

INACTIVE AND ABANDONED MINE LANDS—Ruby Mine, Nighthawk Mining District, Okanogan County, Washington

by Fritz E. Wolff,
Donald T. McKay,
and David K. Norman

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
Information Circular 111
May 2010



WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

INACTIVE AND ABANDONED MINE LANDS—Ruby Mine, Nighthawk Mining District, Okanogan County, Washington

by Fritz E. Wolff,
Donald T. McKay,
and David K. Norman

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
Information Circular 111
May 2010



WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

DISCLAIMER

Neither the State of Washington, nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the State of Washington or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the State of Washington or any agency thereof.

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

Peter Goldmark—*Commissioner of Public Lands*

DIVISION OF GEOLOGY AND EARTH RESOURCES

David K. Norman—*State Geologist*

John P. Bromley—*Assistant State Geologist*

Washington State Department of Natural Resources Division of Geology and Earth Resources

Mailing Address:

MS 47007
Olympia, WA 98504-7007

Street Address:

1111 Washington St SE
Natural Resources Bldg, Rm 148
Olympia, WA 98501

Phone: 360-902-1450

Fax: 360-902-1785

E-mail: geology@dnr.wa.gov

Website: <http://www.dnr.wa.gov/AboutDNR/Divisions/GER/>

This and other DGER publications are available online at:

<http://www.dnr.wa.gov/ResearchScience/Topics/GeologyPublicationsLibrary/Pages/pubs.aspx>

The bibliography of the Washington Geology Library is at: [http://](http://www.dnr.wa.gov/ResearchScience/Topics/GeologyPublicationsLibrary/Pages/washbib.aspx)

www.dnr.wa.gov/ResearchScience/Topics/GeologyPublicationsLibrary/Pages/washbib.aspx

Suggested citation: Wolff, Fritz E.; McKay, Donald T.; Norman, David K., 2010, Inactive and abandoned mine lands—Ruby Mine, Nighthawk Mining District, Okanogan County, Washington Division of Geology and Earth Resources Information Circular 111, 11 p.

Contents

Introduction	1
Summary	2
Access.	3
Ownership	3
History	3
Geologic setting	3
Openings	3
Materials and structures	4
Water	4
Milling operations	5
Waste rock dumps	5
General information	5
Mine operations data	5
Physical attributes	6
Vegetation	6
Wildlife	6
Water quality	7
Acknowledgments	7
References cited	7
Appendix A. Methods and field equipment	8
Appendix B. Water quality standards for hardness dependent metals.	9
Appendix C. Plat of mineral survey no. 1021, Ruby Mining Company claims	10

FIGURES

Figure 1. Plan view of mine workings, Ruby mine.	1
Figure 2. Photo showing Ruby mine site.	2
Figure 3. Photo showing lower adit portal	4
Figure 4. Photo showing mill building interior with footings	4
Figure 5. Photo showing interior of maintenance shop	5

TABLES

Table 1. Location and map information	5
Table 2. Mine features	5
Table 3. Soil analysis	6
Table 4. Soil quality standards for unrestricted land use	6
Table 5. Bat habitat information	6
Table 6. Surface water field data	6
Table 7. Surface water analysis and applicable Washington State Water Quality Standards	6

Inactive and Abandoned Mine Lands— Ruby Mine, Nighthawk Mining District, Okanogan County, Washington

Fritz E. Wolff, Donald T. McKay, and David K. Norman
Washington Division of Geology and Earth Resources
MS 47007; Olympia, WA 98504-7007

INTRODUCTION

The Washington State Department of Natural Resources (DNR), Division of Geology and Earth Resources (DGER), has built a database and geographic information system (GIS) coverage of major mines in the state and published a series of corresponding Open File Reports and Information Circulars. Site characterization field work was initiated in 1999 (Norman, 2000). Work was funded through interagency grants from the U.S. Forest Service (USFS), Region 6. Other agencies sharing in the project were the U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (DOE).

More than 3800 mineral properties have been located in the state during the last 100 years (Hunting, 1956). Many are undeveloped prospects of little economic importance. Therefore, in considering the population to include in the Inactive and Abandoned Mine Lands (IAML) inventory, we have identified approximately 60 sites that meet one 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.

The IAML site characterizations 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 are also included. Acquisition of this information is a critical first step in any sys-

