NATURAL RESOURCES

INACTIVE AND ABANDONED MINE LANDS— Mystery and Justice Mines, Monte Cristo Mining District, Snohomish County, Washington

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

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES

Open File Report 2003-7
April 2003

site
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WASHINGTON STATE DEPARTMENT OF
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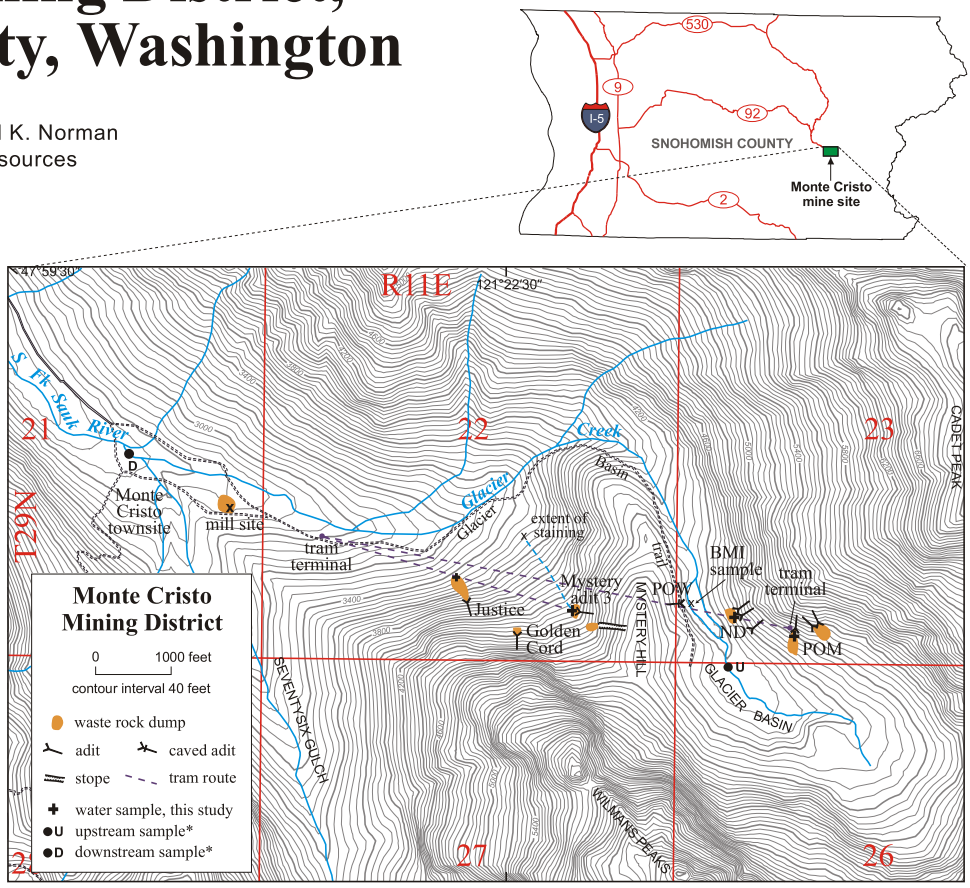

Figure 1. Map showing general location of the Monte Cristo Mining District in Snohomish County and a site map of the Mystery and Justice mines. ND, New Discovery mine; POM, Pride of the Mountains mine; POW, Pride of the Woods mine; *, Raforth and others (2002).

INTRODUCTION

Presently in Washington State there is 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). The current goal is to build a single database and geographic information system (GIS) coverage of major mines in the state. 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 in any systematic approach 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.

Over 3800 mineral properties have been located in the state during the last 100 years (Huntting, 1956). Many are undeveloped prospects of little economic importance. Therefore, in considering the population to include in the Inactive and Abandoned Mine Land (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.

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.

SUMMARY

The Mystery and Justice mines accounted for about 90 percent of the Monte Cristo district's total production. They lie on steep slopes beneath Cadet Peak and Wilmon Peaks, respectively, at elevations of 3000 to 5000 feet in the Cascade Mountains 60 miles east of Everett. Although separate companies operated the mines, they appear to have worked the same persistent vein system. The mines are located on a linear trend through portions of SE¼ sec.22 and SW¼ sec.23, T22N R11E (Fig. 1). DGER personnel collected field data during July 2001 and September 2002.

The nomenclature surrounding the Mystery mine can be confusing. The Pride of the Woods, Pride of the Mountains, and New Discovery workings lie on the east side of Mystery Hill in Glacier Basin, but are connected to the Mystery mine on the west side of Mystery Hill through a series of raises and stopes. Mystery adit 3 eventually served as the main haulage level for the aforementioned Glacier Basin properties. Various reports also refer to the Mystery/Pride workings as the "Monte Cristo"

mine (Derkey, 1990). Aside from Glacier Creek, the nomenclature for Mystery Hill and Glacier Basin do not appear on the Blanca Lake 7.5′ USGS topographic map, but are well-established in guidebooks, mine maps, and other print media.

Similarly, the three adits of the Golden Cord mine [*aka* Golden Chord] were connected to the Justice tunnel by a raise. The Golden Cord openings can be seen on the northeast slope of Wilmon Peaks from the trail near Glacier Falls. They lie approximately 400 feet above the Justice tunnel portal and 600 feet to the southeast. Data reported here for the Justice mine was obtained at the site of the Justice tunnel, referred to as adit 3 in historic reports (James D. Sword, 1906, unpub. report on Monte Cristo mining properties in DGER mine file, 13 p.).

Ownership

A total of 33 claims were staked in the area between 1889 and 1906, of which 16 were patented. This number includes patented lode and placer claims. In 1994, 9 patented claims comprising all but 3 of the original Mystery mine complex were transferred from private ownership to the U.S. Forest Service (USFS) in an exchange brokered by the Trust for Public Lands (TPL). All the former mine lands are surrounded by the Henry M. Jackson Wilderness Area. The area is widely used by trail hikers and climbing parties. In addition to federal and private ownership, the Monte Cristo Preservation Association (MCPA) maintains a public trust under Snohomish Country sponsorship for the historic townsite of Monte Cristo. Further information on land status in the area can be obtained from Mount Baker–Snoqualmie National Forest headquarters in Mountlake Terrace, Washington.

