MONTE CRISTO MINE AREA

SITE HAZARD ASSESSMENT

Part of Model Toxics Control Act Regulations
WAC 173-340-320

For the
Monte Cristo Mine Area
Snohomish County, Washington

Prepared by
Snohomish Health District
Everett, Washington

And

Washington Department of Ecology
Toxics Cleanup Program

January 2004

Table of Contents

List of Figures

List of Tables

List of Photographs

List of Appendices

Site Hazard Assessment
Summary Score Sheets

Site Name:			
Monte Cristo Mine Area	Section: 21-22-23	Township: T22N	Range: R11E

Site Address: No site address
Ecology ID:

City:	County: State:	Zip:
Silverton	Snohomish, WA	98241

ERTS	Facility Site ID #	TCP ID N5-2251399

Lat:	Long:
47 59' 30"	121 22' 30"

Site Scored/Ranked a 1 for 2/27/2004. most hazardous least hazardous
↖ scale of 1 → 5

Introduction

This report describes the Site Hazard Assessment that was conducted at the Monte Cristo Mine Area located at the South Fork of the Sauk River, approximately 60 miles east of Everett in Snohomish County, Washington. The assessment with extended sampling was conducted in September 2003 by Snohomish Health District and Washington State Department of Ecology. The results of this assessment show a rank of one on a scale of one to five where one is most hazardous and five is least hazardous to human health and the environment. The SHA scoring is attached as Appendix A.

A Site Hazard Assessment (SHA) is the second step after known or suspected contamination is identified at a site. It is part of the Washington State environmental regulations called the Model Toxics Control Act Cleanup Regulations, Chapter 173-340 WAC. The purpose of a SHA is to evaluate if contamination is present and to estimate the level of risk to human health and the environment. The SHA does not necessarily investigate the extent and types of contamination, nor potential contaminant pathways -as these tasks are usually part of the third step (Remedial Investigation/Feasibility Study) in the cleanup process before the cleanup is conducted (step four) and before compliance monitoring (step five) to confirm that cleanup is complete.

This SHA included the routine collection of site information to evaluate the level of risk to human health and the environment and it included additional sampling to estimate the level of contamination at selected locations at the Monte Cristo Mine Area. The SHA focused on metal contamination at selected locations for soil, waste piles, river sediment and surface water using grab samples. This sampling did not include comprehensive monitoring and did not include groundwater sampling.

Site Location and Description

The Monte Cristo Mining Area, hereafter referred to as the site, is located approximately 60 miles east of Everett, in the Cascade Mountains, between Cadet and Wilmans Peaks (also called Wilmons Peaks) in the Pride of the Mountains Range, in central Snohomish County, Washington. Elevation of the mill and town site is roughly 2700 feet above sea level. Mine elevation in the area ranges from mill level to 5200 feet above sea level. The Mystery and Justice mines accounted for 90 percent of the Monte Cristo area production and these mines lie at 4600 feet and 3600 feet above sea level, respectively as shown on Figure 1.

The former town site of Monte Cristo is located at the confluence of Glacier Creek and Seventy-Six Creek, to become the South Fork of the Sauk River. The town site includes partially restored cabins, building foundations and foundation remnants from the mine concentrator, power house, turn table, tram cable trusses and tram bunkers (where the aerial tram lines terminated). The most significant structure from an environmental standpoint is the mine concentrator used for crushing ore for economic transport to the smelter, see Figure 1.

Site Mining History

The mining history of Monte Cristo is described by Philip Woodhouse (1979) and a brief overview is summarized below. Joseph Persall first discovered the area now known as the Monte Cristo Mining Area in the summer of 1889. In the years that followed Persall's initial prospecting discovery drew interest form other prospectors and investors.

Local capital investment funded initial mining development and exploration. Ten active mines were started. By 1891 mining activity at Monte Cristo had reached Eastern financial interests. The need for rail service and a smelter was key to area development. John D. Rockefeller purchased major interests in the mines through the Colby-Hoyte Syndicate. The Rockefeller money funded construction of the Everett Monte Cristo Railway and the Puget Sound Refining Company smelter that was constructed in Everett primarily to process Monte Cristo ores. The smelter was located along Puget Sound for marine access in what is now recognized as the northeastern area of Everett. The railroad and smelter were completed in the spring of 1893.

Production at Monte Cristo Mining Area reached a peak in 1897. Most of the production originated from the Mystery/Pride mine complex and the Justice mines located in the Glacier Creek drainage east of the town site.

In 1903 the Rockefeller syndicate sold their interests in the mines, railroad and smelter to American Smelting and Refining Corporation (Asarco). Over the next ten years the mining industry fluctuated up and down and experienced constant set backs in rail transportation, loss of rail service and eventual closure of the Everett Asarco Smelter in 1912. In the last years of operation, the smelter was reduced to processing only arsenic ore. Loss of rail service due to winter avalanches and rock sides was a factor in closure of the Everett Smelter and the mines at Monte Cristo.

During the next decade, the Monte Cristo area experienced some small jolts of interest in mining. The Boston America Company decided to build a 200-ton a day concentrator in 1917, however this concentrator was never completed and the Boston American Mine shut down in 1920. Most mines closed between 1913 and 1925 with a few sporadic developments in the 1940-1950s.

After mining, a new trade began in the Monte Cristo area -tourism. Interest in using the railway to Monte Cristo and the hotel encouraged Sunday visitors through the 1960s. Tourism, hiking, fishing and visiting the historic mining town site were popular venues from the 1920s and continue to the present day as reported in a recent Seattle Post-Intelligencer newspaper article entitled "Treasures of Monte Cristo" printed on August 21, 2003.

Prospectors were originally interested in the galena deposits (lead sulfide) in the rocky cliffs of the mountains above the town site. These outcrops lead to discovery of deposits of gold, silver and other metals. Gold was the primary ore during the first ten years of development. Other deposits include lead, zinc, copper and arsenic. When Asarco took over the mining operations, most of the gold had already been removed and Asarco's primary purpose was processing ore for extracting arsenic. For gold, silver and other metals, Asarco smelter shipments averaged 0.63 ounces per ton for gold, 2.6 ounces per ton for silver, 1 to 3 percent for lead, zinc, and copper, and 16 to 25 percent arsenic for the 862 tons delivered to the smelter between 1913 and 1915 (Wolff et al 2003; note the Asarco Everett Smelter operated through 1912 and the Asarco Ruston/Tacoma Smelter operated to the 1980s).

The mining process began with extracting the rock ore from the earth using mining methods of blasting, power tools and hand tools. Ore would either be stockpiled or carried by aerial tram bucks to tram terminals, then by land pulled by oxen to the concentrator, crushed at the concentrator and then transported by rail to the smelter (Woodhouse 1979). Large quantities of crushed rock, ore and waste remain at the concentrator and tram terminals.

Rock waste, spillage and dumping occurred at many locations including at stockpiles and dumps at the mine openings, along the tram routes from the mine locations to the tram way terminals, and at the concentrator site. Spillage is suspected along the railroad route from the concentrator to the smelter location.

There are 21 named former active mine locations in the Monte Cristo Mine Area with 12 located in the Glacier Creek drainage, six located in the Seventy-Six Creek drainage and three located above the Silver Falls-Cultus Lake drainage. A series of tram lines were constructed for aerial transport of the ore by cable to the tram terminals and then by land by oxen to the concentrator for processing and then by rail to the smelter. Overburden or rock not suitable for processing was left behind near the mine openings as mine waste or dumps. Much of the overburden has elevated concentrations of metals however these concentrations tend to be lower compared to the ore tailings and waste at the concentrator location.

