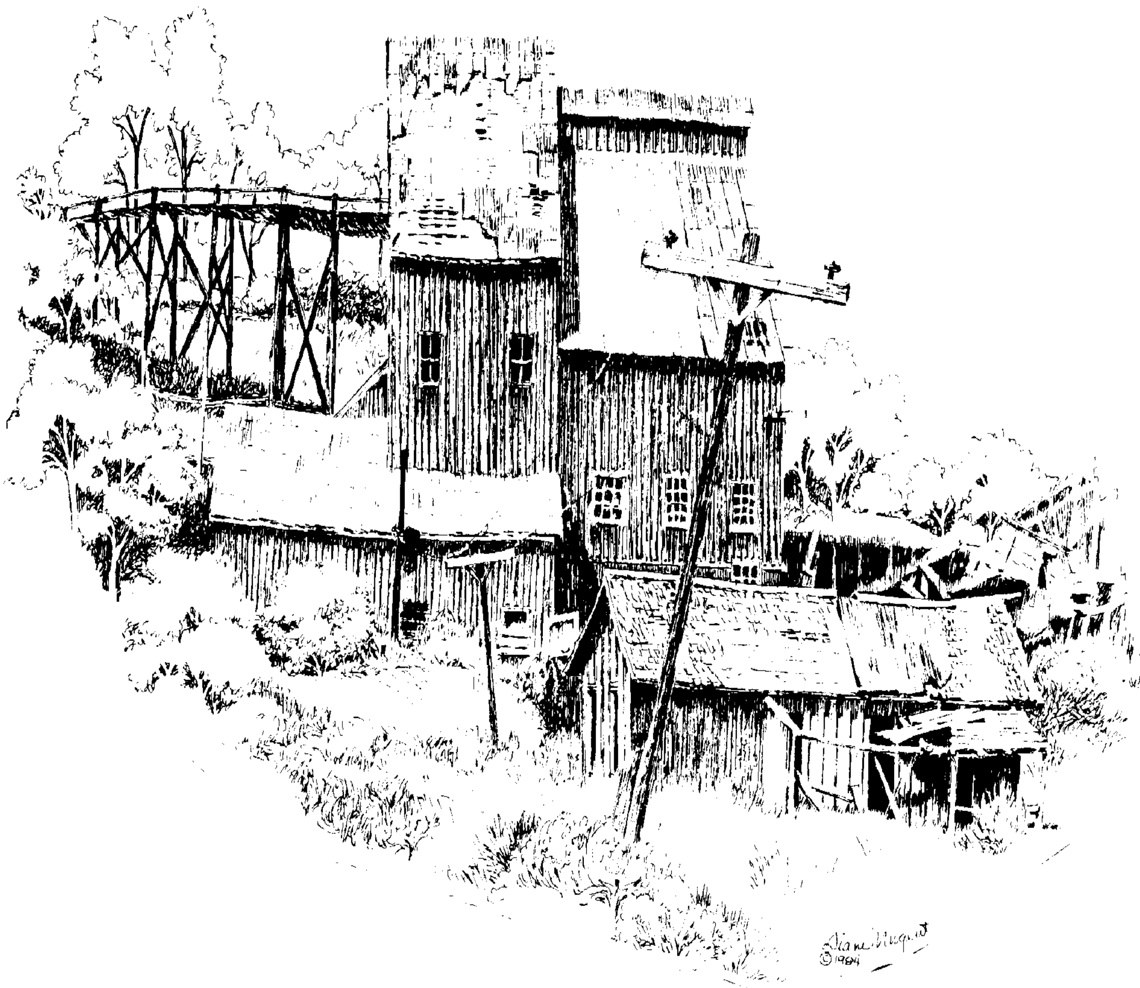
Montana Bureau of Mines and Geology
Abandoned-Inactive Mines Program
Deerlodge National Forest
Volume V
Jefferson River Drainage



MBMG 347

John Metesh
Jeff Lonn
Rich Marvin
James Madison
Robert Wintergerst

Prepared for the U.S. Department of Agriculture
Forest Service - Region 1

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Appendix

Introduction

To fulfill its obligations under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Northern Region of the U.S. Forest Service (USFS) desires to identify and characterize the abandoned and inactive mines with environmental, health, and/or safety problems that are on or affecting National Forest System lands. The Northern Region administers National Forest System lands in Montana and parts of Idaho and North Dakota. Meanwhile, the Montana Bureau of Mines and Geology (MBMG) collects and distributes information about the geology, mineral resources, and ground water of Montana. Consequently, the USFS and the MBMG determined that an inventory and preliminary characterization of abandoned and inactive mines in Montana would be beneficial to both agencies and entered into participating agreements to accomplish this work. The first forest inventoried was the Deerlodge National Forest. The results of this inventory are presented in five volumes: Volume I - Basin Creek, Volume II - Cataract Creek, Volume III - Flint Creek and Rock Creek, Volume IV - Upper Clark Fork River, and Volume V - Jefferson River.

1.1 Project Objectives

In 1992, the USFS and MBMG entered into the first of these agreements to identify and characterize abandoned and inactive mines on or affecting National Forest System lands in Montana. The objectives of this discovery process, as defined by the USFS, are as follows:

1. Utilize a formal, systematic program to identify the "Universe" of sites with possible human health, environmental, and/or safety-related problems that are either on or affecting National Forest System lands.

2. Identify the human health and environmental risks at each site based on site characterization factors, including screening-level soil and water data that have been taken and analyzed in accordance with EPA quality control procedures.

3. Based on site characterization factors, including screening-level sample data where appropriate, identify those sites that are not affecting National Forest System lands, and can be eliminated from further consideration.

4. Cooperate with other state and federal agencies and integrate the Northern Region program with their programs.

5. Develop and maintain a data file of site information that will allow the region to pro-actively respond to governmental and public interest group concerns.

In addition to the USFS objectives outlined above, the MBMG objectives also included gathering new information on the economic geology and hydrogeology associated with these abandoned and inactive mines. Enacted by the Legislative Assembly of the State of Montana (Section 75-607, R.C.M., 1947, Amended), the scope and duties of the MBMG include “...the collection, compilation, and publication of information on Montana's geology, mining, milling, and smelting operations, and ground-water resources; investigations of Montana geology emphasizing economic mineral resources and ground-water quality and quantity.”

1.2 Abandoned and Inactive Mines Defined

For the purposes of this study, mines, mills, or other processing facilities related to mineral extraction and/or processing are defined as abandoned or inactive as follows:

> A mine is considered abandoned if there are no identifiable owners or operators for the facilities or if the facilities have reverted to federal ownership.
>
> A mine is considered to be inactive if there is an identifiable owner or operator of the facility, but the facility is not currently operating, and there are no approved authorizations or permits to operate.

1.3 Health and Environmental Problems at the Mines

Abandoned and inactive mines may host various safety, health, and environmental problems. These may include metals that contaminate ground water, surface water, and soils; airborne dust from abandoned tailings impoundments; sedimentation in surface waters from eroding mine and mill waste materials; unstable waste piles with the potential for catastrophic failure; and physical hazards associated with mine openings and dilapidated structures. Although all problems were examined at least visually (see appendix I - Field Form), the hydrologic environment appears to be affected to the greatest extent. Therefore, this investigation focused most heavily on impacts from the mines to surface and ground water.

Metals are often transported from a mine by water (ground-water discharges or surface runoff) either by being dissolved, suspended, or carried as part of the bedload. When sulfides are present, acid can form and in turn, increases metal solubility. This condition, known as acid mine drainage (AMD), is a significant source of metal releases at many of the mine sites in Montana.

1.3.1 Acid Mine Drainage

Trexler *et al.* (1975) identified six components that govern the formation of metal-laden acid mine waters:

1) availability of sulfides, especially pyrite,
2) presence of oxygen,
3) water in the atmosphere,

4) availability of leachable metals,
5) availability of water to transport the dissolved constituents, and
6) mine characteristics, which affect the other five elements.

To this list, most geochemists would add mineral availability, *e.g.*, calcite, which can neutralize the acidity. These six components occur not only within the mines themselves but can exist within mine dumps and mill tailings piles, making waste materials sources of contamination as well.

Acid mine drainage (AMD) is formed by the oxidation and dissolution of sulfides, particularly pyrite (FeS_2) and pyrrhotite ($Fe_{1-x}S$). Other sulfides play a minor role in acid generation. Oxidation of iron sulfides forms sulfuric acid (H_2SO_4), sulfate ($SO_4^{=}$), and reduced iron (Fe^{2+}). Mining of sulfide-bearing rock exposes the sulfide minerals to atmospheric oxygen and oxygen-bearing water. Consequently, the sulfide minerals are oxidized and acid mine waters are produced.

The rate-limiting step of acid formation is the oxidation of the reduced iron. This oxidation rate can be greatly increased by iron-oxidizing bacteria (*Thiobacillus ferrooxidans*). The oxidized iron produced by biological activity is able to promote further oxidation and dissolution of pyrite, pyrrhotite, and marcasite (FeS_2 - a dimorph of pyrite).

Once formed, the acid can dissolve other sulfide minerals such as arsenopyrite (FeAsS), chalcopyrite ($CuFeS_2$), galena (PbS), tetrahedrite ($[CuFe]_{12}Sb_4S_{13}$), and sphalerite ([Zn,Fe]S) to produce high concentrations of copper, lead, zinc, and other metals. Aluminum can be leached by the dissolution of aluminosilicates common in soils and waste material found in southwestern Montana. The dissolution of any given metal is controlled by the solubility of that metal.

1.3.2 Solubility of Selected Metals

At a pH above 2.2, ferric hydroxide ($Fe[OH]_3$) precipitates to produce a brown-orange color in surface waters and forms a similar colored coating on rocks in affected streams. Other metals, such as copper, lead, cadmium, zinc, and aluminum, if present in the source rock, may co-precipitate or adsorb onto the ferric hydroxide (Stumm and Morgan 1981). Alunite ($KAl_3[SO_4]_2[OH]_6$) and jarosite ($KFe_3[SO_4]_2[OH]_6$) will precipitate at pH less than 4, depending on $SO_4^{=}$ and K^+ activities (Lindsay 1979). Once the acid conditions are present, the solubility of the metal governs its fate and transport:

Manganese solubility is strongly controlled by the redox state of the water and is limited by several minerals such as pyrolusite and manganite; under reduced conditions, pyrolusite (MnO_2) is dissolved and manganite ($MnO[OH]$) is precipitated. Manganese is found in mineralized environments as rhodochrosite ($MnCO_3$) or weathering products of rhodochrosite.

Aluminum solubility is most often controlled by alunite ($KAl_3[SO_4]_2[OH]_6$) or by gibbsite ($Al[OH]_3$) depending on pH. Aluminum is one of the most common elements in rock-forming minerals such as feldspars, micas, and clays.

Silver solubility is strongly affected by the activities of halides such as Cl^-, F^-, Br^-, and I^-. Redox and pH also affect the solubility of silver but to a lesser degree. Silver substitutes for other cations in common ore minerals, such as tetrahedrite and galena, and is found in the less common hydrothermal minerals pyrargyrite (Ag_3SbS_2) and proustite (Ag_3AsS_3).

Arsenic tends to precipitate and adsorb with iron at low pH and de-sorb or dissolve at higher pH. Thus, once oxidized, arsenic will be found in solution in higher pH waters. At pHs between 3 and 7, the dominant arsenic compound is a monovalent arsenate H_2AsO_4. Arsenic is abundant in metallic mineral deposits as arsenopyrite (FeAsS), enargite (Cu_3AsS_4), and tennantite ($Cu_{12}As_4S_{13}$), to name a few.

Cadmium solubility data are limited. In soils, the solubility of cadmium is controlled by the carbonate species octavite ($CdC0_3$) at a soil-pH above 7.5 and by strengite ($Cd_3[PO_4]_2$) at a soil-pH below 6. In soils, octavite is the dominant control on solubility of cadmium. In water, at low partial pressures of H_2S, $CdCO_3$ is easily reduced to CDs.

Copper solubility in natural waters is controlled primarily by the carbonate content; malachite ($Cu_2[OH]_2CO_3$) and azurite ($Cu_3[OH]_2[CO_3]_2$) control solubility when CO_3 is available in sufficient concentrations. In soil, copper complexes readily with soil-iron to form cupric ferrite. Other compounds such as sulfate and phosphates in soil may also control copper solubility in soils. Copper is present in many ore minerals, including chalcopyrite ($CuFeS_2$), bornite (Cu_5FeS_4), chalcocite (Cu_2S), and tetrahedrite ($Cu_{12}Sb_4S_{13}$).

Mercury readily vaporizes under atmospheric conditions and, thus, is most often found in concentrations well below the 25 µg/L equilibrium concentration. The most stable form of mercury in soil is its elemental form. Mercury is found in low temperature hydrothermal ores as cinnabar (HgS), in epithermal (hot springs) deposits as native mercury, and as native mercury in human-made deposits where mercury was used in the processing of gold ores.

Lead concentrations in natural waters are controlled by lead carbonate, which has an equilibrium concentration of 50 µg/L at pHs between 7.5 and 8.5. As with other metals, concentrations in solution increase with decreasing pH. In sulfate soils with a pH less than 6, anglesite controls solubility while cerussite, a lead carbonate, controls solubility in buffered soils. Lead occurs in the common ore mineral galena (PbS).

Zinc solubility is controlled by the formation of zinc hydroxide and zinc carbonate in natural waters. At pHs greater than 8, the equilibrium concentration of zinc in waters with a high bicarbonate content is less than 100 µg/L. Franklinite may control solubility at pH less than 5 in water and soils, and is strongly affected by sulfate concentrations. Thus, production of sulfate from AMD may ultimately control solubility of zinc in water affected by mining. Sphalerite

(ZnS) is common in mineralized systems.

(References: Lindsay 1979, Stumm and Morgan 1981, Hem 1985, Maest and Metesh 1993)

1.3.3 The Use of pH and SC to Identify Problems

In similar mine evaluation studies, pH and specific conductance (SC) have been used to distinguish "problem" mine sites from those that have no adverse water-related impacts. The general assumption is that low pH (<6.8) and high SC (variable) indicate a problem and that neutral or higher pH and low SC indicate no problem.

Limiting data collection only to pH and SC largely ignores the various controls on solubility and can lead to erroneous conclusions. Arsenic, for example, is most mobile in waters with higher pH values (>7), and its concentration strongly depends on the presence of dissolved iron. Cadmium and lead may also exceed standards in waters with pH values within acceptable limits.

Reliance on SC as an indicator of site conditions can also lead to erroneous conclusions. The SC value of a sample represents 55 to 75 % of the total dissolved solids (TDS), depending on the concentration of sulfate. Without knowing the sulfate concentration, an estimate of TDS based on SC has a 25 % error range. Furthermore, without having a statistically significant amount of SC data for a study area, it is hard to define what constitutes a high or low SC value.

Thus, a water sample with a near-neutral pH and a moderate SC could be interpreted to mean that no adverse impacts have occurred when in fact, one or more dissolved-metal species may exceed standards. With this in mind, the evaluation of a mine site for adverse impacts on water and soil must include the collection of samples for analyses of metals, cations, and anions.

1.4 Methodology

1.4.1 Data Sources

The MBMG began this inventory effort by completing a literature search for all known mines in Montana. The MBMG plotted the published location(s) of the mines on USFS maps. From the maps, the MBMG developed an inventory of all known mines that are located on or could affect National Forest System lands in Montana. The following data sources were used:

1) the MILS data base (U.S. Bureau of Mines),
2) the MRDS data base (U.S. Geological Survey),
3) published compilations of mines and prospects data,
4) state publications on mineral deposits,

5) U.S. Geological Survey publications on the general geology of some quads,
6) recent USGS/USBM mineral resource potential studies of proposed wilderness areas, and
7) MBMG mineral property files.

During subsequent field visits, the MBMG located numerous mines and prospects for which no previous information existed. Conversely, other mines for which data existed could not be found.

1.4.2 Pre-field Screening

Field crews visited those sites with the potential to release hazardous substances, and sites that did not have enough information to make that determination without a field visit. For problems to exist, a site must have a source of hazardous substances and a method of transport from the site. Most metal mines contain a source for hazardous substances, but the common transport mechanism, water, is not always present. Consequently, sites on dry ridge tops were assumed to be lacking this transport mechanism, while mines described in the literature as small prospects were considered to have an inconsequential hazardous materials source; neither were visited.

In addition, the MBMG and the USFS developed screening criteria (table 1) that they used to determine if a site had the potential to release hazardous substances or posed other environmental or safety hazards. The first page of the Field Form (appendix I) contains the screening criteria. If any of the answers were “yes” or unknown, the site was visited. Personal knowledge of a site and published information were used to answer the questions. USFS mineral administrators used these criteria to "screen out" several sites using their knowledge of an area.

Mine sites that were not visited were retained in the data base along with the data source(s) that was consulted (see appendix II). Often these sites were viewed from a distance while visiting another site. In this way, the accuracy of the consulted information was often checked.

Placer mines were not studied as part of this project. Although mercury was used in amalgamation, the complex nature of placer deposits makes mercury detection difficult and is beyond the scope of this inventory. Due to their oxidized nature, placer deposits are not likely to contain other anomalous concentrations of heavy metals. Limestone and building stone quarries, gravel pits, and phosphate mines were considered to be free of anomalous concentrations of hazardous substances and were not examined.

1.4.3 Field Screening

All sites that could not be screened out as described above were visited. All visits were conducted in accordance with a Health and Safety Plan that was developed for each forest. An MBMG geologist usually made the initial field visit. The geologist gathered information on environmental degradation, hazardous mine openings, presence of historical structures, and land ownership. Some site locations were refined using conventional field methods or by USFS Global Positioning System (GPS) crews. Each site is located by latitude/longitude and by township-range-section-tract (see figure 1 for explanation).

