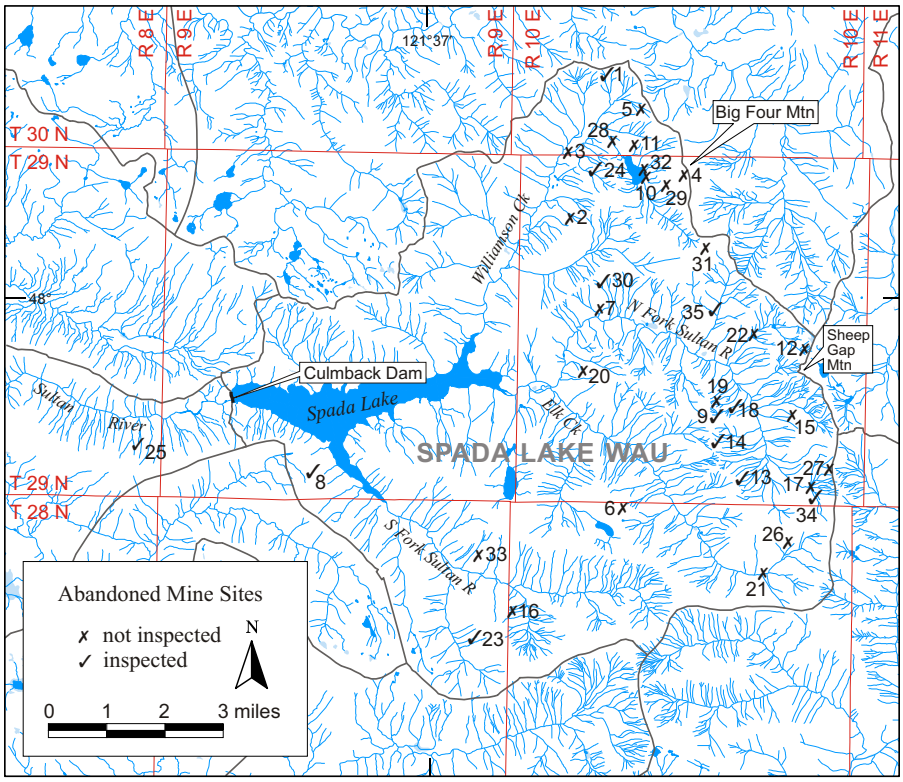

Figure 3. Surface waters in the Spada Lake WAU. Clockwise from the top: Williamson Creek, North Fork Sultan River, Elk Creek, and South Fork Sultan River. Numbers identify abandoned and inactive mine sites: 1. "45" mine, 2. Ala-Dickson mine, 3. Alpha and Beta placers, 4. Big Copper mine, 5. Big Four mine, 6. Blue Stone mine, 7. Bolding-Wood prospect, 8. Border Queen mine, 9. Calumet mine, 10. Copper Lake mine, 11. Cornucopia mine, 12. Cu WO3 prospect, 13. Doris mine, 14. Florence Rae mine, 15. Goat Haven mine, 16. Golden Eagle mine, 17. Helena & Sadie mine, 18. Iowa mine, 19. Jerry Chatman mine, 20. John Newhouse mine, 21. Jones prospect, 22. Kelly Creek mine, 23. Kromona mine, 24. Little Chief mine, 25. Lockwood Pyrite mine, 26. Marvel mine, 27. Miiki Maru mine, 28. Milwaukee mine, 29. Milwaukee & Silver Horseshoe mine, 30. Mountain Cedar mine, 31. Occidental mine, 32. Silver Horseshoe mine, 33. St. Theresa mine, 34. Sultan King mine, 35. Sunrise mine.

Figure 4. Rugged peaks and incised tributary drainages of the North Fork Sultan River. Arrows denote locations of adits.

the southeastern edge of the WAU (including the Sultan King mine).

Surface-Water Development

The most significant surface-water development in or near the WAU is the Spada Lake reservoir (and Henry M. Jackson Hydroelectric Project) on the Sultan River, a tributary to the Skykomish River. It is operated by the City of Everett and Snohomish County Public Utility District No. 1 as a municipal water supply and for hydroelectric power generation. The Sultan River was first developed in 1917 as a water supply source for the City of Everett. The reservoir was created in 1965 with the completion of the Culmback Dam, primarily to provide water supply storage. In 1984, the dam was raised 90 feet as part of the Henry M. Jackson Hydroelectric Project. Approximately 7 miles to the west, additional storage capacity is provided off-channel by the Chaplain Lake reservoir, from which municipal water supplies are drawn. Currently, the Sultan River is the primary source of water for more than 410,000 people in Snohomish County (Pacific Groundwater Group, 1995).

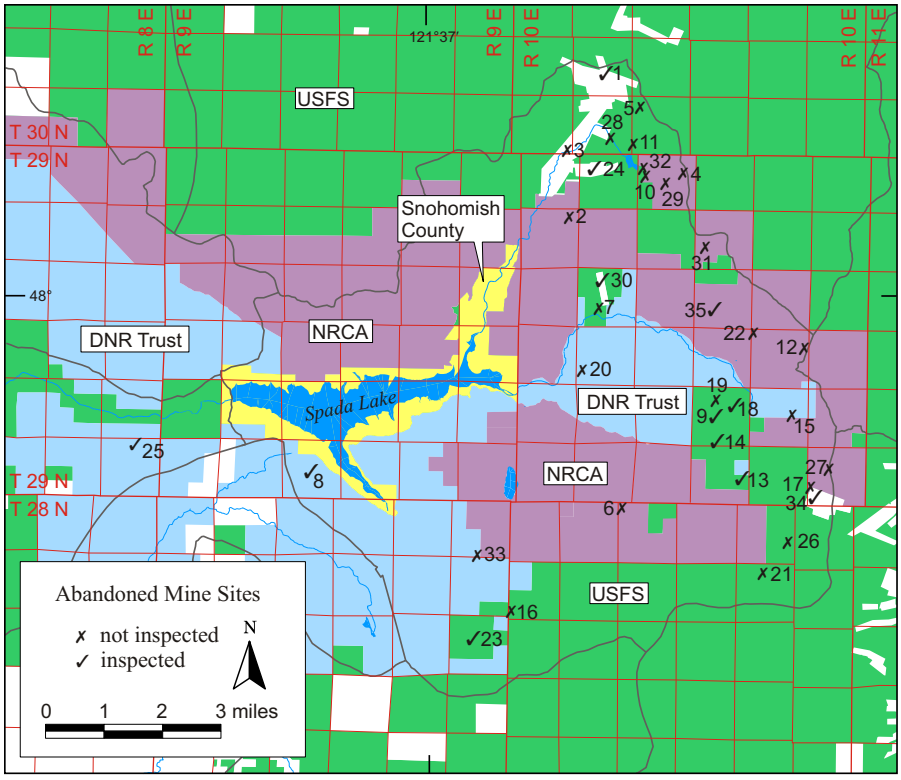

Figure 5. Distribution of land ownership within the Spada Lake WAU. Numbers identify abandoned and inactive mine sites: 1. "45" mine, 2. Ala-Dickson mine, 3. Alpha & Beta placers, 4. Big Copper mine, 5. Big Four mine, 6. Blue Stone mine, 7. Bolding-Wood prospect, 8. Border Queen mine, 9. Calumet mine, 10. Copper Lake mine, 11. Cornucopia mine, 12. Cu WO3 prospect, 13. Doris mine, 14. Florence Rae mine, 15. Goat Haven mine, 16. Golden Eagle mine, 17. Helena & Sadie mine, 18. Iowa mine, 19. Jerry Chatman mine, 20. John Newhouse mine, 21. Jones prospect, 22. Kelly Creek mine, 23. Kromona mine, 24. Little Chief mine, 25. Lockwood Pyrite mine, 26. Marvel mine, 27. Miiki Maru mine, 28. Milwaukee mine, 29. Milwaukee & Silver Horseshoe mine, 30. Mountain Cedar mine, 31. Occidental mine, 32. Silver Horseshoe mine, 33. St. Theresa mine, 34. Sultan King mine, 35. Sunrise mine.

Geology and Mineralization

The Spada Lake WAU is underlain mainly by Tertiary granodiorite and tonalite of the Index batholith and mid-Cretaceous to Tertiary slate, phyllite, semischist, graywacke, and argillite of the Western mélange belt (Tabor and others, 1988, 1993). Sandstone and argillite in the mélange belt grade eastward into slaty argillite, slate, phyllite, and semischist in the upper Sultan Basin area (Tabor and others, 1993).

Granitic rocks intruded the older sedimentary rocks of the Cascades during the Cretaceous and early Tertiary. Most of the ore deposits of the Spada Lake basin occur as hydrothermal deposits in fissures, mineralized joints, and shear zones in or close to granitic bodies (Moen, 1976). Veins range from fractions of an inch to as much as 15 feet thick, with the average being about 3 feet. Common ore minerals include pyrite, pyrrhotite, arsenopyrite, chalcopyrite, galena, and sphalerite (Moen, 1976). An exception to the fissure-vein type of mineralization is the Sunrise breccia pipe, which is an elliptical breccia zone caused by injection of diorite that arched and fractured the already metamorphosed brittle sedimentary rocks (Cannon-Hicks Associates Ltd., 1970).

Mining History

The early history of mining development and operation in the Sultan Basin is summarized in the following excerpt (Carithers and Guard, 1945):

"Prospecting in the region in and around the Sultan Basin began sometime after 1874, when silver was first reported in the Silver Creek District. The first major discovery was in 1891, when the "45" vein was found. The development of the area was slow and closely linked with the growth of transportation facilities. Early in the 1890s, the Great Northern Railway main line was built though Sultan and Index, and another line was completed that connected the Monte Cristo district with Everett. This stimulated development of the entire area, and in 1896 the "45" mine became the first producer in the basin. The shipments from this property depended upon the Everett and Monte Cristo Railway, whose operation was interrupted by washouts of the right-of-way. In an attempt to maintain production, the "45" mine operators constructed a puncheon road connecting the mine with the Great Northern Railway near Sultan. This road opened the basin to horse-drawn wagons, and aided development considerably. Feeder trails and roads were built, and later the Florence Rae and the old Iowa mines became small producers. The road from Sultan to Olney Pass was improved by degrees during logging operations, and in 1935 this graveled road was extended into the basin by the Civilian Conservation Corps. From 1937 to 1941 several more small shipments were made from the Florence Rae and Iowa mines. The old roads over which ore was hauled from the formerly operating properties are now washed out or otherwise deteriorated, and a few branches are needed from the present graveled road to again bring transportation facilities to most of the mining properties of the basin area.

"None of the mines in the Sultan Basin had more than a brief or sporadic record of production. This is partly due, of course, to the difficult accessibility of the region. Four mines, the "45", the Iowa, the Florence Rae, and the Sultan King have produced

about 4,016 tons of ore valued at $134,831. The "45" mine, during its few years of operation from 1896 to 1902(?), accounted for almost 80 percent of the total tonnage and about 75 percent of the value."

Transportation infrastructure continued to be the key factor in mine development in this region from the first days of prospecting in the 1870s to the tapering off of mining operations in the 1970s. In the late 1940s, mine owners jointly petitioned for financial assistance and regulatory approvals for "mine-to-market" roads to serve both the north and south forks of the Sultan River. This led to further development of existing mines in the Florence Rae and Iowa group, the Sunrise property, and one of the largest operations in the WAU, the Kromona mine and mill complex in the headwaters of the South Fork Sultan River.

Mining operations in these areas were quite active through the 1950s to the 1970s. Since then, a number of factors have combined to limit mining activities, especially in the North Fork drainage. These factors include concerns over possible impacts to water quality in the Spada Lake Reservoir and the establishment of the Morning Star Natural Resource Conservation Area. The only access road into the North Fork drainage area has been abandoned and much of the original road bed has been recontoured to match surrounding topography. No production mining has taken place for the past 50 years, aside from exploration tunneling and diamond drilling (Sunrise mine, 1968–1971; Florence Rae mine, 1970s).

Water Quality

The 35 mine sites within the Spada Lake WAU (Fig. 3) are mostly clustered among the tributaries and headwaters above the Williamson Creek and North Fork Sultan River valleys. Two concentrating mills were reportedly built on the valley floor. The Sultan Basin Mining Company mill, located near the site of the Iowa camp on the upper reaches of the North Fork Sultan River, may have served a number of mines in this area (USFS, 1969). The other mill site is a complex of perhaps three smaller mills located along Williamson Creek near the site of the Little Chief mine. Mining activity also occurred at the Kromona mine and mill site in the southwestern portion of the WAU along the middle fork of the South Fork Sultan River. Literature research also identified possible mill sites in two locations that we did not visit on the ground.

Water was present at 11 of the 12 sites inspected (Table 2). Six displayed indications of possible water-quality problems, such as visible discoloration, low pH, or chemical analytes identified in field or laboratory tests. Table 3 summarizes water quality data for these sites. Natural background chemical levels attributable to regional mineralization were not quantified as part of this effort. Consequently, interpretation of lab data indicating only slightly elevated concentrations of metals and sulfate should be considered in this context.