The town site includes two concentrator locations. The United Concentration Gravity Mill was located east of the town site approximately 100 ft above the south bank of Glacier Creek. The foundation shows it was built into the slope at multiple levels. The concentrator crushed and

≈ 1,971 million tons

processed approximately 300 tons of ore per day from 1894 through 1912. The concentrator used crushers and rolls to breakup the rock and water washed jigs and floatation to process the concentrate. Tailings from the concentrator are reported discharged directly into Glacier Creek (Wolff et al 2003). A second concentrator was commissioned by Boston American in 1917 however this concentrator was not completed and Boston American closed operations in 1920. Processing at the concentrator was primarily a mechanical process. For more information about mining operation and history, see the Monte Cristo publication by Woodhouse (1979) and the Monte Cristo Preservation Association website at www.whidbey.com/mcpa for current information.

Surface Water and Ground Water Features

The South Fork of the Sauk River incorporates drainage from Glacier Creek and Seventy-Six Creek, and unnamed tributaries such as one flowing from Silver Falls and Cultus Lake as shown on figure 1. The South Fork of the Sauk River is classified as a class AA river and flows northward and joins the North Fork of the Sauk River at Bedal whence it flows north-westward to Darrington. North of Darrington, the Sauk River is joined by the Suiattle River and flows north to Rockport where it joins and becomes the Skagit River and flows westward to Puget Sound west of Mt. Vernon, Washington.

The Glacier Creek drainage basin includes three unnamed tributaries and most of the mine locations along the north slopes of Wilmans Peaks, east and west slopes of the Mystery Ridge and the west face of Cadet Peak. Most of the terrain is steep with rocky cliffs soaring above glacial moraine and outwash material and little vegetation. The Seventy-Six basin includes two unnamed tributaries and four mines and flows through less severe forested terrain. Both creeks show discharge of a large volume of water, a moderate to steep gradient and are glacial fed.

Ground and Surface Water Uses

Very little is known about the groundwater in the area and no well logs were identified. It is unclear what water source is used for the seasonal cabins around the town site and surrounding area. US Forest Service and Monte Cristo Preservation Association have cabins at the former town site and it is reported that bottled water is transported in for domestic use. Private cabins and seasonal residences were observed outside the former town site which appear to use shallow water supply wells or piping from surface water sources.

Groundwater is estimated to be shallow and flowing north and north-westward influenced by the proximity of the numerous creeks. At higher elevation at several mine sites, water was observed flowing from the mine portals, such as the Justice and Mystery Mines and discharged into mine waste rock or dumps and then into Glacier Creek.

There is no known information showing that ground water withdrawal is permitted in this area. Using a two mile radius search, no water well logs were identified, and it is estimated that surface water is used for both drinking water and agricultural purposes. Review of water right

applications within a two mile radius in the area reveals no acreage that grant use of water for irrigation. There is no group A or group B drinking water systems within a two miles radius.

Previous Work.

Previous environmental work at the Monte Cristo Mine Area includes three reports and one site visit log. These reports are briefly discussed below and see Appendix B for complete reports.

-The Water and Sediment Quality of Creeks in Washington Mining Districts Report (Washington Department of Ecology, 2002, publication #02-03-024, June) has one section addressing the Monte Cristo District. It includes results for water sampling in June 2001 (high flow) and August 2000 (low flow) and sediment sampling in August 2000. Elevated levels of arsenic were observed down stream of the mines and town site in water and sediment. Metals reported showing a significant increase downstream are arsenic, cadmium, mercury, iron and zinc compared to upstream sample locations. One concern is that the reported upstream location appears to be down flow or below the 89 Mine and may not represent true natural background conditions (i.e. without anthropogenic influences).

-Inactive and Abandoned Mine Lands –Mystery and Justice Mines in Monte Cristo Mining District Report (Wolff, McKay, Jr, and Norman, 2003, Washington Department of Natural Resources, Open File Report 2003-7, April) gives a detailed summary of history, geologic setting, mining operations, waste rock dumps, ownership, physical attributes and hazards. The report lists elevated levels of arsenic, copper, lead and zinc.

-Abbreviated Preliminary Assessment for the Monte Cristo Concentrator Site Report (Boles, 2002, US Forest Service, October) recommends that the USFS conduct a Site Inspection and notes that five metals exceed US EPA preliminary remediation goals for arsenic, lead, mercury, iron and antimony.

-Initial Field Site Visit Log by Washington Department of Ecology, July 2003, ERTS # 535035 identifies several locations of concern for potential human health and environmental risk resulting from possible exposure to metals. Potential health and environmental hazards include mine waste, concentrator tailings, and mine debris. Sites such as the concentrator, mine openings (portals), mine dumps, tram routes where spillage occurred and tram terminals may pose exposure to metals and possible health and environmental risks, in addition to the physical hazards of abandon mine locations. No sampling was conducted. Several tourists, hikers and bikers were observed; and approximately 20 people were observed on Thursday, September 25, 2003 at the town site and along the trails.

SHA and Sampling Procedures

The Site Hazard Assessment included three days of field work for observation and sampling. First day focused on the Seventy-Six Creek drainage basin. Sampling was conducted at the '76 Mine, Sidney Mine, and a mine dump approximately at the former Peabody Mine, and walking the former town site and sampling at the concentrator location (listed as Conc on Figure 1).

The second day was spent visiting the Justice Mine and sampling. Samples were collected at the Justice Mine, two locations at the creek flowing from the Justice Mine, the Pride/Mystery Tram Terminal, and the Comet Bunker Tram Terminal. Sampling was also conducted at Glacier Creek below the concentrator and where Glacier Creek flows into Lake Monte Cristo approximately six miles down river along the South Fork of the Sauk River (two miles north of Barlow Pass).

The third day included visiting the headwaters to Glacier Creek and sampling at three mines and three locations -89 Mine, Pride of the Mountain Mine, Pride of the Woods Mine, and the Comet Bunker Tram Terminal, the Severance House within the former town site, and at Glacier Creek below the concentrator.

Field activities included GPS readings for location and elevation, soil sampling using X-Ray Fluoroscopy (XRF) to estimate metal concentration levels. Field measurement of surface water parameters were collected for pH, temperature, specific conductance and dissolved oxygen. Grab sampling was used. Soil samples were collected using a stainless steel spoon to dig approximately 4 to 6 inches below the surface, to avoid surface disturbance. Lab and XRF samples were split, with XRF samples placed in a plastic zip-lock bag at the sample location for later XRF screening. Lab samples were placed in labeled glass containers. Creek sediment samples were collected using a stainless steel spoon in an active flow portion of the channel where water was flowing turbulently and avoided locations where water was placid. These samples were primarily fine to coarse sand with minor quantities of small pebbles and silt. The samples were placed in a plastic bag for XRF or in a glass container for laboratory analysis. Soil and creek sediment samples in this report will be referred to as soil samples. For water samples, field parameters were measured and 1 liter poly containers were lowered into the flowing water to fill the container, acidified using 1:1 HNO_3 and sealed. Water samples were not filtered. No duplicate or trip blank samples were collected.