History

Joseph Pearsall located the district's first mineral discovery during the summer of 1889 in what is now known as Seventysix Gulch. The following spring, Fred and Mac Wilmans and another prospector, Frank Peabody, made their way across mountainous terrain from Silver Creek into Glacier Basin and located the eastern extension what became known as the 'Pride' vein. [The brothers' correct name is Wilmans. Maps and other documentation present variations in spelling such as Wilmons, Wilman, and Wilmon]. By 1891, news of the startup mines reached eastern interests financing the Northern Pacific railroad. John D. Rockefeller bought majority interests in the mines through the Colby-Hoyt syndicate acting as intermediaries. It soon became obvious that a railroad and smelter were key factors in the mine's potential profitability. Neither were available. However, construction started on a smelter at the settlement of Lowell near Everett, Wash., in the spring of 1892. At the same time, construction began on the Everett and Monte Cristo Railway (E&MCR) following a much-debated route along the South Fork Stillaguamish River watergrade. Rockefeller funded both projects, which were completed one year later.

During this time, a number of aerial tramways were constructed from mine storage bunkers perched on ledges several thousand feet above the United Concentration Company's gravity mill, which was built at the railroad's eastern terminus in Monte Cristo.

The tram from the Pride of the Mountains claim free-spanned 1100 feet of Glacier Basin, went through a snow shed on Mystery Hill and continued down slope on towers to the mill. The Mystery no. 3 tunnel was driven from the west side of Mystery Hill in the summer of 1896. It connected all the 'Pride' vein development in Glacier Basin by raises and crosscuts. This action considerably shortened the aerial tram delivery of ore to the concentrator (Woodhouse, 1979).

Production for the district reached a peak in the summer of 1897. Almost all of the 310,000 tons eventually produced came from the Mystery/Pride complex and Justice mines (Sword, 1906). Serious washouts damaged the E&MCR during 1896 and again in 1897, requiring immense expenditures of time and money to repair. These events led the Rockefeller interests to sell their holdings in 1903 to the Guggenheim smelter trust, the American Smelting and Refining Co., better known as ASARCO. The mines, but not the smelter, were sold back to the Wilmans brothers two years later. The Wilmans in turn sold their interests in 1906 to mining speculator Samuel Silverman who formed the Monte Cristo Mining and Metals Co. Silverman planned to install a roasting plant at Monte Cristo to produce arsenic trioxide, a pesticide in wide use at the time. However the company went into receivership in 1907 before installation of the roasting facility. The last serious attempt at mining in the district took place in 1915. Spikes in gold prices over the intervening years until the present time generated periodic exploration activity. Continued washouts on the E&MCR right-of-way, coupled with increasing arsenic content as mining progressed to deeper levels, hastened the district's demise as a producing mining district. The primary use today is recreation and conservation within the agreements reached during formation of the Henry M. Jackson Wilderness Area. These factors render it unlikely that the deposits will be revisited as a mineral resource in the future.

Geologic Setting

Near-vertical shear zones in granodiorite and andesite contain irregular sulfide ore lenses 100 to 300 feet long and 1 to 15 feet wide. These shear zones are visible in cliffs at various locations over a distance of several thousand feet. The ore minerals are arsenopyrite, pyrite, chalcopyrite, galena, and sphalerite. Minor quantities of stibnite, jamesonite, and realgar were found. Ore within 50 to 250 feet of the surface contained abundant galena, sphalerite, and chalcopyrite. Galena mineralization became nonexistent at depths varying from 50 to 250 feet below the surface; some chalcopyrite and sphalerite continued below those levels. However at 500 feet below the surface, all operations in the district reported the sulfide assemblage turned to massive arsenopyrite, pyrite, and pyrrhotite (Spurr, 1901). Analyses of hand-sorted ore from the Rainy mine correlate almost perfectly with the composition of pure arsenopyrite with a major silica fraction contributed by the quartz gangue. Smelter shipments during the years 1913 to 1915 averaged 0.63 ounces per ton gold and 2.6 ounces per ton silver; arsenic content of the 862 tons delivered varied from 16 to 25 percent. These shipments were the last reported from the district. Gold content of run-of-mine ore in the district falls in the range 0.07 to 0.18 ounces per ton. Lead, zinc, and copper values of 1 to 3 percent were common in early production returns.

Openings

The Justice tunnel is located at the foot of a vertical cliff 800 feet above and south of the Glacier Basin trail (Fig. 1). It bears southwest at elevation 3600 feet. The portal and surrounding wall rock are sound at the entrance (Fig. 2), however steep slopes on the approach to this opening are dangerous. A linear feature switchbacking uphill in the brush below the Justice tunnel appears to be a way-trail leading to the Golden Cord workings.

Figure 2. *(above)* Justice mine tunnel portal from inside looking north. Note the discharging stream in the lower righthand corner of the photo.

Figure 3. *(above right)* Portal of Mystery adit 3.

Figure 4. *(lower right)* Open stope on the Pride vein above Mystery adit 3 (Fig. 1). View to the east. Timbers are 6 to 8 feet long.

Mystery adit 3 is visible from the Glacier Basin trail above the iron-stained waste rock dump on the west-facing slope of Mystery Hill. It is open and accessible, but collar timbers at the portal are rotten and slabs of tonalite have closed off most of the entrance (Fig. 3). This opening follows the Pride vein on a bearing of N70E approximately 3500 feet under Cadet Peak. Production stopes have been mined almost continuously along this distance; some are 900 feet higher than the haulage tunnel elevation. Mystery adits 1 and 2 are caved. Their former location is indicated by the presence of iron-stained waste rock dumps 150 and 100 feet respectively above adit 3 (Fig. 1, not distinguishable at map scale). Near these dumps a rock-filled gully rises steeply to the east. At the top, a 6-foot wide stope opens to the surface beneath an overhanging cliff. There is a vertical drop-off at the edge of the approach (Fig. 4). The exact distance to the bottom is unknown, but we assume the vein was mined continuously to the adit 3 haulage level, approximately 350 feet below. This opening presents an extreme physical hazard. Sulfide mineral float is abundant in the talus around these openings. The 1500 feet between the Justice tunnel and the Mystery adits is an avalanche chute.