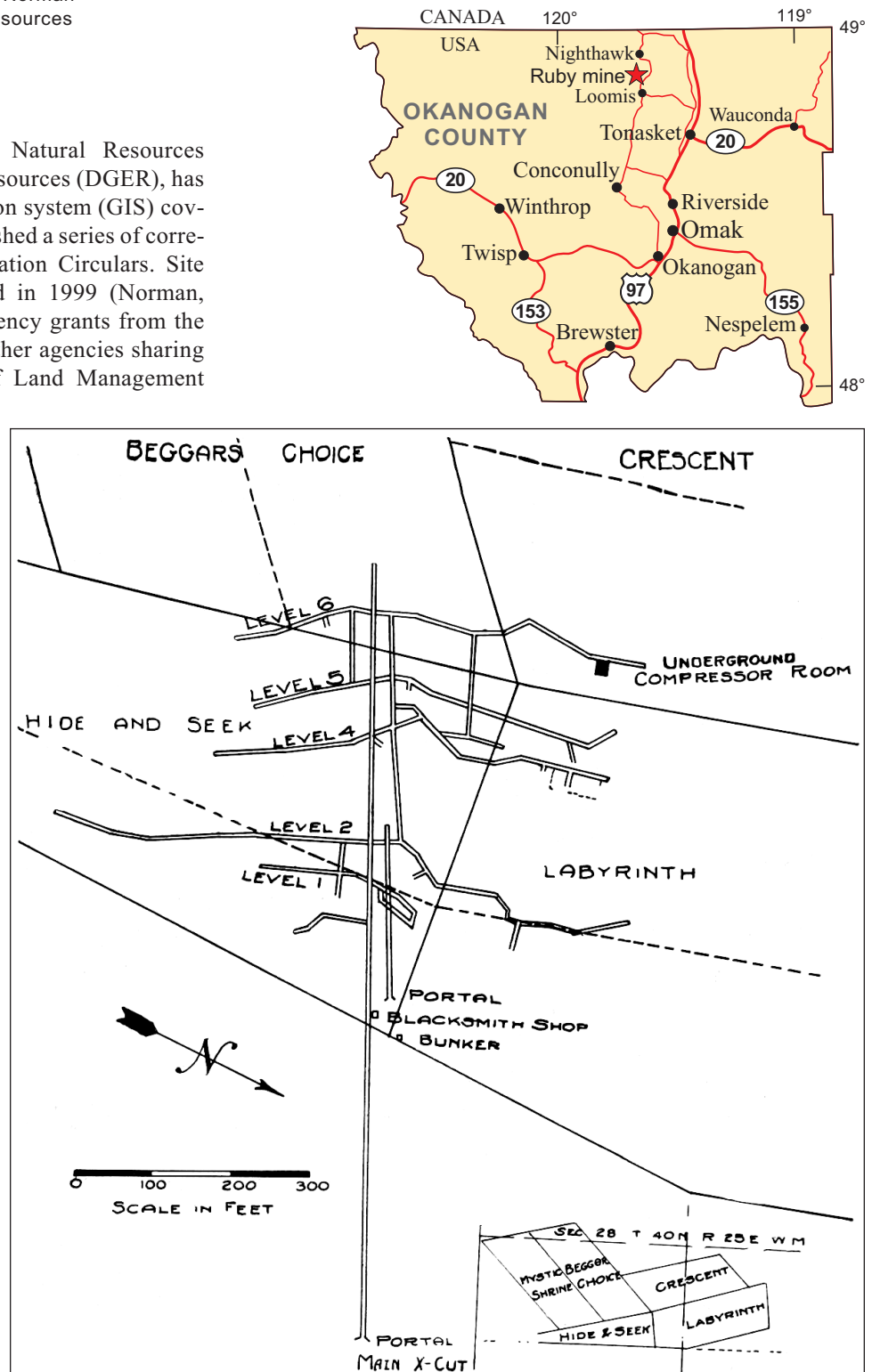


Figure 1. Plan view of mine workings, Ruby mine (after Patty, 1921).

tematic approach to determine if remedial or reclamation activities are warranted at a particular mine. The IAML database captures this information in spreadsheet format (Microsoft Access). Reports such as this one provide documentation on mines or groups of mines within specific mining districts or counties. IAML reports are posted online at <http://www.dnr.wa.gov/geology/pubs/>. These reports state what we believe to be the known facts at the time of publication. Changes brought about by future events must be taken into consideration by the reader.

SUMMARY

The Ruby mine is located in Okanogan County on the northeast face of Chopaka Mountain, about 5 miles south of Chopaka, Wash., in sec. 28, T40N R25E. It is renowned for some exceptional silver mineralization. Assays of 200 ounces per ton (opt) silver have been reported from high grade lenses, but the run-of-mine production averaged about 10 opt silver. The property is owned by a private entity, Ruby Mine LLC of Tacoma. It consists of five patented claims and two tax lots.

Aside from the first year's production in 1903, which probably emanated from the upper adit, most of the more than 5000 feet of development began with driving the lower mill-level adit, followed by upraises connecting a total of five levels, and lateral drifts north and south along the vein at each level (Fig. 1). It is unclear whether this amount of development, which is impressive for mines in the Okanogan, was done under the first owner, Ruby Mining Co. (1902–1915), or the second owner, Pyrrargyrite Mining Co. (1915–1926). An unknown amount of work was done in 1938 by lessees. The statistical production data from the mine prior to 1920 is sketchy, but our best estimate from data that has been reported is that the property produced in total about 12,100 tons of crude ore yielding 151,000 ounces silver.

From an ore deposit standpoint, the mineralization at Ruby is something of an oddity: Two mineralized quartz veins, one of which was reported to be more productive than the other, are enclosed in a linear shear zone consisting of hornblende-rich fault gouge and highly basic (ultramafic) rocks, gabbro grading to dunite. This structure is in turn surrounded by (felsic) granodiorite of the Anderson Creek pluton forming the core of Chopaka Mountain. The vein(s) meander through the shear zone as open-space filling containing white, friable quartz and lenses and stringers of the silver minerals argentite, pyrrargyrite, and proustite. Arsenopyrite, sphalerite, and galena are present. This structure can be irregularly traced on the surface more than 3000 feet to the northwest to the Mountain Sheep mine, developed on a high-silver structure essentially identical to that found at the Ruby mine.

The principal openings are two parallel crosscutting adits separated by 400 feet in elevation. Between the two adits, a series of connecting raises follow the southwest-dipping vein upward to four intermediate levels on which drifts have been driven laterally



Figure 2. Ruby mine site. View to the northwest.

to the north and south. The lower adit (Level 6) is 1028 feet long, striking S65°W. The upper adit (Level 1) is 250 feet long and open. The lower adit portal wall rock, timbers, and haulage track are intact. Bats were observed at the portal.