For laboratory analysis, samples were analyzed for priority pollutant metals (PPM) and water samples were analyzed for total metals for PPM. Three laboratories were used. Snohomish Health District used Edge Analytical Laboratory in Burlington and Ecology used Manchester Environmental Laboratory at Port Orchard, Washington. For sulfide analysis, Ecology used Severn Trent Laboratory in Tacoma, Washington. Samples were analyzed for priority pollutant metals using EPA method 245.5 for soil and 245.1 for water for mercury; EPA method 3050B for soil and EPA method 200.8 (ICPMS) for water for priority pollutant metals. General chemistry and hardness were analyzed for selected water samples. Two samples were submitted for general water chemistry to Manchester Laboratory for sulfate, total dissolved solids, and sulfide (by Severn Trent Laboratory) and laboratory methods are listed on the lab sheets. Ten water samples were analyzed for hardness to calculate Washington Water Quality Criteria for metals. The three laboratories performed routine QA/QC and conducted matrix spike and matrix spike duplicate analysis. Sample analysis results were reviewed by the respective laboratory and if appropriate, sample results are flagged with a qualification. Full laboratory reports are attached with chain-of-custody sheets in Appendix C.

SHA Sampling Results

Water field parameters, hardness and general chemistry results are listed on Table 1. These results show that pH is relatively neutral varying from 6.69 to 8.12. Temperature reflects the glacial source of water and ranges from approximately 5 – 8°C and specific conductance varies from 0.018 to 0.023 umho/cm at Glacier Creek from headwaters to below the concentrator and an order of magnitude higher at 0.24 umho/cm at the creek flowing from Justice Mine. Hardness results are 4.8 and 8.1 mg/L at the headwaters for Seventy-Six Creek and Glacier Creek, respectively and range between 7.9 to 9.5 mg/L at locations below former mines with the exception of the creek flowing from the Justice Mine with two readings at 104 and 99 mg/L. The creek from the Justice Mine shows elevated pH, specific conductance and hardness relative to the other sampling locations. General chemistry results show low levels for total dissolved solids (TDS at 12 – 17 mg/L), no detected sulfides (ND>0.005 mg/L) and low levels for sulfates (1.16 to 2.90 mg/L).

The soil x-ray fluoroscopy results are summarized on Table 2 and the complete readings are listed in Appendix D. These results show interference, possibly from other metals, moisture, and/or shutter interference, so the results need to be used as a screening method and not as a quantitative measure. Lead readings appear to be more reliable compared to arsenic readings. The lead results for Monte Cristo area show a large range from less than 100 to 11,494 mg/kg or parts per million. Soil results are discussed below following the laboratory results.

Laboratory soil and water results are summarized on Table 3 with Washington Model Toxics Control Act (MTCA) cleanup levels, Washington Water Quality (WWQ) criteria or other standards, and see Appendix C for complete laboratory reports. Soil results show elevated concentration levels for arsenic, cadmium, lead, mercury and antimony and one or two occurrences for chromium and thallium. Arsenic levels range from 122 to 41,400 mg/kg and lead concentrations range from 26 to 20,400 mg/kg significantly higher than their respective MTCA cleanup levels at 20 and 250 mg/kg. The highest metal concentrations occur at the concentrator, Pride of the Woods Mine, Comet Mine Bunker, and Comet Mystery Tram locations.

Surface water results for total metals show exceedances for arsenic, lead and one occurrence for cadmium above MTCA or WWQ. Water results at the headwaters for both Seventy-Six and Glacier Creeks show no detection or low concentrations for all metals tested except arsenic and lead. Note, for some results the level of detection is higher than the cleanup level or criterion, so these results can not be evaluated. Surface water results at and below the mine locations show detections for lead, copper and antimony and show elevated levels primarily for arsenic and lead. The total metal arsenic results exceed the MTCA cleanup level and the WWQ criterion for human health and do not exceed the WWQ criterion for acute or chronic aquatic life. Arsenic levels range from non detected (ND>0.50 ug/L, microgram per liter or parts per billion) at the headwaters to 9.64 ug/L at Seventy-Six Creek at the Sidney Mine Dump. Arsenic levels for the Glacier Creek drainage vary from 1.7 ug/L at the headwaters to 7.89 and 12.2 ug/L for two samples below the concentrator location, and 27.4 ug/L at the South Fork of the Sauk River at its confluence with Lake Monte Cristo approximately six miles north of the Monte Cristo Mine Area. The highest arsenic concentrations occur at the creek flowing from the Justice Mine at 235

and 264 ug/L. The total metal lead results are above WWQ criterion at 76 Creek and Glacier Creek below the concentrator and at the confluence at Lake Monte Cristo. Cadmium is above WWQ criterion at one occurrence at the creek flowing from the Justice Mine.

In order to interpret the soil results a comparison was made using laboratory and XRF results as listed on Table 4. Note sample number and laboratory identification are listed in the first column. For lead, all the laboratory results except one show higher concentrations compared with the XRF results with one exception, the Comet Mine Bunker. Arsenic results show both laboratory and XRF readings above and below each other at respective sampling locations and generally within an order of magnitude. Note, mercury laboratory results range from less than one to 8.6 mg/kg where the XRF results are significantly higher. The mercury XRF results are not accurate and represent some type of interference, probably the tungsten shutter of the instrument. Thus, the mercury XRF results should be dismissed. Likewise the nickel XRF results are not accurate with the exception of the samples at the South Fork of the Sauk River at the confluence of Lake Monte Cristo and these results are 96.5 and 80.3 mg/kg respectively. On the other hand, most of the copper and zinc results appear reliable and show consistency between the laboratory and XRF results and appear to be representative for each sampling location.

Another evaluation shows soil metal concentrations at Monte Cristo area compared to background levels for Washington State as listed on Table 5. The natural background soil metal concentrations are taken from the Ecology 1994 study where the sample sets include background for Puget Sound Lowland, western Washington and statewide with 45, 86, and 166 sample sets, respectively (Ecology 1994, page 6-4, Table 7). For the Monte Cristo Mine Area, the soil metal results all exceed background for all metals with the exception of chromium, nickel and beryllium. The Monte Cristo arsenic levels are 20 to 700 times above soil background and lead is 10 to 1000 times above background level. The arsenic, cadmium, lead, mercury, copper, silver, zinc and antimony are common metals found in sulfur bearing metal mineralization and this area represented a very rich sulfur-bearing metal mineralization system.

Comparison with Previous Work

In addition to these results, two previous reports were used during the completion of this SHA (see Appendix B). The Wolff et al report (2003) shows metal soil results for three mine locations –Mystery, Pride of the Woods, and Pride of the Mountains Mines, and the Ecology report (2002) shows soil and water metal results at two locations within the Glacier Creek Drainage. These results are reprinted with the SHA results on Tables 5 and 6 and Table 5 includes lead/arsenic ratio analysis.

Both previous studies indicate impacts to soils and surface water in the vicinity of the mine locations and down gradient at Glacier Creek. Sampling results published by Wolff et al (2003) and Ecology (2002) are consistent with sampling results prepared by the Snohomish Health District and Ecology for this SHA. Lead/arsenic ratio analysis shows the SHA results for soil ranging from 0.07 to 0.46 for the headwater and mine locations to 2.4 at the Comet Mystery Tram Terminal, and 0.2 to 2.8 at the concentrator location. Most of these lead/arsenic ratios are below 0.5 with two exceptions noted above at the Comet Mystery Tram Terminal and the

Concentrator locations. Background lead/arsenic ratios range from 0.41 to 0.73 and the Wolff et al report shows a range of 0.09 to 0.4 and these are consistent with the SHA results. For water, the Ecology (2002) report shows elevated levels for arsenic both during high and low flow at 7.34 and 9.24 ug/L similar to the SHA results at 7.89 to 12.4 ug/L at Glacier Creek below the concentrator location. These previous reports confirm the SHA results.