The Pride of the Woods (POW) adit lies on the east slope of Mystery Hill in Glacier Basin (Fig. 1). It is caved at the entrance. New Discovery (ND) adits 1, 2, and 3 lie beneath a mineralized

shear zone. All three openings are visible from the POW waste rock dump on the opposite side of Glacier Creek (Fig.5). ND adit 1 follows the vein several thousand feet beneath Cadet Peak. Adit 2 was driven to ventilate the upper Mystery adit 3 stopes (Fig. 6). This portal appears stable but the tunnel is reported collapsed about 600 feet from the entrance (Northwest Underground Explorations, 1997). Tramway carrier-wheels and cabling were found at the entrance (Fig. 7). A trickle of water emanates from adit 2. The purpose of ND adit 3 is unknown. It is approximately 150 feet southeast of adit 2 and is collared in barren granodiorite.

The Pride of the Mountains (POM) adits are found on the southwest slope of Cadet Peak at elevation 5000 feet. This site is perched beneath an exposure of oxidized sulfide minerals. Several adits were found at this location, as well as a pile of boulders and 2-inch cable that anchored the previously mentioned aerial tramway free-span to the top of Mystery Hill (Fig. 8). The principal opening is blocked by slough to within a foot of the portal roof (Fig. 9). Six inches of water stand inside the portal behind the caved material. The impounded water and blockage at the portal suggest conditions for a potential hydraulic blowout. A second opening at the POM claim can be seen to the east from the adit 1 waste rock dump. A horizontal opening at this site (Fig. 10) is probably the historic "Mukilteo" tunnel (Northwest Underground Explorations, 1997). A steep unfenced incline of unknown depth was found nearby (Fig. 11).

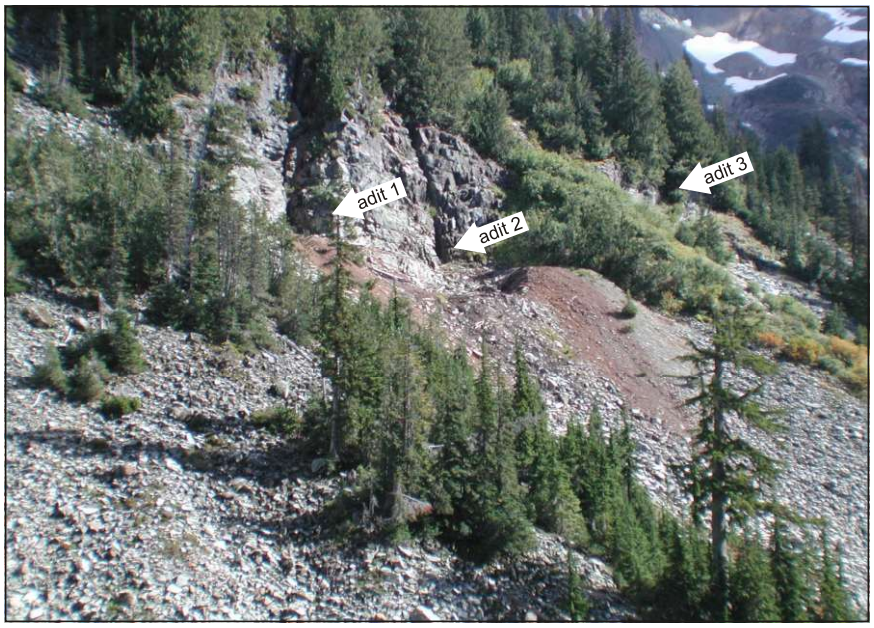

Figure 5. Arrows show location of New Discovery adits above Glacier Creek. View to the east.

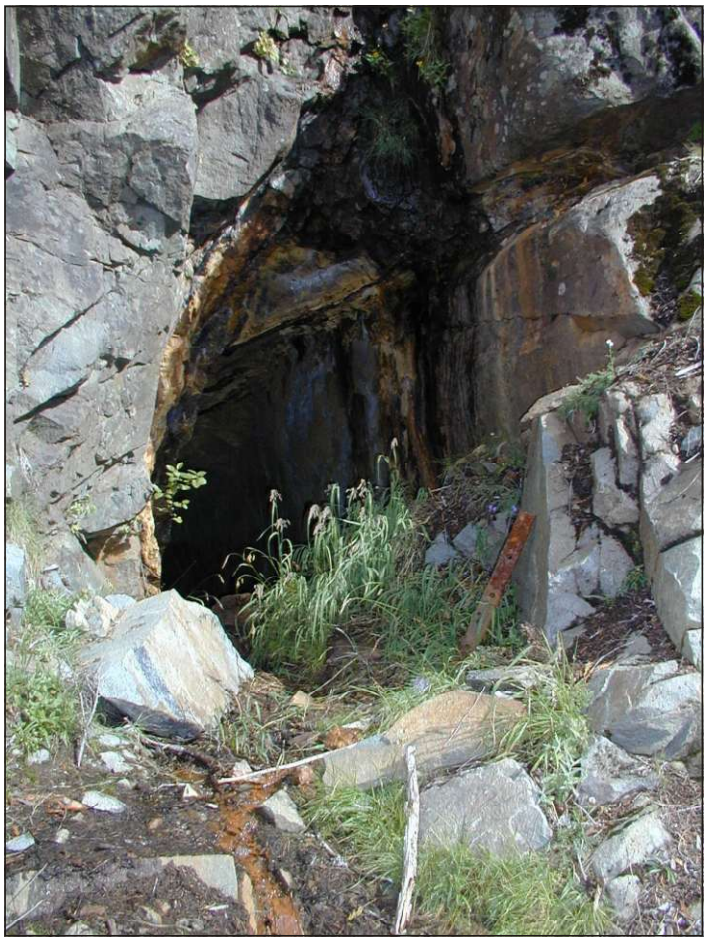

Figure 6. New Discovery adit 2. Note water discharge in lower lefthand corner of photo.