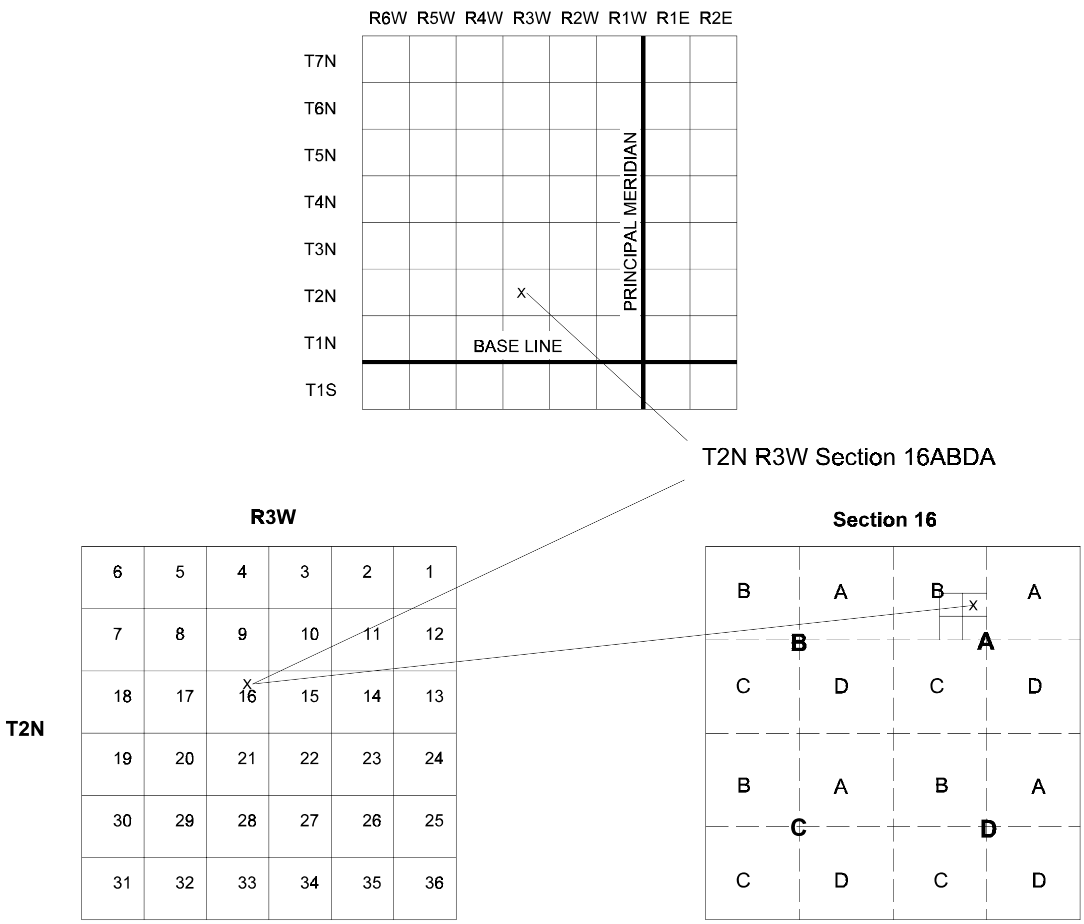

Figure 1. The tract of a mine is found as shown using quarter-sections counterclockwise.

At sites for which little geologic or mining data existed, geologists characterized the geology, collected samples for geochemical analysis, evaluated the deposit, and described workings and processing facilities present.

On public lands, geologists mapped sites with ground-water discharge, flowing surface water, or contaminated soils (as indicated by impacts on vegetation) using a Brunton compass and tape. The maps show locations of the workings, exposed geology, dumps, tailings, surface water, and geologic sample locations.

Sites with potential environmental problems were studied more extensively. The selection of these sites was made during the initial field visit using the previously developed screening criteria (table 1). In other words, if at least one of the first six screening criteria was met, the site was studied further. Sites that were not studied further are included in appendix III.

Table 1. Screening criteria.

Yes	No	
_	_	1. Mill site or tailings present
_	_	2. Adits with discharge or evidence of a discharge
_	_	3. Evidence of or strong likelihood for metal leaching or AMD (water stains, stressed or lack of vegetation, waste below water table, etc.)
_	_	4. Mine waste in flood plain or shows signs of water erosion
_	_	5. Residences, high public use area, or environmentally sensitive area (as listed in HRS) within 200 feet of disturbance
_	_	6. Hazardous wastes/materials (chemical containers, explosives, etc.)
_	_	7. Open adits/shafts, highwalls, or hazardous structures/debris

If the answers to questions 1 through 6 were <u>all</u> "NO" (based on literature, personal knowledge, or site visit), then the site was not further investigated.

1.4.3.1 Collection of Geologic Samples

The geologist took the following samples as appropriate:

1) select samples: specimens representing a particular rock type taken for assay;

2) composite samples rock and soil taken systematically from a dump or tailings pile for assay, representing the overall composition of material in the source;

3) leach samples duplicates of selected composite samples for testing leachable metals (EPA Method 1312).

All three types of samples were used, respectively, to characterize the economic geology of the deposit, to examine the value and metal content of dumps and tailings, and to verify the availability of metals for leaching when exposed to water. Assay samples were taken to provide some information on the types of metals present and a rough indication of their concentrations. Outcrops and waste materials were not sampled extensively enough to provide reliable estimates of tonnages, grades, or economic feasibility.

1.4.4 Field Methods

A hydrogeologist visited all of the sites the geologist determined had the potential for environmental problems. A hydrogeologist also visited the sites that only had evidence of seasonal water discharges, possible sedimentation, airborne dust, mine hazards, or stability problems and determined if there was a potential for significant environmental problems. The hydrogeologist then determined whether sampling was warranted and if so, selected soil and water-sampling locations.

1.4.4.1 Selection of Sample Sites

This project focused on the impact of mining on surface water, ground water, and soils because mine disturbances may have high total metal concentrations yet may be releasing few metals into the surface water, ground water, or soil. Conversely, another disturbance could have lower total metal content, but may be releasing metals in concentrations that adversely impact the environment.

The hydrogeologist selected and marked water and soil sampling locations based on field parameters (SC, pH, Eh, etc.) and observations (*e.g.,* erosion and staining of soils/stream beds). The hydrogeologist chose sample locations that would provide the best information on the relative impact of the site to surface water and soils. If possible, surface-water sample locations were chosen that were upstream, downstream, and at any discharge points associated with the site. Soil sample locations were selected in areas where waste material was obviously impacting natural material. In most cases, where applicable, a composite sample location across a soil/waste mixing area was selected. In addition, sample sites were located to assess conditions on National Forest System lands; therefore, samples sites were located on National Forest System lands to the extent ownership boundaries were known.

Because monitoring wells were not installed as part of this investigation, the evaluation of impacts to ground water was limited to strategic sampling of surface water and soils. Background water-quality data are restricted to upstream surface-water samples; background soil samples were not collected. Laboratory tests were used to determine the propensity of waste material to release metals and may lend additional insight to possible ground-water contamination at a site.

1.4.4.2 Marking and Labeling Sample Sites

Sample location stakes were placed as close as possible to the actual sample location and labeled with a sample identification number. The hydrogeologist wrote a site-sampling and analysis plan (SAP) for each mine site or development area that was then approved by the USFS project manager. Each sample location was plotted on the site map or topographic map and described in the SAP; each sample site was given a unique identifier based on its location as follows:

D DA T L I C

D: Drainage area - determined from topographic map
DA: Development Area (dominant mine)
T: Sample type: T - Tailings, W - Waste Rock, D - Soil, A - Alluvium, L - Slag S - Surface Water, G - Ground Water
L: Sample Location (1–9)
I: Sample Interval (default is 0)
C: Sample Concentration (High, Medium, Low) determined by the hydrogeologist based on field parameters

1.4.4.3 Collection of Water and Soil Samples

Sampling crews collected soil and water samples, and took field measurements (*e.g.*, stream flow) in accordance with the following:

Sampling and Analysis Plan (SAP) - These plans are site specific, and they list the type, location, and number of samples and field measurements to be taken at a site.

Quality Assurance Project Plan or QAPP (Metesh 1992) - This plan guides the overall collection, transportation, storage, and sample analyses, and the collection of field measurements.

MBMG Standard Field Operating Procedures (SOP) - The SOP specifies how field samples and measurements will be taken.

1.4.4.4 Existing Data

Data collected in previous investigations were neither qualified nor validated under this project. The quality-assurance managers and project hydrogeologist determined the usability of such data.

1.4.5 Analytical Methods

The MBMG Analytical Division performed the laboratory analyses and conformed, as applicable, to the following:

Contract Laboratory Statement of Work, Inorganic Analyses, Multi-media, Multi-concentration. March 1990, SOW 3/90, Document Number ILM02.0, EPA, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada

Method 200.8 Determination of Trace Metals in Water and Waste by Inductively Coupled Plasma and Mass Spectrometry - EPA

Method 200.7 Determination of Trace Metals in Water and Waste by Inductively Coupled Plasma and Mass Spectrometry - EPA

If a contract laboratory procedure method did not exist for a given analysis, the following method was used:

Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846, 3rd edition, EPA, Washington D.C.

EPA Method 1312 Acid-rain Simulation Leach Test Procedure - Physical/Chemical Methods, SW-846, 3rd edition, EPA, Washington D.C., Appendix G

All analyses performed in the laboratory conformed to the MBMG Laboratory Analytical Protocol (LAP).

1.4.6 Standards

EPA and various state agencies have developed human health and environmental standards for various metals. To try put the metal concentrations that were measured into some perspective, they were compared to these developed standards. However, it is understood that metal concentrations in mineralized areas may naturally exceed these standards.

1.4.6.1 Water-Quality Standards

The Safe Drinking Water Act (SDWA) directs EPA to develop standards for **potable** water. Some of these standards are mandatory (primary), and some are desired (secondary). The standards established under the SDWA are often referred to as primary and secondary maximum contaminant levels (MCLs). Similarly, the Clean Water Act (CWA) directs EPA to develop water-quality standards (acute and chronic) that will protect **aquatic organisms**. These standards may vary with water hardness and are often referred to as the Aquatic Life Standards. The primary and secondary MCLs along with the acute and chronic Aquatic Life Standards for selected metals are listed in table 2. In some state investigations, the standards are applied to samples collected as total-recoverable metals. Because total-recoverable metals concentrations are difficult if not impossible to reproduce, this investigation used dissolved metals concentrations.

1.4.6.2 Soil Standards

There are no federal standards for concentrations of metals and other constituents in soils; acceptable limits for such are often based on human and/or environmental risk assessments for an area. Because no assessments of this kind have been done, concentrations of metals in soils were compared to the limits postulated by the EPA and the Montana Department of Health and Environmental Sciences for sites within the Clark Fork River basin in Montana. The proposed upper limit for lead in soils is 1,000 to 2,000 mg/kg, and 80 to 100 mg/kg for arsenic in **residential** areas. The Clark Fork Superfund background levels (Harrington-MDHES 1993) are listed in table 3.

Table 2. Water-quality standards.

	PRIMARY MCL[1] (mg/L)	SECONDARY MCL[2] (mg/L)	AQUATIC LIFE ACUTE[3,4] (mg/L)	AQUATIC LIFE CHRONIC[3,5] (mg/L)
Aluminum		0.05-0.2	0.75	0.087
Arsenic	0.05		0.36	0.19
Barium	2			
Cadmium	0.005		0.0039/0.0086[6]	0.0011/0.0020[6]
Chromium	0.1		1.7/3.1[6,7]	0.21/0.37[6,7]
Copper		1	0.018/0.034[6]	0.012/0.012[6]
Iron		0.3	1	
Lead	0.05		0.082/0.2[6]	0.0032/0.0077[6]
Manganese		0.05		
Mercury	0.002		0.0024	0.000012
Nickel	0.1		1.4/2.5[6]	0.16/0.28[6]
Silver		0.1	0.0041[8]	0.000012[8]
Zinc		5	0.12/0.21[6]	0.11/0.19[6]
Chloride		250		
Fluoride	4	2		
Nitrate	10 (as N)			
Sulfate	500[9]	250		
Silica		250		
pH (Standard Units)		6.5-8.5		

(1) 40 CFR 141; revised through 8/3/93
(2) 40 CFR 143; revised through 7/1/91
(3) Priority Pollutants, EPA Region VIII, August 1990
(4) Maximum concentration not to be exceeded more than <u>once</u> every 3 years.
(5) 4-day average not to be exceeded more than <u>once</u> every 3 years.
(6) Hardness dependent. Values are calculated at 100 mg/L and 200 mg/L.
(7) Cr^{+3} species.
(8) Hardness dependent. Values are calculated at 100 mg/L.
(9) Proposed, secondary will be superseded.

Table 3. Clark Fork Superfund background levels (mg/kg) for soils.

Reference	As	Cd	Cu	Pb	Zn
U.S. Mean soil	6.7	0.73	24.0	20.0	58
Helena Valley Mean soil	16.5	0.24	16.3	11.5	46.9
Missoula Lake Bed Sediment	-	0.2	25.0	34.0	105
Blackfoot River	4.0	<0.1	13.0	-	-
Phytotoxic Concentration	100	100	100	1,000	500

1.4.7 Analytical Results

The results of the sample analyses were used to estimate the nature and extent of potential impact to the environment and human health. Selected results for each site are presented in the discussion; a complete listing of water quality and soil chemistry are presented in appendix IV.

All of the data for this project were collated with existing data and were incorporated into a new MBMG abandoned-inactive mines data base. The data base will eventually include mines and prospects throughout Montana. It is designed to be the most complete compilation available for information on the location, geology, hydrogeology, production history, mine workings, references, and environmental impact of each of Montana's mining properties. The data fields in the current data base are presented in appendix V and are compatible with the MBMG geographic information system (GIS) package.

1.5 Deerlodge National Forest

The 1.3 million acre Deerlodge National Forest (DNF-administered land) straddles the Continental Divide in southwestern Montana (figure 2). Headquartered in Butte, it lies in the heart of historic mining country. The forest's eight mountain ranges, with elevations ranging from 4,075 to 10,604 feet, create a diverse landscape, grading from semiarid grassland foothills near the valley bottoms, to coniferous forests, to alpine regions of steep rocky peaks.

1.5.1 History of Mining

Some knowledge of the local mining history is helpful in understanding the problems created by the abandoned and inactive mines in the area. Gold was first discovered in the Deerlodge National Forest area on Gold Creek in the southwest portion of Powell County in 1852. By 1860, some gold placer mines were operating on Gold Creek, but most gold placers were discovered about 1865. Associated lode deposits were located soon thereafter.

Placers reached their maximum production before 1872, when the richest ones began to play out. By 1870, production from gold and silver lode deposits had become important. Most lode mines had been discovered by the late 1880s, with the main period of production from 1880 to 1907. Mines with silver as the major commodity were most active from 1883 until 1893, when the silver panic forced the closure of many of these polymetallic mines. Many operations never resumed. Mines yielding gold ores, especially of the "free milling" variety, which contain free gold, enjoyed a greater longevity. Some of these gold producers were worked until 1942, when the federal government placed restrictions on gold mining as a result of World War II. During World War II, government price supports and essential industry rulings brought many small to medium copper, lead, and zinc properties into production. Following the war, the increased supply and labor costs coupled with the withdrawal of price supports prematurely closed most of these properties. The Korean conflict brought some of these back on line as once again the government influenced the economics of mining. Additional properties were brought on line as the Defense Logistics Agency experienced a period of creating stockpiles of critical strategic minerals.

Towns such as Philipsburg were turned into industrial centers for production of manganese until the quotas were met, and once again, the buying programs and price supports were eliminated creating ghost towns, partially mined deposits, and environmental hazards. For most, it may be decades or centuries before economics will coax them into production again.

These boom-to-bust cycles continued with government influence through the 1980s when new environmental standards closed the Anaconda smelter and left many of the mines with no place to sell the ore. The resulting inactive-abandoned properties continue to impact the environment.

1.5.1.1 Production

The total value of minerals produced from lode mines within the Deerlodge National Forest boundaries was probably more than $60 million at the time of production (USGS/USBM 1978, O'Neill *et al.* 1983, Loen and Pearson 1984, Elliott *et al.* 1992). This estimate excludes the Butte and Philipsburg districts whose production totals are $6 billion and $91 million, respectively. These districts lie adjacent to but outside of the Deerlodge National Forest.