Some mine openings observed from the helicopter are discharging water but were not accessible for collection of water-quality data. None of these sites appeared to have discolored discharge, stressed vegetation, or other indications of significant water-quality problems as observed from the air.

The Lockwood Pyrite mine, which is outside the WAU, is included here because it may be a source of acid mine drainage. However, discharge from the adit infiltrates into the ground after a short distance (43 feet) and does not reach the local drainage system, which is 2600 feet away. At the time of visitation, the main adit was discharging 2 gallons/minute. The pH was 2.7 (acidic), and the specific conductivity was 1468 microseconds per centimeter. The water sample exceeded the water quality standards for arsenic, copper, iron, lead, zinc, and mercury (Table 3).

The sites with the lowest pH and highest metals concentrations were the Kromona mine and mill complex on the South Fork Sultan River and the Lockwood Pyrite mine, located slightly to the west and downstream of the Spada Lake WAU. Water and sediment samples from these sites yielded elevated concentrations of most analytes. Sites along the North Fork Sultan River displayed lower metals concentrations in discharge

Table 2. Mine sites with water, Spada Lake WAU

Site name	Feature	Sample location	Discharge	Discoloration	Lab samples?
"45" mine	mid-slope adit	slight discharge from adit	2–3 gpm	none	no
	Upper Magus adits 1 and 2	slight flow from adit (no discoloration)	1–2 gpm	none	no
Calumet mine	adit	1 foot standing water in adit; discharge over waste rock	2–5 gpm	none	yes
Doris mine	upper adit	moderate drainage	2–5 gpm	none	no
Florence Rae mine	adit 1 (upper)	standing water; evidence of seasonal discharge	0–5 gpm	none	yes
	adit 2 (upper)	standing water	none	none	yes
Iowa mine	lower adit	standing water with evidence of discharge	<1 gpm	none	no
	main adits (2)	standing water	none	none	no
Kromona mine	upper (reservoir) adit	2 feet deep inside and draining out of adit portal	2–5 gpm	none	yes
	lower (main) adit	sediment and water (slightly flowing); also culvert draining adit	~1 gpm	none	yes
	mill	trickling through, pooling	~1 gpm	orange, turquoise	yes
Little Chief mine	lower adit	surface flow over outside of portal	~1 gpm	none	no
Lockwood Pyrite mine	short (upper) adit	standing water	none	adit walls only	no
	main (lower) adit	acid mine drainage flowing from adit	2 gpm	orange	yes
Sultan King mine	adit 1 (longest)	drainage from caved adit	2–3 gpm	waste rock only	yes
Sunrise mine	lower adit	flow from pipe; adit collapsed(?)	1 gpm	orange	yes
	upper adit 1	standing (in adit); also some surface (ambient) flow outside of portal	none	none	no
	upper adits 2 and 3	standing water inside adit	none	none	no

water (where sampled and detected), remaining well within state ground-water quality standards (Chapter 173-201A WAC) (Table 1), which are essentially based on drinking water.

Out of the 16 sites known to exist in the North Fork drainage, we were able to observe only seven from the air and to land and collect laboratory samples at only four of those seven. Still, the sites sampled were the larger mines, and generally more than one adit was sampled at a given site. Clearly, water at some of these mines contains low concentrations of copper, zinc, and sulfates. Though not a significant hazard by themselves, these sites may be contributing to cumulative contaminant loading from other sites. A mill site (Sultan Basin Mining Co.) documented along the North Fork Sultan River near the site of the old Iowa camp (USFS, 1969) was not inspected. We were unaware of its existence at the time, so we did not evaluate this site on the ground.

In the Williamson Creek drainage, we noted that the two largest mines ("45" and Little Chief) were discharging water, but the water was not discolored. Four other mine sites are located in this drainage, as well as a cluster of small mill sites along the valley floor west of the Little Chief mine site.

Physical Hazards

Physical hazards at sites within the Spada Lake WAU consist of open horizontal adits, unknown conditions inside mine workings, remnants of old mill and tram foundations, machinery, and debris. Most of the open adits had standing water or mud on the floors and water drizzling from the walls and ceiling. Although these sites are extremely remote, many show signs of recent human visitation. A summary of sites with notable physical hazards is presented in Table 4. Figures 6, 7, 8, and 9 show conditions at the Florence Rae mine, Kromona mill site, Kromona upper tram landing, and Lockwood lower adit, respectively.

Bat Habitat

No bats were observed at any site, but we identified the following as having possible bat habitat: "45", Florence Rae, Iowa, Kromona, and Little Chief. A summary of habitat observations made is provided in Appendix D.

SITE-SPECIFIC OBSERVATIONS

Reconnaissance of the WAU was conducted by air via helicopter, owing to the inaccessibility of most sites. Of the 12 mines inspected, 11 had water present. The Kromona mine, located in the upper reaches of the South Fork Sultan River, was the only property producing concentrations of heavy metals exceeding portions of the Washington State water quality guidelines (Table 1). Elevated levels of arsenic, copper and lead were found in various samples from two adits and the former mill site (Table 3). A comprehensive list of mines within the Spada Lake WAU is given in Appendix B. Brief narratives of on-site observations during our field visits of September 2000 are provided in Appendix C.

"45" Mine

The "45" mine lies at the precipitous head of the Williamson Creek drainage. We observed only two of the upper adits of this site from the air. Water drained from or adjacent to what may be tunnel no. 1 (DGER mine map file). Some wood and metal debris lies on the platform here that was apparently blasted into the mountainside. At what may be tunnel no. 2, a few gallons per minute of water drains from an open adit. Wooden debris is scattered down the steep slope next to the waste-rock dump.

Border Queen Mine

One of three reported adits found. This 12-foot adit lies obscured by vegetation at the side of the road.

Calumet Mine

We observed a cable dangling from trees on the steep ridge leading down from the Calumet adit (4650 feet msl). Twelve inches of clear water stands inside the adit. The water drains a short distance at about 1 gallon per minute before infiltrating into the waste-rock dump. A small amount of wood and metal debris lies near the adit portal. We were unable to locate any of the open cuts on the Calumet claim.

Table 3. Sites with chemical analytes detected, Spada Lake WAU. Unit of measure: mg/L (water); mg/kg (sediment). ND, not detected; *, value derived from field test because non-preserved laboratory sample not available; **, value in question due to suspected meter malfunction; switched to litmus for other pH tests. Lockwood Pyrite is actually located outside the Spada Lake WAU immediately to west (downstream). See Table 1, p. 3, for applicable Washington State water quality standards

Location	Matrix	Arsenic	Copper	Iron	Lead	Zinc	Mercury	Sulfate	pH
Calumet mine—adit	water	ND	ND	ND	ND	0.013	ND	32	7.48
Florence Rae mine—adit 1 (upper)	water	ND	0.021	0.16	ND	0.044	ND	18	7.6
Florence Rae—adit 2 (upper)	water	ND	0.011	ND	ND	0.014	ND	8.8	7.72
Kromona mine—lower (main) adit	water	0.027	0.018	ND	ND	0.016	ND	<200*	4*
Kromona mine—lower (main) adit	sediment	1500	14,000	62,000	83	260	0.26	19	5.79
Kromona mine—waste rock below tramline	water	0.025	ND	ND	ND	0.022	ND	<200*	7.5**
Kromona mine—upper adit	water	ND	0.2	0.22	ND	0.021	ND	<200*	5*
Kromona mine—millsite	water	0.18	0.4	3.0	0.017	0.02	ND	<200*	5*
Kromona mine—millsite	sediment	21,000	63,000	140,000	650	310	0.68	48	4.85
Lockwood Pyrite mine—lower adit	water	0.38	1.3	770	0.11	4.0	0.0011	<1600*	2.7*
Lockwood Pyrite mine—lower adit	sediment	42	260	260,000	40	200	ND	34,000	3.09
Sunrise mine—lower adit	water	ND	ND	4.6	ND	ND	ND	13	6.6
Sultan King mine—adit 1 (longest)	water	ND	ND	ND	ND	0.016	ND	40	7.38

Doris Mine

From the air, we observed waste rock from upper adits and what appeared to be one of the adit portals, where we saw minor discharge but no discoloration. No water samples were collected because there was no safe landing spot nearby. Workings on the lower vein were not located; literature documents a shallow shaft and two 6-foot drifts.

Florence Rae Mine

The large stoped-out area at the cliff base measures approximately 8 feet tall by 40 feet wide. The excavation appears to narrow into an adit that extends an unknown distance into the mountain. Debris, including much piping, empty explosives boxes, and at least five empty 55-gallon drums, litters the site. The interior is wet, and water collects in the lower portal opening.

Iowa Mine

The mill site reported to be adjacent to the Sultan River near the old Iowa camp was not investigated. The mine openings are 2000 feet from and 500 feet above the North Fork Sultan River. From the air, we observed standing water in the upper and lower adits, but no discharge and no discoloration. Water flows over the small waste rock dump.

Kelly Creek Mine

Minor erosion of the heavily iron-stained earth was observed from the air in the area of the Kelly Creek adits. No openings were seen.

Kromona Mine

We identified acid mine drainage from the adit and found elevated metals concentrations in the soil in and around the mill site. Much wood and metal debris from the collapsed tram station and other buildings lies around and below the main adit (Fig. 8).

Little Chief Mine

We located what we believe is the lower adit penetrating a near vertical cliff. We saw no evidence of the reported mill sites (Little Chief and Phelps Glacier)

Lockwood Pyrite Mine

Vegetation conceals the dangerous vertical opening of the partially caved upper adit. This opening is hidden when approaching from above. We identified acid mine drainage—a high level of sulfates and dissolved metals in the small amount of water draining from the lower adit (Fig. 9).

Table 4. Sites with notable physical hazards, Spada Lake WAU

Site	Feature	Condition	Machinery	Comments
Calumet mine	adit	open, discharging water	suspended cable, tram pulley, old tools, and metal debris	Small slide on left side of portal partially blocks entrance, but it's still accessible. Adit walls and ceiling appear fairly solid.
Florence Rae mine	adit 1 (upper)	open, standing water, crammed full of barrels, etc.	remnants of tram station, numerous (fairly new) barrels, piping, corrugated sheet metal, scaffolding, old explosives crates, etc.	Adit crammed full of debris, primarily barrels, piping, corrugated sheet metal, etc. (Fig. 6). A stope located just to the right of the adit (between the two adits) contains scaffolding, piping, and various unidentified equipment. Remnants of old wooden explosives crates were found in and about the mine. More crates were seen scattered about well inside the adit. For safety reasons, we did not continue farther into the adit to investigate, so we are uncertain if it still contains explosives.
Florence Rae mine	adit 2 (upper)	open, standing water	none noted	This adit is located immediately to the south of adit 1. It is not as full of old junk, barrels, etc., as adit 1.
Iowa mine	main adits (2)	one open and timbered, both overgrown with brush	none noted	Two internally connected adits about 100 feet apart and at elevations of 2895 and 2850 feet. One adit is so densely overgrown, the portal is not visible. The other adit had water drizzling over the top of the entrance and some standing water in the adit itself. Old vertical timbers were noted inside the jagged rock entrance.
Iowa mine	lower adit	open; some discharge	none noted	Branched adit with single entrance and one level of workings. From the air, we could see standing water inside the adit. An area of lush grass marked a small amount of seasonal(?) drainage coming from the right side of the adit portal and draining over the waste rock.
Kromona mine	mill	concrete foundations only	none noted	Remains of mill and powerhouse consist of a series of large concrete foundations and machinery mounts on a wooded hillside. Foundation is in eleven sections on eight levels, starting near the river bank and continuing up the hill (Fig. 7).
Kromona mine	lower (main) adit	open, timbered, draining	tram station with pulleys, brakes, old concentrating table (small leach pad?), rails, piping, lumber with nails, cable, etc. (Fig. 8)	Debris strewn everywhere. Colluvium over portal partially blocks entrance, but adit still quite accessible. Adit is timbered and documented to be quite deep with substantial internal workings. Could not see end. Three 1-inch+ steel cables are anchored to rock on right side of adit; two are still under tension. All three cables are lying in water and will eventually rust through and break.
Lockwood Pyrite mine	main (lower) adit	open, discharging acid drainage and metals	none noted	Adit open and timbered; strong sulfur odor. Trash scattered outside portal, indicating recent human presence. (Still being prospected?) From portal, no end visible (curves left limiting vision). Conspicuously discolored (orange) drainage from main adit.
Lockwood Pyrite mine	short (upper) adit	caving, but accessible	none noted	Less significant feature than main adit. End of adit visible with flashlight (~15 feet in from portal). Portal partially blocked by cedar stump pushed into trench (caved adit?). Near portal, either part of original ceiling caved or was cut through from bottom. Approach from uphill side potentially dangerous, as adit and portions of caved ceiling are not visible from above.

Figure 6. Discarded barrels, piping, and sheet metal in adit at Florence Rae mine.