Materials and Structures

Cast iron pneumatic drill parts and various hand tools litter the Mystery adit 3 surface bench. A tubular steel tower reported to have been erected for the Bleichert tramway at this location is no longer there (Woodhouse, 1979). The tram terminals at the Justice, POM, and ND portals are burned and collapsed. The site of the former Mystery Hill cookhouse in Glacier Basin is located on a small level clearing adjacent to the hiking trail. A midden of rusted cans, animal bones, and other historic refuse lies a few feet away on the bank of Glacier Creek. Nothing remains of the cookhouse itself. A structure that combined the function of bunkhouse, kitchen, and tram headworks at the Justice tunnel was cabled to the cliff near the portal (Northwest Underground Explorations, 1997). Although still standing in 1930s photographs (Fig. 12), it is now crushed and burned.

Water

A stream emanating from the Justice tunnel infiltrates the waste rock dump prior to reaching Glacier Creek, approximately 0.1 mile away (Fig. 13). Its pH was 5.0, and the conductivity was 150 µS/cm. A sample from this point analyzed at 200 µg/L arsenic, which exceeds Washington State water quality standards shown in Table 9, part 3. Copper, lead and zinc analyses at this location were at or below 100 µg/L.

A pH reading of 4.4 and conductivity of 578 µS/cm. was obtained in water discharging from Mystery adit 3. Discharge of 40 gpm at the portal reduced to approximately 5 gpm at the point of infiltration in talus 0.5 mile from Glacier Creek (Fig. 14). The Mystery adit 3 water samples contained up to 3300 µg/L arsenic, 710 µg/L copper, 110 µg/L lead, and 6100 µg/L zinc. Water discharging from this and all other mine portals sampled as part of this site characterization should be considered unfit for human consumption. (See Table 9.) Data obtained by Raforth and others (2002) indicate that arsenic and zinc concentrations in Glacier Creek increase after passing through the mined area and

Figure 7. *(top)* Aerial tramway suspension wheels at New Discovery adit 2.

Figure 8. *(middle)* Tramway anchoring site at the Pride of the Mountains landing. View to the west. Notch on top of Mystery Hill is on the centerline of the historic tram route.

Figure 9. *(bottom)* Pride of the Mountains adit, showing water behind surface sloughing.

mineralized country rock, but remain within standards for drinking water for these and other metal analytes . A benthic macroinvertebrate sample taken in Glacier Creek directly below the POW waste rock dump (Fig. 15) contained the following taxa: 14 stoneflies (*Plecoptera pteronarcyd*) and 6 mayflies (*Ephemeroptera baetid*). These taxa are relatively sensitive to environmental degradation, therefore their presence indicates that mining activity in the Glacier Creek headwaters have not had a measurable effect on the stream's macrobiotic life even though fines from waste rock dumps have migrated to riparian margins, forming a red-brown, ferricrete-like soil.

Milling Operations

The United Concentration Co. gravity mill at Monte Cristo no longer exists except for its stone footings and burned structure (Fig. 16). The railroad trestle shown switchbacking across Glacier Creek in period photographs is gone. The remains of the Mystery mine's tram tailworks was found near the Glacier Basin trail. No mill tailings were found.

Waste Rock Dumps

A grab sample taken from the Mystery adit 3 dump analyzed at 14,000 mg/Kg arsenic, 700X the maximum level listed for "Unrestricted land use" in table 6, WAC 173-340-900. Levels of copper, lead, and zinc were 5X, 8X and 4X respectively. Similar concentrations of metals were detected at the POW and POM waste rock dumps. The latter dump appears soft and easily traversable. It is not. Footholds are tenuous in the iron-cemented 38-degree slope, and the dump runs several hundred feet to the floor of Glacier Basin (Fig.17).

GENERAL INFORMATION

Names: Mystery mine, *aka* Pride of the Mountains, Pride of the Woods, New Discovery, and Monte Cristo

Justice mine, *aka* the Golden Cord or Golden Chord

MAS/MILS sequence numbers:
Mystery: 0530470554
Justice: 0530610408

Access: Two-wheel drive road to Barlow Pass. Locked gate at Barlow Pass opens to a deterio-

rated mine access road to Monte Cristo townsite. Trail to Mystery and Justice mines.

Status of mining activity: none

Claim status: The ORMC number is the BLM designation for mining claims in Oregon and Washington. Per the Mining Law of 1872, lode mining claims fall in two categories:

1. *Unpatented claims* require a minimum annual expenditure of $100 assessment work per claim. A $100 maintenance fee may be paid in lieu of performing assessment work. Unpatented claims are classified as *active* or c*losed*. *Active* denotes a valid, up-to-date claim. *Closed* denotes that the maintenance fee, assessment work, or other requirements have not been met, and that the claim is no longer valid. The following table contains information on active claims only.
2. *Patented claims* are owned in fee simple by the discoverer and their assigns. A mineral survey is performed as part of the patent application process, prior to the issuance of a patent. Some lode claims initially mined underground may at a later date turn into an open pit operation. If this occurs, a Surface Mining Permit is required, which contains certain stipulations regarding reclamation.

See Table 1.

Current Ownership

U.S. Forest Service and private

Surrounding land ownership:
Mount Baker–Snoqualmie National Forest.
The former mined lands lie within the
Henry M. Jackson Wilderness Area.

Location and Map Information

See Table 2.

Directions

Drive approximately 30 miles east from Granite Falls on the Mountain Loop highway to Barlow Pass. A gravel road follows the Sauk River 4 miles to the town site of Monte Cristo. The road is gated and locked. Four-wheel-drive vehicles are recommended. Cross the bridge near the townsite and proceed past the Monte Cristo Preservation Association cabins to the Glacier Basin trailhead. Follow the trail upstream approximately 1 mile to a large washout on the bank of Glacier Creek. The Justice mine tunnel lies directly south on the slopes of Wilmon [*sic]* Peak about 400 feet above the trail. Climb the talus slope and angle to the east side of the waste rock dump to reach the portal. Mystery adits 1, 2, and 3 are located on the west slope of Mystery Hill, 1500 feet east of the Justice tunnel at about the same elevation. They can be reached from the Glacier Basin trail by climbing the talus to a point where an orange-stained watercourse leads directly uphill to the portal.