The Ruby mill is empty, but most of the structure is reasonably intact, as are a maintenance shop with blacksmithing forge, and an empty powder magazine, both located on the lower adit waste rock dump (Fig. 2). The office/bunkhouse located on the flat near the tailings is still recognizable but in a state of disrepair.

Water discharges from the lower adit, runs across the dump, and infiltrates near the mill. At pH 6.0–6.2, the drainage is slightly acidic. When compared to WAC-173-201A-240 (Toxic substances [surface waters]), the analyses for arsenic and zinc exceed the State standard (see Table 7).

The 75 ton per day (tpd) mill built by Pyrrargyrite Mining was completed in the summer of 1920. It used both flotation and gravity separation. The first year of mill operation was 1921, when it probably processed stockpiled ore. The mill was well equipped with the best available mineral dressing equipment known at the time. Recorded production figures indicate the mill processed approximately 11,000 tons of ore up to 1923, the last year of operation (Gerry, 1922, 1924, 1925, 1927a).

The waste rock dumps contain about 17,400 tons of shot rock, or a minimum volume of about 12,400 cubic yards. Stope volumes are unknown. Analyses from Huchton's (1995) composite grab sample indicate that the major contaminant of concern is arsenic, which exceeds the WAC 173-340-900 State standard for unrestricted and commercial use for soils by a factor of 225 (see Table 3). The silver content in Huchton's sample equates to 1.6 opt. The tailings, estimated at 8100 cubic yards, were not analyzed.

ACCESS

The property is located in sec. 28, T40N R25E. To reach it, proceed 9.2 miles north of Loomis to an intersection. Turn left on Chopaka Road and drive 2.4 miles to the mine access road that lies to the west of the highway. The mill building and waste rock dump are plainly visible at this point at the base of the steep northeast slope of Chopaka Mountain.

OWNERSHIP

The property, which is privately held, is owned by Ruby Mine LLC, Tacoma, Wash. It consists of five claims patented under Mineral Survey No. 1021: Beggars Choice, Crescent, Labyrinth, Hide and Seek, Mystic Shrine (Appendix C), and tax lots 6 and 7. The total land asset is 127 acres. Contact the Okanogan County Assessor for additional details.

HISTORY

The Ruby discovery in April of 1902 is credited to A.M. Riste and George Bowers, who then sold the property in November of the same year to Ruby Mining Company, Inc. Hagerty (1905) stated that in the first full year of development, 1903, "...the mine produced about \$20,000 in silver values from the initial 211 feet of adit." Since the vein wasn't intersected in the crosscutting lower adit until about the 1000-foot point, this initial production must have come from the 250-foot-long upper adit closest to the outcrop. The claims were surveyed in 1910 for patent under Mineral Survey 1021. Patent 351011 was subsequently issued to Ruby Mining in August of 1913.

In 1915, the Pyrargyrite Mining Co. Inc. purchased the mine (Patty, 1921). Patty reported that from 1915 to 1920 Pyrargyrite Mining shipped "...31 railcars of crude ore showing a gross value of approximately \$25,000." Working backward from the price of silver at that time of 60 cents per ounce, the shipments would amount to about 1240 tons containing 44,640 ounces of silver—indicating a not inconsiderable grade of 35 opt silver for what was probably hand-sorted ore. By 1920, a body of milling-grade ore running 10 to 15 opt silver had been blocked out, and the company constructed a 75 tpd electrically powered mill to produce concentrate.

Statistics for the years during which the mill operated, 1921 to 1923, show that 10,855 tons of ore produced concentrates containing about 107,000 ounces of silver (Gerry, 1922, 1924, 1925, 1927a). Brown (1934) reported that a grab sample he obtained from the lower adit dump averaged 92.1 opt silver and 0.01 opt gold. The Minerals Yearbook (Miller and Luff, 1939) reported some activity at the Ruby in 1938 but no other details. A newspaper clipping indicates that a partnership of Oroville men had "...leased the mine and put a crew to work reopening it" (*Wallace Miner*, July 24, 1975). This is the last reported activity at the site in DGER mine files.

Ruby Mining was incorporated at Loomis in December 1902, and Pyrargyrite Mining at Oroville in January 1915. Both corporations were administratively dissolved for nonpayment of fees in 1923. Chloride Queen Mining and Smelting Co. Inc. of Chelan, Wash., owned the property from the date of incorporation, May 1926, through 1938, after which time the company was administratively dissolved.

GEOLOGIC SETTING

Ore mineralization occurs as a partial filling in a gouge-lined shear zone striking approximately N20°W and dipping 45S°W. It contains pyrite, chalcopyrite, and arsenopyrite; the silver minerals proustite, pyrargyrite, and argentite; some galena and sphalerite, and minor free gold. The gangue mineral is milky white, friable quartz containing 5 percent lime.

The setting is somewhat unusual for ore deposits of this type, in that the mineralized shear zone is gabbro varying in places to hornblende diorite, and in others to dunite. "The exact relationship of these highly basic rocks to the granodiorite which occurs on all sides of it [and forms the core of Chopaka Mountain] has not been determined, but may be a differentiation from that mass. It is very rich in hornblende, often running as high as 73 per cent and seldom falling below 40 per cent. Apatite is conspicuous, sometimes representing 5 per cent of the rock" (Umpleby, 1911).