Figure 7. Footprint of the lower three tiers of the Kromona mill. Five more tiers are located uphill. Tributary to the Sultan River is in the background.

Milwaukee Mine

No evidence of mining observed from the air.

Mountain Cedar Prospect

From the air we observed a small area of disturbance in the Mountain Cedar claim. We did not visit the reported lower adits at Mountain Cedar.

Sultan King Mine

We located the largest adit (no. 1, described as 1200 feet long in historical records) and possibly one of the smaller adits (no. 4?). Adit 1 was caved in and drains 2 to 3 gallons of water per minute. Debris at the site was limited to rusted metal, including two compressors, and rotted lumber.

Sunrise Mine

This site consists of three open upper adits and one closed lower adit. No discharge from these adits was visible from the air. The lower

Figure 8. Remnants of the upper tram station near the main adit at the Kromona mine.

Figure 9. Outside main adit at the Lockwood Pyrite mine. Analysis of discolored mine drainage (foreground of photo on left) confirmed acid mine drainage and dissolved metals. View inside adit portal (photo on right) shows massive sulfide deposit on adit walls and acid mine drainage on adit floor.

adit, where the development work in the 1960s and 1970s took place (Lasmanis, 1995), is collapsed. A 6-inch diameter pipe protruding horizontally from the ground discharges orange water that flows about 10 feet to a drainage leading to Vesper Creek, which is tributary to the Sultan River. Some wood and metal debris and an empty above-ground fuel storage tank litter the area of the lower adit. The pH was slightly acidic and sulfate was measured at 13 mg/L. The only metal detected in the water sample was iron at 4.6 mg/L; arsenic, copper, lead, zinc and mercury were not detected.

Cecile Creek Watershed, Okanogan County, Washington

SUMMARY

Geography

The Cecile Creek watershed analysis unit (WAU) (Fig. 10) encompasses approximately 36,800 acres (57.5 mi^2) in the central portion of the Sinlahekin drainage basin in north-central Okanogan County. This area is transitional between the sparsely vegetated, rolling topography and semiarid climate to the south (Fig. 11) and east and the forested highland and subhumid climate of the Wenatchee/ Okanogan National Forest and Pasayten Wilderness to the west. The principal surface waters are Sinlahekin Creek, Toats Coulee Creek, and Cecile Creek. All flow into Palmer Lake.

The Sinlahekin Valley forms the centerpiece of the WAU and carries from the upper Sinlahekin, Palmer Lake, and the Similkameen River, which are parts of the Chopaka and Similkameen WAUs to the north. Sinlahekin Creek receives additional flow from two drainages within the western portion of the Cecile Creek WAU. The first of these (flowing in from the northwest portion of the WAU) is the lower reaches of Toats Coulee Creek, which has its headwaters in the Pasayten Wilderness (North Fork Toats Coulee WAU), some 10 miles to the northwest. The other primary drainage is Cecile Creek, which flows between Tillman Mountain/Gold Hill to the north and Douglas Mountain to the south. Unlike the other tributary drainages, the Cecile Creek drainage basin is entirely contained within this WAU.

Elevation (above sea level) ranges from about 500 feet along the valley floor of the Sinlahekin to about 1700 feet on the western border of the WAU. However, the vast majority of the acreage lies between 750 and 1500 feet.

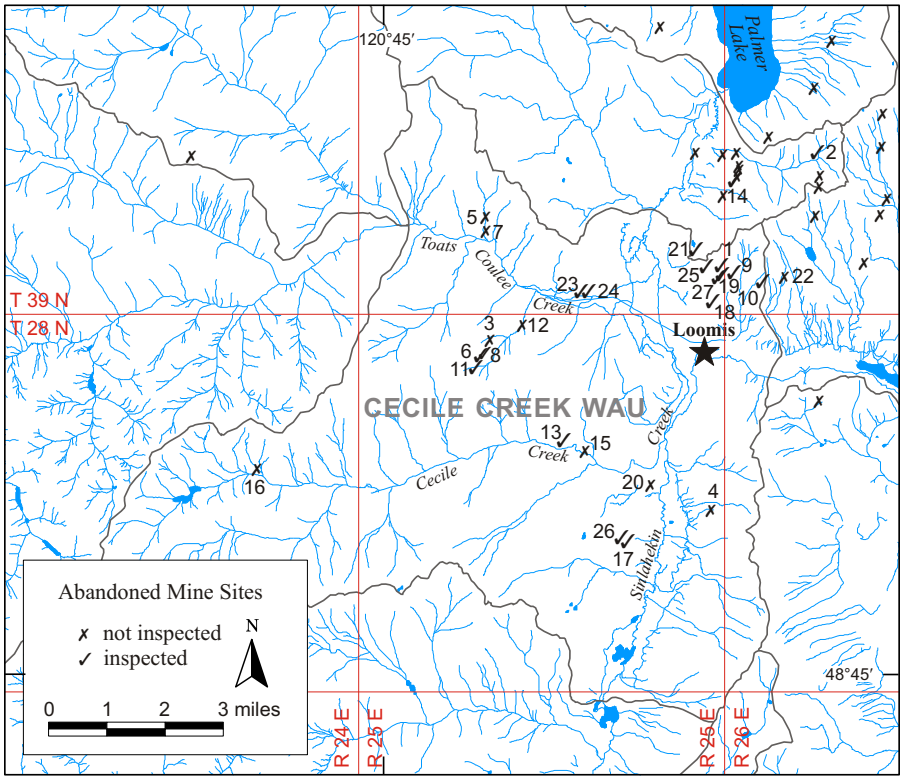

Figure 10. Major surface waters in the Cecile Creek watershed, encompassing the upper reaches of the Sinlahekin Creek basin. Numbers identify abandoned and inactive mine sites: 1. Black Bear mine, 2. Bunker Hill mine, 3. Cleve mine, 4. Detroit-Windsor mine, 5. Double Standard mine, 6. E Pluribus mine, 7. Eclipse mine, 8. Frankie Girl mine, 9. Gladstone(?) mine, 10. Gold Crown mine, 11. Gold Hill mine, 12. Golden Fleece mine, 13. Hercules mine, 14. John Judge mine, 15. Little Falls mine, 16. Lucky Strike mine, 17. Oro Fino mine, 18. Palmer Mountain tunnel, 19. Prospect mine, 20. Red Jacket mine, 21. Security mine, 22. Summit mine, 23. Summit mill site, 24. Tunnel mill site, 25. unnamed mine, 26. Utica mine, 27. War Eagle mine.

Climate

The climate in this region includes large seasonal temperature extremes, from well below freezing throughout the winter to nearly 100ºF in the late summer. Annual precipitation ranges from 10 inches on the eastern portions of the WAU to 25 inches in the western portion. The majority of annual precipitation falls in the winter as snow. The spring melt releases most of this water in May and June. In addition to supplying streamflow, a significant portion of snow melt infiltrates into soil. This ground water slowly discharges to tributary streams and eventually to Sinlahekin Creek, providing a relatively low but constant base flow discharge for the remainder of the year (Montgomery Water Group and others, 1995).

Vegetation

Vegetative cover varies from a nearly shrub-steppe landscape on the eastern portions of the WAU (and some south-facing slopes elsewhere) to open ponderosa pine and grass in the central portion to moderately closed canopy areas of Douglas fir and western larch in the higher elevations on the western fringe of the WAU. Springs are typically flagged by small groves of quaking aspen and other hardwoods immediately downgradient.

Land Ownership

The State of Washington owns or manages about 85 percent of the total land area, either as harvestable forest land or as the Sinlahekin Wildlife Recreation Area, managed by the Washington Department of Fish and Wildlife (WDFW). The U.S. Fish and Wildlife Service (USFW) manages several small parcels, U.S. Bureau of Land Management (BLM) accounts for 5 percent, and private land ownership makes up the remainder.

Public recreation is seasonally intense due to big-game hunting, off-roading, cross-country skiing, and horseback riding. Former patented mining claims near Gold Hill (Fig. 12), owned in fee simple, are being developed for large-lot residential usage. Cattle grazing and orchard operations use available surface and ground water in and around some mine sites.

Geology and Mineralization

Cecile Creek WAU is underlain mainly by Triassic granodiorite, orthogneiss, and metavolcanic and metasedimentary rocks (Rinehart and Fox, 1972; Stoffel and others, 1991). Ore mineralization occurs as quartz fissure veins penetrating openings in argillite, limestone, conglomerate, quartzite and greenstone. Deposits appear to be small and near-surface. Many veins pinch out in less than 100 feet of pitch and stope length. The veins range from stringers less than 1 inch thick to massive quartz veins 20 feet thick.

Ore minerals present are pyrite, arsenopyrite, chalcopyrite, galena, sphalerite, scheelite, argentite, proustite, pyrargyrite, native silver, and free gold.(Moen, 1976).

Mining History

The town of Loomis is currently a crossroad with a small store and restaurant. In 1870, it was a remote winter cattle station. In 1871, lode gold was discovered near the base of Chopaka Mountain, immediately north of the Cecile Creek WAU. Hiram F. Smith, later a member of state legislature, was credited with the discovery and initial development of this claim (Moen, 1982). In 1886, the opening of nearby Indian reservation lands for prospecting created a rapid influx of miners to the area. By 1891, the three-block-long main street of Loomis was lined with buildings, including eight saloons and two dance halls (Barlee, 1999). Figure 13 shows the town circa 1900, near the height of its development. The early history of this area is well summarized in "Mining in the Pacific Northwest" (Hodges, 1897).

One of the first sites of production was on the south end of Palmer Mountain at the Black Bear and War Eagle group of five claims (Bethune, 1891; Landes and others, 1902). Productive workings in this complex reached a depth of 190 feet, which encouraged investment in expansive workings elsewhere on the mountain.

At the base of the mountain, near the town of Loomis, the Palmer Mountain Gold Mining & Tunnel Company followed shortly thereafter with a highly publicized cross-cut tunnel to be driven through the base of the mountain 3600 feet horizontally to a depth of 1200 feet. By the late 1890s, the company had driven 250 feet by hand, with encouraging results. The proposed expansive mill had not yet been built. A flume from Toats Coulee Creek, one mile to the west, was being considered for power generation for air drills, tramways, and reduction plants at the tunnel site. [Our recent site inspection revealed evidence of the flume serving two old mill sites near the mouth of Toats Coulee Creek, but nothing extending across the Sinlahekin Valley to the tunnel site

Figure 11. Concrete foundations for the nine-stamp mill at the base of Palmer Mountain. Foreground and background show the open, sparsely vegetated geography of the Cecile Creek WAU. View to the southwest.

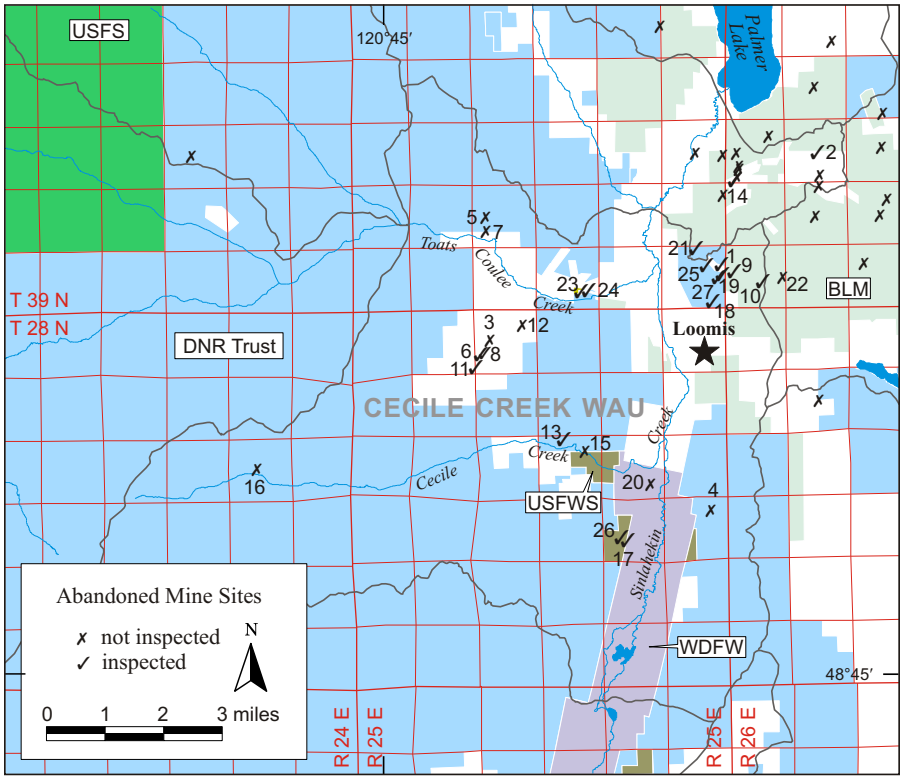

Figure 12. Distribution of land ownership within the Cecile Creek WAU. Numbers identify abandoned and inactive mine sites; 1. Black Bear mine, 2. Bunker Hill mine, 3. Cleve mine, 4. Detroit-Windsor mine, 5. Double Standard mine, 6. E Pluribus mine, 7. Eclipse mine, 8. Frankie Girl mine, 9. Gladstone(?) mine, 10. Gold Crown mine, 11. Gold Hill mine, 12. Golden Fleece mine, 13. Hercules mine, 14. John Judge mine, 15. Little Falls mine, 16. Lucky Strike mine, 17. Oro Fino mine, 18. Palmer Mountain Tunnel, 19. unnamed prospect, 20. Red Jacket mine, 21. Security mine, 22. Summit mine, 23. Summit mill site, 24. Tunnel mill site, 25. unnamed mine, 26. Utica mine, 27. War Eagle mine.

on Palmer Mountain. It is more likely that power was generated at the base of Toats Coulee and transmitted by line to Palmer Mountain.]