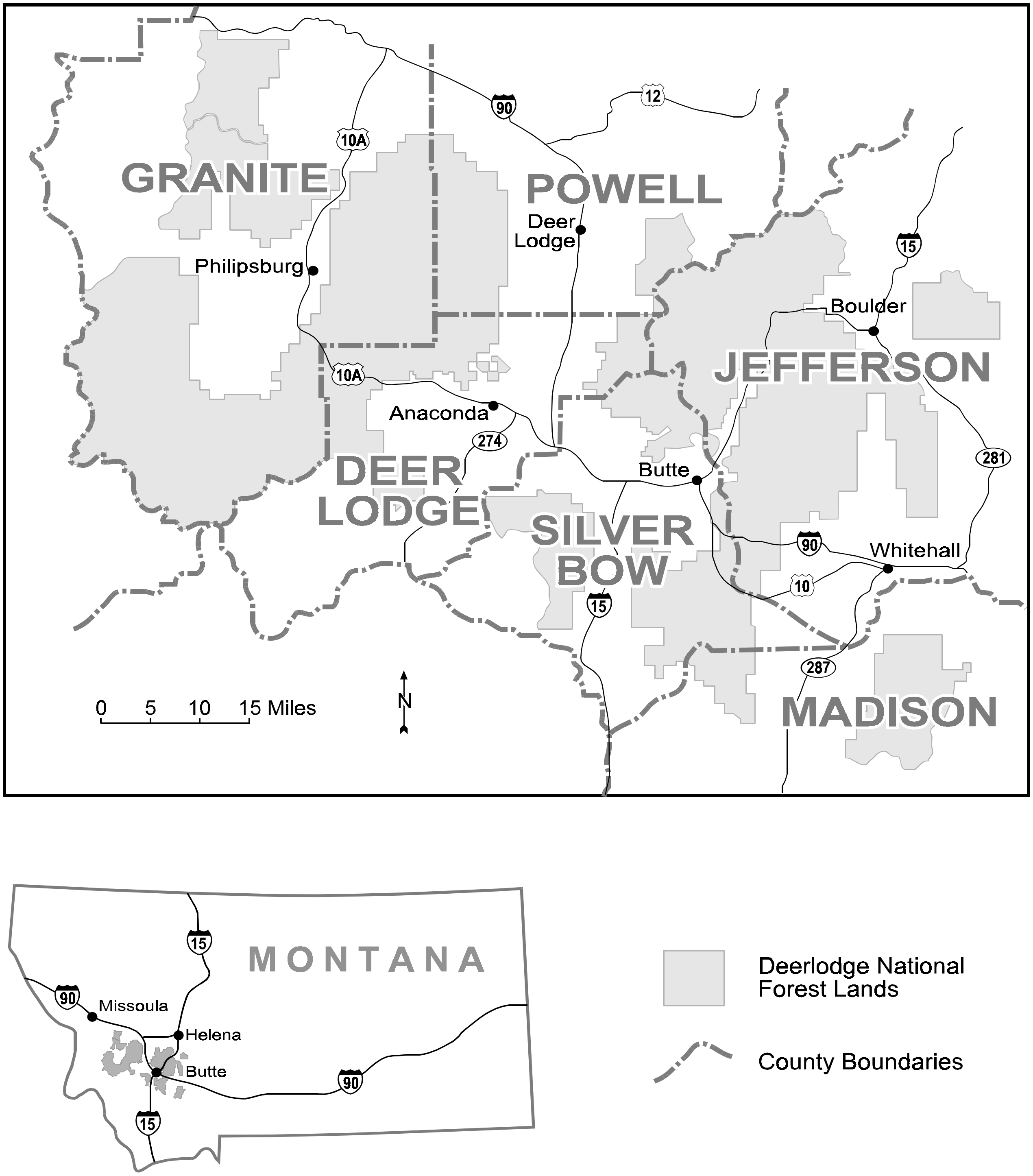

Figure 2. The Deerlodge National Forest occupies parts of six southwestern Montana counties.

1.5.1.2 Milling

An understanding of the history of milling developments is essential for interpreting mill sites, understanding tailings characteristics, and determining the potential for the presence of hazardous substances. Mills, usually adjacent to the mine, produce two materials: 1) a product that is either the commodity or a concentrate that is shipped offsite to other facilities for further refinement, and 2) waste, which is called tailings.

In the 1800s, almost all mills treated ore by crushing and/or grinding to a fairly coarse size followed by concentration using gravity methods. Polymetallic sulfide ores were concentrated and shipped to be smelted (usually to sites off National Forest–administered land). Gold was often removed from free-milling ores at the mill by mercury amalgamation. Cyanidation arrived in the United States about 1891, and because it resulted in greater recovery rates, it revolutionized gold extraction in many districts. Like amalgamation, cyanidation also worked only on free-milling ores, but it required a finer particle size. About 1910, froth flotation became widely used to concentrate sulfide ores. This process required that the ore be ground and mixed with re-agents to liberate the ore-bearing minerals from the barren rock.

Overall, there were two fundamental processes used for ore concentration: gravity and flotation, and three main processes used for commodity extraction: amalgamation, cyanidation, and smelting. Each combination of methods produced tailings of different size and composition, each used different chemicals in the process, and each was associated with a different geologic setting.

1.6 Summary of the Deerlodge National Forest Investigations

A literature search (Emmons and Calkins 1913, Roby *et al.* 1960, Becraft *et al.* 1963, Ruppel 1963, Earll 1972, McClernan 1976, Krohn and Weist 1977, MILS data base–U.S. Bureau of Mines, MRDS data base–USGS/USBM 1978, Erickson *et al.* 1981, O'Neill *et al.* 1983, Wallace *et al.* 1983, Loen and Pearson 1984, Elliott *et al.* 1985, Elliot *et al.*1988, Elliott *et al.*1992) identified 1,057 sites in the general area of the Deerlodge National Forest. The pre-field investigation that followed indicated that at least 1,043 abandoned or inactive metal mines and mills are located on or affect land administered by the Deerlodge National Forest. Most became inoperative long before environmental regulations were put into effect, so tailings piles, waste-rock dumps, and mine discharges persist to potentially affect the environment today. Table 4 summarizes the results of the Deerlodge National Forest inventory.

Table 4. Summary of Deerlodge National Forest investigation.

Total Number of Abandoned-Inactive Mine Sites:

<u>PART A - Field Form</u>		
Located in general area from Literature Search		1050
Not on or affecting DNF		- 7
<u>PART B - Field Form (Screening Criteria)</u>		
Possibly affecting the DNF		**1043**
Screened out by DNF minerals administrator	**OR**	
by description in literature		- 484
Not found (location inaccurate)		- 80
Visited by geologist		**479**
Screened out by geologist		- 376
Visited by hydrogeologist		**103**
Screened out by hydrogeologist		- 4
<u>PART C - Field Form</u>		
Sampled (Water and Soil)		99

A separate discussion of each of the 99 sites is included in the five volumes that compose the DNF report. All 1,050 sites inventoried are listed in appendix II of each volume.

1.7 Mining Districts and Drainage Basins

The Deerlodge National Forest includes all or part of 30 mining districts as defined by the USGS (Elliott *et al.* 1992, Loen and Pearson 1984). Some mines are not located in traditional mining districts and for the purposes of this study, have been organized into areas delineated by topography. In either case, boundaries have been determined in part by changes in geology and in part by drainage divides. This provides a convenient way to separate the forest into manageable areas for discussion of geology and hydrology, and perhaps more important, it is an aid to the assessment of cumulative environmental impacts on each drainage.

Jefferson River Drainage

The Jefferson River drainage is in the eastern portion of the Deerlodge National Forest and includes the Boulder River drainage. Basin Creek and Cataract Creek are in the Boulder River drainage, but because they contain a relatively high density of mines, they were presented as Volume I and Volume II of the Deerlodge National Forest reports.

The terrain ranges from broad, flat valleys in the Jefferson and Boulder drainages to rugged mountain ranges and encompass an area of about 9,500 square miles. There are no large cities in the drainage, but there are several small towns (population less than 10,000), including Whitehall, Cardwell, Basin, Boulder, and Twin Bridges.

2.1 Geology

The Jefferson River basin of Deerlodge National Forest contains all or parts of 10 mining districts: the Big Foot, Boulder Mountains, Elkhorn, Highlands, Homestake, Lowland, Pipestone, Pony, South Boulder, and Tidal Wave districts. However, these can be grouped by geology and drainage basin into just five areas, described below. Figure 3 presents the mines and mills within the Deerlodge National Forest in the Jefferson River (main stem) basin, and figure 4 presents those in the tributary Boulder River basin.

Highlands Mountains

Included in this discussion of the Highlands district are properties sometimes considered to be in the Moose Creek district (Loen and Pearson 1984). The two districts are linked by geography and geology. Geologic mapping in the area was initiated by Veazey (1934) and continued by Sahinen (1950) and Cass (1953). Although Ruppel *et al.* (1983) mapped at only a 1:250,000 scale, they paid more attention to the complex structural geology than did previous authors. Smedes (1980) mapped the western and southwestern portions of the area in detail as part of the Humbug Spires Wilderness study.

Sedimentary rocks of Proterozoic to Jurassic age are exposed in the area. Archean metamorphic rocks are in fault and depositional contact with sediment south of the district. All of these units were folded and thrust by late Cretaceous compression, then intruded by quartz monzonite, diorite, aplite, and pegmatite of the Boulder Batholith and its satellite stocks. These late Cretaceous igneous rocks almost surround the area in outcrop and may underlie the entire area at shallow depths. North to northwest–striking high-angle faults cut the sedimentary rocks and some of the plutonic rocks; in other cases igneous rocks post-date high-angle faults.

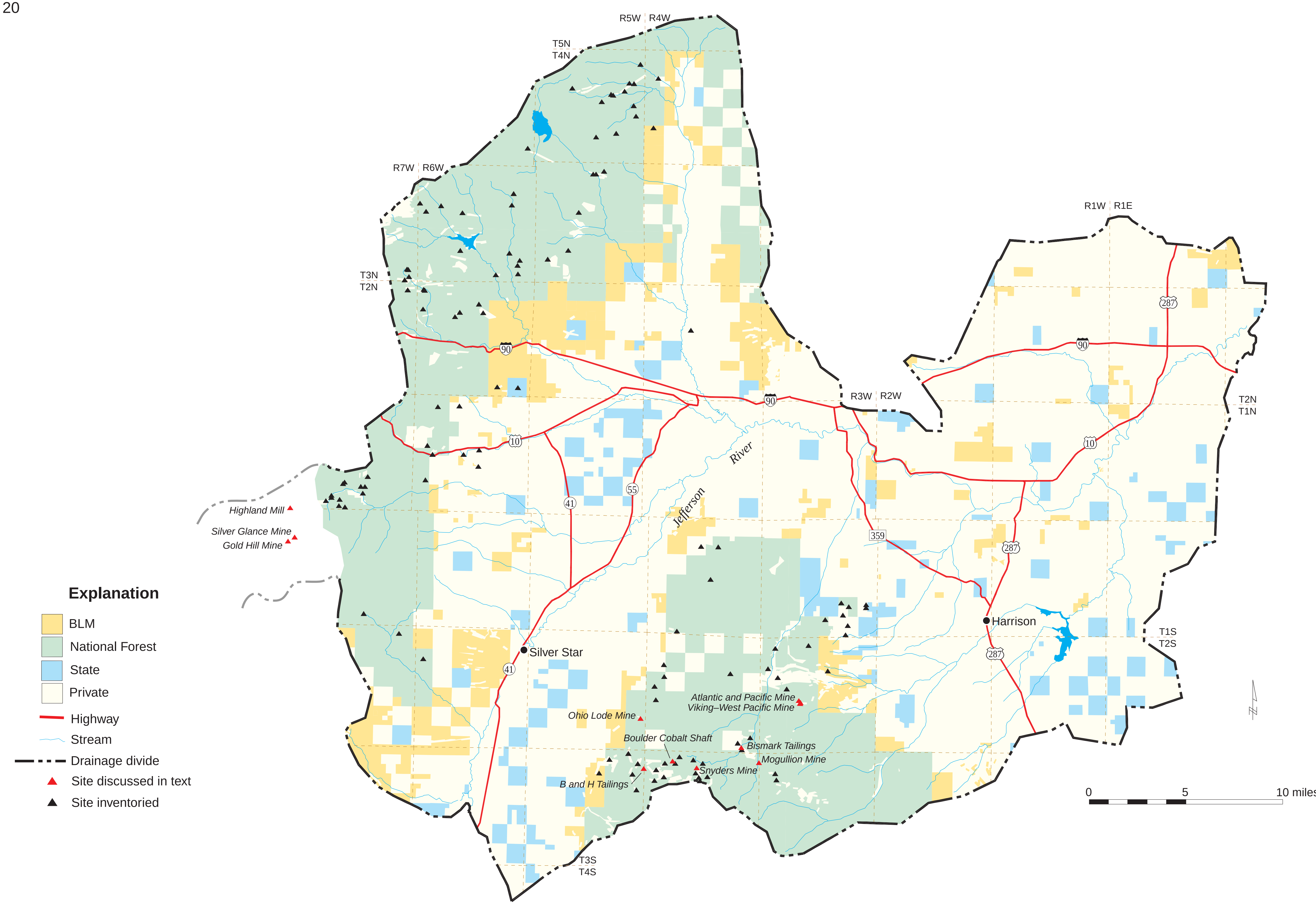

Figure 3. Abandoned-inactive mines in the Jefferson River drainage are generally found in the higher elevations of the Tobacco Root Mountains and the continental divide.

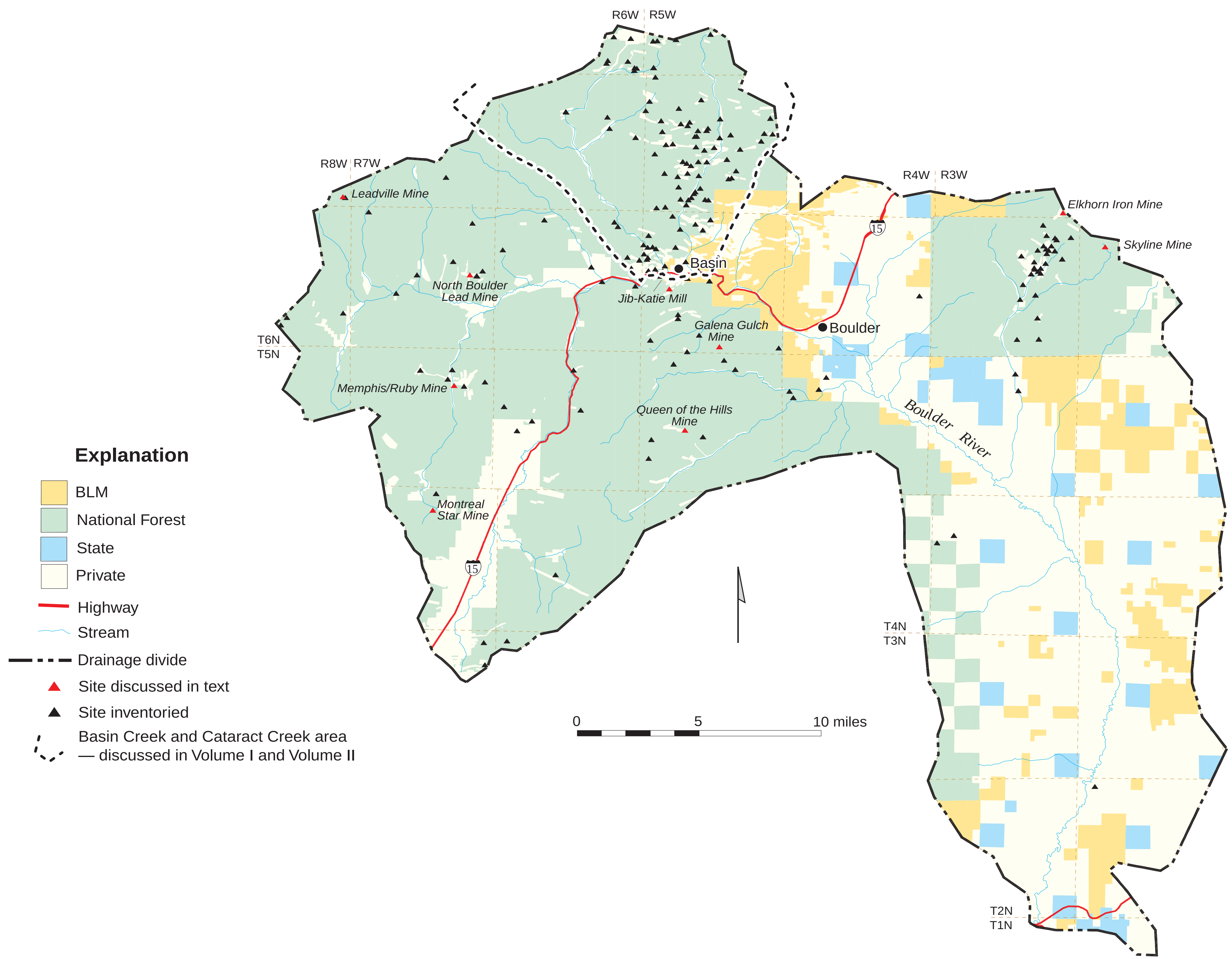

Figure 4. Abandoned-inactive mines in the Boulder River basin are found in the higher elevations of the Elkhorn and Boulder mountains. The tributaries, Basin Creek and Continental Creek, are discussed in volumes I and II.

Lowland Mountains

The Lowland Mountains lie in a northeast-trending area of Eocene Lowland Creek volcanics. The area was mapped by Smedes *et al.* (1962) and Wallace (1987). The district has been the site of numerous intensive exploration programs, and MBMG files contain much of the resulting unpublished information.

The geology of the district is characterized by two welded tuff units. Foster (1987) believed the mineralization occurred in fumaroles that developed as the ash compacted and cooled. De-gassing structures filled with adularia are common near the veins. The last stage in Lowland Creek volcanism was the emplacement of nearby intrusions of rhyolitic composition.

Boulder Mountains Area

The Boulder Mountains area discussed in this paper combines several mining districts and areas defined by the USGS (Loen and Pearson 1989, Elliott *et al.*1992), including the Big Foot, Oro Fino, Pipestone, Homestake, and Little Pipestone districts, and the North Boulder and South Boulder mountains areas. Geology across these areas is remarkably similar. The entire Boulder Mountains area is underlain by igneous rocks, mostly monzogranite, granodiorite, and aplite of the Cretaceous Boulder Batholith, but also including some Cretaceous Elkhorn Mountains volcanics and Tertiary Lowland Creek volcanics. Numerous high-angle normal (?) northwest-, northeast-, and north-trending faults cut the area. Geologic mapping in the area was done by Becraft and Pinckney (1961), Pinckney and Becraft (1961), Ruppel (1963), Ruppel *et al.* (1993), Smedes (1967, 1968), Smedes *et al.* (1962), and Wallace (1987).

Tobacco Root Mountains

This area includes the South Boulder district, the northern part of the Tidal Wave district, and the west edge of the Pony district.