Areas of Impact

Areas of impact include the soil, creek sediment, surface water and potentially shallow ground water. Based on the SHA, specific areas of impact in the vicinity of the site from most to least significant are the: 1.) Concentrator location, 2.) Comet Mine Tram Terminal Bunker, 3.) Pride of the Woods Mine, 4.) mine opening rock waste dumps such as the Justice Mine, Pride of the Woods Mine and Pride of the Mountain Mine, and 5.) locations around the former town site such as the railroad track Power House and the Severance House. In addition, surface water has been impacted by mining operations and mine waste run off, specifically for arsenic and some occurrences for lead and cadmium. The impacted areas include the creek flowing at the Justice Mine, Glacier Creek, Seventy-Six Creek and South Fork of the Sauk River at Lake Monte Cristo. Note, groundwater sampling was not conducted as part of this SHA.

Summary and Recommendations

These and earlier sampling results confirm significant contamination both in soils, creek sediment and surface water associated with former mine operations and mine waste at the Monte Cristo Mine Area. The two earlier studies and this work show significant contamination in soil including creek sediment for arsenic, lead, mercury, cadmium, and antimony. Surface water results show elevated levels for arsenic at the Seventy-Six Creek, Glacier Creek, the creek flowing from the Justice Mine, and at the South Fork of the Sauk River and some occurrences for lead and one occurrence for cadmium. Considering the laboratory analytical evidence, the Snohomish Health District and Ecology recommend a rank of one on a scale of one to five where one is most hazardous and five is least hazardous to human health and the environment.

Recommendations from this SHA are:

1.) Post clear signage for human health and environmental hazards at the Monte Cristo Mining Area for chemical in addition to physical hazards at the Concentrator, tram terminal bunkers, and mine locations clearing stating the presence of chemical hazards from arsenic, lead and other metals;
2.) Conduct a remedial investigation to characterize the extent of contamination, pathways and risks to human health and the environment;
3.) Conduct groundwater monitoring to evaluate groundwater conditions;
4.) Conduct a Terrestrial Ecological Evaluation for simplified or site-specific TEE; and
5.) Evaluate interim cleanup actions such as capping selected locations at the Concentrator and tram terminal bunkers where the highest metal concentration are open and accessible to visitors and the environment in order to minimize exposure and migration of metals.

Special Considerations

The immediate resident population in the vicinity of the site is low. Interviews with seasonal residents revealed 10-20 people live in the area or maintain vacation properties in the area. The former town site of Monte Cristo is widely known as a recreational destination for families and rock hounds. The Monte Cristo Preservation Association and the northwest newspapers encourage visits and recreational use of the area. In addition, the town site, the concentrator and two of the tram terminal bunkers are relatively easy to access for people visiting this region for most able body access. A Seattle Post Intelligencer article described the old Monte Cristo town site and the surrounding area as a very popular hiking destination. The article notes that on a summer day as many as 100 cars can be parked in the Barlow Pass parking area on the Mountain Loop Highway at the trail head to Monte Cristo mine area –a four mile walk or bike ride to the former town site and mines (Seattle PI August 21, 2003, Getaway Section).

Signs exist in various locations around the town site which alert visitors of the common dangers at mining districts. The signage mainly includes the physical hazards associated with the actual mines or tunnels. There is little or no signage regarding chemical hazards resulting from elevated levels of metals found in the soils or waste piles associated with the former mining operations, and elevated arsenic levels in surface water. Clear signage for chemical health hazards is strongly recommended for this site, and signage should be posted at specific locations where elevated metal concentrations have been confirmed such as the concentrator and tram terminal locations, and mine locations.

Ecological risk: This site does not meet criteria for primary Terrestrial Ecological Evaluations (TEEs) under Ch. WAC 173-340-7491, and, before or during the RI/FS, should have an evaluation for simplified or site-specific TEE conducted.

Note, this SHA focused on selected locations in the Monte Cristo Mine Area and selected reaches of Glacier Creek and Seventy-Six Creek. The assessment did not include other tributaries to Glacier Creek and Seventy-Six Creek and other drainage basins within the Monte Cristo Mine Area. Also groundwater was not sampled in this assessment.

References

Monte Cristo Preservation Association, 2003, website at www.whidbey.com/mcpa

Seattle Post-Intelligencer, 2003, The Treasures of Monte Cristo –Cover Story –Hiking Monte Cristo: Seattle PI Getaway Section by Greg Johnston, August 21, pages 10-13.

US Forest Service, 2002, Abbreviated Preliminary Assessment for the Monte Cristo Concentrator Site Report: US Forest Service, Dennis J Boles, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington, October.

Washington Department of Ecology, 2003, Initial Field Site Visit Log by Ecology, Toxics Cleanup Program, Northwest Regional Office, July 9, ERTS # 535035.

Washington Department of Ecology, 2002, Second Screening Investigation of Water and Sediment Quality of Creeks in Ten Washington Mining Districts with Emphasis on Metals: Ecology Publication #02-03-024, June.

Washington Department of Ecology, 1994, Natural Background Soil Metals Concentrations in Washington State: Ecology Publication #94-115, October.

Wolff, Fritz E., Donald T. McKay, Jr., and David K Norman, 2003, Inactive and Abandoned Mine Lands –Mystery and Justice Mines, Monte Cristo Mining District, Snohomish County, Washington: Washington Department of Natural Resources Open File Report 2003-7, April.

Woodhouse, Philip R. with Robert L. Wood, 1979, Monte Cristo: Seattle, Washington Mountaineers Publishers.