Another promising operation was the appropriately named Summit mine (a.k.a. Grand Summit, Palmer Mountain Summit, Alice) at the top of Palmer Mountain. By the turn of the century, miners had sunk just one shaft and one adit, about 50 feet each (Hodges, 1897). After the brief redevelopment in the late 1930s to capture the price increase in the gold market, the Summit mine had expanded to a total of 1200 feet of workings on three levels and an amalgamation mill (Huntting, 1956; DGER mine map file). From the literature, it is not clear whether the mill was on Palmer Mountain with the mine property or if it was one of the documented mill sites near the mouth of Toats Coulee Creek. [Aerial photography does not reveal any indication of a mill site (large buildings, tailings) near the mine site. Currently, the property is fenced and posted "no trespassing". Inhabited dwellings exist near the mine portals in the southeastern end of the patented mine claim.]

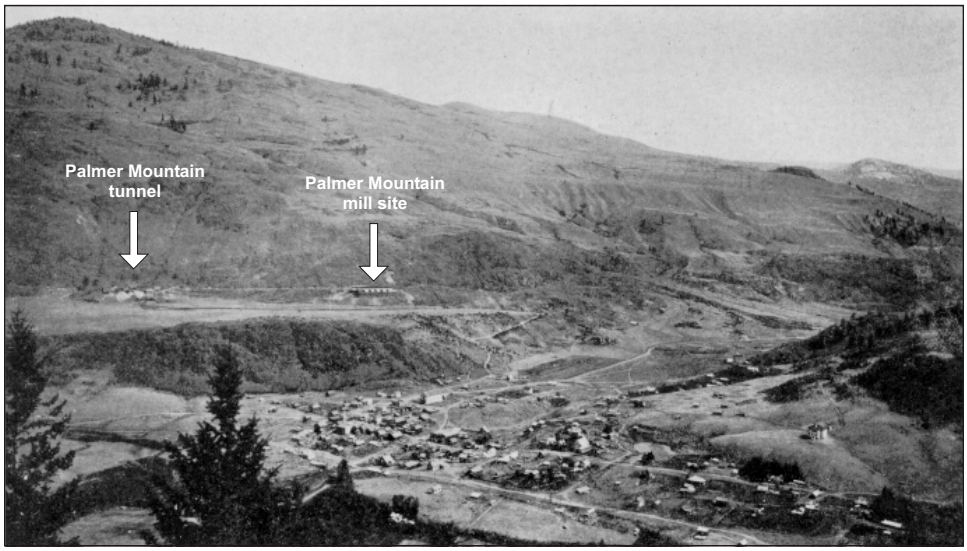

Figure 13. The town of Loomis, near the height of its development (circa 1910). Palmer Mountain is in the background to the left. The arrow on the right points to the Tunnel mill site, the foundations of which are shown in Figure 11.

About a mile to the northwest (just north of the boundary of the Cecile Creek WAU), the John Judge mine (a.k.a. Leadville or Denver City) developed its underground workings before the turn of the century, eventually including 2500 feet of adits and shafts (Rinehart and Fox, 1972).

To the northeast, rediscovery of sulfide ores, which previous prospectors passed over as useless, prompted further development of sites such as Copper World and Ivanhoe mines (also slightly outside of the Cecile WAU).

The Security mine, located at the western base of Palmer Mountain, is not mentioned in early literature. Documented workings are known to include a 620-foot adit and a 200-foot adit (DGER mine map file), but the actual dates of development remain in question.

Figure 14. Lower adit at the Security mine. Drainage from the adit forms a small oasis in otherwise dry shrub-steppe environment. Water samples revealed no significant water quality problems. Cool air flowing from adit indicates possible bat habitat.

Across the Sinlahekin Valley in the Toats Coulee drainage, the properties that became the Eclipse and Double Standard mines were discovered in the 1890s, while mine development on Gold Hill (immediately south of Toats Coulee) was well under way, with a number of shafts ranging from 10 to 85 feet in depth within claims such as E Pluribus, Frankie Girl, Golden Fleece, and Cleve. South of Gold Hill, the lower reaches of the Cecile Creek drainage supported workings (~50-foot shafts, shallow adits, surface cuts) at the Hercules, Little Falls, and Red Jacket mines. However, no reference to the Lucky Strike mine (near the headwaters of Cecile Creek) was found in early literature.

At the base of Douglas Mountain, the Utica mine and its northeast extension, Oro Fino, had several shallow shafts, a short crosscut adit, and a surface cut, but no records were found indicating development past the turn of the century.

Across the Sinlehekin Valley on the western slopes of Aeneas Mountain, the Detroit-Windsor group of five claims sank a shaft 100 feet with a crosscut at the 90-foot level. Bethune (1891) reported that the miner had plans to continue the shaft, with additional (deeper) crosscut levels, however, it's not clear if this additional work was ever performed.

The Okanogan Historical Society relates a variety of anecdotal examples of investment schemes that came to naught, such as the Palmer Mountain tunnel, for which a large nine-stamp reduction mill was built to lure investors (Fig. 11), only to be torn down without having been put into production. Mooney (1976) writes of a young Ohio lawyer, editor of a local news tabloid (Madre d'Oro, circa 1892), who was tarred and feathered in the

town of Loomis for his frequent written criticisms of the operation.

By the early 1900s, most of the area had been prospected, several concentrating mills had been constructed, and gold-silver concentrates were being shipped to Tacoma from several local mines. However, contrary to the expectations of many, significant mining activity did not continue much past the initial flurry of the late 1890s to early 1900s. Both before this period of initial production, and to some degree after, independent miners continued to "gopher on the surface"—as Hodges put it—result-

Table 5. Sites with notable physical hazards, Cecile Creek WAU

Site name	Feature	Condition	Comments
Black Bear mine	shaft	open	Deep shaft, <100 feet. Poorly fenced. Drift leading to east observed inside shaft.
Black Bear mine	shaft	open	Upper of three shafts; ~50 feet deep; connected to middle shaft by incline. No fence. No water observed.
Bunker Hill mine	lower adit	partially open, with rubble at portal	Partially caved adit enters hillside at bearing of N20E. Inside of adit curves to left, so full extent not visible (>50 feet). Pool of water inside ~8–10 inches deep; extent unknown.
Bunker Hill mine	shaft/steep incline	open with unstable collar	Steep incline (45°). Loose material in funnel-shaped opening. Not visible from uphill approach.
E Pluribus mine	shaft with prospects nearby	open, unfenced, deep	60-foot shaft following quartz vein (2 feet wide). Diameter of shaft ~4 feet. Fir tree 2 feet in diameter thriving in waste rock around shaft collar.
Frankie Girl mine	middle adit	open, not timbered, appears sound	Long adit curves to right; no end visible. No standing water, but adit floor and walls damp. Trash on floor and graffiti on interior walls serve as evidence that site is accessed.
Frankie Girl mine	lower adit	open, dry, partially caved	Partially collapsed adit, >100 feet long, bears 224°. Six buildings on downhill side of road, some partly collapsed.
Gladstone(?) mine	shaft	open, deep	~50-foot vertical shaft, dry with loose rock collar, surrounded by collapsed rail fence.
Gold Crown mine	shaft	open, fenced with 3-foot hogwire	~30-foot vertical shaft with water at bottom. Old timbers holding waste rock away from opening contribute to soft collar. Shaft opening fenced with 3-foot tall hogwire.
Gold Hill mine	shaft	open, hidden, water at bottom	12-foot shaft with 2 to 3 feet of water in bottom. Additional water heard (but not seen) trickling into the shaft. Shaft hidden in brush, just off the road. Fallen branches and tree over it. No fence.
Hercules mine	adit	partially open	Only top 3 feet of adit remains open, the bottom being dammed by a 3-foot tall berm. However, it is still accessible. Air in adit stagnant.
John Judge mine	open shaft	open to entry, soft collar	Open shaft with deteriorated timber collar level with top of waste rock dump. Bridged or plugged at 40-foot depth.
Security mine	lower adit	open, unstable, discharging water	Timbered adit with water flowing at about 0.5 gpm. More than 100 feet of open adit visible; literature suggests it goes back >600 feet.
Security mine	shaft	open, unfenced	Vertical shaft located within a 25-foot trench or open cut. Discernable depth >50 feet, however, light visible part way down shaft appears to be coming from intersection with upper adit.
Security mine	upper adit	rubble partially closing portal, but still open	Adit appears to connect with the shaft ~25 feet above it, about 50 feet into the adit.
Summit mine	4 shafts, 2(?) adits, possible mill site	not inspected	Literature suggests 4 shafts (300 feet, 100 feet, 20 feet), haulage tunnel 450 feet; 3 levels of workings totaling 1200 feet, plus a mill site. Not visited.
unnamed mine	adit with vertical winze	open	Northwesternmost of 3 features at this site is an open adit with a vertical winze located just inside adit portal. Open and unfenced, dry.
unnamed mine	adit	open, 25 feet long	Adit bears 140°; depth 25 feet. No moisture noted. No significant temperature gradient or air flow noted. Adit open and unfenced.
unnamed mine	shaft	open, 50 feet deep	Vertical shaft, 50 feet in depth, open and unfenced. No water observed in shaft.
unnamed prospect	shaft	open, deep	40-foot open shaft, next to an open ditch and three shallow shafts. No drifts observed.
unnamed prospect	3 shallow shafts, 1 open ditch	open, shallow	Open ditch and three shallow shafts (6, 6, and 10 feet) next to a 40-foot open shaft. No drifts observed.
War Eagle mine	shaft	open, 60 feet deep	One of two shafts identified on the ground at the War Eagle site. Shown as shaft icon on USGS Loomis 7.5-minute quadrangle map. Shaft ~60 feet deep and open.
War Eagle mine	shaft	open, 60 feet deep, soft collar	One of two shafts identified at the War Eagle site. Funnel-shaped collar surrounds shaft opening.

ing in a variety of isolated and undocumented features, such as shallow shafts and open cuts along the sides of Palmer Mountain and elsewhere.

In the years following, production was sporadic at best, such as in the late 1930s when an increase in the price of gold prompted a brief resumption of operation at a number of mines and mills in the area (Moen, 1976).

Water Quality

In the Cecile Creek WAU, only the Security mine at the western base of Palmer Mountain was found to be discharging water (Fig. 14). The adit appears to have intercepted a local groundwater spring and discharges clear water from the portal of the timbered adit into a small green oasis of hardwoods and underbrush, then infiltrates back into the ground. Field tests on water at the adit portal indicate a near-neutral pH and only trace levels of metals or sulfate.

The Gold Crown shaft, on the northeast boundary of the WAU apparently intercepts ground water. We saw water at about the 30-foot level of the shaft, but did not collect a sample. A spring is located about 300 feet west of the adit. Across the Sinlahekin valley, in the lower reach of Toats Coulee Creek, the Summit and Tunnel mill sites are reported to have been located within the flood plain. The locations are based on old mining district maps. Available literature does not list any production by these mills. No evidence of tailings remains at these sites.

The group of claims on Gold Hill is being subdivided and sold for large-lot residential use. In addition to the physical hazards associated with abandoned workings in a developing residential area, the effect of mine drainage on nearby domestic wells was of concern to the developers at the time of our inspection. A few wells have already been drilled in the vicinity of mine workings. The wells are reported to be about 300 feet deep and capable of supplying 1.5 gallons/minute. We did not collect water samples from the individual, privately owned wells. The literature reviewed on mines in the Gold Hill area indicate little production and only a small extent of underground workings.

The Hercules adit is perched above the north side of the steep valley of the Cecile Creek drainage. The floor of this 50-foot adit is damp, but we found no indications of discharge. We did not locate the Lucky Strike, Little Falls, and Red Jacket mines in the field. In the area of the Utica and Oro Fino claims we found evidence of past surface disturbance. Across the valley on the west slope of Aeneas Mountain, we were unable to locate the Detroit-Windsor mine.

In summary, we identified no significant, ongoing surface water impacts from mining activities within this WAU. This is attributable to the dry climate and the passage of time since mines and mills were active. (Tailings from mills may have washed downstream decades ago.)

Physical Hazards

The gentle rolling hills and sparse undergrowth of the Cecile Creek WAU offer easy, year-round access to ATV users (quads in summer, snowmobiles in winter), hikers, hunters, cross-country skiers, and horseback riders. This accessibility makes public safety the primary abandoned-mine problem.