"Two leads have been encountered, only one of which is of commercial importance. Heavy black gouge, largely composed of powdered and secondary hornblende, occurs along the fault plane and is usually mixed with the ore. The ore shows a tendency to follow the hanging wall, but exceptions are numerous. Although the fissure is very irregular in width, varying from three or four to twenty feet, the ratio of vein material to gouge varies even more markedly from place to place. On the whole, gouge predominates. The vein matter occurs as lenses, stringers and as cement in brecciated material and varies from ½ inch to 12 or more feet in thickness, averaging about 15 inches" (Umpleby, 1911). Patty (1921) reported that the ore minerals sometimes show slickensided faces, indicating post-deposition movement.

In a study of northern Okanogan County mines for the Mineral Availability System inventory (Lucas, 1975), an assessment of Ruby mine potential stated that "The majority of mineralized veins found in the Nighthawk–Loomis area have been mined out; the Ruby vein, however, which falls into the category of a shear zone or depth persistent deposit, appears to have been abandoned without further exploration in 1939, possibly due to a combination of economic and world political factors" (DGER mine file). In spite of the considerable horizontal and vertical development at the Ruby, Moen's (1976) opinion was that given the two primary leads, only parts of the vein had been mined, and that much of the deposit "...had yet to be explored". The Mountain Sheep mine is located 3000 feet north of the Ruby on the same face of Chopaka Mountain. Its mineralization and host rock are virtually identical to that of the Ruby and the shear zone at both mines has the approximate same dip and strike. The outcrop has been traced on the surface between the two properties with some difficulty, due to the precipitous slopes. It is plausible to suppose that the deposits are related, thereby providing an interesting exploration target.

OPENINGS

Two parallel crosscutting adits were driven below the outcrop, separated by 400 feet in elevation. The lower adit (Level 6) is 1028 feet long, striking S65°W. The upper adit (Level 1) is 250 feet long. A series of raises follow the vein upward from the lower adit to the surface and connect with four intermediate lev-



Figure 3. Lower adit portal. View to the southwest (S65°W).

els. Aside from ore mined initially from the upper adit, it appears that the mine was essentially developed upward through the raises, and that the majority of production was dropped by gravity to the lower adit, which served as a main haulage way. The portal wall rock, timbers, and haulage track were intact at the time of the DGER site visit. A cool mist exhausted from the portal, and water 4 inches deep, flowing at several gallons per minute (gpm), covered the floor (Fig. 3). We observed bats of undetermined species at the lower adit portal in August 2001, a presence confirmed by DNR biologist John Fleckenstein (oral commun., 2010).

At the time of Patty's examination in 1920, the maximum horizontal development, with drifts running northwest and southeast along strike, was about 950 feet on Level 2. In the lower adit, a winze was sunk at the face of the northwest drift to a depth of 210 feet on the vein, giving a total vertical development at the mine of about 770 feet measured down dip. Patty (1921) stated that the winze was flooded at the time, but was reported to have exposed milling grade ore of 10 to 15 opt silver. Total underground development exceeds 5000 feet (Hunting, 1956).

Robert Stone (written commun., 2009) confirmed that an aerial tramway carried ore from the upper adit to the surface prior to the driving of the lower adit. Two strands of cable can be seen lying across the dump beneath the upper adit bunker in a circa-1975 file photo (DGER mine file). DGER did not access the upper adit because of the waste rock dump's approximate



Figure 4. Mill building interior with footings.

40° angle of repose and intervening cliffs. Patty's map shows a blacksmith shop and ore bunker at the upper adit. Huchton (1995) reported that the upper adit was dry and intact, and only the ruins of the bunker remained in place.

MATERIALS AND STRUCTURES

The circa-1920 mill has been abandoned for some time, but the red metal roofing applied in the past has kept most of the structure reasonably intact. A section of the north side structure has been scavenged for material, along with part of the roof (Fig. 4). The mill machinery has been removed. A maintenance shop with blacksmithing forge is located on the lower adit waste rock dump (Fig. 5). The powder magazine nearby is empty, open, and intact. The bunkhouse/office located on the flat near the tailings is still recognizable but in a state of disrepair.

WATER

In July 1995, Huchton (1995) estimated the flow from the lower adit at 12 to 18 gallons per minute (gpm), which ran across the dump and infiltrated behind the mill. DGER estimated the August 2001 flow at about 3 gpm. The drainage is slightly acidic—pH measuring 6.0 to 6.2. Although both DGER and Huchton took water samples of the adit discharge, the results as reported in Table 4 differ somewhat due to Huchton's use of lower detection limits. When compared to WAC-173-201A-240

(Toxic substances [surface waters]), the combined data indicate that dissolved metal analyses for arsenic and zinc exceed the state standard.

MILLING OPERATIONS

The 75 tpd electrically powered mill built by Pyrrargyrite Mining was completed in summer of 1920 and awaited only the arrival of energy in the Okanogan Valley Power Company's line from a dam on the Similkameen River before turning over. The first year of mill operation was 1921. The mill was well equipped with the best available mineral dressing equipment known at the time, differing mainly in degree of sophistication from present day practice. The flow sheet was unique in that flotation both preceded and followed gravity concentration by tabling. Recorded production figures indicate that the mill processed approximately 11,000 tons. No mill throughput is reported after 1923 (Gerry, 1922, 1924, 1925, 1927a,b, 1928-1930).