Geologic mapping in the area has been done in progressively greater detail, beginning with Tansley *et al.* (1933). Reyner (1947), Reid (1957), Johns (1961), Vitaliano and Cordua (1979), and Ruppel (1985) produced maps of portions of the area. Finally O'Neill *et al.* (1983) completed the 1:50,000-scale map as part of the Middle Mountain–Tobacco Root mineral resource potential study. In the Tobacco Root Mountains, Archean amphibolite-grade metamorphic rocks are cut by northwest-striking high-angle faults that were active in Proterozoic time. Laramide compression reactivated some of these faults to form reverse left-lateral oblique-slip displacements in Precambrian and Paleozoic rocks (Schmidt and Garihan 1986). These recurrently active, northwest-trending fault systems played a large role in controlling the position of the dioritic to granitic, late Cretaceous Tobacco Root batholith and its satellite plutons, which in turn localized mineralization. Some northwest-trending faults remained active after emplacement of the intrusive rocks, and they served as conduits for hydrothermal fluids. The two major faults of this type in the area are the Mammoth and Bismark faults.

Elkhorn Mountains

The Elkhorn district's productive mineral deposits have been intensively studied. Weed and Barrell (1901) and Stone (1911) gave preliminary descriptions of the geology and ore deposits. Klepper *et al.* (1957) mapped the area in more detail and provided the definitive work on the geology of the district.

In the Elkhorn district, Paleozoic and Mesozoic sedimentary rocks were deformed by Cretaceous compression into north-trending folds and faults. At the same time, the sediment was covered by extrusive rocks of the andesitic Elkhorn Mountains volcanics and intruded by dikes and sills. Following compression, the Boulder Batholith of granitic composition and satellite bodies of diorite and gabbro were emplaced, accompanied by extensive contact metamorphism of the country rocks. Most mineralization in the district is probably related to the intrusion of the Boulder Batholith and its satellite stocks.

2.2 Economic Geology

The economic geology of the Boulder Mountains has not been comprehensively described but is similar to that of the Basin mining district. Pardee and Schrader (1933), Roby *et al.* (1960), Ruppel (1963), and U.S. Bureau of Mines (1988) gathered information on some of the larger mines. Loen and Pearson (1989) and Elliott *et al.* (1992) compiled existing information on all known mines on the Dillon and Butte 1 x 2 degree quadrangles.

Virtually all mines are hosted by plutonic rocks or adjacent volcanic country rocks. Most examine veins that are short and discontinuous but often rich. The veins usually occupy east-west structures, contain abundant base-metal sulfides, and have high silver-to-gold ratios. A few disseminated molybdenite occurrences are present in plutonic rocks near Butte.

The Boulder Mountains area has been a small producer of metals; the total value has been estimated at only $638,600 (Loen and Pearson 1989, Elliott *et al.* 1992). This value was derived from at least 4,332 oz of gold, 76,999 oz of silver, 21,933 lbs of copper, 433,344 lbs of lead, and 152,611 lbs of zinc.

The economic geology of the Tobacco Root Mountains has been described by Winchell (1914), Lorain (1932), Tansley *et al.* (1933), Full and Armstrong (1945), and Cather and Linne (1983; also reported by O'Neill *et al.* 1983). The most productive mines of the district are associated with either the northwest-striking faults and are adjacent to Cretaceous intrusive rocks. Deposits are generally quartz-pyrite vein segments in wide fault zones with disseminated pyrite in metamorphic and igneous wallrocks. In the Tidal Wave district, vein and replacement deposits also occur in Paleozoic limestones, mostly in the Meagher Limestone (Ruppel 1985). Many small mines and prospects with high precious gold values are scattered across the range. Silver-to-gold ratios are low, usually less than 1:1. Mineralogy of the veins is primarily quartz and pyrite, with local base-metal sulfides.

Production totals are approximately 56,675 ounces of gold, 116,660 ounces of silver, 1,088,111 pounds of copper, worth about $6 million at the time of production (Loen and Pearson 1989).

Mines in the Elkhorn mining district were studied by Weed and Barrell (1901), Pardee and Schrader (1933), Klepper *et al.* (1957), Roby *et al.* (1960), and finally by the USGS/USBM (1978). The latter comprehensive report on the Elkhorn Wilderness study area covered most of the mines investigated in this study. In the short allotted time for this inventory, we could not hope to improve on the excellent geologic information provided by this report.

Three basic types of ore bodies occur in the Elkhorn district (Klepper *et al.* 1957), and all three are related to intrusions of Boulder Batholith age. Most mines worked oxidized replacement zones in carbonate rocks. Silver-bearing galena, pyrite, and sphalerite are primary ore minerals common to deposits of this type. Most were mined for their silver content and the productive Elkhorn mine is an example. The second type are skarn deposits like those found at the Elkhorn Iron mine and the Golden Curry mine. A third type of deposit is represented only by the Skyline, a mineralized breccia pipe in andesitic Elkhorn Mountains volcanics.

The district produced a total of 70,015 oz Au, 14,982,751 oz Ag, 383 tons Cu, 8,304 tons Pb, and 3,081 tons Zn (Klepper *et al.* 1957).

Steeply dipping, north-striking veins and quartz-cemented breccia zones occur in three areas within the Lowland mining district, at the Ruby-Columbia, Kit Carson, and April mines. Mineralogy of the veins is predominantly quartz, but they also contain calcite, adularia, pyrite, argentite, galena, chalcopyrite, and sphalerite. Apparently, base-metal and sulfide content increases and precious metal content decreases with depth in the system (unpublished information, MBMG files). Some ore was very high grade, containing over 100 oz/ton silver and 10 oz/ton gold, but the average was closer to 1.9 oz/ton gold and 34 oz/ton silver. This small district produced 51,420 ounces of gold, 857,680 ounces of silver, and 550 pounds of copper, worth $1,680,250 at the time (Elliott *et al.* 1992, Pardee and Schrader 1933).

Most mineral deposits in the Highland mining district are probably related to the Cretaceous igneous activity. An exception is the stratabound massive sulfide mineralization in Belt sediment south of the district. This mineralization is probably syngenetic or diagenetic in origin, and Proterozoic in age (Thorson 1984). Other metallic deposits are either veins and replacement zones or skarns in Paleozoic carbonates. Most lode production in the district has come from a replacement zone in Cambrian Meagher dolomite at the Butte Highlands mine, outside the Missouri River basin (Veazey 1934, Newcomb 1941, Sahinen 1950). Production from the Highlands district was worth at least \$2.5 million at the time of production (Loen and Pearson 1984), with most of this value derived from gold.

2.3 Hydrology and Hydrogeology

The Jefferson River flows from its origin at the confluence of the Beaverhead, Big Hole, and Ruby rivers to its confluence with the Gallatin and Madison rivers to form the Missouri River. The Boulder River is the largest tributary and warrants a separate discussion. Other large tributaries include Willow, South Boulder, and Whitetail creeks. Annual runoff estimates at recent measurement stations are presented in table 5.

Table 5. Stream-gaging data for the Jefferson River drainage (seasonal records only).

Gage Location	Period of Record	Drainage Area (sq. miles)	Annual Mean Flow (cfs)
Jefferson R. near Twin Bridges	1940–1994*	7632	2014
Willow Cr. near Harrison	1923–1994**	83.8	40.7
Jefferson R. near Three Forks	1978–1994	9532	1931

*August 1940–September 1943, October 1957–September 1972, May–present
** April 1938–September 1982, October 1982–present seasonal only
Source: Shields *et al.* 1995

In general, the Jefferson River drainage is bounded on the east and south by the Tobacco Root Mountains and on the west by the Highland Mountains and the Continental Divide. The higher elevations of the Highland Mountains and the Tobacco Root Mountains were glaciated. Quaternary terminal moraine is found in the upper reach of South Boulder Creek; smaller moraines are found in tributaries in the Highland Mountains. With few exceptions, near-stream deposits are Quaternary alluvium along the entire drainage. The surficial deposits on the valley margins of the upper reaches are generally Quaternary terraces and alluvial fans or Tertiary lake bed sediment (Alden 1953).

The average annual precipitation ranges from 12 inches in the valley to 40 inches in the higher elevations of the Tobacco Root Mountains (Montagne *et al.* 1982). Average annual temperatures range from 40 to 45ºF in the valley to 25 to 30ºF in the mountains (Bergantino 1978).

Water use in the Jefferson River drainage is predominantly irrigation by surface water. The river is controlled to some degree by the Lima, Ruby, Clark Canyon, and Willow Creek reservoirs. There are about 310,000 acres irrigated upstream of Twin Bridges and 390,000 acres irrigated above Three Forks; about 12,500 acres are irrigated above the Willow Creek Reservoir. A summary of reservoir capacities and extremes (water year 1994) for reservoirs on the Jefferson River tributaries is presented in table 6.

Table 6. Reservoir statistics for the Jefferson River drainage.

Reservoir	Useable Capacity*	WY 1994 Extremes*
Lima (Red Rock River)	84,050	80,820 to 8,560
Ruby River	39,740	39,500 to 0
Clark Canyon	255,600	170,000 to 76,000
Willow Creek	17,730	18,000 to 2,270

*acre-feet

Source: Shields *et al.* 1995

Ground water also is used for irrigation but to a lesser extent. The most common use of ground water is for domestic and public supply in Three Forks.

The Boulder River drainage, a major tributary of the Jefferson River, flows from Elk Park Pass northward to Boulder and then southward to its confluence with the Jefferson River near Cardwell. Major tributaries include Bison, Basin, Cataract, and Elkhorn creeks. Stream flow is monitored at one station in the drainage on the Boulder River near Boulder (table 7).

Table 7. Stream-gaging data for the Boulder River drainage.

Gage Location	Period of Record	Drainage Area (sq. miles)	Annual Mean Flow (cfs)
Boulder River near Boulder	1929–1994*	381	117

*Specifically: May 1929–December 1932, March 1934–September 1972, October 1984–present

Source: Shields *et al.* 1995

The drainage is bounded by the Continental Divide, west of Boulder. The Elkhorn Mountains and Bull Mountain bound the north and east sides of the drainage below Boulder. The higher elevations of the Continental Divide and the Elkhorn Mountains were glaciated. Quaternary glacial moraines are found in several tributaries in the Continental Divide. The shallow deposits in Elk Park in the upper drainage and below Boulder in the lower part of the drainage comprises terrace and alluvial fan deposits (Alden 1953). The valley bottom generally comprises Quaternary alluvium between Basin and Boulder.

Average annual precipitation ranges from 12 inches in the lower valleys to 20 inches in the mountains (Montagne *et al.* 1982). Average annual temperatures range from 35 to 40ºF in the valley to 30 to 35ºF in the mountains (Bergantino 1978).

Water use in the Boulder River drainage includes municipal water supplies at Basin (surface water) and at Boulder (ground water), domestic use and irrigation (about 3,500 acres above Boulder [Shields *et al.* 1996]). Hot springs and wells have been developed at Boulder and at Boulder Hot Springs. A large mining venture on Bull Mountain in the lower part of the drainage utilizes agitated vat-leaching and settling ponds.

2.4 Summary of Jefferson River Drainage

There are 171 mine and mill sites on or near the Deerlodge National Forest within the Jefferson River basin. Of these, 19 were found to have the potential to have an adverse effect on soil or water quality on DNF-administered land. Of the 19 that have the potential to affect DNF-administered land, 17 sites have one or more discharges from workings or waste material and seven exhibited signs of water or wind erosion. The sites listed in **bold** may pose environmental problems and are discussed in the following sections.

If mine openings or other dangerous features (unstable structures, highwalls, steep waste-rock dumps) were observed at a site, it is identified (Y) under the hazard heading in each table. In general, only those sites at which samples were collected were evaluated. Of the 171 sites inventoried, 36 were identified as having a potential safety problem. A listing of all of the sites inventoried, arranged by mining district and tributary, are presented in tables 8–13.

Table 8. Summary of sites in the Jefferson River drainage - main stem (Highlands district).

Name[1]	Visit	Owner[2]	Sample[3]	Hazard[4]	Remarks
Ballarat	Y	NF	N	NE	Reclaimed
Brooks Prospect	Y	NF	N	NE	Dry, caved adit
Curly Gulch Adits	Y	NF	N	NE	Dry, caved adits
Denny	Y	NF	N	NE	Dry, caved adit
Eager	Y	NF	N	NE	Dry, caved shaft
Elkhorn-Buckhorn	Y	NF	N	NE	Prospect pits
Gold Hill	Y	MIX	Y	NE	Streamside tailings
Highland P	N	NF	N	NE	dry, ridge top, Phosphate prospect
Highland Mill	Y	NF	Y	N	Streamside tailings
Highland View	N	NF	N	NE	Dry prospect
Iron Cliff	Y	NF	N	NE	Dry, caved adits
Limekiln Hill	Y	MIX	N	NE	Dry, ridge top prospects
Queen N	N	NF	N	NE	Dry, ridge top
King&McPhail	Y	NF	N	NE	Operating permit?
Murphy	Y	PRV	N	NE	Part of Highlands mine
Only Chance	Y	PRV	N	NE	Part of Highlands mine
Overlook	Y	NF	N	Y	Dry, open adit
Overlook Mill[5]	Y	NF	N	NE	No tailings found
Ozark	Y	NF	N	NE	Dry, caved shafts
Ready Cash	Y	NF	N	Y	Dry, open 30' shaft
Red Wing	Y	NF	N	NE	Dry, caved adit
Silver Glance	Y	PRV	Y	NE	Flowing drill hole
Templeman	Y	NF	N	Y	Dry, open adit
Tilton	Y	PRV	N	NE	Part of Highlands mine
Tucker Creek	N	NF	N	NE	Phosphate prospect
Van Dorston	Y	N	N	Y	Dry, open 20' shaft

1) Mines in **bold** may pose environmental problems and are discussed in the text; others are included only in appendix II (all mines) and appendix III (sites visited).
2) Administration/Ownership Designation
   NF: DNF-administered land
   PRV: Private
   MIX: Mixed (DNF-administered land and private)
   UNK: Owner unknown
3) Solid and/or water samples (including leach samples)
4) Y: Physical and/or chemical safety hazards exist at the site.
   NE: Physical and chemical safety hazards were not evaluated.
5) Mill site present

Table 9. Summary of sites in the Upper Jefferson River drainage (Tidal Wave district).

Name[1]	Visit	Owner[2]	Sample[3]	Hazard[4]	Remarks
Bear Gulch	Y	MIX	N	NE	4 caved adits
B&H	Y	PRV	Y	NE	Active; adit discharge
B & H Tailings	Y	NF	Y	N	Streamside tailings
Boulder Cobalt	Y	NF	N	NE	Dry, open, locked adits
Boulder Cobalt Prospect	Y	NF	N	N	Dry, caved adit
Boulder Cobalt Shaft	Y	NF	Y	Y	Discharging shaft
Boulder Cobalt West	Y	NF	N	Y	Dry, open adit
Coal Creek	Y	NF	N	Y	Dry, open stope
Dry Boulder Iron	Y	NF	N	NE	Mineral local only
Giant	Y	PRV	N	NE	Dry, caved adits; open stope
Hamilton	N	PRV	N	NE	Ridge top; < 100' workings
Lower Coal Cr.	Y	NF	N	Y	Dry, open adit
Mill Creek	N	NF	N	NE	Ridge top
Moffet-Johnston	N	PRV	N	NE	Dry, observed from distance
Grouse	Y	NF	N	Y	Dry, open adit
Ohio Lode	Y	MIX	Y	NE	Active springs
Pete and Joe	N	PRV	N	NE	Part of B & H mine; discharge
Strawn	N	N	N	NE	Screened by NF
Strawn Mill	N	PRV	N	NE	No effect on NF

1) Mines in **bold** may pose environmental problems and are discussed in the text; others are included only in appendix II (all mines) and appendix III (sites visited).
2) Administration/Ownership Designation
   NF: DNF-administered land
   PRV: Private
   MIX: Mixed (DNF-administered land and private)
   UNK: Owner unknown
3) Solid and/or water samples (including leach samples)
4) Y: Physical and/or chemical safety hazards exist at the site.
   NE: Physical and chemical safety hazards were not evaluated.

Table 10. Summary of sites in the Upper Boulder River drainage (Boulder Mountains district).

Name[1]	Visit	Owner[2]	Sample[3]	Hazard[4]	Remarks
16:1 (High Grade)	N	NF	N	NE	No effect on DNF-administered land
A & B	Y	PRV	N	NE	Dry, caved shaft
Alport	Y	PRV	N	NE	Dry, caved shaft
Ajax	Y	PRV	N	NE	Dry, caved workings
Attowa	Y	PRV	N	NE	Dry, caved workings
Beefstraight	Y	MIX	N	N	Dry, caved workings
Beefstraight North	Y	NF	N	Y	Dry, open shaft
Big Foot	N	PRV	N	NE	Ridge top location
Big Four	Y	PRV	Y	NE	No impact on DNF-administered land
Big Major	Y	PRV	N	NE	Dry, caved shaft
Blackwell	Y	NF	N	NE	Prospect only
Blue Rock	Y	NF	N	NE	Dry, caved adit
Bluebell (Marsh)	Y	PRV	N	NE	Dry, caved adit
Carlson and Berkin Flat	N	MIX	N	NE	Screened by NF
Cascade	N	PRV	N	NE	Observed from distance, dry
Clark	N	NF	N	NE	Mineral occurrence only
Connie Joe (Spire Rock)	Y	NF	N	Y	Dry, open adit
Dead End	Y	NF	N	NE	Prospect pits
Easter Lily (Ogle)	N	NF	N	NE	No effect on DNF-administered land
Eureka	N	NF	N	NE	Ridge top location
Evening Star	N	NF	N	NE	Dry, ridge top
Franklin or Carlson Quartz	Y	NF	N	NE	Dry, caved adits
Galena Gulch	Y	NF	Y	NE	Adit discharge
Galena Gulch West	Y	PRV	N	Y	Dry, open adit
Gold Bug	Y	PRV	N	NE	Prospect pits only
Golden Girl #4	Y	NF	N	NE	Dry, caved workings
Gopher	Y	PRV	N	NE	Dry pits
Grubstake	Y	NF	Y	NE	Streamside dump
Harriet	Y	MIX	Y	NE	No effect on DNF-administered land
Infinite (Blackbird)	Y	NF	N	Y	Dry, open adit
Iron Mountain	N	PRV	N	NE	Dry, ridge top location
Jib-Katie Mill	N	MIX	N	N	Dry, streamside tailings

Table 10 continued.