Of those individual mine features inspected at various mine sites (Table 5), at least half present some significant hazard, typically falling and entrapment hazards related to open underground workings. The most significant hazards were open shafts with soft collars and steeply inclined adits or raises. We did not see any hazardous materials during our site visit. Little remains of surface improvements and machinery.

Vertical shafts, unfenced or poorly fenced, and open adits are present at most of the former mine operations. The following 13 properties have openings that are extremely hazardous: Black Bear, Bunker Hill, E Pluribus, Frankie Girl, Gladstone(?), Gold Crown, Gold Hill, Hercules, John Judge, Security, Summit, unnamed, and War Eagle. The E Pluribus and Frankie Girl mines lie in close proximity to the residential development on Gold Hill.

At the Palmer Mountain tunnel, all that remains of the once-substantial surface improvements are the large concrete footings of the stamp mill (Figs. 11, 13) and an empty concrete reservoir. The adit is sealed with a concrete and steel plug that allows no hydraulic relief. Typically such plugs eventually blow out if water is behind them. Higher on the mountain, we identified the shafts of the Black Bear and War Eagle groups, the Gold Crown, possibly the Gladstone, and some unnamed prospects. Rudimentary or collapsed fences existed around a few of the shafts (Fig. 15).

At the Gold Crown mine, we detected water at the bottom of a 30-foot shaft. Old timbers holding waste rock away from the opening create a soft collar around the shaft. The opening is fenced with 3-foot-tall hogwire.

Farther north (slightly outside the WAU boundary), we located the John Judge and Bunker Hill mines. At John Judge, a shaft reported to be 182 feet deep (DGER mine map file) sits uncovered above a waste rock dump (Fig. 16). It is bridged by debris at 40 feet. The top 4 feet of the collar is supported by deteriorating timbers. An open adit, extending back more than 100 feet, was also found.

At Bunker Hill, openings to underground workings include two adits (one collapsed) and a steep incline with a funnel-shaped opening in loose rocks and dirt that is not immediately visible when approaching from above. The sides of the nearby open horizontal adit are partially caved, and the adit curves to the left so the entire length is not visible, but it clearly extends back more than 50 feet. Standing water could be seen in a pool inside the adit; but it was not sampled.

The Security mine, at the western base of the mountain, has two open and unstable adits and a shaft, which may be connected internally.

Across the Sinlehekin valley at Toats Coulee Creek, the Summit and Tunnel mill sites lie between the road and Toats Coulee Creek, just before the road rises up off the flood plain. A concrete structure, pockmarked with gunfire, stands adjacent to the road. The footprint of the building measures 20 x 30 feet, and the 1-foot-thick walls are about 11 feet high. The concrete floor supports three machine mounts with 2-inch-diameter steel bolts and electrical conduit on the mounting platforms. The site is posted “no trespassing” and is closed to vehicle access with a small cable gate.

Farther up on Gold Hill, mine features around and within a developing residential subdivision will continue to increase risk over time. At the E Pluribus site, an open and unfenced shaft, approximately 60 feet deep, is located a short distance off the road into the subdivision. Nearby at Frankie Girl, two adits remain open. One of the adits is partially collapsed; the other appears sound. The end of the adit was not visible. Trash on the adit floor and graffiti on interior walls serve as evidence that the site is frequently visited.

From Cecile Creek south, sites do not pose the same hazards as mines in the northern half of the WAU. Possible exceptions may be at the Little Falls, Red Jacket, and Detroit-Windsor mine

sites. According to literature, they included shafts 50 feet or more deep, but we did not find them. The Hercules mine had only a partially open adit and noticeably stagnant air. A search at Utica and Oro Fino identified insignificant surface cuts; the reported adits were not located. Literature search on the Lucky Strike mine (at the headwaters of Cecile Creek) yielded no information about significant workings or historical production, so we made no attempt to locate it during field inspections.

Bat Habitat

The best potential for bat habitat appeared to be at the Black Bear, John Judge, Bunker Hill and Security mines. We found the Security site the most likely. Notable airflow and temperature gradient (cooler than ambient air) was observed at the lower adit of the Security mine. The upper adit and shaft did not exhibit as much air flow. However, the two upper workings appear to be connected, and the open cut in which the shaft portal is located supports ferns, indicative of a warm, moist microclimate at least partially attributable to the influence of the mine openings.

At Black Bear, the open shafts may be internally connected, but we observed no significant airflow or temperature gradient at the time of inspection (June). Similarly, at Bunker Hill, the lower adit may be connected to other workings, however, no significant airflow was observed. The temperature gradient observed may be largely due to shading.

At John Judge, the open shaft with timbered collar is blocked at 40 feet, preventing bat entry to lower workings. Nearby, the open adit (Denver City claim) showed no indications of apparent value for bat habitat.

A summary of habitat observations made during site inspection of the selected mines is provided in Appendix G.

Figure 15. Upper photo shows one of several open shafts on Palmer Mountain with a collapsed fence around shaft opening. Loose rock around the shaft collar increases hazard. Lower photo shows view down shaft.

SITE-SPECIFIC OBSERVATIONS

This WAU contains 27 former mines and prospects, which were discovered, operated, and closed within the period from 1890 to 1910. We inspected 19. The actual name and location of a few mines or prospects (War Eagle and Gladstone) proved problematical due to lack of documentation. Appendix E is a comprehensive list of mines within the Cecile Creek WAU. Brief narratives of on-site observations are provided in Appendix F.

Black Bear Mine

Hazards at this site include three open shafts (15, 50, and 100+ feet deep) that may be internally connected. A bat survey is warranted.

Bunker Hill Mine

This site has a steep (>40°) incline/shaft with loose material around the opening. It also has an open horizontal adit. A bat survey should be conducted.

E Pluribus Mine

This mine is located in a developing rural residential subdivision. A real estate sign on a nearby tree leads people to the site. The primary hazard is a 60-foot shaft. The shaft is dry and the

shaft opening is accessible. At least one well (350-foot depth, 1.5 gallons/minute) exists 0.7 miles northeast (downhill) of the mine site; another is about the same distance to the southwest. More wells (and people) are likely here. Screening tests for metals may be a prudent measure for individual well owners.

Frankie Girl Mine

Primary hazards were two (>100 feet) adits and one shallow shaft/pit. One of the adits is partially collapsed. The other adit was driven into solid rock without timber supports for bracing; the adit appears to be sound. We recommend plugging both adits—the real estate development in the old Gold Hill mining district increases the hazard exposure. One domestic well (350 foot depth; 1.5 gpm) is located 0.5 miles northeast (downhill) and presumably another well is located 0.75 miles southwest (uphill). Screening tests for metals may be a prudent measure for individual well owners.

Figure 16. Open shaft with timbered collar at the John Judge mine. This shaft is reported to be 182 feet deep. Litter and debris are visible at ~40 feet; this may not be the actual bottom. Open cut (to left) leads up to a collapsed adit intersecting the shaft.

Gladstone(?) Mine

Suspected to be the Gladstone mine, although only shafts (no adits) were identified on the ground. There are four shafts, referred to as sites D, E, F and G in field notes. Most significant of these appears to be site E, which is a vertical shaft about 50 feet deep, surrounded by a collapsed wooden rail fence.

Gold Crown Mine

The 30-foot vertical shaft with water at bottom presents a falling/drowning hazard. Decaying timbers holding waste rock away from the opening contribute to its soft collar. A 3-foot-tall hogwire fence is around the opening. The shaft should be plugged or at least fenced better.

Gold Hill Mine

Derkey and others (1990) cite 4000 feet of crosscuts and drifts associated with this mine, however, all we found was a 12-foot shaft with 2 to 3 feet of water in the bottom. We heard (but did not see) additional water trickling into the shaft. The shaft is hidden in brush just below the road. Some fallen branches and a tree are lying over it. It is not fenced.

Hercules Mine

Partially caved at the entrance, only the top 3 feet of the adit portal remains open. Stagnant air was observed at the portal; this may be a respiratory hazard for anyone entering. With no evidence of mine drainage from the portal or air exchange, water quality and bat habitat do not appear to be issues at this site.

John Judge Property

The "John Judge property" is a combination of at least three mining operations (Leadville No. 1, Leadville No. 2, and Denver City) and as many as 13 patented claims. The primary physical hazard is an open shaft with decaying timbers around the collar (Fig. 15). The shaft presents a potentially fatal falling hazard. The Denver City site has an open adit.

Security Mine

We found two open adits and one open shaft. Clear water discharges from the lower adit. Temperature gradient, airflow, and presence of multiple openings suggest potential use for bats. Other wildlife definitely use the site for a water source and summer refuge. We recommend conducting a bat survey.

Summit Mine

Literature suggests substantial workings (1,600+ feet) and a mill at this site. It is used as an active homesite. We were not able to access the property at the time of our visit. Further on-site inspection should be conducted after contacting the landowner. From the border of the property, we saw no obvious indications of on-going mining, but were not able to determine if the documented shafts and adits are still open. This site should not be confused with a mine of the same name in secs. 22 and 23, T40N R25E—Nighthawk District, which was inspected and documented by the Okanogan County Health District (Huchton, 1995).

Summit Mill Site

A concrete foundation and partial walls for a mill (or powerhouse) are located within the flood plain of Toats Coulee Creek. No tailings or machinery remains were visible. We recommend analyzing a composited soil sample in the area to determine if metals concentrations remain at the site.

Tunnel Mill Site

This site is located adjacent to the Summit mill site. No significant features remain.

Unnamed Mine

Features at this site include a 25-foot deep adit, a second adit of unknown depth with a vertical winze, and a 50-foot shaft, all open and unfenced.

Unnamed Prospect

The primary hazard is the 40-foot unfenced vertical shaft. Other features include three closely spaced, shallow shafts (6, 6, 10 feet) and one open trench. All features align northwest to southeast. Most likely, this is associated with the War Eagle mine.

War Eagle Mine

We found two shafts, each about 60 feet deep, located within 200 feet of each other, a 6-foot deep prospect pit, and a ditch located between the two shafts. Literature also mentions a 100-foot deep adit, which we could not locate. There is no water on site; the bottoms of the shafts appear to be dry. One of the shafts has a funnel-shaped collar, further compounding the hazard.

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APPENDIX A: Literature Review and Field Inspection Forms

Washington State
Department of Natural Resources
ABANDONED MINE INVENTORY
LITERATURE REVIEW CHECKLIST

Evaluator:_____
Site Number:_____ Review Date:___/___/_____
[Autonumber assigned by database]

Mine Identification

1. **Property Name**: _____

Alternate Names: _____

MILS Sequence No. _____ MRDS No. _____

DNR Bulletin 37 No. _____ DNR OFR 90-18 No. _____

State ID No. _____ EPA ID No. _____

2. **Ownership**: *Fed Indian State County City Pvt Unk Other:* _____

Primary Owner
Name or Agency: _____

Address: _____

Telephone: _____

Ownership Includes: Surface Only Minerals Only Both Partial Owner _____%

Secondary Owner
Name or Agency: _____

Address: _____

Telephone: _____

Ownership Includes: Surface Only Minerals Only Both Partial Owner _____%

Comments: _____

3. Location Data

State: WA County: _____ Twn____ Rge____ Sec(s)_____

Subdivision_____ Merid: WM

Longitude (dec.): _____ Latitude (dec.): _____
Longitude (d,m,s): _____ Latitude (d,m,s): _____
UTM-N: _____ UTM-E: _____ UTM Zone: _____

Long/Lat from: MILS (db) OFR90-18 (db) Quad map Other: _____

Elevation:_____ UOM: *feet / meters* Map Name: _____ Scale: _____

___ Aerial Photo Useful? If so, enter photo number: _____

Mining District: _____ Area of Site: _____ UOM: *sq. ft / acres / hect*

WAU: _____ WRIA: _____ FS Watershed/HUC: _____

Directions / Landmarks:_____

_____

2 Wheel Drive? Y / N 4 Wheel Drive? Y / N Hike? Y / N Other: _____

4. Historical Data

Type of Operation: *Surface Underground Both Prospect Placer Dredge Mill Unk*

Status of Operation: *Past Producer Explored Prospect Raw Prospect Developed Prospect* [>300 ft. of workings]

Commodities: Gold Silver Copper Lead Zinc Other:_____

Acid Producer / Indicator Minerals:

Arsenopyrite Chalcopyrite Galena Marcasite Sphalerite Sulfide Iron Oxide

*Limonite Pyrite Pyrrhotite Stibnite Other:*_____

Neutralizing Host Rock: *Carbonite Dolomite Limestone Marble Other:* _____

Mill Method: *Amalgamation Arrastre Gravity Crusher (only) Heap Leach Other Leach*

Carbon-in-Pulp Cyanidation Stamp Flotation Jig Plant Retort No Mill

Workings / Development: _____
[attach additional sheets if needed]
_____Total Feet:_____

Bats: Portal Aspect(s): *N NE E SE S SW W NW* Multiple Access Points? *Y / N*

Cold Air Traps? *Y / N* Warm Air Traps? *Y / N* Probable Air Flow? *Y / N*

Structures / Improvements: _____

Years of Operation: *From:*_____ *-to-* _____ Annual Precipitation: *<25 cm >25 cm*

Comments - Historical Data:_____
[attach additional sheets if needed]
_____

---

5. Specialty Data

Site in known/suspected floodplain: *None Annual - 10 year 10-100 yr 100-500 yr >500yr*

Water nearby? *Yes / No* Distance: *<100 ft <500 ft < 1000 ft <5000 ft Uphill / Downhill*

Type: *Unnamed Drainage Creek River Lake Pond Spring Wetland Reservoir*

Uphill/Downhill from site? *Uphill Downhill Flat Across Ridge Across Valley*

Waterbody Name: *-Unknown-* *-Unnamed-* _____

Domestic Well Nearby? *Yes / No* Downstream Surface Withdrawal Nearby? *Yes / No*

Comments - Water: _____

_____

_____

Dwelling, campsite or other high use area nearby? *Yes / No*

Type, location if any:_____

Threatened / Endangered species known to be on or near site? *Yes / No*

Type, location if any:_____

Priority: *H / M / L* **Summary of Issues:**

Washington State
Department of Natural Resources

ABANDONED MINE INVENTORY
FIELD INSPECTION

Inspection Date: __/__/____ Page 1 of ___

Evaluator:_____ Agency:_____

Site Name: _____ Site Number: _____–

GPS Location Lat: N_____._____ Lon: W_____.
[center of site] Signal Quality, Datum, etc.: _____

Access Directions: _____

Ownerships Crossed: _____

Transport Mode: *2 Wheel Drive?* *4 Wheel Drive?* *Hike?* *Other:* _____

Access Impediments: _____
(Gates, keys needed, road closures, hostile landowners, etc.)