WASTE ROCK DUMPS

The only reliable figure for estimating waste rock volume is Patty's figure for development work in adits, drifts, and raises of 5000 feet, equating to about 17,400 tons of shot rock or a waste rock volume of about 12,400 cubic yards. The analyses from Huchton's (1995) composite dump sample indicate that the major contaminant of concern was arsenic, which exceeds WAC 173-340-900 State standards for unrestricted and commercial use in soils by a factor of 225 (see Table 3). The tailings, estimated at 8100 cubic yards, were not analyzed.

GENERAL INFORMATION

Names: Ruby, Pyrrargyrite

MAS/MILS sequence number: 0530470038

Access: two-wheel drive, climb

Status of mining activity: none

Claim status: five patented claims viz. Mineral Survey no. 1021; U.S. Patent no. 351011 issued August 19, 1913. Tax lots 6 and 7, contiguous with the claims, are part of the property.

Current ownership: Ruby Mine, LLC, Tacoma, Wash.

Surrounding land status: Bureau of Land Management

Location and map information: see Table 1



Figure 5. Interior of maintenance shop.

Table 1. Location and map information.

Mine property	County	Location	Decimal latitude	Decimal longitude	1:24,000 quad.	1:100,000 quad.
Ruby	Okanogan	sec. 28, T40N R25E	48.93626	119.69319	Nighthawk	Oroville

Directions: proceed 9.2 miles north of Loomis to an intersection; turn left on Chopaka Road and drive 2.4 miles to the mine access road

MINE OPERATIONS DATA

Type of mine: underground

Commodities mined: silver, minor copper

Geologic setting: mineralized white quartz occurring in a shear zone of hornblende-rich gabbro and dunite; shear zone surrounded by granodiorite of the Anderson Creek pluton

Ore minerals: chalcopyrite, galena, sphalerite, proustite, pyrrargyrite, argentite; minor free gold and copper oxidation products

Non-ore minerals: quartz, pyrite, arsenopyrite

Host rock: gabbro grading to dunite in places

Period of production: intermittent 1903–1939; major productive period, 1915–1923

Table 2. Mine features. — — —, no data.

Description	Condition	Fenced (yes/no)	Length along bearing (feet)	Width (feet)	Height/depth (feet)	True bearing	Elev. (feet)	Decimal latitude	Decimal longitude
mill site	mostly intact	no	— — —	— — —	— — —	— — —	1215	48.93626	119.69319
lower adit (Level 6)	open	no	1028	6.5	7	S65W	1304	48.93564	119.69397
upper adit (Level 1)	open	no	250	6.5	6.5	N85W	1751	48.93519	119.69616

Table 3. Soil analysis. Analyses in bold indicate levels that exceed one or more standard shown in Table 4. Data from Huchton (1995). — — —, no data.

Metals	Antimony	Arsenic III	Cadmium	Copper	Cyanide	Iron	Lead	Mercury	Silver	Zinc
Composite dumps	— — —	4511	1.9	18.8	— — —	— — —	89.8	0.16	49.8	170.7

Table 4. Soil quality standards for unrestricted land use. WAC 173-340-900, Model Toxics Control Act, Table 749-2: Priority contaminants of ecological concern for sites that qualify for the simplified terrestrial ecological evaluation procedure (partial data). Concentrations are milligrams/kilogram. Levels for silver and gold are not specified.

Metals	Antimony	Arsenic III	Cadmium	Copper	Cyanide	Iron	Lead	Mercury	Silver	Zinc
Unrestricted land use	32	20	25	100	no std.	no std.	220	9 (inorganic)	no std.	270
Industrial or commercial use	32	20	36	550	no std.	no std.	220	9 (inorganic)	no std.	570

Development: 5000 feet of adits, drifts, and raises; stope volumes unknown

Production: estimated 151,000 ounces silver from 12,100 tons

Mill data: 75 tpd combined flotation and gravity concentrator

PHYSICAL ATTRIBUTES

Features: see Table 2

Materials: steel mine rail

Machinery: mill equipment foundations, forge

Structures: blacksmith shop, bunkhouse/office, powder magazine, mill, ore bunker

Waste rock dumps, tailings impoundments, highwalls, or pit walls: tailings lie on the flat immediately adjacent to the mill, upslope from the Chopaka Road; waste rock dumps opposite upper and lower adit portals; estimated total tailings, 8100 cubic yards; estimated waste rock, 12,400 cubic yards

Analysis of waste rock dumps: see Table 3

Waste rock, tailings, or dumps in excess of 500 cubic yards: two

Reclamation activity: none

Table 5. Bat habitat information.

Opening	Aspect	Air temp. (°F) at portal	Air flow: exhaust	Air flow: intake	Multiple interconnected openings	Bats or bat evidence
Lower adit	NE	48	~2 mph	no	yes	yes

Table 6. Surface water field data. *, data from Huchton (1995).

Description	Flow (gpm)	Conductivity (μS/cm)	pH	Bed color	Temp. (°F)
Flow from lower adit	12–18*	820*	6	unstained	50°

VEGETATION

Shrub-steppe grasses, weeds, inland fir, and tamarack.

WILDLIFE

The following wildlife have been observed within 2 miles of the Ruby mine: blue grouse, mountain goat, mountain sheep, bald eagle, mule deer, white-tailed deer, cavity nesting ducks, golden eagle, lynx, chukar partridge, and moose. Rainbow trout inhabit Champneys Slough (Washington Department of Fish and Wildlife Habitats and Species database map in the vicinity of

Table 7. Surface water analysis. Metal concentrations are in micrograms/liter (μg/L); hardness is in milligrams/liter (mg/L); USEPA, U.S. Environmental Protection Agency; — — —, no data; *, standards for these metals are hardness dependent; ≤ indicates metal was not detected—the number following is the practical quantitation limit above which results are accurate for the particular analysis method—the metal could be present in any concentration up to that limit and not be detected. Conversion formulae are shown in <http://www.ecy.wa.gov/pubs/wac173201a.pdf>. Standards calculated for hardness values specific to Part 1 below are shown in Appendix B.