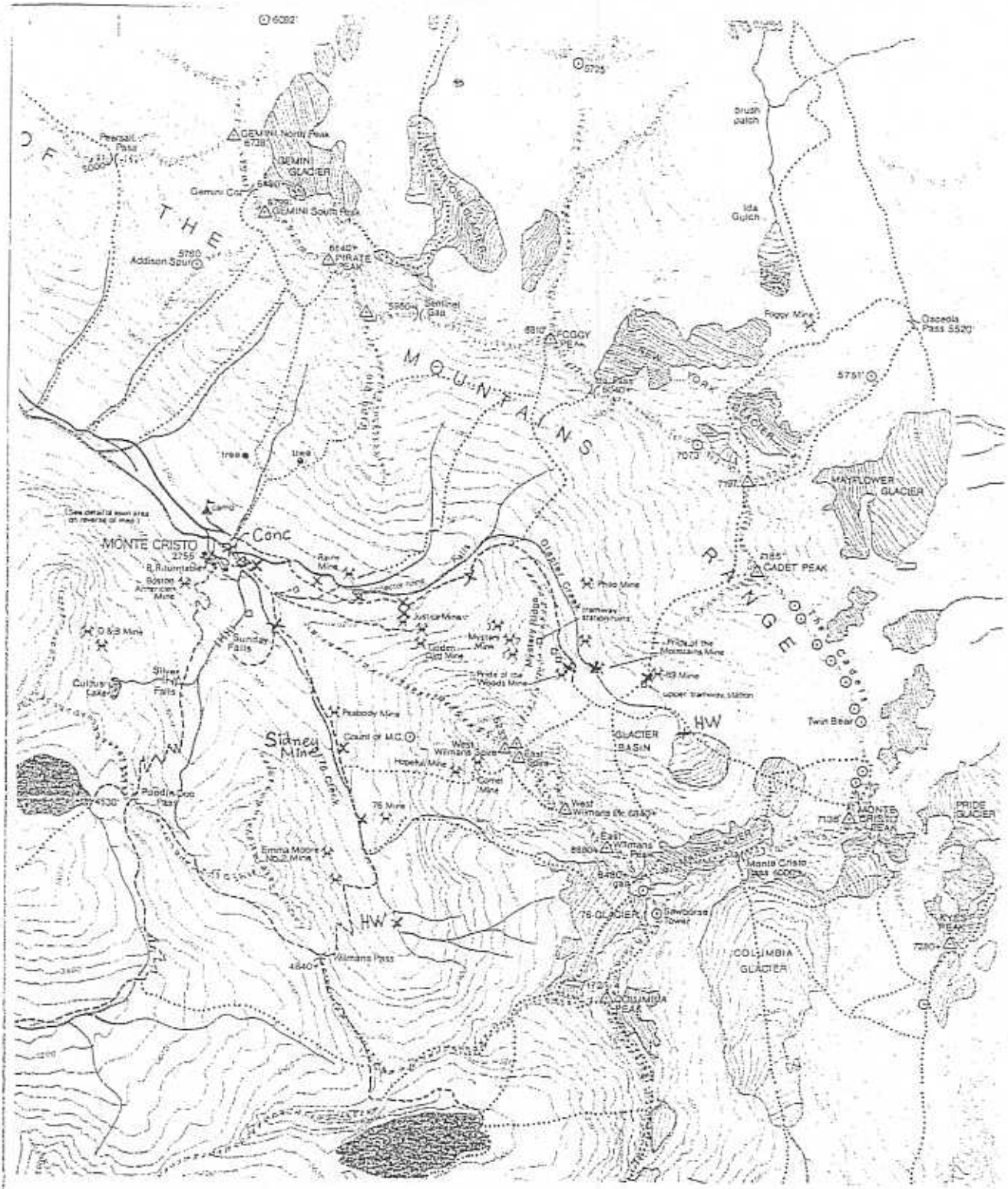

Figure 1. Monte Cristo Mine Area, Snohomish County, Washington

Figure shows mine locations, sample locations (X), creek headwater locations (HW), concentrator (conc) and general topography. Scale is 1 inch = 1750 feet or 0.3 mile.

North

0 5000 Feet

0 1 Mile

Monte Cristo Mine Area
Snohomish County, Washington

WARM Rank 1

Scale of 1 to 5 where 1 is most hazardous and 5 is least hazardous to human health and the environment

SHA Pathway Scores

Surface Water – Human Health = 38.4 = 5
Air – Human Health = 3.8 = 1
Groundwater – Human Health = 38.1 = 3
Surface Water – Environment = 81.0 = 5
Air – Environment = 29.5 = 4

Rank 1

Table 1. Surface Water Field Parameters and Water General Chemistry at Monte Cristo Mine Area, Snohomish County, Washington

Sample Number	Location	Date/Time	pH	Temp °C	Spec Cond umho/cm	DO mg/L	Hardness mg/L	TDS mg/L	Sulfate mg/L	Sulfide mg/L
3374080	Seventy-Six Creek Headwaters	9/11/2003	na	na	na	na	4.83	na	na	na
3374081	Seventy-Six Creek Sidney Mine Dump	9/11/2003	na	na	na	na	9.48	na	na	na
	Seventy-Six Creek above Boston An. Mine	9/11/2003	na	na	na	na	na	na	na	na
	Seventy-Six Creek at bridge	9/11/2003	na	na	na	na	na	na	na	na
3394090	Glacier Creek Headwaters	9/25/2003 12:48	7.21	7.14	0.018	10.16	8.15	12	1.16	ND>0.005
	Glacier Creek 89 Mine Debris	9/25/2003 13:15	na	na	na	na	na	na	na	na
3394091	Glacier Creek S at Pride of the Mountain Mine	9/25/2003 13:55	7.06	7.43	0.018	9.71	8.48	na	na	na
3394094	Glacier Creek N at Pride of the Mountain Mine	9/25/2003 14:17	6.91	4.74	0.021	8.98	8.44	na	na	na
3374082	Creek at Justice Mine	9/12/2003 12:20	8.12	4.87	0.241	10.85	104	na	na	na
3374083	Creek below Justice Mine above Glacier Cr	9/12/2003	na	na	na	na	99.5	na	na	na
	Glacier Creek above Concentrator	9/12/2003	na	na	na	na	na	na	na	na
	Glacier Creek above Concentrator	9/12/2003	na	na	na	na	na	na	na	na
3374084	Glacier Creek below Concentrator+	9/12/2003 17:00	na	na	na	na	7.92	na	na	na
3394092	Glacier Creek below Concentrator+	9/25/2003 17:30	6.69	8.57	0.023	9.80	8.40	17	2.90	ND>0.005
3394093	Glacier Creek below Concentrator+	9/25/2003 17:45	na	na	na	na	9.46	na	na	na
3374085	So Fork Sauk River at Lake Monte Cristo*	9/12/2003 18:00	7.04	11.19	0.029	9.44	12.1	na	na	na

* South Fork of Sauk River where river flows into Lake Monte Cristo, six miles north Monte Cristo Mine Area.

na = not available or not analyzed.

+ Glacier Creek water below Concentrator location at Monte Cristo Mine Area.

ND>0.005 = Substance not detected above level specified and in this example not above 0.005 mg/L or parts per million.

Table 2. Soil Metal Results using X-Ray Fluorescence at Monte Cristo Mine Area, Snohomish County, Washington