Jim Jr	Y	PRV	N	NE	Dry, caved workings
Jupiter	N	NF	N	NE	No visible impacts
King	Y	NF	N	Y	Dry, open adit
Leadville	Y	NF	Y	Y	Adit discharge; flooded shaft
Legged Hill Prospects	Y	NF	N	NE	Dry, caved workings
Mascot / M. Extension	Y	NF	N	NE	Dry, caved adit
May Day	Y	NF	Y	NE	Seasonal erosion
Montana	Y	PRV	N	NE	Dry, caved adit
Montreal Star	Y	NF	Y	NE	Adit discharge
Moscow	N	NF	N	NE	No visible impacts on DNF-administered land
Mountain Chief	N	PRV	N	NE	Dry ridge top location
Mountain Queen	Y	NF	N	Y	Dry, open workings
Mystery - Little Darling	Y	PRV	N	NE	Streamside dump; no impact on DNF-administered land
Nannies Brown	N	PRV	N	NE	Dry, ridge top location
Nellie-Mascot	Y	MIX	Y	Y	Open adit on private, no impact on DNF-administered land
Niki (Lonnie Stevens)	N	PRV	N	NE	No impact on DNF-administered land
North Boulder Lead	Y	PRV	Y	Y	Shaft discharge
Ogle	N	NF	N	NE	Mineral occurrence only
Pay Rock	N	PRV	N	NE	Dry, ridge top location
Queen of the Hills	Y	NF	Y	Y	Open adit with discharge
Rock Creek Claim	Y	NF	N	NE	Dry, caved adits
Saratoga	Y	PRV	N	NE	Dry, caved shaft
Section 36 Shaft (Aluise?)	Y	NF	N	Y	Dry, open shaft
Shamrock	Y	PRV	N	NE	Dry, caved shaft
Silver Queen	Y	NF	N	NE	Dry, caved shaft
Silversmith/S Silversmith	Y	MIX	N	NE	Dry, reclaimed
Smokey Quartz Prospect	Y	PRV	N	NE	No visible impacts on DNF-administered land
South Fork State Creek	Y	NF	N	NE	Dry, caved shaft
Springtime (Nickelodeon)	Y	NF	N	Y	Dry, open adit

Table 10 continued.

St Anthony (Silver Bell)	Y	PRV	N	Y	Dry, open workings
State	Y	PRV	N	NE	Dry, covered workings
Suicide Cabin	Y	NF	N	Y	Dry, partially open adit
Suicide Cabin South	Y	NF	N	Y	Dry, open adit
Thompson Park	N	NF	N	NE	Mineral occurrence only
Thunderbolt Mtn Prospect	N	NF	N	NE	Small prospect only
Toll Mountain	N	NF	N	NE	Mineral occurrence only
Twohy	Y	PRV	Y	NE	Adit discharge, not onto DNF-administered land
Unknown Lowland #1	Y	NF	N	NE	Dry, caved workings
War Eagle and Leroy	Y	PRV	Y	NE	Streamside dumps
Water Gulch	Y	NF	N	NE	Dry prospect
Welch Quarry	N	NF	N	NE	Dry, no visible impacts
Whitetail Park Vein	Y	MIX	N	NE	Dry prospect pits

1) Mines in **bold** may pose environmental problems and are discussed in the text; others are included only in appendix II (all mines) and appendix III (sites visited).
2) Administration/Ownership Designation
   NF: DNF-administered land
   PRV: Private
   MIX: Mixed (DNF-administered land and private)
   UNK: Owner unknown
3) Solid and/or water samples (including leach samples)
4) Y: Physical and/or chemical safety hazards exist at the site.
   NE: Physical and chemical safety hazards were not evaluated.

Table 11. Summary of sites in the Upper Boulder River drainage (Lowland district).

Name[1]	**Visit**	**Owner**[2]	**Sample**[3]	**Hazard**[4]	**Remarks**
Carla, Pauline, & Faith	Y	PRV	N	NE	Dry, caved adit
Columbia	Y	PRV	N	NE	Dry, caved adits
April	Y	NF	N	NE	Dry, short, caved adit
Kit Carson	Y	MIX	N	NE	Dry workings
Memphis	Y	NF	Y	NE	Adit discharge
Ruby	Y	PRV	N	NE	Dry workings
Ruby Mill	Y	PRV	N	NE	Dry, no visible impacts

1) Mines in **bold** may pose environmental problems and are discussed in the text; others are included only in appendix II (all mines) and appendix III (sites visited).
2) Administration/Ownership Designation
   NF: DNF-administered land
   PRV: Private
   MIX: Mixed (DNF-administered land and private)
   UNK: Owner unknown
3) Solid and/or water samples (including leach samples)
4) Y: Physical and/or chemical safety hazards exist at the site.
   NE: Physical and chemical safety hazards were not evaluated.

Table 12. Summary of sites in the Lower Boulder River drainage (Elkhorn district).

Name[1]	Visit	Owner[2]	Sample[3]	Hazard[4]	Remarks
Arcturus	Y	MIX	N	NE	Dry, reclaimed pit and trenches
Blackbird	N	NF	N	NE	Dry, observed from distance
Boulaway	Y	NF	N	NE	Dry, caved adit
C & D	Y	PRV	N	NE	Dry, caved workings
Eclipse	N	NF	N	NE	Dry, observed from distance
Elkhorn Iron	Y	MIX	Y	Y	Two adit discharges
Elkhorn Queen	N	PRV	N	Y	Screened by NF; open shaft
Golden Moss	Y	PRV	N	NE	Dry, reclaimed workings
Heagan	N	MIX	N	NE	Screened by NF
High Up	Y	NF	N	NE	Dry, caved workings
James R Keen	Y	PRV	N	NE	Dry workings
Klondyke	Y	PRV	N	NE	Dry workings
Leslie Lake	Y	NF	N	NE	Skyline claim block
Louise	N	PRV	N	NE	Dry, ridge top
Luxenburg	N	NF	N	NE	Screened by NF; dry, ridge top
North Louise	N	NF	N	NE	Dry, ridge top
Queen Ann	Y	NF	N	Y	Dry, open adits
Relief	N	NF	N	NE	Mineral local only
Skyline	Y	NF	Y	Y	Discharging adit
Sport	Y	PRV	N	NE	Discharge, possibly natural
Steve	Y	NF	N	N	No workings found
Tacoma	N	NF	N	Y	Screened by NF; open adits
Union	Y	PRV	N	NE	Dry, locked adit

1) Mines in **bold** may pose environmental problems and are discussed in the text; others are included only in appendix II (all mines) and appendix III (sites visited).
2) Administration/Ownership Designation
NF: DNF-administered land
PRV: Private
MIX: Mixed (DNF and private)
UNK: Owner unknown
3) Solid and/or water samples (including leach samples)
4) Y: Physical and/or chemical safety hazards exist at the site.
NE: Physical and chemical safety hazards were not evaluated.

Table 13. Summary of sites in the South Boulder Creek drainage (South Boulder district).

Name[1]	Visit	Owner[2]	Sample[3]	Hazard[4]	Remarks
A & P Mine	Y	MIX	Y	Y	Adit discharge, mass wasting
A & P Tailings[5]	Y	NF	Y	Y	Mass wasting, erosion
Bismark	Y	PRV	N	NE	Adit discharge, locked
Bismark Tailings[5]	Y	MIX	Y	N	Springs in tailings
Baseman Tailings[5]	Y	NF	Y	NE	Streamside tailings
Castle Rock	Y	NF	N	NE	Covered by talus
Curly Bill	N	NF	N	NE	Adits <50' long; ridge top
Curly Bill #3	Y	NF	N	NE	Dry, caved workings
Craig	Y	NF	N	Y	Dry, open adit
Crystal Butte	Y	NF	N	N	Covered by talus
Highland Mary	N	NF	N	NE	Dry, ridge top
Inha	Y	NF	N	N	Prospect pits
Midnight	Y	NF	N	N	Two dry, caved adits
Mogullion	Y	NF	Y	Y	Adit discharge, caved
Nicholson	Y	NF	N	N	Active Operating permit
Old Cabin	Y	NF	N	Y	Two dry, open adits
Quartz City	Y	PRV	N	NE	Dry, caved workings
Snyder′s	Y	NF	Y	Y	Two open, discharging adits
Sultana	Y	NF	N	NE	Short, dry workings
Viking–W. Pacific	Y	NF	Y	NE	Two adit discharges, caved
L. White Chief	Y	PRV	N	Y	Open, inclined adit
U. White Chief	Y	PRV	N	NE	Dry, caved workings

1) Mines in **bold** may pose environmental problems and are discussed in the text; others are included only in appendix II (all mines) and appendix III (sites visited).
2) Administration/Ownership Designation
   NF: DNF-administered land
   PRV: Private
   MIX: Mixed (DNF and private)
   UNK: Owner unknown
3) Solid and/or water samples (including leach samples)
4) Y: Physical and/or chemical safety hazards exist at the site.
   NE: Physical and chemical safety hazards were not evaluated.
5) Mill site present

2.4.1 Summary of Environmental Observations

With few exceptions, the mines in the Jefferson River basin are scattered with no more than one or two mines in a subdrainage. Adverse impacts to water and soils at most sites is generally limited to the disturbed area, but in some cases, such as the Elkhorn Skyline mine, the disturbed area can be several acres.

By far, the single most "bad actor" is the Atlantic and Pacific mine and tailings on Park Creek, which is a tributary to the South Boulder River. Acid, mine-adit discharges, waste material in contact with surface water, water-borne and wind-borne tailings, and potential for mass wasting are exhibited at this site. The impact to water quality is evident well downstream of the main development area.

2.5 Highland Mill Tailings

2.5.1 Site Location and Access

The Highland mill tailings (T1N R8W 36 DC) are at the head of the Middle Fork of Moose Creek, about 13 miles south of Butte. Moose Creek is a tributary to the Big Hole River. The disturbed area is on DNF-administered land. The site can be accessed via an improved dirt road (Roosevelt Drive) that leads south from Montana State Highway 10.

2.5.2 Site History - Geologic Features

The Highland mill, a cyanidation facility, was originally built below the 600-foot adit at the Highland mine (Volume IV - Clark Fork Drainage) in the early 1930s, but it was moved to avoid polluting Basin Creek, an important water supply for the City of Butte. The mill was rebuilt above Moosetown in 1937, and operated until the Highland mine closed in 1942.

Approximately 59,000 tons of tailings are present in four impoundments along the drainage below the remnants of the mill. The tailings in all four impoundments contain low metal values, except for gold, which averages 0.032 oz/ton. The ore that was processed by the mill was mostly oxidized; tailings consisted of quartz, iron-stained clays, and mica.

2.5.3 Environmental Condition

The tailings cover approximately seven acres of gently sloping valley bottom and marshland. There are four impoundments evident: the upper three are in one drainage and lowest is below the confluence of three drainages. Seeps and springs emerged from all of the tailings piles, and in some locations, especially around the uppermost impoundments, substantial erosion has occurred.

The lowest of the upper three impoundments was constructed of wooden planks and numerous empty 35-gallon drums. Several of the drums were labeled as follows:

NET 200
AERO BRAND CYANIDE
AMERICAN CYANAMID COMPANY
MADE IN CANADA

2.5.3.1 Site Features - Sample Locations

Soil and water-quality samples were collected at the site on August 25, 1993. Water sample MHTS20H was collected from the Middle Fork of Moose Creek, upstream of the confluence with the tailings-impacted subdrainage. The flow rate of the creek was 3.4 gpm. Sample MHTS60L was collected from a small spring that flows into the lower portion of the site; the flow rate of the spring was 1.3 gpm. Sample MHTS90H was collected from a spring above the uppermost impoundment; the flow rate of the spring was 0.38 gpm. Sample MHTS80H was collected near a wooden drain structure that apparently carries water under the uppermost impoundment. Sample MHTG10H was collected where the water discharges from the drain, immediately below the uppermost impoundment. The flow rate at this location was 5.7 gpm. Sample MHTS70H was collected at a breach in the lower impoundment; the flow rate through the breach was 6.6 gpm. Samples MHTS30H, MHTS40H, and MHTS50H were collected from the small stream channels that converged at the lower end of the lowermost tailings impoundment. The flow rates of the streams were 15, 13, and 75 gpm, respectively. Sample MHTS10H was collected from Middle Fork of Moose Creek, downstream of all the impoundments; the flow rate of the creek was 120 gpm.

Soil samples MHTD10H, MHTD20H, MHTD30H, and MHTD40H were collected from tailings deposits within each of the four impoundments. Tailings were in contact with flowing water along the entire reach and are susceptible to erosion. Sample sites are shown in figure 5.

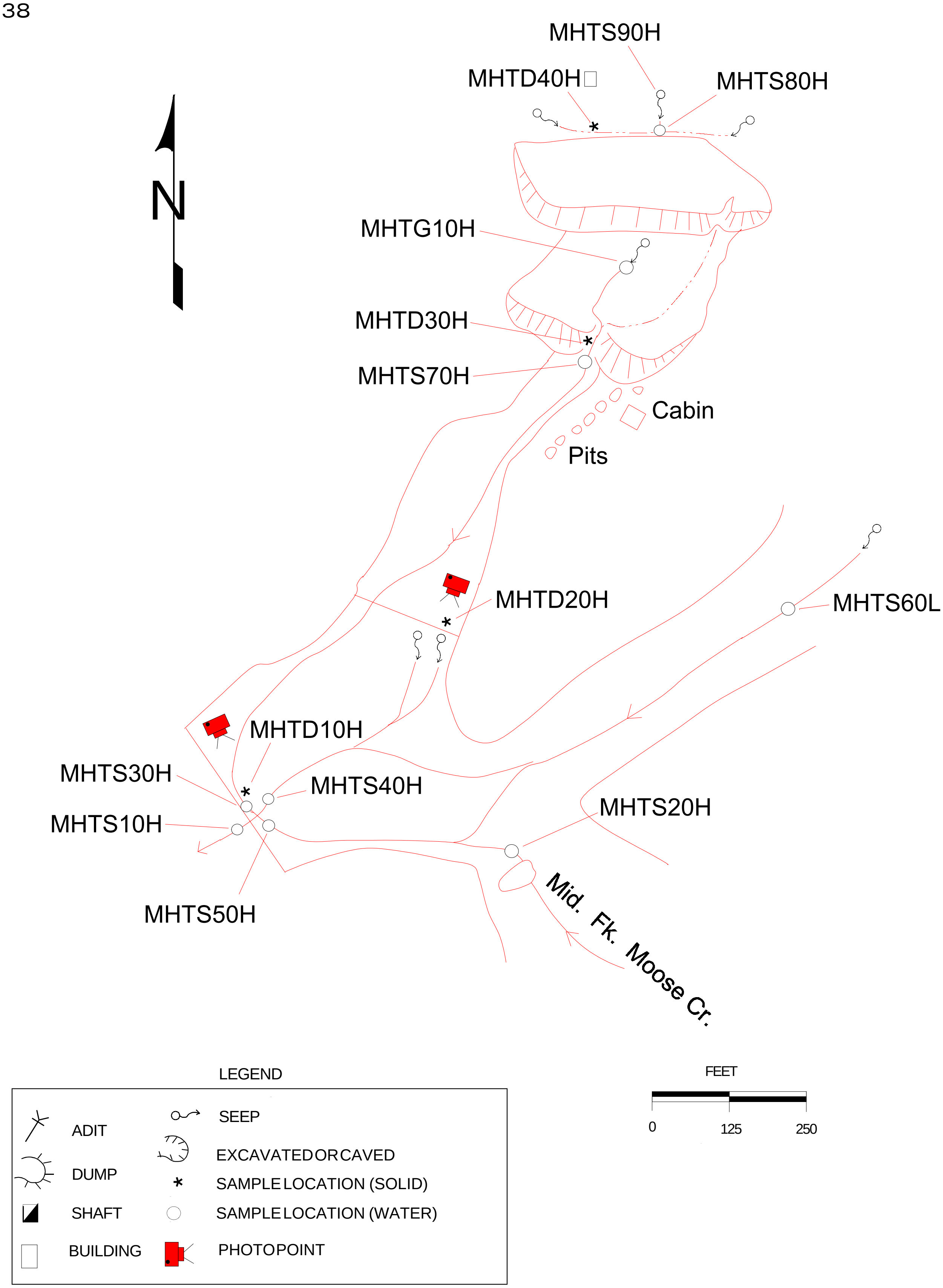

Figure 5. The Highland mill tailings (8/25/93)consisted of at least four impoundments affecting three tributaries of the Middle Fork of Moose Creek

Figure 5A. Sample MHTD10H was collected from the tailings in the lowermost impoundment.

Figure 5B. Cyanide drums were used to construct part of the tailings impoundment.

2.5.3.2 Soil

Across the entire site, the concentrations of arsenic and copper in the soil exceed phytotoxic levels. The concentration of zinc in the soils of the lower impoundment is above phytotoxic levels.