PART 1: ANALYSIS BY USEPA METHOD 6020, INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETRY

Sample location	Arsenic	Cadmium*	Copper*	Iron	Lead*	Mercury	Zinc*	Hardness
Lower adit discharge (Huchton, 1995)	198	≤2.0	≤20.0	— — —	≤2.0	≤0.5	320	— — —
Lower adit discharge (DGER, 2001)	≤100	— — —	≤100	≤1000	≤100	— — —	≤100	340

PART 2: APPLICABLE WASHINGTON STATE WATER QUALITY STANDARDS

Type of standards (applicable Washington Administrative Code)	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc	Hardness
Surface water standards, aquatic life (WAC 173-201A-240, Toxic substances, Table 240(3) freshwater, chronic level maximums)	190	*	*	none	*	0.012	*	100
Ground water standards, domestic consumption (WAC 246-290-310, Maximum contaminant levels, Table 4, inorganic chemical characteristics)	10	5	1300	300 (cosmetic only)	15	2	5000	— — —

T40NR25E section 28, accessed Feb. 5, 2003). See Table 5 for bat habitat information.

WATER QUALITY

Surface waters observed: Similkameen River

Proximity to surface waters: 4000 feet

Domestic use: cattle grazing, recreational shooting

Acid mine drainage or staining: pH 6 at lower adit

Water field data: see Table 6

Surface water migration: adit discharge infiltrates behind mill building

Surface water analysis: see Table 7

ACKNOWLEDGMENTS

The authors thank our editors Jari Roloff and Karen Meyers for helpful suggestions on the layout and content of this report, and Lee Walkling for library support. Jerry Smith (Okanogan, Wash.) and Rob Stone (Nighthawk, Wash.) provided helpful information on Ruby mine history.

REFERENCES CITED

- Brown, O. B., 1934, Mineral investigations project—Ruby Mine, Chopaka Mountain, Nighthawk District, Washington: Civil Works Administration, Washington Emergency Relief Administration, file 93, 2 p.
- Gerry, C. N., 1922, Gold, silver, copper, lead, and zinc in Washington. *In* Loughlin, G. F., Mineral Resources of the United States, 1920; Part 1—Metals: U.S. Geological Survey, p. 261-270.
- Gerry, C. N., 1924, Gold, silver, copper, lead, and zinc in Washington. *In* Loughlin, G. F., Mineral Resources of the United States, 1921; Part 1—Metals: U.S. Geological Survey, p. 421-428.
- Gerry, C. N., 1925, Gold, silver, copper, lead, and zinc in Washington. *In* Loughlin, G. F., Mineral Resources of the United States, 1922; Part 1—Metals: U.S. Geological Survey, p. 245-256.
- Gerry, C. N., 1927, Gold, silver, copper, lead, and zinc in Washington. *In* Katz, F. J., Mineral Resources of the United States, 1923; Part 1—Metals: U.S. Geological Survey, p. 405-416.
- Gerry, C. N., 1927, Gold, silver, copper, lead, and zinc in Washington. *In* Katz, F. J., Mineral Resources of the United States, 1924; Part 1—Metals: U.S. Geological Survey, p. 285-295.
- Gerry, C. N., 1928, Gold, silver, copper, lead, and zinc in Washington. *In* Katz, F. J., Mineral Resources of the United States, 1925; Part 1—Metals: U.S. Geological Survey, p. 551-562.
- Gerry, C. N., 1929, Gold, silver, copper, lead, and zinc in Washington. *In* Katz, F. J., Mineral Resources of the United States, 1926; Part 1—Metals: U.S. Geological Survey, p. 455-470.
- Gerry, C. N., 1930, Gold, silver, copper, lead, and zinc in Washington. *In* Katz, F. J., Mineral Resources of the United States, 1927; Part 1—Metals: U.S. Geological Survey, p. 589-598.
- Hagerty, J. M., 1905?, The story of Okanogan: [privately published by the author], 33 p.
- Huchton, R. M., 1995, Washington Department of Ecology Toxics Cleanup Program—Initial investigation report, data collection [Ruby Mine]: Okanogan County Health Department, [20 p.].
- Hunting, M. T., 1956, Inventory of Washington minerals; Part II—Metallic minerals: Washington Division of Mines and Geology Bulletin 37, Part II, 2 v.
- Lucas, J. M., 1975, The availability of nickel, chromium and silver in Washington: Washington Division of Geology and Earth Resources Open File Report 75-14, 140 p., 1 plate. [http://www.dnr.wa.gov/publications/ger_ofr75-14_nickel_chromium_silver.pdf]
- Miller, T. H.; Luff, Paul, 1939, Gold, silver, copper, lead, and zinc in Washington. *In* Hughes, H. H., Minerals yearbook, 1939: U.S. Government Printing Office, p. 479-492. [<http://digioll.library.wisc.edu/cgi-bin/EcoNatRes/EcoNatRes-idx?type=header&id=EcoNatRes.MinYB1938&isize=M>]
- Moen, W. S., 1976, Silver occurrences of Washington: Washington Division of Geology and Earth Resources Bulletin 69, 188 p. [http://www.dnr.wa.gov/publications/ger_b69_silver_occurrences_wa.pdf]
- Norman, D. K., 2000, Washington's inactive and abandoned metal mine inventory and database: Washington Geology, v. 28, no. 1/2, p. 16-18. [http://www.dnr.wa.gov/Publications/ger_washington_geology_2000_v28_no1-2.pdf]
- Patty, E. N., 1921, The metal mines of Washington: Washington Geological Survey Bulletin 23, 366 p. [http://www.dnr.wa.gov/publications/ger_b23_metal_mines_wa_1.pdf and http://www.dnr.wa.gov/publications/ger_b23_metal_mines_wa_2.pdf]
- Umpleby, J. B., 1911, Part I—Geology and ore deposits of the Myers Creek mining district; Part II—Geology and ore deposits of the Oroville–Nighthawk mining district: Washington Geological Survey Bulletin 5, 111 p. [http://www.dnr.wa.gov/publications/ger_b5_mining_districts_okanogan_co.pdf] ■