Serial #XL700-U35737059LY, see Appendix D for complete readings

No	Location/Creek Basin, mg/kg	Arsenic	Chromium	Lead	Mercury	Nickel	Copper	Zinc
		As	Cr	Pb	Hg	Ni	Cu	Zn
13	76 Creek headwater sediment	207.2	<LOD	94.8	12.2	<LOD	<LOD	150.1
14	76 Cr mine talus	574.8	<LOD	297.4	13.1	<LOD	115.9	1589.6
15	76 Cr Sidney mine dump-N	518.8	<LOD	323.4	13.1	<LOD	116.1	1708.8
16	76 Cr Sidney mine dump-E	9984	<LOD	102.7	134.2	<LOD	101.1	<LOD
17	76 Cr down gradient	588.4	<LOD	122.6	16	<LOD	51.4	232.2
18	76 Cr dump-East	17996.8	<LOD	115.1	185.8	<LOD	389.4	<LOD
19	Concentrator level 1-East	10297.6	<LOD	4268.8	70.4	<LOD	997.6	4348.8
20	Concentrator level 1-West	2339.2	<LOD	5827.2	60.4	406.6	250.8	167.1
21	Concentrator level 2-East	27980.8	<LOD	6438.4	242	<LOD	391.8	216.2
22	Concentrator level 2-West	17190.4	<LOD	11494.4	1140	15590.4	3878.4	2009.6
23	Concentrator level 4-Center	5440	5958.4	916.8	881.6	15590.4	3708.8	1779.2
24	Concentrator level 5-East	21888	2720	4729.6	827.2	4880	1109.6	466.4
25	Concentrator level 5-West	26099.2	<LOD	1480	570.8	<LOD	<LOD	266.6
26	Pride/Mystery Tram Terminal	9977.6	<LOD	11494.4	545.2	3747.2	1340	943.2
27	Pride/Mystery Tram Terminal	4518.4	<LOD	9395.2	224	<LOD	368.8	297.8
28	Comet Mine Bunker-South	48486.4	<LOD	3209.6	760.8	<LOD	122.7	205
29	Comet Mine Bunker-North	6988.8	<LOD	1409.6	48.1	<LOD	81.3	440.8
30	RR Track at Power House	275	<LOD	39.6	15.4	<LOD	74.9	151.7
31	Glacier Creek above Conctrtr	105.4	<LOD	23.1	<LOD	<LOD	89	88.2
32	Glacier Creek below Conctrtr	148.2	<LOD	38.8	9.2	<LOD	80	105.8
33	So Fork Sauk River-Lake MC	292.8	<LOD	91.2	<LOD	80.3	65.5	115.8
39	Glacier Creek headwater sed	132.5	<LOD	17	32	686.8	153.2	101.1
61	Glacier Creek headwaters	84.4	<LOD	24.4	<LOD	<LOD	64.7	34.8
40	Glacier Cr 89 mine tailings	60	<LOD	<LOD	177.5	3638.4	671.2	352.4
43	Pride of the Mountain 1343	153.6	<LOD	54	196.7	4000	775.2	446.4
44	Pride of the Mountain 1414	<LOD	11200	<LOD	7315.2	91084.8	29696	15296
53	Pride of the Mountain 1414 Loc 2	134.3	<LOD	86.4	<LOD	<LOD	<LOD	96.1
45	Pride of the Mountain 1416	734.4	<LOD	96.5	67.6	1400	241	223.2
54	Pride of the Mountain 1416 Loc 2	736.4	<LOD	86.8	<LOD	<LOD	43.5	103.7
46	Pride of the Woods 1435	13299.2	1868.8	959.2	463.6	8179.2	1769.6	787.6
47	Pride of the Woods 1437	18892.8	<LOD	1429.6	462	3609.6	829.6	388
59	Glacier Creek POW mine	12397	<LOD	922.4	372.2	na	159.2	<LOD
62	Glacier Creek POW mine Loc 2	14092.8	<LOD	1120	551.6	na	173.7	<LOD
60	Glacier Creek POW mine Loc 3	22297.6	<LOD	1629.6	1908.8	<LOD	5907.2	2548.8
55	Comet Mine Bunker	13593.6	<LOD	1840	274.6	<LOD	69.7	238.8
56	Town site Severance House	200.2	<LOD	54.7	18.4	<LOD	59.4	206
57	Glacier Creek below Concentrator	122	<LOD	28.1	12.1	<LOD	51.2	85.9
58	Glac Cr below Concentrator-bar	300.4	<LOD	43.5	<LOD	<LOD	75.2	144.9
61	Glacier Creek Headwaters	84.4	<LOD	24.4	<LOD	<LOD	64.7	34.8

<LOD = Result lower than detection.

na = Not available.

Table 3. Soil and Water Laboratory Analytical Results for Monte Cristo Mine Area, Snohomish County, Washington

Results in bold exceed Model Toxics Control Act Cleanup Level.

Soil Analytical Results, mg/kg No	Location		Arsenic As	Cadmium Cd	Chromium Cr	Lead Pb	Mercury Hg	Nickel Ni	Copper Cu	Silver Ag	Zinc Zn	Antimony Sb	Beryllium Be	Selenium Se	Thallium Tl
3394095	Glacier Creek Headwater Sed		122	0.65	16.4	26.3	0.874	12.1	21.7	0.18	123	0.43	0.18	ND>5.00	0.14
3394096	Pride of Mountain Mine Soil		332	1.89	9.71	130	0.528	7.9	48	0.45	328	0.57 J	0.17	ND>5.00	0.22
3394097	Pride of Woods Mine Soil		41400	2.42	12.1	2760	8.61	ND>5.0	517	49.1	271	416	0.18	ND>5.00	5.42
10531	Justice Mine Adit Soil		4900	6.75	ND>0.232	228	0.61	15.7	93.3	ND>0.232	312	12	ND>0.070	ND>3.01	0.92
3394098	Comet Mine Bunker Soil		31200	9.12	11.0	7340	2.28	11.3	212	17	180	168	0.15	ND>5.00	0.17
3374087	Comet Mine Bunker South Soil		14700	2.29	11.1	1950	0.368	12.1	78	5.39	435	719	0.11	U>0.50	0.12
10532	Comet Mystery Tram Soil		8450	8.33	ND>0.240	20400	4.47	ND>0.481	1160	320	882	133	ND>0.072	ND>3.13	0.4 J
10529	Concentrator Level 1 West Soil		3460	4.13	2.44	9580	8.5	ND>0.469	378	126	149	1365	ND>0.070	ND>3.05	7.5
10530	Concentrator Level 1 East Soil		34900	11.4	5.74	7000	7.07	0.604	516	115	852	4582	ND>0.088	ND>3.80	5.3
3374086	Concentrator Level 2 West Soil		14600	1.54	1.5	16300	4.33	3.26	1340	118	471	3990	U>0.10	1.4 J	9
3374088	So Fork Sauk River Sed-Lk MC*		1090	3.90	36.6	278	0.091	96.5	207	6.94	806	15.7	0.17	U>0.50	0.17
MTCA Cleanup Level, mg/kg		Carc/Noncarcinogen			CrIII/CrVI										
MTCA method A			20	2	2000/19	250	2	na	na	na	na	na	na	na	na
MTCA method B - Direct Contact			0.667/24.0	40	120,000/240	na	na	1600	na	400	24000	32	160	400	5.6
Water Analytical Results, ug/L		Hardness													
3374080	76 Creek Headwater	5	U>0.50	U>0.10	U>0.50	0.12	U>0.050	U>0.50	0.18	U>0.10	U>5.0	0.48	U>0.10	U>0.50	U>0.10
3374081	76 Creek Sidney Mine Dump	9	9.64	U>0.10	U>0.50	0.19	U>0.050	U>0.50	0.26	U>0.10	U>5.0	2.22	U>0.10	U>0.50	U>0.10
3394090	Glacier Creek Headwater	8	1.7	U>0.10	U>0.50	U>0.10	U>0.050	U>0.50	U>0.50	U>0.10	U>5.0	1.8 J	U>0.10	U>0.50	U>0.10
3394091	Glacier Creek POM Mine	8	3.8	U>0.10	U>0.50	0.14	U>0.050	U>0.50	U>0.50	U>0.10	U>5.0	1.9 J	U>0.10	U>0.50	U>0.10
3394094	Glacier Creek POM Mine N	8	3.6	U>0.10	U>0.50	0.10	U>0.050	U>0.50	U>0.50	U>0.10	U>5.0	1.9 J	U>0.10	U>0.50	U>0.10
3374082	Creek at Justice Mine	104	235	0.14	U>0.50	1.26	U>0.050	0.92	4.22	U>0.10	21	11.3	U>0.10	U>0.50	U>0.10
3374083	Creek below Justice Mine	99	264	0.48	U>0.50	0.74	U>0.050	1.19	2.83	U>0.10	56.8	11.6	U>0.10	U>0.50	U>0.10
3374084	Glacier Cr Below Concentrator++	8	7.89	U>0.10	U>0.50	0.13	U>0.050	U>0.50	0.67	U>0.10	U>5.0	1.3	U>0.10	U>0.50	U>0.10
3394093	Glacier Cr Below Concentrator++	9	12.2	U>0.10	U>0.50	0.29	U>0.050	U>0.50	0.55	U>0.10	6.2	1.9 J	U>0.10	U>0.50	U>0.10
3374085	So Fork Sauk River at Lake MC*	12	27.4	U>0.10	U>0.50	0.63	U>0.050	U>0.50	1.41	U>0.10	U>5.0	5.44	U>0.10	U>0.50	U>0.10
MTCA Cleanup Level or Other, ug/L		Carc/Noncarcinogen			CrIII/CrVI										
MTCA method A Ground Water (Nov 2001)			5	5	na/na	15	2	na	na	na	na	na	na	na	na
MTCA method B Surface Water (Aug 2001)		0.0982/17.7/5bkgd		20.3	243000/486	na	na	1100	2660	25900	16500	1040	273	2700	1.56

ND> or U>5 = Metal not detected above level specified; this example not above 5 mg/kg for soil; not above 5 ug/L for water.