Table 14. Soil sampling results, Highland mill tailings (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Tailings along seep path in impoundment (MHTD40H)	553[1,2]	1.02[1]	1141[1,2]	123[1]	153[1]
Tailings in breach through impoundment (MHTD30H)	218[1,2]	0.83[1]	500[1,2]	11.1	108[1]
Soil and tailings in impoundment (MHTD20H)	340[1,2]	1.86[1]	797[1,2]	89.6[1]	944[1,2]
Tailings in impoundment (MHTD10H)	496[1,2]	1.09[1]	1264[1,2]	64.3[1]	191[1]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.5.3.3 Water

Although concentrations of manganese were slightly above the secondary MCL (0.05 mg/L) at several locations around the site, tailings do not appear to be the source. Instead, natural background levels in the soil and bedrock of the area are probably high. Mercury, which occurred at a concentration of 0.14 µg/L at sample location MHTS30H, was the only other metal that exceeded water-quality standards.

Table 15. Water-quality exceedences, Highland mill tailings.

Sample Site	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**	**Cl**	**F**	**NO_3**	**SO_4**	**Si**	**pH**
M. F. Moose Cr. upstream(MHTS20H)									S										
Tributary east of impoundments (MHTS60L)																			
Spring above tailings (MHTS90H)																			
Drain above tails (MHTS80H)																			
Below upper impoundment (MHTG10H)									S										
Below upper three impoundments (MHTS70H)									S										
Below upper impoundments (MHTS30H)										C									
Below upper impoundments (MHTS40H)																			
M. F. Moose Cr. confluence with site discharges (MHTS50H)									S										
M. F. Moose Cr. downstream (MHTS10H)																			

Exceedence codes:

P - Primary MCL
S - Secondary MCL
A - Aquatic Life Acute
C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.5.3.4 Vegetation

Barren patches of ground occur across the entire site, especially in the uppermost two impoundment areas. Where vegetation had taken hold, it generally consisted of grasses and low brush, such as willows.

2.5.3.5 Summary of Environmental Condition

Tailings with high concentrations of arsenic, copper, and other metals are spread over seven acres of DNF-administered land. Vegetation in the area was visibly impacted by the tailings. Also, at several locations, erosion was an obvious problem. Water quality at the site was generally good, but tailings washed downstream probably add significantly to the metal load in the Moose Creek drainage. Cyanide is a potential contaminant at the site; however, no samples were analyzed to check for its presence in the soil and surface water. Cyanide is unstable and generally not persistent in natural environments.

2.5.4 Structures

A few remnants of a mill were observed a short distance up the drainage from the tailings. The only other structure observed was a collapsed cabin southeast of the breached tailings impoundment.

2.5.5 Safety

Several small pits located near the collapsed cabin were the only safety hazard observed on the site.

2.6 Silver Glance Mine

2.6.1 Site Location and Access

The Silver Glance mine (T1S R8W 12ACAD) is located on the north side of Gold Hill in the Highland Mountains south of Butte. The site is drained by a small stream that flows into Moose Creek, a tributary to the Big Hole River. Most of the site is on patented land, but a collapsed adit and two small prospect pits are on DNF-administered land. The site is easily accessible by following a secondary dirt road that turns west off the Camp Creek Road.

2.6.2 Site History - Geologic Features

Shallow shafts, pits, and short caved adits explore an area of highly altered aplite and pegmatite that is the northern extension of the Gold Hill deposit (Sahinen 1950). Sericite is the main alteration product. The rock contains veins of brecciated quartz cemented with black quartz and pyrite. The area was drilled as part of an exploration project at Gold Hill during the late 1980s. Figure 6 is a sketch map of the site.

2.6.3 Environmental Condition

The adit at the southeast end of the site had a small, clear discharge that flowed into the unnamed stream. A second adit at the west end of the site also had a small discharge. One of the drill holes at the site was not properly grouted and was discharging water with a strong hydrogen sulfide odor that ran down the hillside toward the unnamed stream. The flow rate from the drill hole was several gallons per minute.

2.6.3.1 Site Features - Sample Locations

Water-quality samples were collected at the site on August 23, 1993. Samples MSGS40L and MSGS50L were collected from two branches of the unnamed stream above the site. The flow rates at these locations were 12 gpm and 3.5 gpm, respectively. Sample MSGS10L was collected from the unnamed stream immediately downstream of the patented claim. The flow rate at this location was 40 gpm. Sample MSGS30L was collected from the discharge on the hillside below the west adit. The discharge had a flow rate of 0.24 gpm. Sample MSGS20L was collected from the unnamed stream below the site. At this point, the stream was flowing at 80 gpm.

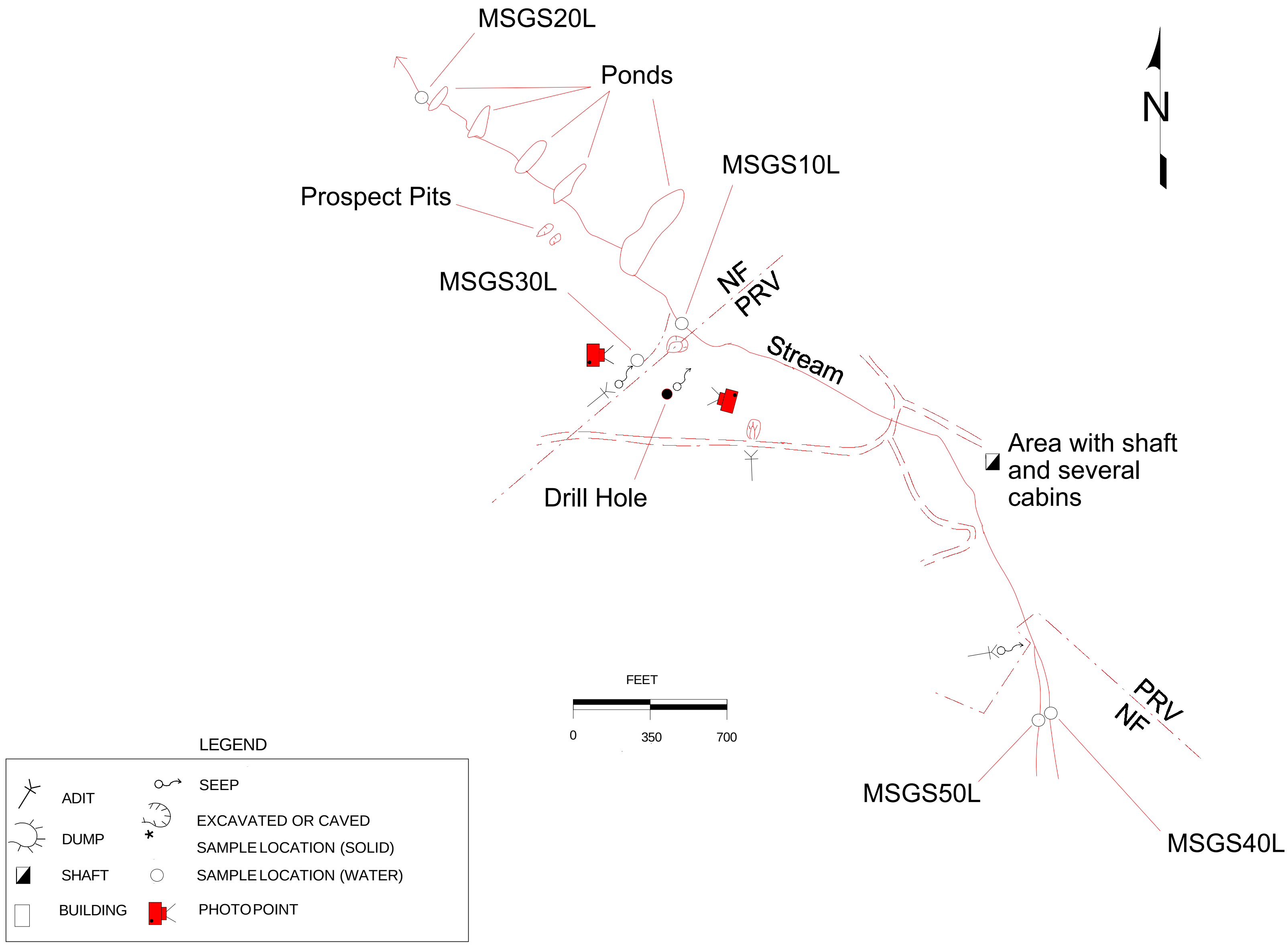

Figure 6. The Silver Glance development area (8/23/93) had several discharges on the site, including a drill hole that discharged water to the unnamed creek.

Figure 6A. Water flows from an exploration drill hole at the site.

Figure 6B. A discharge is located on DNF-administered land a short distance downhill of the west adit.

2.6.3.2 Soil

Erosion of waste materials did not appear to be a problem at the site; therefore, no soil samples were collected.

2.6.3.3 Water

The two samples collected upstream of the site had field pH values of about 6.27, slightly outside the acceptable secondary MCL range of 6.5 to 8.5. The samples collected downstream of the site exceeded the secondary MCLs for iron and manganese.

Table 16. Water-quality exceedences, Silver Glance mine.

Sample Site	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**	**Cl**	**F**	**NO_3**	**SO_4**	**Si**	**pH**
East branch of unnamed creek upstream(MSGS40L)																			S
West branch of unnamed creek upstream(MSGS50L)																			S
Unnamed creek downstream (MSGS10L)							S		S										
West adit discharge (MSGS30L)																			
Unnamed creek downstream (MSGS20L)							S		S										

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.6.3.4 Vegetation

Most of the site was densely vegetated with healthy grasses, brush, and coniferous trees. Several small waste-rock dumps were moderately vegetated.

2.6.3.5 Summary of Environmental Condition

No erosion or sediment-loading problems were evident at the site. However, water discharging from the workings may be responsible for elevated concentrations of iron and manganese downstream.

2.6.4 Structures

Several cabins in poor condition on private land were observed. No structures were observed on DNF-administered land.

2.6.5 Safety

Safety concerns at the site include a partially collapsed adit (south adit) and a shaft that has been backfilled with wood and timbers. However, both features are on private land.

2.7 Gold Hill Mine and Mill

2.7.1 Site Location and Access

The Gold Hill mine and mill (T1S R8W Section 12CAA) are located on a patented claim in the Highland Mountains. The site is drained by a small unnamed tributary to Moose Creek and is easily accessible by following a secondary dirt road that turns west off the Camp Creek Road.

2.7.2 Site History - Geologic Features

Workings at the site include approximately 10 shafts and adits. Most of the openings have either been fenced or sealed.

The Gold Hill property contains diorite of the Boulder Batholith under a roof pendant of Helena Formation cut by aplite (Sahinen 1950). All rocks have been altered and sheared and are cut by veinlets of iron-stained quartz. Mineralization is roughly aligned in a N50W 15–45SW orientation. Sahinen's sample of highly altered aplite was of low grade (0.03 oz/ton gold, 0.10 oz/ton silver), but the area has been of interest to explorers seeking low-grade, bulk-tonnage deposits.

In 1909, a cyanide mill was built on the property and treated ore from the surrounding mines as well (Sahinen 1950). It operated from at least 1910 until 1912. Tailings were settled just downstream along a tributary of Moose Creek.

2.7.3 Environmental Condition

Environmental problems at the site include streamside tailings and discharges from a flooded shaft and an adit. The streamside tailings occur as thin, ill-defined pockets that are generally well vegetated. Some tailings were found on DNF-administered land. The flooded workings at the site are on private land adjacent to the unnamed stream. The discharge from the adit appeared to have been developed into a spring for watering livestock.

2.7.3.1 Site Features - Sample Locations

Soil and water-quality samples were collected on August 20, 1993. Soil sample MGHD10L was collected from a streamside tailings deposit several hundred feet downstream of the mill site. Water sample MGHS10L was collected from the unnamed creek downstream of the property boundary between the DNF and private land. A second water sample (MGHS20L) was collected downstream of the tailings deposit from which the soil sample was collected. The flow rate at the two stream sampling locations was about 11 gpm. Site features and sample locations are shown in figure 7.

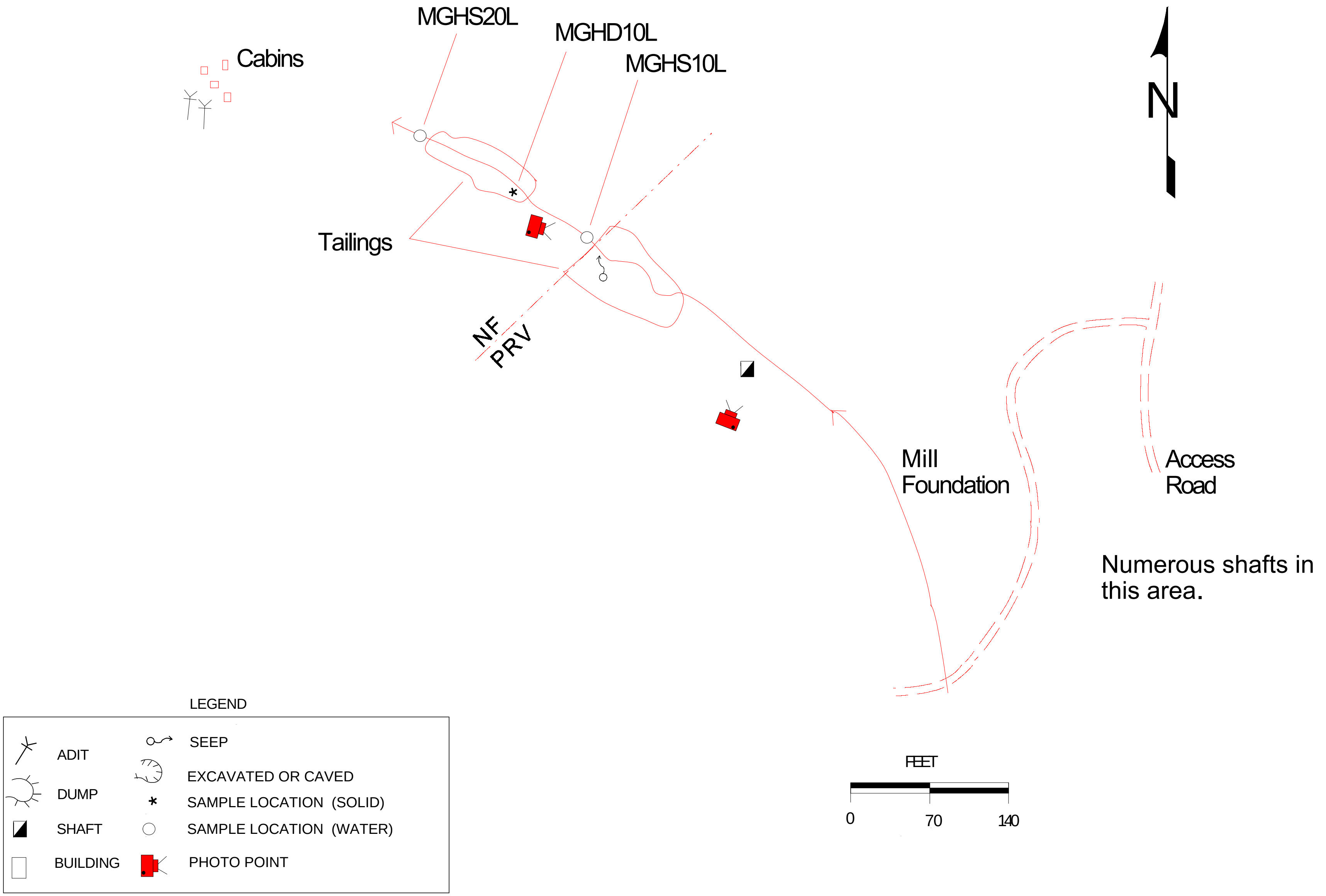

Figure 7. The Gold Hill development area (8/20/93) has a mine and mill on private land. The tailings, however, have been deposited on DNF-administered land

Figure 7A. The flooded shaft is adjacent to the unnamed stream.

Figure 7B. Sample MGHSD10L was collected from the unnamed stream near the DNF-administered land/private boundary.

2.7.3.2 Soil

The soil collected from the tailings on DNF-administered land contained concentrations of arsenic and copper above phytotoxic levels.

Table 17. Soil sampling results, Gold Hill mine and mill (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Streamside tailings (MGHD10L)	1243[1,2]	1.12[1]	193[1,2]	57.3[1]	58.5[1]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.7.3.3 Water

The water samples from the unnamed stream contained elevated levels of aluminum. No other exceedences were observed.

Table 18. Water-quality exceedences, Gold Hill mine and mill.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Unnamed stream near boundary (MGHS10L)	S,C																		
Unnamed stream below tailings (MGHS20L)	S,C																		

Exceedence codes:

- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.7.3.4 Vegetation

The tailings at the site were moderately to densely vegetated with grasses and evergreens despite the high concentration of metals. Vegetation elsewhere around the site appeared healthy.

2.7.3.5 Summary of Environmental Condition

The streamside tailings at the site contain high concentrations of several metals, including arsenic and copper. During runoff events, eroded tailings may contribute significantly to the metal load in the stream. However, under base-flow conditions, aluminum appears to be the only metal that causes water-quality problems. From this preliminary assessment, it was not possible to determine if the aluminum exceedences are natural or mining related.

2.7.4 Structures

Four cabins in poor-to-bad condition were observed on DNF-administered land east of the site.

2.7.5 Safety

Several open shafts and collapse features were observed around the site. Some of the more obvious openings have been fenced and posted with warning signs. No hazards were noted on DNF-administered land.

2.8 Boulder Cobalt Shaft

2.8.1 Site Location and Access

The Boulder Cobalt shaft is on DNF-administered land near the shore of upper Boulder Lake at the head of Dry Boulder Creek on the west flank of the Tobacco Root Mountains (T3S R4W Section 5DBDC). Access to the site is by 4-wheel drive up Dry Boulder Creek about 10 miles from Highway 287.

2.8.2 Site History - Geologic History

The Boulder Cobalt shaft is included in the Boulder Cobalt mine of Cather and Linne (1983), but it is ½ mile from the main workings so it was treated separately in this investigation. The waste-rock dump comprises a few hundred tons of large pieces of amphibolite; some show siderite alteration. Cather and Linne (1983) felt the shaft was less than 100 feet deep, but it may have some short drifts connected with it.