1. Nearest Sites of Human Activity (Give distance, circle units or mark N/A)

*Dwellings*_____ ft / mi *School*_____ ft / mi *Workplace*_____ ft / mi

*Campground*_____ft / mi *Trail*_____ ft / mi *Road*_____ ft / mi

Evidence of Recent Human Activity at Mine? *Yes / No*

2. Sensitive Environments (If any, give name or distance, if known)

Threatened / Endangered Spp	_____ ft / mi	_____	*Unk*	*Yes*	*No*
Wetlands	_____ ft / mi	_____	*Unk*	*Yes*	*No*
Fisheries	_____ ft / mi	_____	*Unk*	*Yes*	*No*
Other:	_____ ft / mi	_____	*Unk*	*Yes*	*No*

3. Water [Are bodies of water found within 2 miles of the site? Check one, note all that apply.] *Yes* *No*

Stream *River* *Pond* *Lake* *Bay* *Other:*_____

Name of nearest waterbody:_____ Dist. _____ ft / mi

4. Airborne Pollutants

Dust Spray Vapor Other: _____

5. Radiation [Did pre-field research indicate this area has produced uranium?] *Yes / No*

6. Explosives [Are any explosives or blasting supplies found on site?] *Yes / No / Unk*

If present, list type and location: _____

7. Other [are any of the following present? Circle all that apply; provide comments in field book.]

Acrid Odor Chemicals Drums/Tanks Bags Power Substations Transformers Power Lines

Aviation Hazards Overhead Wire(s) Overhead Cables Antennas Poles Towers

Tramway(s) Tram Bucket Trestles Wooden Structures Fences Pipes Scrap Metal

Flumes Other: _____

Environmental Hazard? *Yes / No* Ongoing Impacts? *Yes / No*

Physical Hazard? *Yes / No* Potentially Lethal? *Yes / No*

8. Photograph Numbers

9. Sketch Numbers

10. Summary [Note those that may apply] **Priority: *H / M / L* Issues:**

Open Adit? Open Shaft? Acid Drainage? Metal Transport? Bat Habitat? Other Habitat?

Comments [More detail on points noted above or see suggestions below]

Attractive Hazard? Concealed Hazard? Probably visited by people?

Cultural significance? Evidence of Subsidence? Evidence of Mill Site?

Summary of features/hazards encountered at site. Precautions. T&E Spp.

Washington State
Department of Natural Resources

ABANDONED MINE INVENTORY
FEATURE DATA SHEET

Inspection Date:__/__/____ **Feature No. ___of___** Page___of___

Site Name: _____ Site Number: _____–_____

GPS Location Lat: N_____._____ Lon: W_____._____
[Specific to Feature] Signal Quality, Datum, etc.: _____ Elevation: _____

Landmark Description: _____

1. Feature Type

Adit *Shaft* *Waste Rock* *Open Cut* *Pit, Large, >3m* *Pit, Small, < 3m* *Sump*

Glory Hole *Mill Building* *Building* *Solution Pond* *Leach Pad* *Mill Tailings*

Dam *Well* *Cistern* *Mine Dump* *Highwall* *Tunnel* *Placer Mine* *Subsidence*

Other(s):_____

2. Condition Does the condition of above feature represent a physical hazard? ***Yes / No***

Open to Entry *Closed to Entry* *Collapsed, Partial* *Collapsed* *Fenced*

Concealed, Partial *Concealed* *Eroded partial* *Eroded* *Wind Erosion*

Unconfined *Confined* *Unstable* *Unstable Walls* *Foundation* *Standing*

Subsided *Rotten Cribbing* *Empty* *Partially Full* *Full* *Intact* *Other*: _____

3. Size of Feature [Identify size of feature and units of measure] ***Estimate?*** ***Actual?***

Length	Width	Depth/Height	Volume/Area	Unit of Measure
_____	x _____	x _____	_____	_____

Slope _____ Deg. Bank Stability: *Stable?* *Unstable?* *Marginally Stable?*

4. Water Is water present at feature? ***Yes / No***

a) Is water emanating from or passing through feature? ***Yes / No***
b) If present, how does it occur?
Standing Flowing Filled Partly Filled Intermittent Evidence Only
c) Observe water/bed color. Discoloration?
Brown Green Yellow Yellow-Orange Grey-Black Other **:**_____
d) Field Tests:
GPM:_____ pH:_____ Conductivity:_____uS/cm Temp:_____deg **C? / F?**
Sulfate:_____ Iron:_____ Copper:_____ Zinc: _____ Lead:_____
e) Lab Samples Collected? ***Yes / No*** Sample ID #_____

5. Habitat Probable Bat Habitat? ***Yes / No*** Other Probable Habitat? ***Yes / No***

Temp. Gradient? ***Yes / No*** (*Warmer / Cooler*) Portal Temp./Outside Temp: ___/___**C?/F?**

Portal Aspect: ***N / NE / E / SE / S / SW / W / NW*** Air Flow: ***None / Slight / Moderate / Strong***

Multiple Connected Mine Openings? ***Yes / No*** Elevation Difference: ***<20' / 20-50' / >50'***

Comments:_____

6. Plants Are plants present on or around feature? ***Yes / No***
If yes, circle one:
Healthy Stressed Dead Barren Void Partial Revegetation Full Revegetation

7. Staining Are non-water-related stains (spills, oxidation, etc.) present? ***Yes / No***

If present, indicate color: *Yellow-Orange Gray-Black Other*:_____

8. Machinery Is machinery present at site? ***Yes / No***

a) Location: Inside Building Outside Building No Building Other:_____

b) Type of Machinery. Note all that apply:

Amalgamation Equipment Crusher(s) Ore Bins Stamp Mill(s) Vat(s)

Arrastre Floatation Cell Group Retort(s) Tanks(s) Ball Mill(s)

Leach Tank(s) Rod Mill(s) Thickener(s) Other:_____

9. Photograph Numbers:

10. Sketch Numbers:

11. Comments:

APPENDIX B: Mine site inventory—Spada Lake WAU

Site name	Drainage	Operation	Workings (ft)	Landowner	Location.	Elev. (ft)	Near water?	Inspected?
"45" mine	Williamson Creek	underground	4000	private	secs. 29, 32, T30N R10E	4200	yes	yes
Ala Dickson mine	Williamson Creek	unknown	unknown	DNR	sec. 7, T29N R10E	3000	no	no
Alpha and Beta placers	Williamson Creek	placer	n/a	private	secs. 31, 32, T30N R10E; sec. 6, T29N R10E	1830	yes	no
Big Copper mine	Williamson Creek	trench	n/a	DNR (NRCA)	sec. 4, T29N R10E	5200	no	no
Big Four mine	Williamson Creek	underground	100	USFS	sec. 33, T30N R10E	4400	yes	no
Copper Lake mine	Williamson Creek	unknown	unknown	DNR (NRCA)	sec. 4, T29N R10E	3040	yes	no
Cornucopia mine	Williamson Creek	underground	30	USFS	sec. 33, T30N R10E	3600	yes	no
Little Chief mine	Williamson Creek	underground mines, 2 mills	555	private	sec. 5, T29N R10E	3500	yes	yes
Milwaukee mine	Williamson Creek	surface/underground	25	USFS	sec. 32, T30N R10E	2800	yes	no
Milwaukee & Silver Horseshoe mine	Williamson Creek	surface	n/a	DNR	sec. 4, T29N R10E	5200	no	no
Silver Horseshoe mine	Williamson Creek	surface (open cuts)	n/a	USFS	sec. 33, T30N R10E	4500	no	no
Bolding-Wood prospect	North Fork Sultan River	surface/underground	unknown	DNR	sec. 17, T29N R10E	2160	yes	no
Cu WO3 prospect	North Fork Sultan River	surface/underground	unknown	DNR	sec. 23, T29N R10E	5410	no	no
Doris mine	North Fork Sultan River	underground	500	USFS	secs. 34, 35, T29N R10E	3700	yes	yes
Florence Rae mine	North Fork Sultan River	underground/surface	1400	USFS	secs. 26, 27, T29N R10E	4450	yes	yes
Goat Haven mine	North Fork Sultan River	unknown	unknown	DNR	secs. 25, 26, T29N R10E	4800	no	no
Helena and Sadie mine	North Fork Sultan River	underground	unknown	DNR/private	sec. 36, T29N R10E	3280	yes	no
Iowa mine	North Fork Sultan River	underground	1000	USFS (mines)/ DNR (camp/mill)	sec. 27, T29N R10E	2800	yes	yes
Jerry Chatman mine	North Fork Sultan River	underground	172	USFS	sec. 27, T29N R10E	2700	no	no
John Newhouse mine	North Fork Sultan River	underground (caved tunnel)	unknown	DNR	sec. 20, T29N R10E	2800	no	no
Kelly Creek mine	North Fork Sultan River	underground	80	DNR (NRCA)	sec. 23, T29N R10E	3200	yes	no
Miiki Maru mine	North Fork Sultan River	underground	70	DNR (NRCA)	sec. 36, T29N R10E	4400	no	no
Mountain Cedar prospect	North Fork Sultan River	underground/surface	200	private/DNR	sec. 17, T29N R10E	1700	yes	yes
Occidental mine	North Fork Sultan River	unknown	unknown	DNR (NRCA)	sec. 10, T29N R10E	5200	no	no
Sultan King mine	North Fork Sultan River	underground/surface	1500	private	sec. 1, T28N R10E; sec. 36, T29N R10E	3900	yes	yes
Sunrise mine	North Fork Sultan River	underground/surface	900	USFS/DNR	sec. 15, T29N R10E	2973	yes	yes
Blue Stone mine	North Fork Sultan River	unknown	unknown	DNR (NRCA)	sec. 4, T28N R10E	4400	yes	no
Jones prospect	North Fork Sultan River	underground	unknown	USFS	sec. 11, T28N R10E	2680	yes	no

Site name	Drainage	Operation	Workings (ft)	Landowner	Location.	Elev. (ft)	Near water?	Inspected?
Marvel mine	North Fork Sultan River	surface	15	USFS	sec. 2, T28N R10E	3400	no	no
Kromona mine	South Fork Sultan River	underground mine, mill site, camp, trams	2700	USFS/private(?)	sec. 13, T28N R9E	3380	yes	yes
St. Theresa mine	South Fork Sultan River	unknown	unknown	DNR (NRCA?)	secs. 1, 12, T28N R9E	2800	no	no
Golden Eagle mine	South Fork Sultan River	surface	unknown	USFS	sec. 7, T28N R10E; sec. 12, T28N R9E	3200	no	no
Border Queen mine	Olney Creek	underground	83	private/city/DNR	sec. 33, T29N R9E	2080	no	yes
Lockwood mine	Sultan River WAU (head)	underground/surface	250	DNR	sec. 36, T29N R8E	1977	yes	yes