J = Metal was positively identified, result estimated.

na = Cleanup level or standard is not available.

* South Fork of Sauk River -class AA- where river flows into Lake Monte Cristo, six miles north of Monte Cristo Mine Area.

+ = National Toxics Rule human health criterion for Sb, Be, and Tl; noWQ aquatic life criterion.

** See Appendix C or formulae are shown in http://www.ecy.wa.gov/pubs/wa17320a.pdf

++ = Glacier Creek water or sediment sample below Concentrator location at Monte Cristo Mine Area.

Table 3 continued. Water Analytical Results & Washington Water Quality Criteria at Monte Cristo Mine Area, Washington

Results in bold exceed Washington Water Quality Criterion**

Water Analytical Results, ug/L No	Location	Hardness	Arsenic As	Cadmium Cd	Chromium Cr	Lead Pb	Mercury Hg	Nickel Ni	Copper Cu	Silver Ag	Zinc Zn	Antimony Sb	Beryllium Be	Selenium Se	Thallium Tl
3374080	76 Creek Headwater	5	U>0.50	U>0.10	U>0.50	**0.12**	U>0.050	U>0.50	0.18	U>0.10	U>5.0	0.48	U>0.10	U>0.50	U>0.10
3374081	76 Creek Sidney Mine Dump	9	**9.64**	U>0.10	U>0.50	**0.19**	U>0.050	U>0.50	0.26	U>0.10	U>5.0	2.22	U>0.10	U>0.50	U>0.10
3394090	Glacier Creek Headwater	8	**1.7**	U>0.10	U>0.50	U>0.10	U>0.050	U>0.50	U>0.50	U>0.10	U>5.0	1.8 J	U>0.10	U>0.50	U>0.10
3394091	Glacier Creek POM Mine	8	**3.8**	U>0.10	U>0.50	0.14	U>0.050	U>0.50	U>0.50	U>0.10	U>5.0	1.9 J	U>0.10	U>0.50	U>0.10
3394094	Glacier Creek POM Mine N	8	**3.6**	U>0.10	U>0.50	0.10	U>0.050	U>0.50	U>0.50	U>0.10	U>5.0	1.9 J	U>0.10	U>0.50	U>0.10
3374082	Creek at Justice Mine	104	**235**	0.14	U>0.50	1.26	U>0.050	0.92	4.22	U>0.10	21	11.3	U>0.10	U>0.50	U>0.10
3374083	Creek below Justice Mine	99	**264**	**0.48**	U>0.50	0.74	U>0.050	1.19	2.83	U>0.10	56.8	11.6	U>0.10	U>0.50	U>0.10
3374084	Glacier Cr Below Concentrator++	8	**7.89**	U>0.10	U>0.50	0.13	U>0.050	U>0.50	0.67	U>0.10	U>5.0	1.3	U>0.10	U>0.50	U>0.10
3394093	Glacier Cr Below Concentrator++	9	**12.2**	U>0.10	U>0.50	**0.29**	U>0.050	U>0.50	0.55	U>0.10	6.2	1.9 J	U>0.10	U>0.50	U>0.10
3374085	So Fork Sauk River at Lake MC*	12	**27.4**	U>0.10	U>0.50	**0.63**	U>0.050	U>0.50	1.41	U>0.10	U>5.0	5.44	U>0.10	U>0.50	U>0.10
Washington Water Quality Criteria listed by Hardness**					CrIII/CrVI										
Wash Water Quality Criteria-Human Health**		5	0.018	na	na	na	0.14	na	na	na	na	14+	na	170+	1.7+
Wash Water Qual Cri -Aquatic Life Acute**		5	360	0.943	15/45.86	2.13	210	109.01	0.98	0.02	8.78	na	na	20	na
Wash Water Qual Cri -Aquatic Life Chronic**		5	190	0.943	10/14.88	0.08	0.012	12.00	0.85	na	8.02	na	na	5	na
Wash Water Quality Criteria-Human Health**		8	0.018	na	na	na	0.14	na	na	na	na	14+	na	170+	1.7+
Wash Water Qual Cri -Aquatic Life Acute**		8	360	0.24	15/70.05	3.85	210	168.83	1.59	168.83	15.55	na	na	20	na
Wash Water Qual Cri -Aquatic Life Chronic**		8	190	0.16	10/22.72	0.15	0.012	18.75	1.33	18.75	14.2	na	na	5	na
Wash Water Quality Criteria-Human Health**		9	0.018	na		na	0.14	na	na	na	na	14+	na	170+	1.7+
Wash Water Qual Cri -Aquatic Life Acute**		9	360	0.29	15/79.7	4.61	210	192.9	1.85	0.06	15.55	na	na	20	na
Wash Water Qual Cri -Aquatic Life Chronic**		9	190	0.18	10/25.9	0.18	0.012	21.4	1.52	na	14.20	na	na	5	na
Wash Water Quality Criteria-Human Health**		12	0.018	na	na	na	0.14	na	na	na	na	14+	na	170+	1.7+
Wash Water Qual Cri -Aquatic Life Acute**		12	360	0.37	15/97.31	6.10	210	237.09	2.33	237.09	19.12	na	na	20	na
Wash Water Qual Cri -Aquatic Life Chronic**		12	190	0.22	10/31.57	0.24	0.012	26.33	1.87	26.33	17.46	na	na	5	na
Wash Water Quality Criteria-Human Health**		99	0.018	na	na	na	0.14	na	na	na	na	14+	na	170+	1.7+
Wash Water Qual Cri -Aquatic Life Acute**		99	360	0.24	15/546.49	64.23	210	1409.42	16.94	1409.42	113.96	na	na	20	na
Wash Water Qual Cri -Aquatic Life Chronic**		99	190	0.16	10/177.28	2.50	0.012	156.53	11.30	156.53	104.06	na	na	5	na
Wash Water Quality Criteria-Human Health**		104	0.018	na	na	na	0.14	610	na	na	na	14+	na	170+	1.7+
Wash Water Qual Cri -Aquatic Life Acute**		104	360	3.86	15/566.65	67.40	210	1463.16	17.66	1463.16	118.31	na	na	20	na
Wash Water Qual Cri -Aquatic Life Chronic**		104	190	1.06	10/183.82	2.63	0.012	162.50	11.74	162.50	108.04	na	na	5	na

**Some Washington Water Quality Criteria are hardness dependent (Cd, Cu, Pb, Ag, Zn) and for criteria for other hardness values, see Appendix C or formulae below

ND> or U>5 = Metal not detected above level specified; this example not above 5 mg/kg for soil; not above 5 ug/L for water.

* South Fork of Sauk River -class AA- where river flows into Lake Monte Cristo, six miles north of Monte Cristo Mine Area.