The several "Pride" and New Discovery adits are reached by continuing on the trail approximately 1 mile to Glacier Basin. A portion of this trail follows bare, glacially striated granodiorite and rises on a 41 percent grade. The Pride of the Woods adit is above a heavily stained waste rock dump next to the trail. The New Discovery adits are visible on the western exposure of Cadet Peak, a few hundred yards upstream from the Pride of the Woods. The Pride of the Mountain adits are reached by contouring easterly around Cadet Peak to the base of a talus slope composed of large blocks of tonalite and climbing approximately 1000 feet in elevation toward the oxidized outcrops visible from below. The loose talus on this approach is dangerous.

Figure 10. Pride of the Mountains adit, possibly the "Mukilteo" tunnel. Pack for scale.

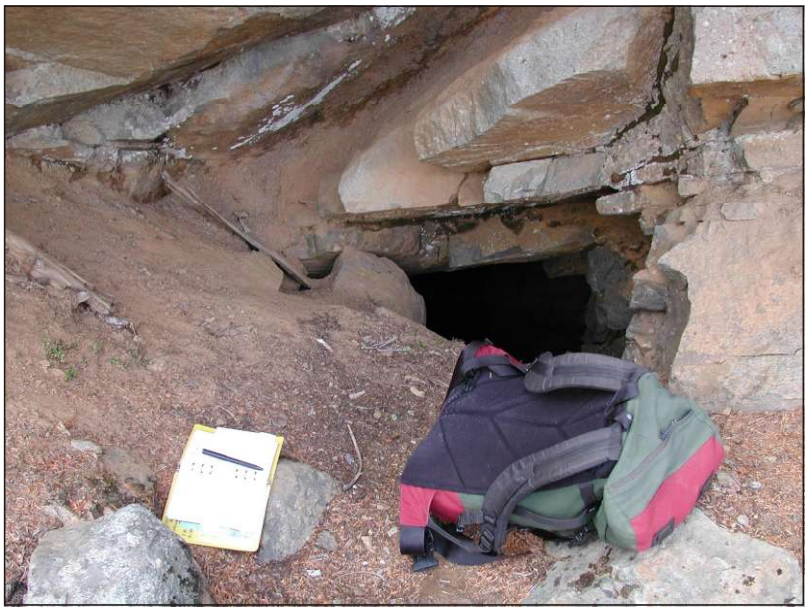

Figure 11. Pride of the Mountains incline. View down dip.

Mine Operations Data

Type of mine: underground

Commodities mined: gold, silver, lead

Table 1. Claim status. *, U.S. Forest Service ownership. Source of data: DGER mine file (August 2002)

Patented claim	Mineral survey no.
Baltic lode	167
Clara lode	160
Mystery lode*	188
Potomac lode*	301
Pride of the Woods lode*	165
I.X.L. lode*	157
Washington lode*	163
Pride of the Mountains lode*	329
Side Line lode *	153
Cadet lode*	259A
"89" lode*	169
Galore lode	861A

Geologic setting: Veins on the Justice Mine are 1 to 3 feet wide in andesite. The Mystery mine complex contains mineralized shear zones 1 to 15 feet wide in granodiorite (Derkey, 1990). Miocene–Oligocene age granodiorite of the Grotto batholith intruded Eocene Barlow Pass volcanics and interbedded sediments (Tabor and others, 1993).

Table 2. Location and map information

Mine name	County	Mine location	1:24,000 map	1:100,000 map	Decimal longitude	Decimal latitude
Mystery	Snohomish	SE¼SE¼ sec. 22 and SW¼ sec. 23, T29N R11E (unsurveyed)	Blanca Lake	Skykomish River	121.368619	47.981128
Justice	Snohomish	SW¼SE¼ sec. 22, T29N R11E (unsurveyed)	Blanca Lake	Skykomish River	121.379092	47.979867

Ore minerals: arsenopyrite (FeAsS), galena (PbS), chalcopyrite ($CuFeS_2$), sphalerite (ZnS)

Non-ore minerals: quartz (SiO_2), calcite ($CaCO_3$), pyrite (FeS_2), stibnite (Sb_2S_3), realgar (AsS) and orpiment As_2S_3)

Host rock: tonalite, andesite, schist

Period of production: intermittent between 1892 and 1907, 1915 (Woodhouse, 1979)

Development: The Mystery complex has approximately 11 adits and more than 12,000 feet of raises, stopes and drifts. The Justice mine has 3 adits, and 1 sublevel totaling 2200 feet in length (Huntting, 1954). The face of the lowest Justice level lies 400 feet below and within 550 feet of a point directly beneath Mystery adit 3 (DGER map file).

Production: Mystery complex, 300,000 tons; Justice, 10,000 tons (Sword, 1906)