APPENDIX C: Mine inspection narratives—Spada Lake WAU

Site name	Summation
"45" mine	Located upper adit (4200 feet) and tram landing at Magus (westernmost of three upper adits). Also located midslope adit and waste dump at 3400 feet. Water observed flowing slightly from upper and midslope adits, but no discoloration noted. Other adits hidden in brush and/or collapsed.
Border Queen mine	Shallow adit (12 feet) immediately west of the Olney Pass Trailhead and Infomation Center. Of the two adits described in literature, only one was located on the ground, immediately adjacent to the road (waste rock falls into ditchline). No evidence of water.
Calumet mine	One open adit, discharging water; nine open cuts. About 1 foot of standing water inside adit, with some discharge of water over waste rock. No discoloration in water or sediment. Water sample collected.
Doris mine	Two adits on upper vein, documented as 250 and 225 feet long and at 3600 and 3700 feet in elevation). Did not locate workings on lower vein (shallow shaft and two 6-foot drifts). Adit appears to have minor discharge; no discoloration observed. No water samples collected (no safe landing spot nearby for helicopter).
Florence Rae mine	Two adits; stope between adits. Adit and stope contain scaffolding, machinery, barrels, old explosive crates, etc. Relatively new debris in adits confirm that this mine was in operation within the last twenty years or so. Water samples were collected from standing water in both portals; results indicate low levels of iron, copper, zinc and sulfate.
Iowa mine	Three adits with >1000 feet of workings; fourth adit ½ mi to northwest; uninvestigated mill site at Iowa Camp. Adits were viewed from the air. Adits nearly ½ mi from North Fork Sultan River; however, mill site (not visited) is immediately adjacent to the Sultan River, near the old Iowa camp. Standing water was observed in the upper and lower adits, but no discharge noted and no discoloration visible. No water sample collected.
Kromona mine	Two adits, both discharging water through waste rock. Large, 8-tiered concrete foundation for 120-ton capacity mill near river. Water tests on adit drainage yielded low levels of arsenic, copper and zinc. Sediment tests from the main adit and mill site yielded substantial concentrations of arsenic, copper, iron, lead, and zinc and lower concentrations of mercury. Sulfate detected in both lab samples and field tests. The main adit, albeit a difficult climb through a huge volume of loose waste rock, is an attractive hazard. The site is well known. Probably the most substantial mining and milling site in the Spada watershed.
Little Chief mine	Open adits observed, however, inaccessibility mitigates human hazard potential. Unconfirmed mills (2?) located west of mine, near flood plain of Williamson Creek. Water was not observed flowing from the portal itself, however, surface water was visible falling from above the portal. The reported mill sites should be investigated further.
Lockwood Pyrite mine	Two open adits. Massive sulfide deposit. Primary feature of concern is the lower (main adit); it is discharging discolored (orange) water at a pH of 2.7. Field tests detected sulfate at 1200–1600 ppm. Water and sediment collected for lab analysis yielded high concentrations of all analytes (As, Cu, Fe, Pb, Zn, Hg, SO_4). Mine is ~2500 feet from Sultan River, and sidehill from the nearest unmapped drainage channel is ~200 feet to west. Trash and footprints around adit portal indicate fairly recent human presence. Located outside Spada WAU, slightly to west.
Mountain Cedar prospect	Five adits and five surface cuts; upper adits (caved) are in a burned-over clearcut at the head of a small drainage. Upper adits were observed from the air. They appeared to be caved at the portals. Erosion extends downhill from adits, >200 feet to head of small drainage. No water observed flowing from upper adits; however, mine diagrams indicate lower adits (not located) may be closer to unnamed tributary to Sultan River. No other features were located during site visit; presumed hidden in brush.
Sultan King mine	Largest adit (adit 1; 1200 feet long) and possibly one of the smaller adits (adit 4?) located. Adit 1 caved at portal. Drainage flowing from caved portal; water draining down sides of large volume of discolored waste rock below portal. Collected water sample; trace of zinc and sulfate only analytes detected. Two old engines with 36-inch-diameter flywheels and piping near portal. Other adits not located.
Sunrise mine	Three upper adits (open); one lower adit (collapsed). Pipe presumably draining lower adit flowing with discolored (orange) water, pH = 5.0–5.5. Collected water sample; found trace of zinc and sulfate and pH (6.6). Upper adits observed from the air. Upper adit 1 is the highest documented adit; adit 3 is the lowest of the three upper adits. Adits are within a couple hundred feet of each other. Adit 2 appeared to have standing water inside, but was not discharging at the time of inspection.

Appendix D: Habitat observations—Spada Lake WAU

Site name	Feature	Potential bat habitat?	Portal aspect	Air temperature inside/outside	Air flow at mine opening	Elevation difference	Comments
"45" mine	midslope adit and Upper Magus adits 1 and 2	yes	S	unknown	probable	185 feet	Mine diagrams in Carithers and Guard (1945) show substantial workings connected by stopes. Many potential cold sinks, heat traps, etc., depicted.
Calumet mine	adit	unknown	N	unknown	none	100 feet	Adit walls and ceiling appear fairly sound and presumably go back the full 250 feet reported by Carithers and Guard (1945). However, diagrams show no heat/cold traps, connected workings, etc. No airflow or temperature gradient observed during field visit. Habitat value appears minimal.
Doris mine	upper adit	unknown	E	unknown	unknown	100 feet	Portal hidden in large rock crevice; easily mistaken for natural feature. No habitat observations made. Observed from air only.
Florence Rae mine	upper adits 1 and 2	yes	E	12.4ºC/16.8°C	slight	50 feet	Mine diagrams (Carithers and Guard, 1945, p. 57) indicate number of features that might contribute to bat habitat (cold/heat traps, connected workings, etc.). However, during site visit, noted only slight air flow and temperature gradient. Actual utility for bat habitat unknown.
Iowa mine	lower adit	unknown	E	unknown	unknown	none	Branched adit with single entrance, one level of workings. From the air we could see standing water inside adit. Mine diagrams did not indicate potential heat/cold traps or other attributes for bat habitat. Observed from air only.
Iowa mine	main adits (2)	yes	SE	unknown	unknown	50 feet	Two adits, located ~100 feet from one another (~50-foot elevation difference) appear to be connected. Diagrams of workings (Carithers and Guard, 1945, Fig 12, p. 63) indicate possible heat/cold traps formed by internal stopes. Observed from air only.
Kromona mine	upper (reservoir) adit	yes	W	12.2ºC/21.8ºC	none	none	Copious water flowing inside adit and over top and sides of portal on outside of adit. Lush growth of moss and plants around portal. Small frog noted in pool in gully below portal. Temperature gradient noted, but no noticeable air flow at time of inspection.
Kromona mine	lower (main) adit	unknown	W	4.8ºC/18.9ºC	none	unknown	Substantial workings documented within this adit. Literature states: "no. 4 raise has penetrated surface from main adit" (exactly where unknown). However, no air flow or temperature gradient noted at time of inspection. Unknown habitat potential.
Little Chief mine	upper adit	unknown	SE	unknown	unknown	none	Diagrams (Carithers and Guard, 1945) of the upper adit show only one opening, and while three distinct branches are shown, nothing indicates that they are on different levels. Lower adit may hold more potential for bat habitat, based on the mine diagrams.
Little Chief mine	lower adit	yes	E	unknown	unknown	50 feet	Sketches (DGER mine map files) of the lower adit indicate two openings: one at the portal (NE aspect) and another along the vertical side of Little Chief canyon (SE aspect).
Lockwood Pyrite mine	short (upper) adit	no	N	unknown	none	none	End of adit visible by flashlight. No apparent habitat value for bats. Standing water inside adit. No notable air flow or temperature gradient.
Lockwood Pyrite mine	main (lower) adit	unknown	N	7.9ºC/8.2ºC	none	none	No air flow or temperature gradient noted. Literature does not indicate potential heat/cold traps or connections to workings on different levels. Human footprints, but no animal tracks, noted in orange sediment on adit floor.
Mountain Cedar prospect	upper adits (tunnels 4 and 5)	no	S	unknown	unknown	none	No apparent habitat value; adit appears to be caved.
Sultan King mine	adit 4	unknown	W	unknown	unknown	150 feet	Observed only waste rock from air.

Site name	Feature	Potential bat habitat?	Portal aspect	Air temperature inside/outside	Air flow at mine opening	Elevation difference	Comments
Sultan King mine	adit 1 (longest)	no	NW	n/a	none		Largest adit caved; no apparent habitat value. Other (shorter) adits not inspected.
Sunrise mine	upper adits 1, 2, and 3	unknown	E	unknown	unknown	150 feet	Adit observed from air.
Sunrise mine	lower adit	no	S	n/a	none		Collapsed adit; no apparent habitat value.

APPENDIX E: Mine site inventory—Cecile Creek WAU

Site Name	Drainage	Operation	Workings (ft)	Landowner	Location	Elev. (ft)	Near Water?	Inspected?
Black Bear mine	Palmer Mountain	underground	2500	private, DNR	sec. 36, T39N R25E	2500	no	yes
Bunker Hill mine	Palmer Mountain	underground	200	private	sec. 20, 25, T39N R26E	3500	no	yes
Cleve mine	Gold Hill	surface/underground	50	private	sec. 4, T39N R25E	3600	no	yes
Detroit-Windsor mine	lower Sinlahekin Creek	underground/ surface cuts(?)	200	DNR	sec. 24, T38N R25E	2800	no	no
Double Standard mine	Toats Coulee Creek	underground	10	DNR	sec. 28, T39N R25E	3000	no	no
E Pluribus mine	Gold Hill	underground	60	private in-holding in DNR and WDFW lands	sec. 4, T38N R25E	3930	no	yes
Eclipse mine	Toats Coulee Creek	surface (underground unknown)	unknown	DNR, WDFW, private	sec. 28, T39N R25E	2600	no	no
Frankie Girl mine	Gold Hill	underground	80	private in-holding in DNR and WDFW lands	sec. 4, T38N R25E	3770	no	yes
Gladstone(?) mine	Palmer Mountain	underground	500	BLM	sec. 31, T39N R26E	2660	no	yes
Gold Crown mine	Palmer Mountain	underground/surface	50	private	sec. 31, T39N R26E	2800	yes	no
Gold Hill mine	Gold Hill	underground	unknown	private in-holding in DNR and WDFW lands	sec. 5, T38N R25E	4200	no	yes
Golden Fleece mine	Gold Hill	underground	100	private in-holding in DNR and WDFW lands	sec. 4, T38N R25E	2880	no	no
Hercules mine	Cecile Creek	underground	unknown	DNR	sec. 15, T38N R25E	2720	no	yes
John Judge mine	Palmer Mountain	underground/surface	2500	private	sec. 19, T39N R26E	2500	no	yes
Little Falls mine	Cecile Creek	unknown	50	DNR/USFW (SWA)	sec. 15, T38N R25E	2400	no	no
Lucky Strike mine	Cecile Creek	surface/underground	unknown	DNR	sec. 14, T38N	4600	no	no
Oro Fino mine	lower Sinlahekin Creek	underground/surface	35	private (near USFW and/or WDFW)	sec. 23, T38N R25E	2530	no	yes
Palmer Mountain tunnel	Palmer Mountain	underground	8000	private, DNR	sec. 1, T38N R25E	1500	no	yes
Red Jacket mine	Cecile Creek	underground	50	private/WDFW	sec. 14, T38N R25E	1600	no	no
Security mine	Palmer Mountain	underground	800	DNR	sec. 36, T39N R25E	2000	no	yes
Summit mill site	Toats Coulee Creek	mill	n/a	private	sec. 34, T39N R25E	1510	yes	yes
Summit mine	Palmer Mountain	underground/mill site(?)	1600	private in-holding within BLM	sec. 30, T39N R26E	3870	no	yes
Tunnel mill site	Toats Coulee Creek	mill	n/a	private	sec. 34, T39N R25E	1500	yes	yes
unnamed mine	Palmer Mountain	underground	unknown	DNR	sec. 36, T39N R25E	2260	no	yes
unnamed prospect	Palmer Mountain	underground/surface	unknown	DNR, private	sec. 36, T39N R25E	2534	no	yes
Utica mine	lower Sinlahekin Creek	underground/surface	135	private (near USFW)	sec. 26, T38N R25E	2430	no	yes

Site Name	Drainage	Operation	Workings (ft)	Landowner	Location	Elev. (ft)	Near Water?	Inspected?
War Eagle mine	Palmer Mountain	underground/surface	240	private	sec. 36, T39N R25E	2360	no	yes