2.8.3 Environmental Condition

This site comprises a single shaft with a head frame and associated waste-rock material (figure 8). The waste rock was spread out in such a way that the height of the dump was never more than a few feet. The dump was contained a 50/50 mixture of altered and unaltered amphibolite with a trace of sulfides.

2.8.3.1 Site Features - Sample Locations

The shaft was flooded to within a few feet of the surface and was only partially covered. A ground-water sample (JBCG10M) was collected from about five feet below the water surface in the shaft. A small spring broke out near the base of the waste-rock dump; the elevation of the spring was about the same as that of the water in the shaft. A sample was collected of the spring (JBCS10M), which was discharging about three gpm. There was little soil in the area in general; there were no visible impacts to the soil that had developed on the dump nor near the base of the dumps so no soil samples were necessary. The site was sampled on 10/21/92.

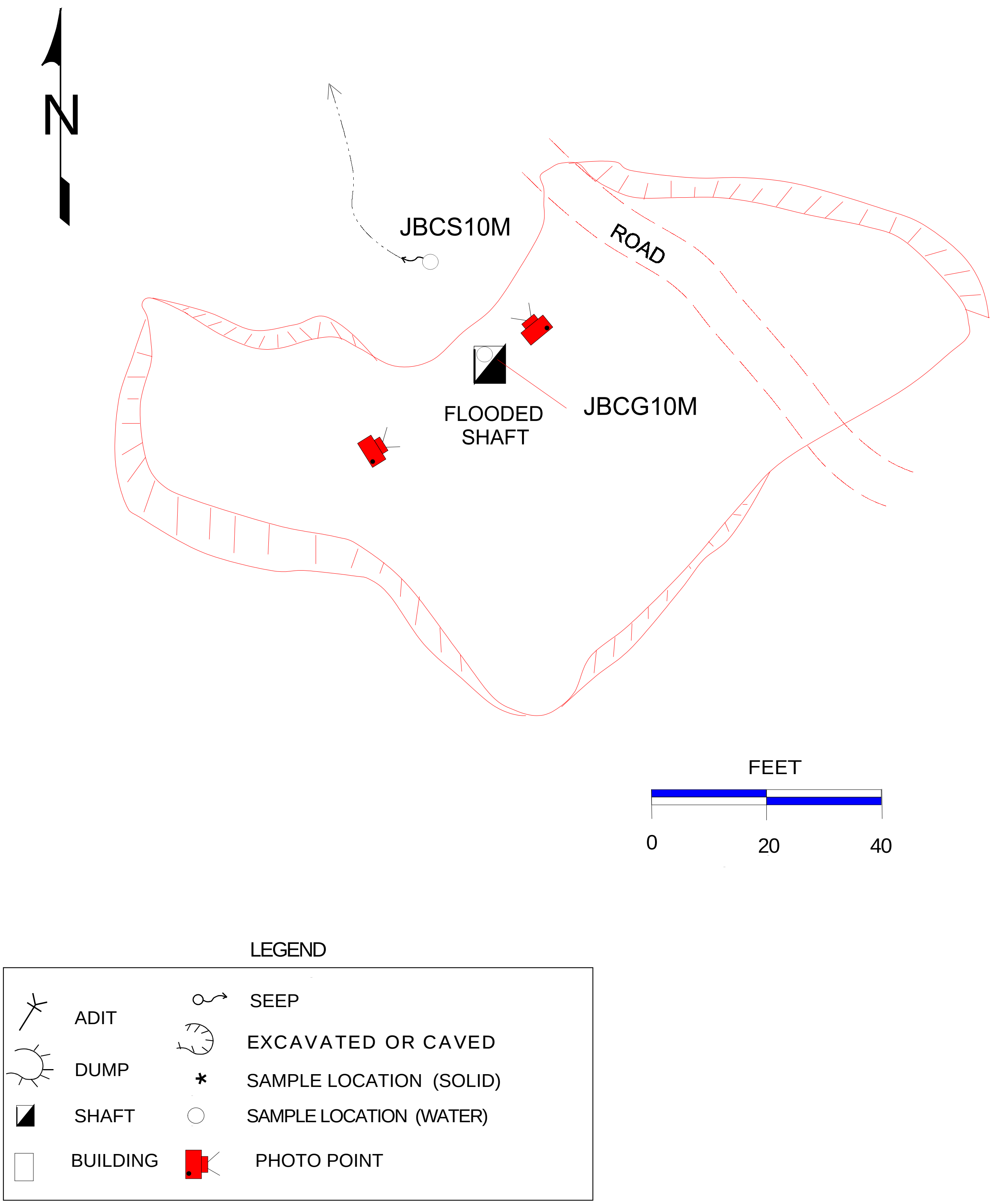

Figure 8. The Boulder Colbalt mine (10/21/92) consists of a single shaft with head frame and a waste-rock dump that had been reworked.

Figure 8A. The Boulder Cobalt mine dump has been reworked. The head frame remains over a flooded shaft.

Figure 8B. A small spring flows northward from the base of the waste-rock dump. This spring originates at about the same elevation as the water in the shaft.

2.8.3.2 Soil

No impacts to soils on or near the dump were visually apparent. The waste-rock dump generally comprised gravel size or large material. Very little material was being washed onto native soils.

2.8.3.3 Water

The water sampled from the flooded shaft exceeded the secondary MCL for manganese. The spring at the base of the waste-rock dump exceeded the aquatic life (chronic) MCL for lead. Overall, the spring contained higher concentrations of dissolved metals but only slightly so.

Table 19. Water-quality exceedences, Boulder Cobalt mine.

Sample Site	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**	**Cl**	**F**	**NO_3**	**SO_4**	**Si**	**pH**
Shaft water (JBCG10M)									S										
Spring below dump (JBCS10M)								C											

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.8.3.4 Vegetation

The vegetation in the area was generally sparse to moderate because of the high-altitude alpine climate. The vegetation on and at the base of the dump did not differ significantly from that of the surrounding area.

2.8.3.5 Summary of Environmental Condition

The Boulder Cobalt mine has a small disturbance area and did not appear to have a significant impact on soils or water quality in the immediate area.

2.8.4 Structures

The head frame for the shaft was the only structure observed on the site. The frame appeared to be solid and not in imminent danger of collapse.

2.8.5 Safety

Although not completely open, the shaft cover was in need of repair. A light snow cover would make for dangerous conditions.

2.9 B & H Mill Tailings

2.9.1 Site Location and Access

The B & H mill (T3S R4W Section 6CCCC) is in Bear Gulch on the west flank of the Tobacco Root Mountains about one-half mile below the B & H mine, which is on private land . The tailings are about 4.5 miles up the Bear Gulch road and about 12 miles from Twin Bridges and are on DNF-administered land.

2.9.2 Site History - Geologic History

Like other mines in the area, the B & H mined randomly oriented veins from a Cretaceous monzonite stock and the surrounding Archean gneiss. The veins contain quartz, pyrite, and arsenopyrite, with minor galena, chalcopyrite, and sphalerite and are most productive where structures intersect (unpublished information, MBMG files). Some of the vein material was of very high grade, up to 6 oz/ton gold (Krohn and Weist 1977). Cather and Linne (1983) suggested that this mineralization is continuous with that of the Boulder Cobalt area. The mine was worked by several companies from 1907 until 1931 and intermittently since then until the present. It is still covered under an operating permit today. According to Cather and Linne (1983) the mine has produced over 13,800 oz of gold from 10,000 of cross cuts and drifts, 1,500 feet of raises, and 400 feet of winzes. Most past production came from an adit 500 feet above the lower portal. The productive Pete and Joe vein was also explored by workings from the B & H, and the Pete and Joe is considered to be part of the B & H deposit.

A flotation mill (Lorain 1937) operated below the lower adit, and tailings were allowed to flow downstream ½ mile to a broad flood plain near Bear Gulch where they were allowed to settle. The tailings consist of coarse pieces of quartz, yellow clay, and some probably sulfides, and constitute 5,000–10,000 tons of material with 0.056 oz/ton gold. The location of the mill and buildings is of interest; they were built in a major avalanche path that descends over 2,000 feet from the top of Apa Mountain. Snowslides have shut down operations numerous times in the past, and they have destroyed buildings and equipment.

2.9.3 Environmental Condition

A large-volume discharge issues from the lower adit of the B & H mine and combines with waters from Bear Gulch Creek, the Pete and Joe discharge, which is on private land, and the Bear Gulch adit cluster discharge, which is on private land, before entering DNF-administered land. The tailings cover about 1,200 square feet on either side of Bear Gulch Creek.

2.9.3.1 Site Features - Sample Locations

The site was sampled on 10/19/92. Samples were collected from Bear Gulch Creek upstream (JBHS20L) and downstream (JBHS10M) of the tailings pile (figure 9). The stream showed significant gain in flow: about 150 gpm upstream versus 260 gpm downstream. Although much of the tailings hosted at least some vegetation, there were several areas barren of vegetation, especially where tailings had been washed onto native soil. A composite soil sample (JBHD10M) was collected at the downstream end of the pile where soil and tailings had mixed.

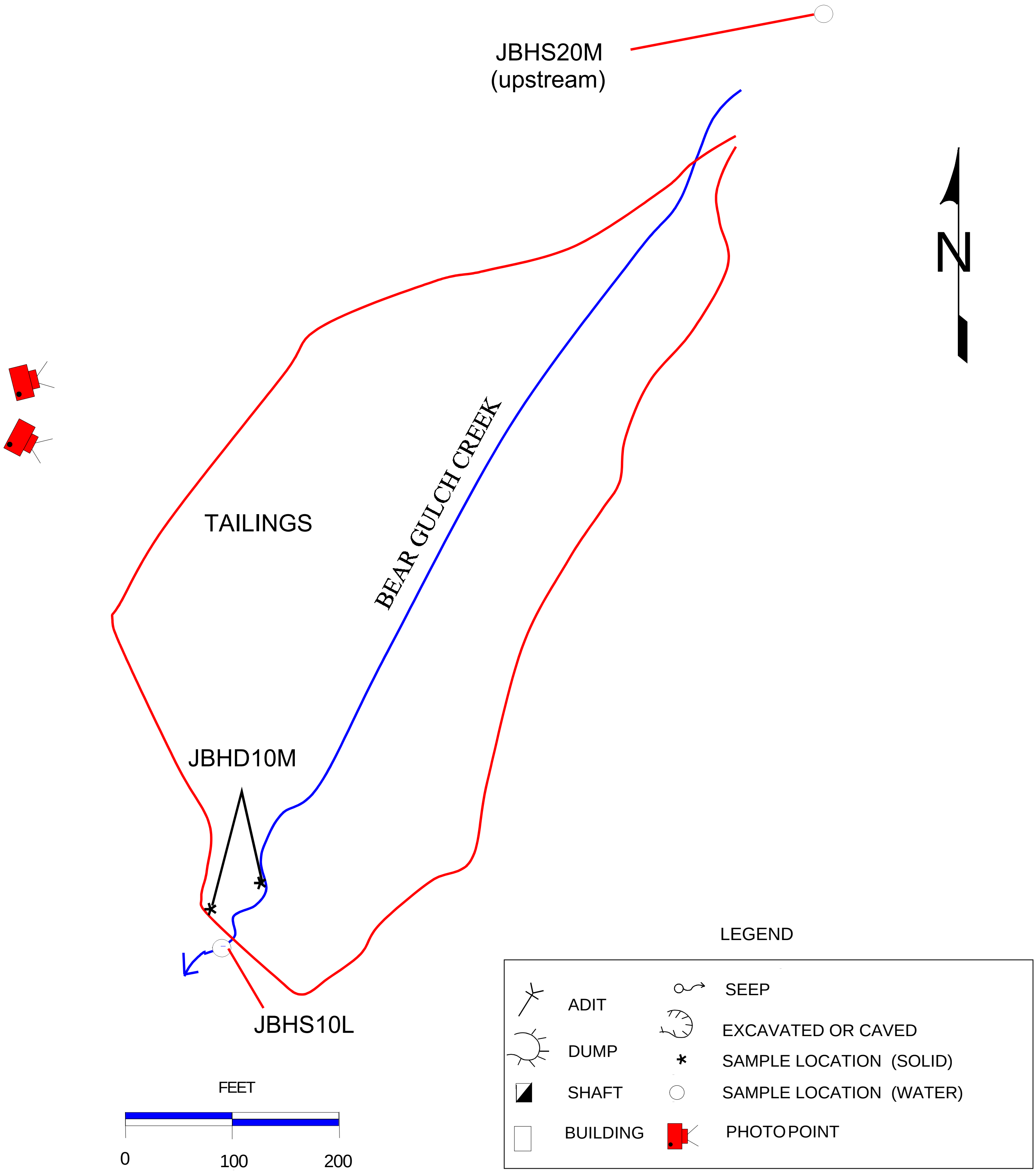

Figure 9. The B & H mill tailings (10/19/92) are bisected by Bear Gulch Creek. Several adits upstream were discharging to the creek

Figure 9A. The B & H tailings covered a large area in the flood plain of Bear Gulch. Vegetation covered some of the tailings, but large barren areas remained.

Figure 9B. Some of the tailings have been deposited alongside the road; vegetation on this portion of the pile was sparse to barren.

2.9.3.2 Soil

Arsenic and copper concentrations exceeded the phytotoxic limit in the sample taken where soils and tailings had mixed. This material was readily available for transport into the creek.

Table 20. Soil sampling results, B& H mill tailings (mg/kg).

Sample Location	**As**	**Cd**	**Cu**	**Pb**	**Zn**
Streamside tailings (JBHD10M)	124[1,2]	1.86[1]	292[1,2]	650[1]	263[1]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.9.3.3 Water

None of the standards considered were exceeded in either the upstream or downstream sample of Bear Gulch Creek. Total dissolved solids increased slightly downstream; sulfate and manganese increased the greatest amount. Zinc concentration was significantly lower in the downstream sample. The concentrations of dissolved metals in the surface-water samples do not reflect well the concentrations of metals in the soils on the stream bank. Arsenic and copper were below detection limits.

Table 21. Water-quality exceedences, B & H mill tailings.

Sample Site	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**	**Cl**	**F**	**NO_3**	**SO_4**	**Si**	**pH**
Bear Gulch - upstream (JBHS20L)																			
Bear Gulch - downstream (JBHS10M)																			

Exceedence codes:
P - Primary MCL
S - Secondary MCL
A - Aquatic Life Acute
C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.9.3.4 Vegetation

As noted, soil had formed to some degree over much of the tailings. Recent wash areas, however, were devoid of vegetation; but it was not evident if this was due to unstable soil or high concentration of metals. Trees on the margins of the tailings that appeared to pre-date the deposition of the tailings appeared unstressed.

2.9.3.5 Summary of Environmental Condition

The B & H mill tailings did not have a significant impact on the water quality of Bear Gulch Creek; none of the constituents exceeded the MCLs considered. Vegetation had been re-established over most of the tailings with a few wash-out areas devoid of vegetation. The concentration of metals and semi-metals, particularly copper and arsenic, were phytotoxic in the lower portion where tailings had mixed with soil adjacent the stream.

2.9.4 Structures

No structures were found on the tailings or surrounding DNF-administered land. The mine, on private land, was not included in this evaluation.

2.9.5 Safety

No safety problems were identified for the tailings area; the mine, on private land, was not included in this evaluation.

2.10 Ohio Lode Mine

2.10.1 Site Location and Access

The Ohio Lode mine (T2S R5W Section 25ADCB) is near the head of Hellroaring Canyon on the west flank of the Tobacco Root Mountains. Access to the site is by way of 4-wheel drive road about 6.5 miles up Hulbert Creek from the town of Waterloo. The northern portion of the workings is on patented land, and the southern portion is on DNF-administered land.

2.10.2 Site History - Geologic History

The Ohio was examined in detail by Cather and Linne (1983). In the vicinity, sill-like porphyritic intrusions interfinger with lower Paleozoic sediment. The igneous rock may have been localized by thrust faults. At the mine, mineralization occurs in limestone, shale, and quartzite between two sill-like intrusions. Metal values are found mainly in northeast-trending shear and breccia zones in quartz-pyrite veins from 0.5 to 15 feet thick. A small skarn containing diopside and quartz also occurs at a limestone-porphyry contact. The porphyritic sills contain disseminated pyrite and feldspars altered to kaolinite, but a sample from one such mineralized igneous body a mile north of the mine had only 0.008 oz/ton gold, 0.22 oz/ton silver, 0.013% copper, 0.008% lead, and 0.009% zinc. Sixteen samples taken by Cather and Linne (1983) at the mine ranged up to 0.414 oz/ton gold and 5.8 oz/ton silver. However, they felt that none of the geologic structures were well enough exposed to allow estimation of resources.

The mine operated from 1938 until 1943 and produced 1,538 oz of gold and 2,722 oz of silver. Workings consist of two caved shafts, two caved adits, and an open pit 70 feet in diameter. Recent exploration drilling has apparently taken place. Water emerging from a flooded shaft was mapped by Cather and Linne (1983).

2.10.3 Environmental Condition

Most of the site is on a scree slope with little vegetation or soil. Reclamation that was apparently done after the exploration drilling obscured nearly all of the roads. The only water on or near the site was found at what was mapped by Cathre and Linne as an adit. Inspection in 1992 indicated that it was probably a natural spring developed as the mine's water supply. One of the two shafts on the site was on DNF-administered land; this shaft was caved and dry. The “dump” below the spring comprised very coarse iron-stained quartzite and plagioclase porphyry; no sulfides were noted on any of the dumps on DNF-administered land.

2.10.3.1 Site Features - Sample Locations

The site was sampled on 9/15/92. As noted, the only water present on the site was from a spring/adit(?) on DNF-administered land on the south end of the disturbed area (figure 10). A sample (JOHS10L) was collected at the origin of the spring, which was discharging about 1.5 gpm. Because the disturbed area consisted of scree and had been partially reclaimed, no soils were sampled. The area near the spring showed no indication of impact by mining-related activity.