Appendix A. Methods and field equipment

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded with a global positioning system (GPS) unit in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

Soil and water samples collected by Huchton (1995) and used in this report were analyzed by White Earth Analytical, Inc., Ephrata Wash.

The water sample DGER collected was analyzed for the metals listed in this report by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA (U.S. Environmental Protection Agency) Method 6010. Holding times for the metals of interest were observed. Instrument calibration was performed before each analytical run and checked by standards and blanks. Matrix spike and matrix spike duplicates were performed with each set.

FIELD EQUIPMENT

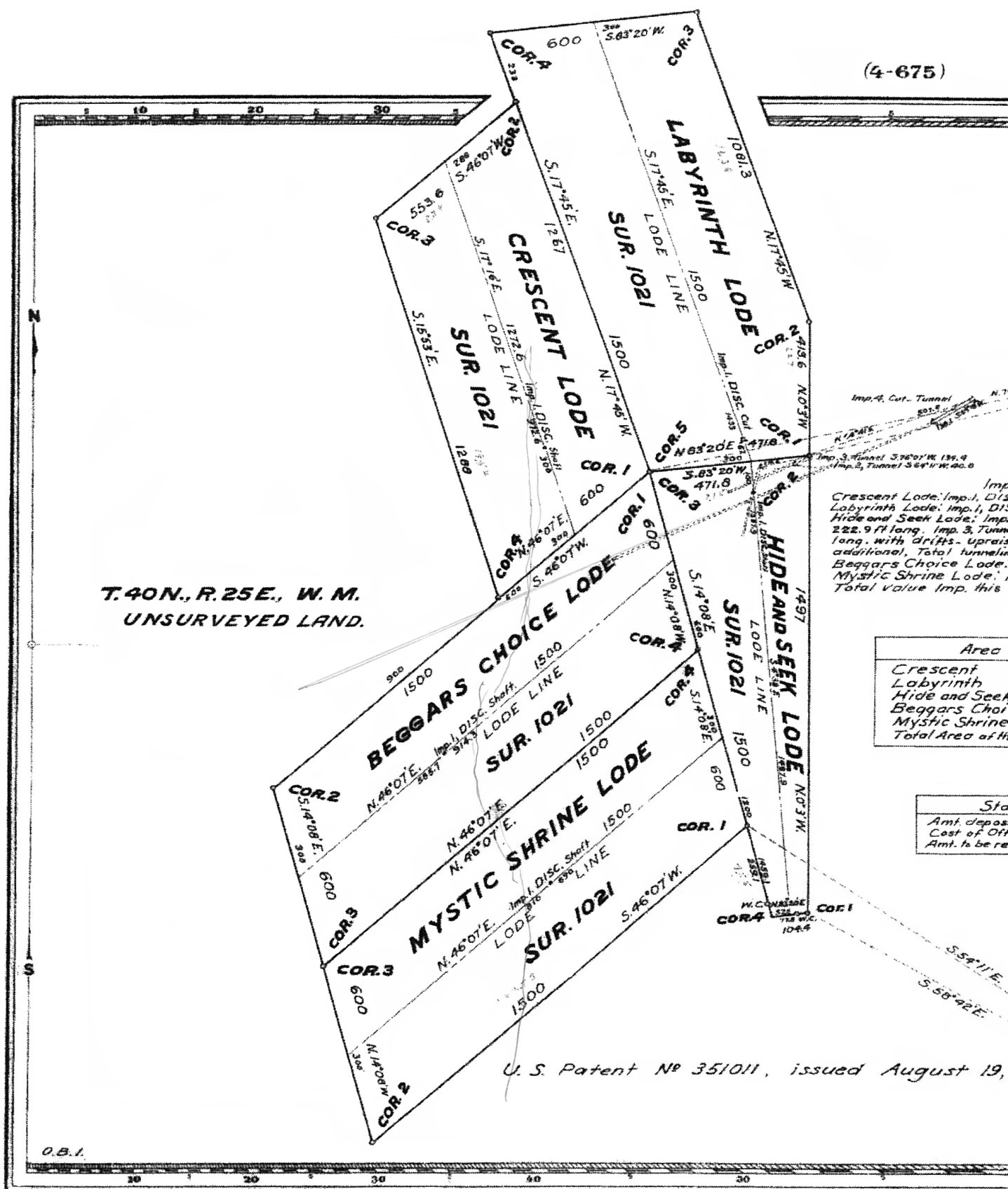
- barometric altimeter
- binoculars
- digital camera
- flashlight
- Garmin GPS III+, handheld GPS unit
- Hanna Instruments DiST WP-3 digital conductivity meter and calibration solution
- litmus paper, range 0–14, and 4–7
- Oakton digital pH meter
- Oakton digital electrical conductivity meter
- Taylor model 9841 digital thermometer