APPENDIX F: Mine inspection narratives—Cecile Creek WAU

Site name	Summation
Black Bear mine	Located three shafts (15, 50, and 100+ feet) that appear to be connected. Ore bin, waste rock dump also on site. Falling hazard present; also possible bat habitat. Rough sketch made on-site illustrates arrangement of three shafts in close proximity. Vertical separation between portals <50 feet (bottom two at same level). Largest shaft (adjacent to old roadbed) appears >100 feet deep (literature indicates 300 feet). In this shaft, a drift is visible taking off to the east. A dilapidated hogwire fence is around this shaft. Brush growing around perimeter of shaft collar obscures visibility. Immediately north (collars at same elevation) is a 15-foot shaft connected by an incline to a 50-foot shaft located immediately to the northwest. A winze is visible in the incline between the two shafts. Immediately south of the deepest shaft is an old roadbed that appears to have served as a platform for all above-ground operations (ore handling). On the downhill side of the roadbed are an old wooden ore bin and two waste rock dumps. Roadbed terminates at westernmost dump.
Bunker Hill mine	Lower adit enters hillside at 20°. Adit curves left, so depth not ascertained. Pool of water inside is about 8 inches deep, extent unknown. Portal obscured by low vegetation and caved sides. Rock sample: dense metamorphic rock with small pyrites disseminated throughout. Middle feature is an open cut or a collapsed shallow adit. Waste dump at this location shows orange staining in mostly fine gravel. Upper feature is shaft or steeply inclined (45°) adit. This feature is extremely dangerous because it is surrounded by a funnel-shaped slope of loose material leading down to the collar of the shaft. The shaft itself is not visible from the uphill approach.
Cleve mine	Not located in the field.
Detroit-Windsor mine	Not located in the field.
Double Standard mine	Not located in the field. Limited information on the site; only minor documented workings (10-foot shaft).
E Pluribus mine	60-foot shaft with 24-inch-diameter fir tree growing from waste rock pile. Real estate sign on tree near the road marks the site. Shaft is dry, no apparent water nearby. 30 feet diagonally up hill are five or more small surface prospects, the deepest being about 4 feet, another being a shallow ditch about 40 feet in length. 100 feet northeast of the 60-foot shaft is a 4-foot-deep shaft. Minor limonite stain present and traces of sulfides. At least one well (350 foot depth, 1.5 gpm) exists 0.7 mi northeast (downhill). Another about the same distance to the southwest.
Eclipse mine	No site inspection. Limited documentation of substantial workings or production. Hodges (1897) comments on surface assays, but does not specifically mention underground workings.
Frankie Girl mine	Large-lot real estate development has been established on the old Gold Hill mining complex. Okanogan County Assessor's office has overlays that delineate lots; most of these having the same boundaries (and names) as original mining claims. Little or no potential for surface water impacts noted during field inspection, however, one domestic well (350 foot depth; 1.5 gpm) located 0.5 mi northeast (downhill) and another located 0.75 mi southwest (uphill). Real estate development in area.
Gladstone(?) mine	Suspected to be Gladstone, although only shafts (no adits) identified on ground. Site is between Gold Crown (to east) and War Eagle (to west). Shafts, referred to as D, E, F, and G in field notes (McKay). E is a ~50-foot vertical shaft surrounded by an old collapsed wooden rail; shaft follows joint. Rock was thrown in to gauge depth and test for water at bottom; no splash. Soft collar. E was selected to represent the coordinates for the overall site. D, ~1200 feet south of E and ~300 feet lower elevation, was viewed through binoculars but not checked. A few wheelbarrow loads of orange (oxidized) waste rock were visible. Volume of waste rock suggests it is not a very deep shaft. F and G are 6-foot-deep shafts (prospects?) near E.
Gold Crown mine	~30-foot vertical shaft with water at bottom. Old timbers holding waste rock away from opening contribute to soft collar. Shaft opening fenced with 3-foot-tall hogwire. Spring 300+ feet west of adit may be source of water in bottom of shaft. Mine workings and ground water may be hydrologically connected. Sulfides, calcite visible in waste rock. Shaft follows joint. Shaft has southwest slope aspect. 45 feet east of this site is a 25-foot-long trench, sloping ~15º at N60E. Much orange color in rock; limonite, pyrite cubes, oxidized. *Note:* This site should not be confused with another mine of the same name, located within the Chopaka WAU, sec. 31, T39N R26E.
Gold Hill mine	Not clear exactly which part of overall Gold Hill complex this feature represents. Old mine claims known to be in this complex include: Pennsylvania, Ohio, Storm King, Danny, Virginia, Indiana, Texas, Blue Belle, E Pluribus, Cleve, Bonanza, Argonaut, Chinook (and others). Site is a 12-foot shaft with 2 to 3 feet of water in the bottom. Water could be heard trickling into the shaft (but not seen). Shaft is just below the road, hidden in brush. Some branches and fallen tree over it. No fence. Pervasive quartz. Very little sulfide noted; only tiny crystals. Limonite staining present.
Golden Fleece mine	Not located in the field.
Hercules mine	Location coordinates taken from map (GPS not available at time of inspection). "X" is in correct location on USGS Loomis 7.5-minute quadrangle map (NW¼NE¼ sec. 15, T38N R25E). Top 3 feet of adit portal open. White/tan precipitate visible at portal. Stagnant air in adit. Floor of adit iron stained and damp, but no evidence of water flowing from adit. About 100 cu yd of waste rock (some fines) ~500 feet above Cecile Creek. Farther up valley, we observed what appeared to be an opening to another adit. Opening was 2 feet tall x 8 feet wide (not readily accessible; did not examine further). Much farther up the valley, we observed evidence of blasting and some waste rock.
John Judge property	The "John Judge Property" is a combination of at least three mining operations (Leadville No. 1, Leadville No. 2, and Denver City) and as many as 13 patented claims. Operations at all sites were both underground and surface. No water on the site. Open shaft with heavy timbers around collar is primary hazard at Leadville No. 1. Other Leadville features are either open cuts or collapsed adits. Denver City site has open adit and series of open cuts uphill (eastward) from adit portal.
Little Falls mine	Not located in field.
Lucky Strike mine	No site inspection. Low priority due to limited documentation of substantial workings or production.

Site name	Summation
Oro Fino/Utica mine	Could locate neither adit indicated on USGS quad nor 15-foot shaft discussed by Hodges (1897). Only features identified near Utica site and its extension, Oro Fino, were two open-trench surface cuts.
Palmer Mountain tunnel	South end of the tunnel sealed with concrete and a steel plate with a rubber gasket. Evidence of water seeping from the seal was observed during the site visit. Very little waste rock is present at the site; not enough to account for 8000 feet of workings. Concrete foundations of mill facilities and a small dam are still present at the site.
Red Jacket mine	Not located in the field.
Security mine	Two open adits and an open shaft; the shaft intersects the upper adit. Water is discharging from the lower adit. Seeps and springs noted along bench at same elevation as mine; assume this is source of water. Nearest significant water body is Sinlahekin Creek, 3000 feet to the west (downhill); quad map shows a couple of small ponds about 1000 feet to the north of site at the same elevation along a bench. Wildlife uses this moist cool area. Field tests revealed no metals, sulfate, or acidity; however, lab analysis showed trace amounts of Cu, Pb, Zn in adit discharge. Significant temperature gradient (12°C cooler) and some air flow noted at lower adit. Lower adits and shafts probably connected (100 feet of vertical separation between adits). Shaft and upper adit definitely connected.
Summit mine	Site is currently being actively used for a residence. Not visited. Site should not be confused with that of 1995 Huchton (Okanogan County Health) inspection of same mine name, but different legal description (secs. 22 and 23, T40N R25E in Nighthawk District).
Summit mill site	Remnants (foundation, portions of bullet-ridden walls) of stout concrete building with machine mounts inside (presumably mill building) within 100 feet of Toats Coulee Creek, along lower side of Toats Coulee Road. Appears to be frequently used, despite 'no trespassing' signs. Stone-lined pit, 6 feet in diameter and 5 feet deep, immediately adjacent to Toats Coulee Creek. Apparent bridge approach and steel eye set in rock observed in same location along shoreline.
Tunnel mill site	Immediately to east of Summit mill site. Remaining evidence of operations is mostly rectangular rows of rocks (perhaps old foundation material), old cans, cleared areas, etc. Recent work done to build bridge near old mill site. More research needed to determine which mine(s) this mill site served, the volume (and final disposition) of tailings generated, and milling methods. No entry made in "Features" table. No particularly prominent features remaining at site.
unnamed mine	25-foot-deep adit, second adit with a vertical winze; and a 50-foot shaft. All features open and unfenced. This site is located ~1000 feet to the northwest of the War Eagle site. Literature for War Eagle indicates a 100-foot adit, but this feature is not shown on the quad map (shaft and prospect only), nor was it found on the ground near the other features for War Eagle.
unnamed prospect	USGS Loomis quad shows this as a single shaft and surface cut, labeled "prospect" and located between War Eagle and Black Bear mines. We found four shafts (6, 6, 10, and 40 feet) and one open ditch; all lined up in close proximity, running northwest to southeast. Most likely, this is associated with the War Eagle mine.
War Eagle mine	Shafts are located accurately on USGS Loomis 7.5-minute quadrangle map. Two shafts, each ~60 feet deep, located within 200 feet of each other; 6-foot deep prospect pit and ditch located between the two shafts. No water on site; bottom of shafts appear to be dry. One of the shafts has something of a funnel-shaped collar, further compounding the falling hazard. Literature discusses a 100-foot adit at this site, which was not located. Two adits in the distance, toward the Security mine, may have been part of War Eagle or another unknown mine/prospect (listed above).

APPENDIX G: Habitat observations—Cecile Creek WAU

Site name	Feature	Potential bat habitat?	Portal aspect	Air temperature inside/outside	Air flow at mine opening	Elevation difference	Comments
Black Bear mine	shafts (3)	unknown	SW	no temperature gradient	no	<50 feet	Shafts probably connected, but no significant air flow or temperature gradient observed at time of inspection (June).
Bunker Hill mine	lower adit	unknown	S	15ºC/26ºC	no	<50 feet	Openings may be connected, but no significant airflow observed. Temperature gradient may be largely due to shading.
Bunker Hill mine	open cut or collapsed adit	no	W				
Bunker Hill mine	shaft/steep incline	unknown	SE		unknown	<50 feet	
E Pluribus mine	shafts (2) with prospect nearby	no	horizontal	no temperature gradient	no		
Frankie Girl mine	middle adit	unknown	NE	10ºC/25.8ºC	no		Temperature differential noted, but no significant air flow observed. Not clear that this adit is connected with any other mine openings.
Frankie Girl mine	lower adit	unknown	NE	not recorded	no		Lower temperature in adit, but no air flow noticed. No standing or flowing water, but slight dampness.
Gladstone(?) mine	shaft	unknown	SW		unknown		Viewed through binoculars only. Small volume of waste rock suggests shallow shaft.
Gladstone(?) mine	shaft (6 feet)	no	SW	no temperature gradient	no		
Gladstone(?) mine	deep shaft (50 feet)	unknown	SW		unknown		Deep open shaft with loose rock collar. Bird observed inside.
Gold Crown mine	shaft	unknown	SW	no temperature gradient	no		30-foot shaft does not appear to be connected to any other workings. No air flow, no temperature gradient.
Gold Hill mine	shaft	no			no		
Hercules mine	adit	unknown	SE		no		Stagnant air.
John Judge mine	open adit, series of open cuts, waste rock	no	W	20ºC/28ºC	no		Large volume of pellet-shaped animal (possibly goat) droppings at back of adit.
John Judge mine	open shaft	no	W	no temperature gradient	no		Open shaft with timbered collar level with top of waste rock dump. Bridged or plugged at 40 feet.
Oro Fino mine	open surface cut (trench)	no	NE				
Palmer Mountain tunnel	adit/tunnel	no	SW				Portal sealed; plugged ~12 feet inside with concrete and steel.
Security mine	lower adit	yes	W	13ºC/~25ºC	moderate	100 feet	Wildlife uses the small drainage flowing from mine; observed rattlesnake, several birds, wood rat, etc. Small bones (fawn?) found in adit entrance. Airflow, temperature gradient, and multiple openings suggest possible bat use.

Site name	Feature	Potential bat habitat?	Portal aspect	Air temperature inside/outside	Air flow at mine opening	Elevation difference	Comments
Security mine	shaft	yes		not recorded	unknown	100+ feet	Shaft and exposed stope/trench appeared to have its own microclimate, as evidenced by the fern grotto seen inside the exposed stope. Presumably, this may be influenced by air flow or temperature/humidity gradients from the open shaft?
Security mine	upper adit	yes	W	not recorded	slight	100 feet	With the air flow observed in the lower adit and probability of openings being connected within mine, probably high potential for bat habitat.
Summit mine	4 shafts, 2(?) adits, possible mill site	unknown	SE				Literature indicates significant workings (1600+ feet). Occupied residence on site.
Summit mill site	concrete walls and other mill remnants	no					
unnamed mine	adit with vertical winze	unknown	NW	no temperature gradient	no	>50 feet	Adit with vertical winze immediately inside portal. Connected to other workings, however, no significant temp gradient or air flow.
unnamed mine	adit	no	NW	no temperature gradient	no	>50 feet	Not certain if two adits and shaft are connected. Proximity suggests they may be, but no temperature gradient or air flow noted.
unnamed mine	shaft	no	NW		no	<50 feet	Not certain if two adits and shaft are connected. Proximity suggests they may be, but no temperature gradient or air flow noted.
unnamed prospect	shaft	no	SW		no		Shafts and prospects do not appear to be connected.
unnamed prospect	3 shallow shafts, 1 open ditch	no	SW		no		
Utica mine	open surface cut (trench)	no					
War Eagle mine	shafts (2)	unknown			unknown		