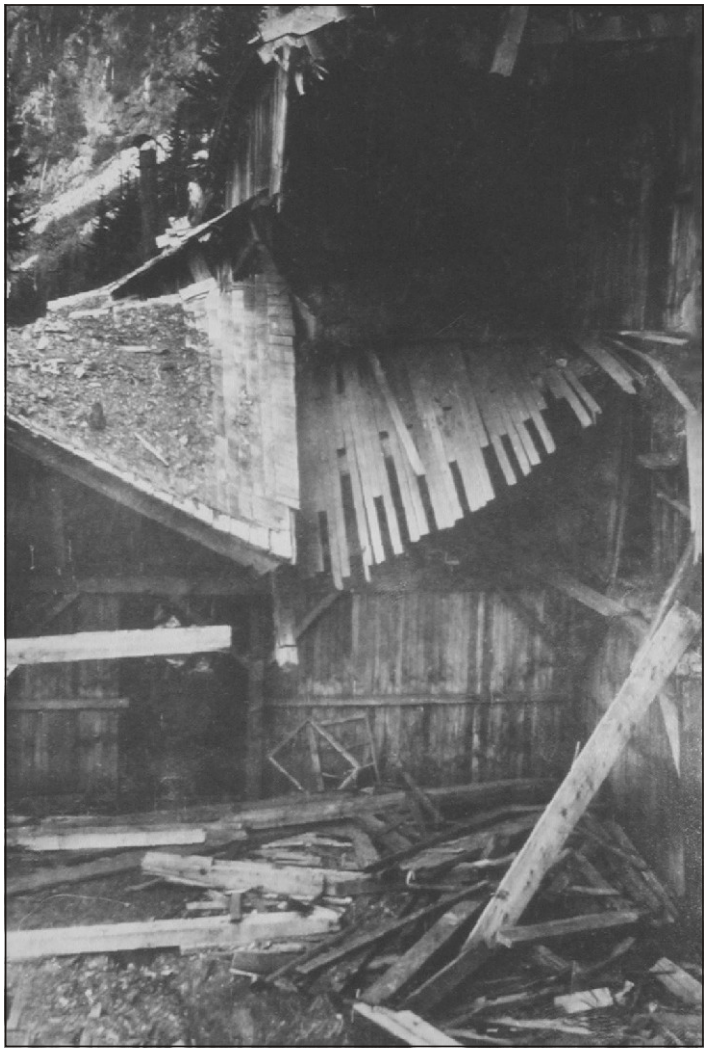

Figure 12. Justice mine building in the 1930s. Tunnel at photographer's feet. Photo courtesy of Gladys Ohlhoff.

Mill data: A 300-tons-per-day gravity mill was completed in 1894. It used a series of crushers and rolls to liberate ore minerals from the host rock and water-washed jigs to develop a concentrate (Woodhouse, 1979). Tailings from the concentrator were discharged directly into Glacier Creek. There is no visible evidence of tailings *per se* around the mill site. A few burned timbers and rock foundation walls indicate its former location.

The Everett Smelter that treated production from Monte Cristo mines was located near the settlement of Lowell. It operated from 1894 to 1912. It was demolished between 1912 and 1914. The land was sold and placed into commercial and residential use. The smelter plant area is now a hazardous waste site being addressed by the State under the authority of the Model Toxics Control Act (D. South, DOE, written commun., 2002).

PHYSICAL ATTRIBUTES

Features: see Table 3

Materials: Burned timbers, miscellaneous cast iron parts, and tram cable were found at all sites. The Mystery adit 3 and Justice

Figure 13. Stream from Justice tunnel. View to the east.

Table 3. Mine features. – – –, no data; *, numbered photos online at http://www.wa.gov/dnr/htdocs/ger/iaml/03-7/

Description	Condition	Fenced (yes/no)	Length (feet)	Width (feet)	Height/depth (feet)	True bearing	Elev. (feet)	Decimal longitude	Decimal latitude	Digital photo*
Justice adit 3	open, solid rock, no timber	no	– – –	6	7	S10E	3660	121.3764	47.98282	DSCN1708
Mystery adit 3	open but partly caved, rotten timbers	no	3500	6	7	S20E	4160	121.3703	47.98114	DSCN1758, 1761
Mystery adit 2	covered with talus	– – –	– – –	– – –	– – –	– – –	~4230	– – –	– – –	
Mystery adit 1	covered with talus	– – –	– – –	– – –	– – –	– – –	~4260	– – –	– – –	
stope on Mystery "Pride" vein	open and hazardous	no	unknown	6	120	N80E	~4360	– – –	– – –	DSCN1764
Pride of the Woods adit	caved	no	unknown	unknown	unknown	S70W	4400	121.3652	47.98141	
New Discovery adit 1	open, unstable portal	no	unknown	5	5.5	N80E	4600	121.3622	47.98124	DSCN3257
New Discovery adit 2	open, overhanging slabs	no	unknown	5	7	N80E	4600	121.3621	47.98096	P9270299
New Discovery adit 3	open	no	unknown	4	6	N80E	4640	121.3616	47.98044	DSCN3263
Pride of the Mountains adit 1	caved to within 14 inches of portal roof accessible	no	unknown	4	6	N10E	4880	121.3592	47.98051	P9270308
Pride of the Mountains prospect pit	caved, filled	no	5	6	5	N/A	5000	121.3587	47.98093	DSCN3274
Pride of the Mountain adit 2 "Mukilteo"?	open, partly filled	no	5	6	2	N20W	5040	121.358	47.98071	DSCN3275
Pride of the Mountain winze or raise	open	no	4	4	unknown	– – –	5040	121.358	47.98071	DSCN3278

tunnel sites are similar in this respect; both served as headworks for aerial tramways, as well as shop, change house, and bunkhouse. Both sit on narrow platforms chiseled out of steep cliffs, as do the New Discovery and Pride of the Mountains sites.

Machinery: Some pneumatic drill parts and iron castings were noted at the Mystery adit 3 location. Two tram wheels were found at the New Discovery adit 2. The cable/rock anchor for the Pride of the Mountains tramway span across Glacier Basin is located near the adit. The site of this anchoring mechanism lines up perfectly with a notch through the forest on Mystery Hill, site of a former span tower (Fig. 8).

Structures: none

Presence of unstable slopes, walls, waste rock, tailings, or impoundments: The area surrounding the open stope found in a gully above Mystery adit 3 should be considered unstable and dangerous. Slabs spalling off joint planes at the Pride of the Mountains upper workings are a hazard, particularly in the area of the prospect pit and winze/raise described in Table 3. The steep, blocky talus slopes leading to Mystery, Pride of the Mountains, and New Discovery openings are locally unstable. The angle of repose near these mines ranges from 35 to 38 degrees, close to the maximum sustainable. The portals of all openings described in this report may produce rockfalls at any time. The New Discovery adit 1 and Pride of the Mountains adit 1 show evidence of water impoundment in the past, thus raising the potential for a hydraulic blowout under certain conditions.