** See Appendix C or formulae are shown in http://www.ecy.wa.gov/pubs/wa617320a.pdf

J = Metal was positively identified, result estimated. na = Cleanup level or standard is not available.

+ = National Toxics Rule human health criterion for Sb, Be, and Tl; noWQ aquatic life criterion.

++ = Glacier Creek water or sediment sample below Concentrator location at Monte Cristo Mine Area.

Table 4. Comparison of Soil Laboratory Analytical Results with Field XRF Results for Monte Cristo Mine Area, Snohomish County, Washington

Results shaded gray are reasonably acceptable correlation probably without inteference. Left column lists sample number for Edge Analytical Laboratory (E Lab) and Manchester Environmental Laboratory (M Lab) with X-Ray Fluorescence Reading.

Soil Analytical Results, mg/kg Sample No-Lab	Location	Arsenic As	Lead Pb	Mercury Hg	Nickel Ni	Copper Cu	Zinc Zn
3394095 M Lab	Glacier Creek Headwater Sediment	122	26.3	0.874	12.1	21.7	123
XRF 39	Glacier Creek Headwater Sediment	132.5	17	32	686.8	153.2	101.1
3394096 M Lab	Pride of the Mountain Mine	332	130	0.528	7.9	48	328
XRF 43	Pride of the Mountain Mine 1343	153.6	54	14.9	4000	775.2	446.4
XRF 45	Pride of the Mountain Mine 1416	734.4	96.5	10.4	1400	241	223.2
3394097 M Lab	Pride of the Woods Mine	41400	2760	8.61	ND>5.0	517	271
XRF 46	Pride of the Woods Mine 1435	13299	959	464	8179	1770	787.6
XRF 47	Pride of the Woods Mine 1437	18893	1429	462	3610	829.6	388
3394098 M Lab	Comet Mine Bunker Soil	31200	7340	2.28	11.3	212	180
3374087 M Lab	Comet Mine Bunker South	14700	1950	0.368	12.1	78	435
XRF 28	Comet Mine Bunker South	48486	3210	761	<LOD	123	205
XRF 55	Comet Mine Bunker Soil	13594	1840	275	<LOD	69.7	238.8
10529 E Lab	Concentrator Level 1 West	3460	9580	8.5	ND>0.469	378	149
XRF 20	Concentrator Level 1 West	2339	5827	60.4	406.6	251	167
10530 E Lab	Concentrator Level 1 East	34900	7000	7.07	0.604	516	852
XRF 19	Concentrator Level 1 East	10298	4269	70.4	<LOD	998	4349
3374086 M Lab	Concentrator Level 2 West	14600	16300	4.33	3.26	1340	471
XRF 22	Concentrator Level 2 West	17190	11494	1140	15590	3878	2010
10532 E Lab	Pride/Mystery Tram Terminal	8450	20400	4.47	ND>0.481	1160	882
XRF 26	Pride/Mystery Tram Terminal	9978	11494	545	3747	1340	943
XRF 27	Pride/Mystery Tram Terminal	4518	9395	224	<LOD	369	298
10531 E Lab	Justice Mine Adit Soil	4900	228	0.61	15.7	93	312
3374088 M Lab	So Fork Sauk River-Lake MC*	1090	278	0.0911	96.5	207	806
XRF 33	So Fork Sauk River-Lake MC*	293	91	<LOD	80.3	66	116

* South Fork of Sauk River where river flows into Lake Monte Cristo, six miles north of Monte Cristo Mine Area.

ND>5 = Metal not detected above level specified; example not above 5 mg/kg. <LOD = Result lower than detection.

Table 5. Comparison of SHA Soil Results with Previous Study and Regional Background Metal Concentration Levels for Monte Cristo Mine Area, Snohomish County, Washington

Results in bold exceed Model Toxics Control Act Cleanup Level or other standard or criterion.

Soil Analytical Results, mg/kg No	Location	Arsenic As	Cadmium Cd	Chromium Cr	Lead Pb	Mercury Hg	Nickel Ni	Copper Cu	Silver Ag	Zinc Zn	Antimony Sb	Pb:As Ratio
3394095	Glacier Creek Headwater Sediment	122	0.65	16.4	26.3	0.874	12.1	21.7	0.18	123	0.43	0.22
3394096	Pride of Mountain Mine Soil	332	1.89	9.71	130	0.528	7.9	48	0.45	328	0.57 J	0.39
3394097	Pride of Woods Mine Soil	**41400**	**2.42**	12.1	**2760**	**8.61**	ND>5.0	517	49.1	271	**416**	0.07
10531	Justice Mine Adit Soil	**4900**	**6.75**	U>0.232	**228**	0.61	15.7	93.3	U>0.232	312	12	0.46
3394098	Comet Mine Bunker Soil	**31200**	**9.12**	11.0	**7340**	**2.28**	11.3	212	17	180	**168**	0.24
3374087	Comet Mine Bunker South Soil	**14700**	**2.29**	11.1	**1950**	0.368	12.1	78	5.39	435	**719**	0.13
10532	Comet Mystery Tram Terminal Soil	**8450**	**8.33**	U>0.240	**20400**	**4.47**	U>0.481	1160	320	882	**133**	2.4
10529	Concentrator Level 1 West Soil	**3460**	**4.13**	2.44	**9580**	**8.5**	U>0.469	378	126	149	**1365**	2.8
10530	Concentrator Level 1 East Soil	**34900**	**11.4**	5.74	**7000**	**7.07**	0.604	516	115	852	**4582**	0.2
3374086	Concentrator Level 2 West Soil	**14600**	**1.54**	1.5	**16300**	**4.33**	3.26	1340	118	471	**3990**	1.1
3374088	So Fork Sauk River-Lake MC* Sediment	**1090**	**3.9**	36.6	**278**	0.0911	96.5	207	6.94	806	15.7	0.25
Previous Study, mg/kg												**Pb:As**
Wolff 2003	Mystery Adit 3 Dump	**14000**	na	na	**1700**	na	na	500	na	1100	na	0.15
	Pride of Woods Dump	**15300**	ND>1.11	na	**1450**	na	na	195	na	113	na	0.09
	Pride of Mountains Adit 1Dump	**17300**	**7.29**	na	**7040**	na	na	1010	na	941	na	0.40
Natural Background Soil Metal Concentrations at 90th Percentile Values, mg/kg**												**Pb:As**
	Puget Sound Lowland n=45	22.80	0.77	48.15	16.83	0.07	38.19	36.36	na	85.06	na	0.73
	Western Washington n=86	46.21	1.20	47.40	20.42	0.08	44.20	43.23	na	98.39	na	0.44
	Washington Statewide n=166	41.81	0.99	41.88	17.09	0.07	38.19	36.01	na	85.82	na	0.41
MTCA Cleanup Level, mg/kg		Carc/Noncarcinogen		CrIII/CrVI								
MTCA method A		20	2	2000/19/1	250	2	na	na	na	na	na	
MTCA method B - Direct Contact		0.667/24.0	40	120,000/240	na	24	1600	2960	400	24000	32	

* South Fork of Sauk River sediment where river flows into Lake Monte Cristo, six miles north of Monte Cristo Mine Area.

ND>0.10 or U>0.10 = Metal not detected above level specified; in this example not above 0.10 mg/kg.

** Natural Background Soil Metal Concentrations at 90th Percentile Values in mg/kg from Ecology Publication #94-115, October 1994, page 6-4, table 7.

na = not available or not analyzed.

J = metal was positively identified, result is estimated.