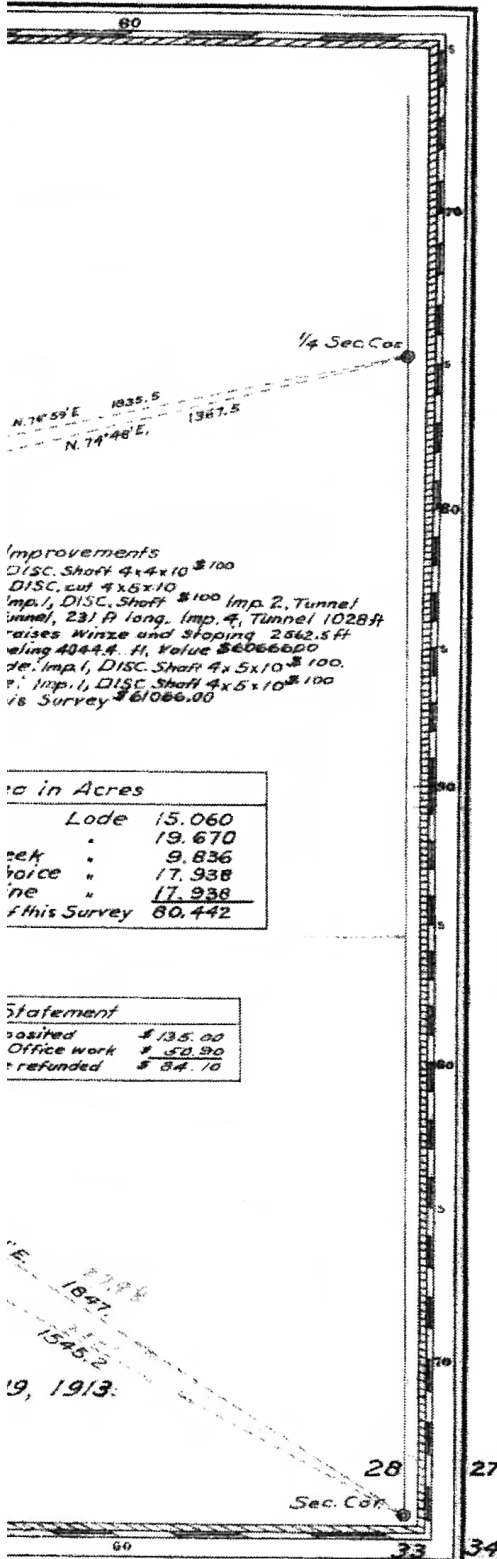
Appendix B. Water quality standards for hardness dependent metals

Conversion formulae are given in WAC 173-201A at <http://www.ecy.wa.gov/pubs/wac173201a.pdf>.

Chronic standard in micrograms/liter ($\mu\text{g/L}$)

Sample location	Hardness (mg/L)	Cd ($\mu\text{g/L}$)	Cu ($\mu\text{g/L}$)	Pb ($\mu\text{g/L}$)	Zn ($\mu\text{g/L}$)
Lower adit discharge	340	2.5	32.3	9.3	295.0





Claims Located
 Crescent, Amended March 9, 1904
 Labyrinth, Aug. 29, 1910
 Hide and Seek, Aug. 29, 1910
 Beggars Choice, March 9, 1904
 Mystic Shrine, March 9, 1904

Mineral Survey No. 1021

Waterville Land District.

PLAT

OF THE CLAIM OF

The Ruby Mining Company
 KNOWN AS THE

**CRESCENT, LABYRINTH,
 HIDE AND SEEK, BEGGARS CHOICE,
 AND MYSTIC SHRINE LODES.**

IN Mt. Chapaca MINING DISTRICT.

Okanogan COUNTY, Washington
 Containing an Area of Acres.

Scale of 300 Feet to the inch.

Variation 23°30'—26°45'E.

SURVEYED—Sept. 20—Oct. 9—1910—BY
 George J. Gardiner

U.S. Mineral Surveyor.

The Original Field Notes of the Survey of the Mining Claim of
 The Ruby Mining Company
 known as the

Crescent, Labyrinth,
 Hide and Seek, Beggars Choice,
 and Mystic Shrine Lodes.

From which this plat has been made under my direction,
 have been examined and approved, and are on file in this office,
 and I hereby certify that they furnish such an accurate description
 of said Mining Claim as will, if incorporated into a patent,
 serve fully to identify the premises, and that such reference
 is made therein to natural objects or permanent monuments
 as will perpetuate and fix the locus thereof.

I further certify that Five Hundred Dollars worth of labor has
 been expended on improvements made upon said Mining
 Claim by claimant or its grantors, and that
 said improvements consist of (See Plat)

that the location of said improvements is correctly shown
 upon this plat, and that no portion of said labor or im-
 provements has been included in the estimate of expendi-
 tures upon any other claim.

And I further certify that this is a correct plat of said Mining
 Claim made in conformity with said original field notes of the
 survey thereof, and the same is hereby approved.

U.S. Surveyor General's Office.

Olympia Washington

November 17, 1910

U.S. Surveyor General for

Washington