Analysis of tailings and dumps: see Tables 4 and 5

Waste rock, tailings, or dumps in excess of 500 cubic yards: at all sites

Reclamation activity: none

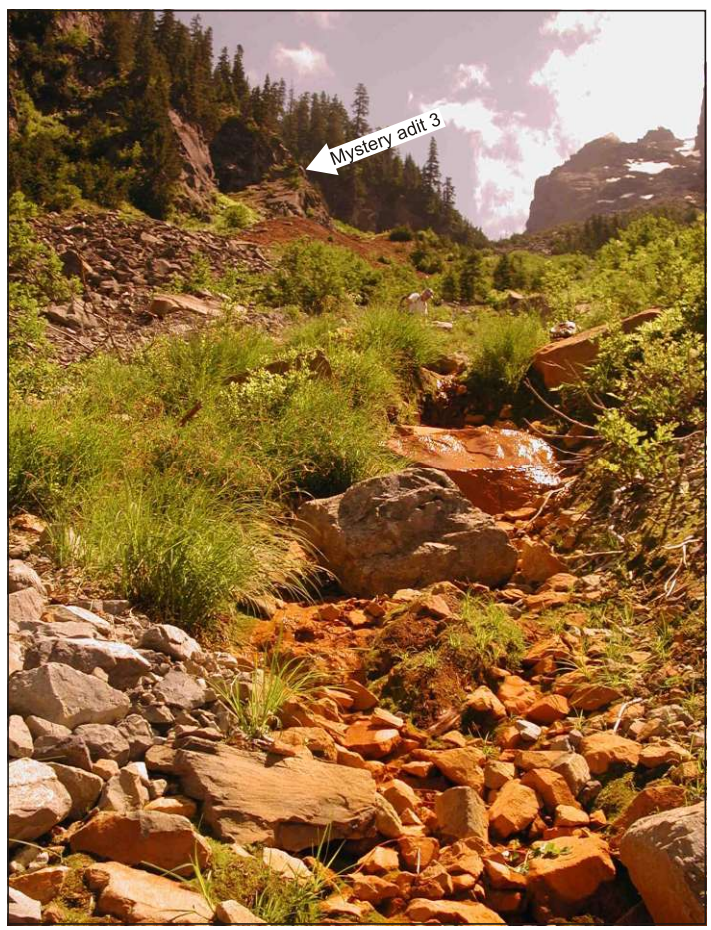

Figure 14. Acid mine drainage from Mystery adit 3 (arrow).

VEGETATION

We found subalpine spirea, false solomon's seal, mosses, grasses, and cattails along the margins of water discharging from the Justice tunnel. Most of the Mystery adit 3 waste rock dump is devoid of vegetation, especially near the margins of the bright-orange acid mine drainage. The talus nearby supports a thicket of mountain hemlock, western red cedar to 7 feet tall, goatsbeard, subalpine spirea, hellebore, bracken fern, moss, and saxifrage (*Saxifraga tolmiei*). Sparse heather, alder, western red cedar, grass and pearly everlasting occupy areas near water emanating from the New Discovery and Pride of the Mountains portals. The waste rock dumps are barren.

WILDLIFE

See Tables 6 and 7

WATER QUALITY

Surface waters observed: Glacier Creek, South Fork Sauk River

Proximity to surface waters: Justice adit 3 to Glacier Creek 0.1 miles; Mystery adit 3 to Glacier Creek 0.4 miles, Sauk River 1.0 mile; Glacier Creek 100 feet to the Pride of the Woods adit, 350 feet to New Discovery, and 1000 feet to the Pride of the Mountains adit.

Domestic use: yes; caretaker and recreation cabins at Monte Cristo townsite, 1.25 miles downstream; trail hikers.

Acid mine drainage or staining: yes, at Mystery adit 3. Bed staining (orange) at ND adit 2.

Water sample data: see Table 8

Water sample results: see Table 9

Surface water migration: The mine waters discharging from all openings examined infiltrate talus within 100 yards of the portal.

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Table 4. Soil analysis. Metal concentrations are in milligrams per kilogram. Numbers in parentheses indicate the factor by which the analysis exceeds standards shown in Table 5. POW, Pride of the Woods; POM, Pride of the Mountains; – – –, no data

Sample location	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc	Gold
Mystery adit 3 dump surface	14,000 (700X)	– – –	500 (5X)	230,000	1700 (8X)	– – –	1100 (4X)	– – –
POW dump surface	15,300 (765X)	<1.11	195 (2X)	55,900	1450 (7X)	– – –	113	– – –
POM adit 1 dump surface	17,300 (865X)	7.29	1010 (10X)	66,700	7040 (32X)	– – –	941 (3X)	– – –

Table 5. Model Toxics Cleanup Act, WAC 173-340-900. Table 749-2. Priority contaminants of ecological concern for sites that qualify for the simplified terrestrial ecological evaluation procedure (partial data). Concentrations are in milligrams per kilogram. Levels shown are for unrestricted land use. Levels for silver, gold, and iron are not specified

Metals	Arsenic III	Cadmium	Copper	Lead	Mercury	Zinc
Level, mg/kg	20	25	100	220	9	270

Table 6. Bat information. POW, Pride of the Woods; POM, Pride of the Mountains

Opening	Aspect	Air temp. (°F) at portal	Air flow: exhaust	Air flow: intake	Multiple openings	Bats or bat evidence	Date observed
Justice adit 3	N	56	yes	no	yes	no	07/20/2001
Mystery adit 3	W	38	yes	no	yes	no	07/21/2001
POW adit	E	56	faint	no	yes	no	09/27/2002
New Discovery adits	SW	60	no	no	yes	no	09/27/2002
POM adit 1	S	60	yes, 5 mph	no	yes	no	09/27/2002

Table 7. Benthic macroinvertebrates. POW, Pride of the Woods

Location	Elev. (feet)	Temp (°F)	Date	Taxon	Common name	Number
Glacier Creek below POW adit	4400	40	27 Sept. 2002	*Plecoptera pteronarcyd*	stonefly	2 species, 14 taxa
Glacier Creek below POW adit	4400	40	27 Sept. 2002	*Ephemeroptera baetid*	mayfly	3 species, 6 taxa

Figure 15. Pride of the Woods waste rock dump and benthic macroinvertebrate (BMI) sample site at Glacier Creek. View upstream (south).

Table 8. Surface water field data. – – –, no data; *, data collected by Robert L. Raforth, Washington Department of Ecology, Water Quality Division (low flow, Aug. 2001; high flow, June 2001); **, numbered photos online at http://www.dnr.wa.gov/geology/iaml/03-7/

Sample ID	Description	Flow	Conductivity (µS/cm)	pH	Bed color	Temp (°F)	Elev. (feet)	Decimal longitude	Decimal latitude	Digital photo**
W-JUS1	murky flow from Justice adit 3 infiltrates talus at this point	<5 gpm	150	5.0	orange	53	3400	– – –	– – –	DSCN1720
No sample	clear flow from Justice adit	425 gpm	155	5.0	light iron stain	40	3660	121.3764	47.98282	– – –
W-MYS1	stream from Mystery adit 3 at base of waste rock dump	5 gpm	578	4.4	red-orange	51	3880	121.3715	47.9821	DSCN1780
W-MYS2	clear discharge from adit 3	40 gpm	570	4.4	orange and thick orange slime	40	4160	121.3703	47.98114	DSCN1759-1760
– – –	Glacier Creek upstream from mine sites, high flow*	32 cfs	20	7.33	natural	36	4400	121.3615	47.9794	– – –
348072 348073	Glacier Creek upstream from mine sites, low flow*	7.5 cfs	18	6.78	natural	38	4400	121.3615	47.9794	– – –
– – –	Glacier Creek downstream from mine sites, high flow*	83 cfs	19	7.15	natural	45	2750	121.3927	47.9865	– – –
348076 348077	Glacier Creek downstream from mine sites, low flow*	20 cfs	19	7.02	natural	45	2750	121.3927	47.9865	– – –
NEWDISCH20	New Discovery adit 2 discharge	< 5 gpm	290	6.7	orange with white precipitate	46	4600	121.3622	47.98124	P9270299
PR-MTS	Pride of the Mountains adit 1 discharge	<5 gpm	260	7.7	bed is natural; water is light yellow	46	4880	121.3592	47.98051	– – –

Table 9. Surface water analysis. Metal concentrations are µg/L; Hardness is in mg/L. – – – no data; *, hardness corrected data collected by Robert L. Raforth, Washington Department of Ecology, Water Quality Division (low flow, Aug. 2001; high flow, June 2001). ** Standards for these metals are hardness dependent. 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 6010, INDUCTIVELY COUPLED PLASMA								
Sample location	**Arsenic**	**Cadmium**	**Copper**	**Iron**	**Lead**	**Mercury**	**Zinc**	**Hardness**
stream in Justice waste rock dump	200	– – –	<100	<1000	<100	– – –	<100	60
stream in Mystery adit3 waste rock dump	1100	– – –	700	12000	<100	– – –	6000	250
discharge from Mystery adit 3	3300	– – –	710	48000	110	– – –	6100	240
discharge from New Discovery adit 2	30	<5	<10	729	11	– – –	225	130
discharge from Pride of the Mountains adit 1	6350	40	2640	17700	562	– – –	5170	160
PART 2: ANALYSIS BY USEPA METHOD 6020, INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETRY*								
Sample location	**Arsenic**	**Cadmium**	**Copper**	**Iron**	**Lead**	**Mercury**	**Zinc**	**Hardness**
Glacier Creek upstream, high flow*	0.28	– – –	<.02	– – –	<.02	.0042	<0.2	8.13
Glacier Creek upstream, low flow*	4.52	– – –	0.264	– – –	.032	<.002	1.8 est.	6.92
Glacier Creek downstream, high flow*	7.37	– – –	0.31	– – –	.02	.0058	5.04	7.38
Glacier Creek downstream, low flow*	9.24	– – –	0.27	– – –	<.02	<.002	5.58	6.80
PART 3: APPLICABLE WASHINGTON STATE WATER QUALITY STANDARDS								
Type of standards (applicable Washington Administrative Code)	**Arsenic**	**Cadmium**	**Copper**	**Iron**	**Lead**	**Mercury**	**Zinc**	**Hardness**
Surface water standards (WAC 173-201A, Standard for aquatic life in surface freshwater, chronic level maximums at 100 mg/L hardness)	190	**	**	none	**	0.012	**	100
Ground water standards (WAC 246-290, Washington State Department of Health, standards for ground water, domestic consumption)	50	none	1300	300 (cosmetic only)	15	2.0	5000	– – –

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Figure 16. United Companies concentrator site.

Figure 17. 38-degree slope on Pride of the Mountains waste rock dump.

Appendix A

PHOTOGRAPHIC DOCUMENTATION

Photos (JPEG format) listed in tables may be found on our website at http://www.dnr.wa.gov/geology/iaml/03-7/.

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

All water samples were collected as simple grab samples in pre-cleaned 500 mL HDPE bottles with preservative and kept on ice for transport to Sound Analytical Services, Inc. (SAS). Soil samples from dumps or tailings were taken from subsurface material and double bagged in polyethylene. Chain of custody was maintained.

Water and soil samples were analyzed for arsenic, cadmium, copper, iron, lead, and zinc by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA Method 6010. Samples were analyzed for mercury by cold vapor atomic absorption (CVAA), USEPA Method 7470 (water), and Method 7471 (soil).

Holding times for the metals of interest were observed (28 days for mercury, 180 days for other metals). 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

WAC 173-201A. Chronic standard (μg/l). *, hardness data from Raforth and others (2002); – – –, no data

Sample location	Hardness (mg/l)	Cd (μg/l)	Cu (μg/l)	Pb (μg/l)	Zn (μg/l)
Stream in Justice waste rock dump	60	– – –	7.34	1.44	67.79
Stream in Mystery adit 3 waste rock dump	250	– – –	24.84	6.72	227.16
Discharge from Mystery adit 3	240	– – –	23.98	6.43	219.43
Discharge from New Discovery adit 2	130	1.25	14.20	3.34	130.53
Discharge from Pride of the Mountains adit 1	160	1.46	16.96	4.18	155.63
Glacier Creek upstream, high flow*	8	– – –	1.31	0.14	12.30
Glacier Creek upstream, low flow*	7	– – –	1.17	0.13	10.98
Glacier Creek downstream, high flow*	7	– – –	1.17	0.13	10.98
Glacier Creek downstream, low flow*	7	– – –	1.17	0.13	10.98