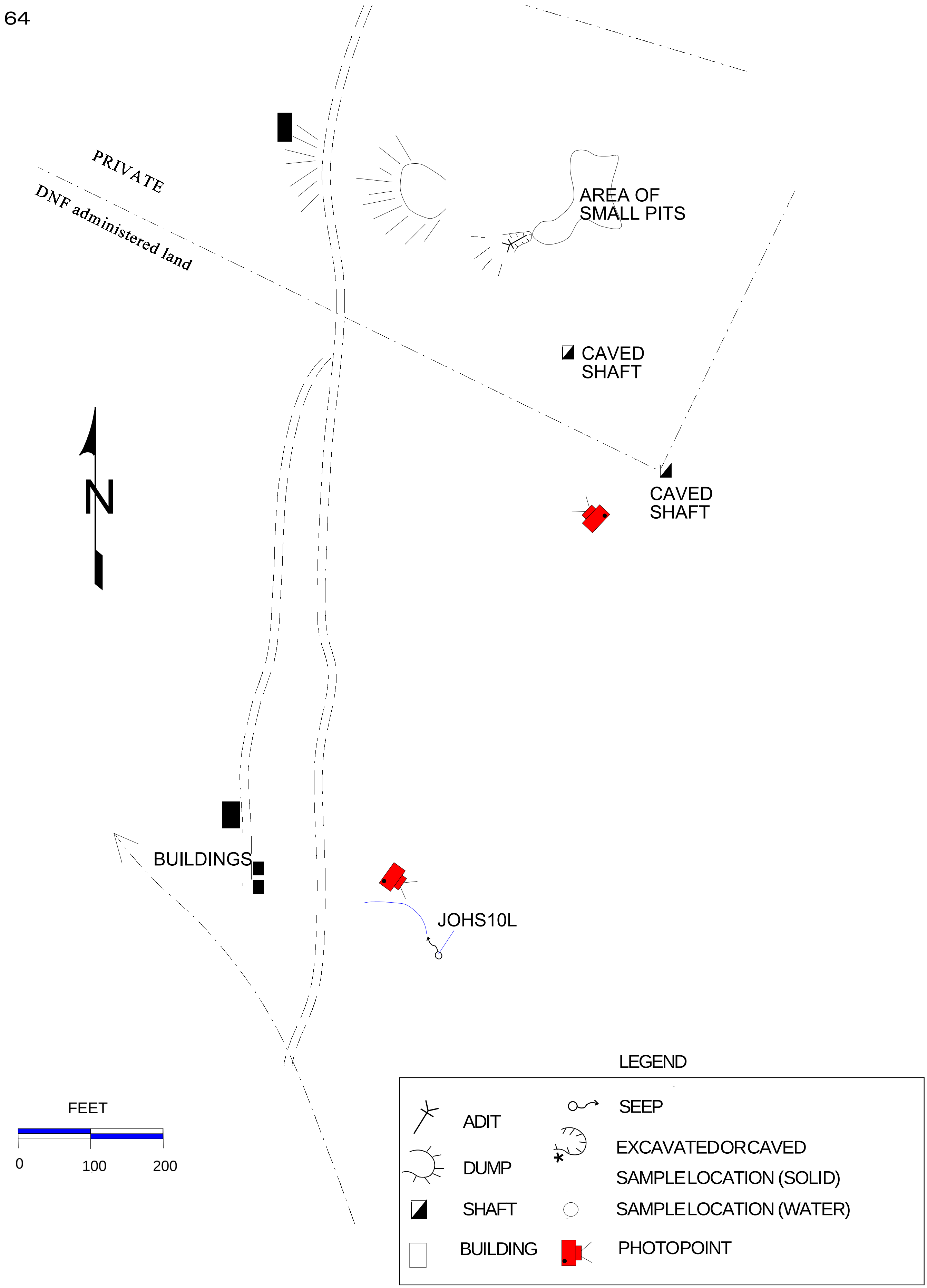

Figure 10. The Ohio Lode mine (9/15/92) covered a large area on a steep slope. Much of the area was "reclaimed" after exploration drilling.

Figure 10A. The surface workings of the Ohio Lode mine were difficult to distinguish from the surrounding scree and talus.

Figure 10B. A spring emanates from what is either a caved adit or a developed spring on the south end of the Ohio Lode mine.

2.10.3.2 Soil

Soils on the site were limited to the south end where the spring/adit(?) was discharging. No appreciable amount of waste rock was found; no impacts to soil that was related to mining were observed.

2.10.3.3 Water

None of the standards considered were exceeded in the sample of the spring/adit discharge. Concentrations of metals were generally well below the MCLs and for many constituents, below detection limits.

Table 22. Water-quality exceedences, Ohio Lode mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Spring/adit discharge (JOHS10L)																			

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.10.3.4 Vegetation

The vegetation on the skree slope above and below the mine was mostly barren, as was the vegetation within the disturbed area. Vegetation near the water source was good and showed no stress related to mining activities.

2.10.3.5 Summary of Environmental Condition

The Ohio Lode mine appeared to have little impact on surface water attributable to mining or mining-related activities. Post-mining exploratory drilling, although documented, was not evident. Soils are probably not indigenous to this particular area; skree and talus was common throughout the area.

2.10.4 Structures

A small cabin in poor repair and nearby ruins were observed below the mine on DNF-administered land. An ore bin was observed below the main workings on private land.

2.10.5 Safety

The steep skree slope made for difficult walking; however, this was the case outside the disturbed area as well. The buildings on DNF-administered land did not appear to be in danger of further collapse.

2.11 Montreal Star Mine

Author's Note: The preliminary assessment of the Montreal Star was completed in 1993. In 1994, the site was partially reclaimed. Many of the site features and conditions described below no longer exist.

2.11.1 Site Location and Access

The Montreal Star mine (T4N R7W Section 3CDBC) is located on DNF-administered land about three miles west of the Elk Park exit on Interstate Highway 15. The site is on a north-facing slope that drains into Lowland Creek, a tributary to the Boulder River. The site is easily accessible by car.

2.11.2 Site History - Geologic Features

The Montreal Star was partially reclaimed by the U.S. Forest Service in 1994. Openings were covered and buildings were torn down. Unpublished maps in MBMG files show that workings consisted of a 112-foot shaft with a 100-foot drift, and a portal with 600 feet of associated tunnels. The ore body is a five-foot-wide, N65E 55SE vein and includes several thinner east-west veins (Roby *et al.* 1960). It is hosted by granodiorite and aplite of the Boulder Batholith, and the vein has been cut by a fault on one end that places plutonic rock in contact with Lowland Creek rhyolite. Vein minerals include quartz, pyrite, pyrrhotite, tourmaline, arsenopyrite, chalcopyrite, and bismuthinite. Assay values from 13 samples ranged from 0.005 to 0.03 oz/ton gold, 0.30 to 14.18 oz/ton silver, 0.2 to 3.43% copper, up to 4.6% lead, and a trace to 0.04% bismuth (MBMG files).

2.11.3 Environmental Condition

Water was found in and around several workings at the site. The shaft was flooded to within about 15 feet of the ground surface; the central east and west trenches contained small ponds; the northern caved adit and the westernmost trench had small discharges that flowed across waste rock and then infiltrated the ground. At the foot of the hill below the mine, there was a seep that discharged into a wetland adjacent to Lowland Creek. The discharge had a very low pH.

In addition to water problems, the site also had some erosion concerns. The large waste-rock dump near the shaft was highly mineralized and was cut by rills. A gully along a haul road below the dump had evidently carried a substantial volume of sediment to the foot of the hill, close to the Lowland Creek flood plain.

2.11.3.1 Site Features - Sample Locations

Soil and water-quality samples were collected at the site on 8/17/93. Soil sample LMSD10H was collected from the sediment deposited by the haul road gully. Water-quality samples LMSS40H and LMSS50H were collected from the ponded water in two trenches. Sample LMSG10H was collected from the flooded shaft. Sample LMSS30H was collected from the seep on the edge of the wetlands. The flow rate of the seep was about 0.8 gpm. Finally, samples LMSS10M and LMSS20M were collected from Lowland Creek upstream and downstream of the site. The flow rate of the creek was about 840 gpm at the upstream location and 910 gpm at the downstream location. Site features and sample sites are shown in figure 11.

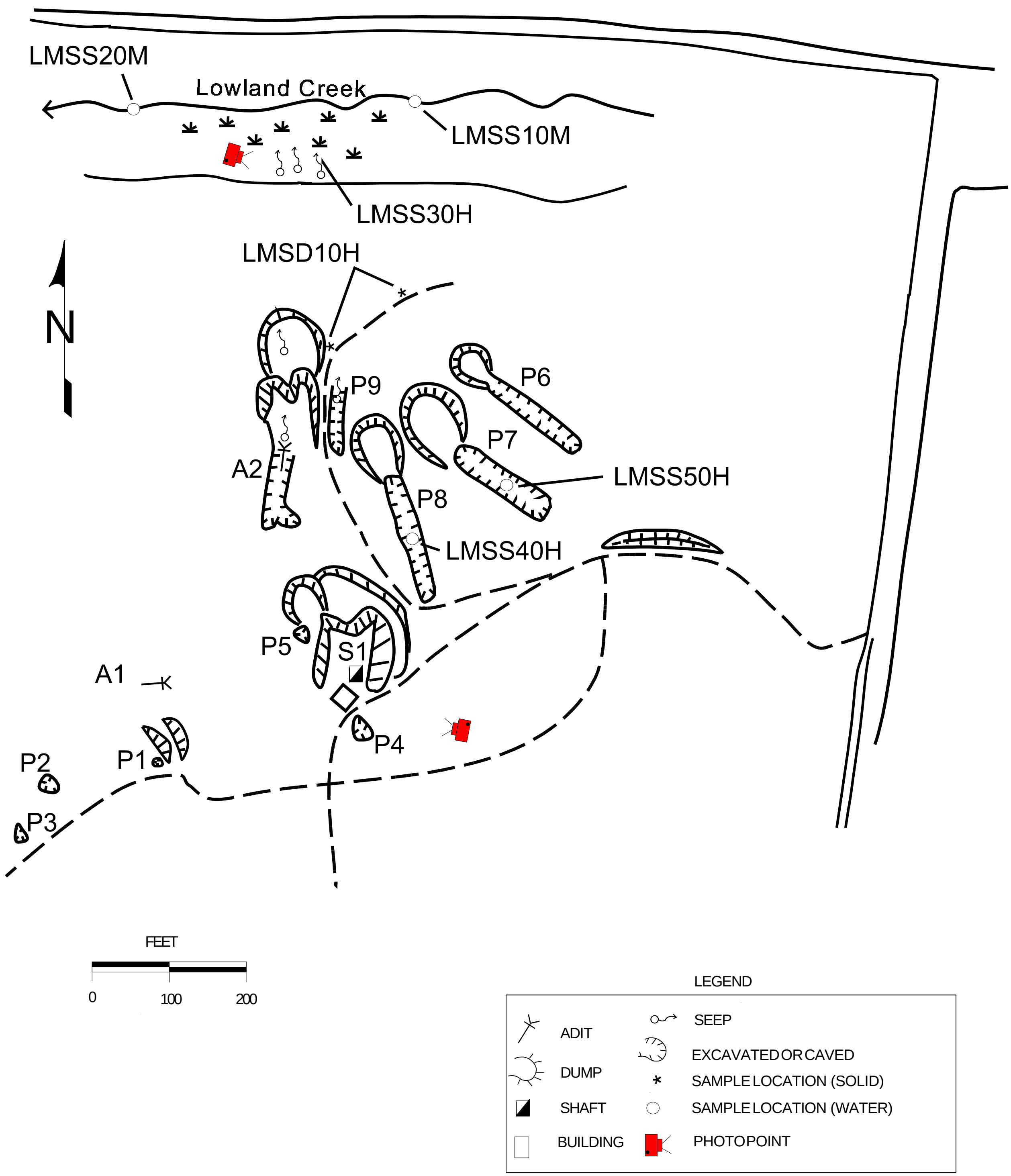

Figure 11. The Montreal Star mine (8/17/93) had extensive workings and several seeps throughout the disturbed area.

Figure 11A. A small head frame was above the flooded shaft at the Montreal Star mine. Water came to within 15 feet of the ground surface.

Figure 11B. The seep on the edge of the wetlands below the Montreal Star mine had a pH of less than 5.

2.11.3.2 Soil

Arsenic concentration in the sediment deposited by the haul road gully was about 24 times greater than the phytotoxic limit (100 mg/kg). Copper only slightly above the phytotoxic limit.

Table 23. Soil sampling results, Montreal Star mine (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Sediment deposited by haul road gully (LMSD10H)	2390[1,2]	1.04[1]	127[1,2]	123[1]	62.7[1]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.11.3.3 Water

The samples collected from the west trench and the seep at the edge of the wetlands had pH values less than 4.5 and contained numerous metals in concentrations exceeding MCLs and aquatic life standards. The similarity of the water from these two locations suggests that a hydrologic connection exists. Water sampled from the east trench was very different from that of the adjacent west trench. It had a pH close to neutral and contained slightly elevated levels of lead and silver; no other metals exceeded standards.

Although the seep on the edge of the wetlands contains high metal concentrations, the creek appears to be impacted only slightly. Copper concentration increased from 6.5 µg/L upstream of the site to 18.3 µg/L downstream of the site. Mercury was not detected in the acid discharge from the mine; its elevated concentration in the creek was perhaps due to naturally high background levels upstream.

Table 24. Water-quality exceedences, Montreal Star mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Lowland Creek, upstream of site (LMSS10M)										C									S*
Ponded water in east trench (LMSS50H)								C				C							
Ponded water in west trench (LMSS40H)	S,A C			P,A C		S,A C	S,A	C	S				S,A C				P,S		S
Seep at edge of wetlands (LMSS30H)	S,A C			P,A C		S,A C		C	S				A,C				P,S		S
Lowland Creek, downstream of site (LMSS20M)						A,C				C									

Exceedence codes:

P - Primary MCL
S - Secondary MCL
A - Aquatic Life Acute
C - Aquatic Life Chronic
* - Laboratory pH was not outside acceptable MCL range

Note: The analytical results are listed in appendix IV.

2.11.3.4 Vegetation

Many of the waste-rock dumps around the site were barren or sparsely vegetated. Also, no vegetation was growing around the seep at the edge of the wetlands. However, once the seep drained into the wetlands, there was no obvious indication of stress to the marsh grasses or willows.

2.11.3.5 Summary of Environmental Condition

The discharges and mine wastes at the Montreal Star pose a significant environmental concern. The preliminary site assessment indicates that discharges from the site are acidic and contain concentrations of aluminum, cadmium, copper, zinc, and sulfate above MCLs. Waste-rock dumps at the site were deeply gullied and sediment containing elevated concentration of metals had been transported down the hillside toward the flood plain of Lowland Creek.

2.11.4 Structures

A mine building that is in fair condition was located near the shaft. In addition, there was a small head frame over the shaft and a powder shed that was a couple hundred feet west of the shaft. At many locations around the site, there were piles of building debris and junk metal.

2.11.5 Safety

Numerous hazards were present at this site. First, inside the mine building next to the shaft, there was a 55-gallon drum labeled perchlorethylene, also known as PCE. The drum still contained some liquid, but it was unknown if it was PCE. Representatives of the National Forest Service were notified immediately following the discovery of this possible hazardous waste. Second, although the flooded shaft had been sealed with a relatively new locking trap door, it was easily opened with a pry bar. When the site was visited in August 1993, vandals had already pulled off several of the planks used to construct the door. Third, pools of water in the two trenches were fairly deep and could be a drowning hazard. And finally, several pits had been backfilled with construction debris, cars, and other junk. The pits were not only an eyesore but could be dangerous if someone were to slip and fall in.

2.12 Memphis Mine

2.12.1 Site Location and Access

The Memphis mine is on Lowland Creek (T05N R07W Section 11CABD) and is on DNF-administered land. The site is approximately 4.5 miles upstream of Ladysmith Campground; the campground is a high-use recreation area. The development area is on the east side of the main road.

2.12.2 Site History - Geologic History

Through this long cross cut, the Ruby zone was explored at the 600-foot level. About 3,000 feet of workings are present (unpublished map, MBMG files). A discharge emerges from the locked portal and runs into the dump. Approximately 9,000 tons of dump material remains. Most is welded tuff with 1% disseminated pyrite and low metal values. The Memphis explored the lower part of the Ruby zone, which was apparently higher in base-metal sulfides and lower in precious metals content (unpublished information, MBMG files). This is supported by the composition of the vein in the ore bin, which is greater than 50% sulfides, including pyrite, sphalerite, galena, and chalcopyrite. A select sample contained only 0.048 oz/ton Au and 6.38 oz/ton Ag.

2.12.3 Environmental Condition

The mine site consisted of an open adit and a waste-rock dump. The adit was boarded shut. Rail tracks led from the adit to a platform built out and over the waste-rock dump. The adit discharged water at a rate of about three gallons per minute; the water soaked into the waste rock a short distance away. Seeps emerged at the base of the waste-rock dump into a boggy area a short distance away. The waste-rock dump contained visible sulfides, but soils did not appear adversely impacted downhill of the dump.

2.12.3.1 Site Features - Sample Locations

Samples were collected at the Memphis mine on 8/11/92. The adit-discharge stream was sampled at the adit (LMPS10L). A seep from the waste-rock dump was sampled at the base of the dump near where it emerged (LMPS20L). The adit discharge was flowing at about three gpm, and the seep was flowing at about one gpm. Soil samples were not collected because the soils at the site did not appear to be adversely impacted from waste material. Sample sites are shown in figure 12.

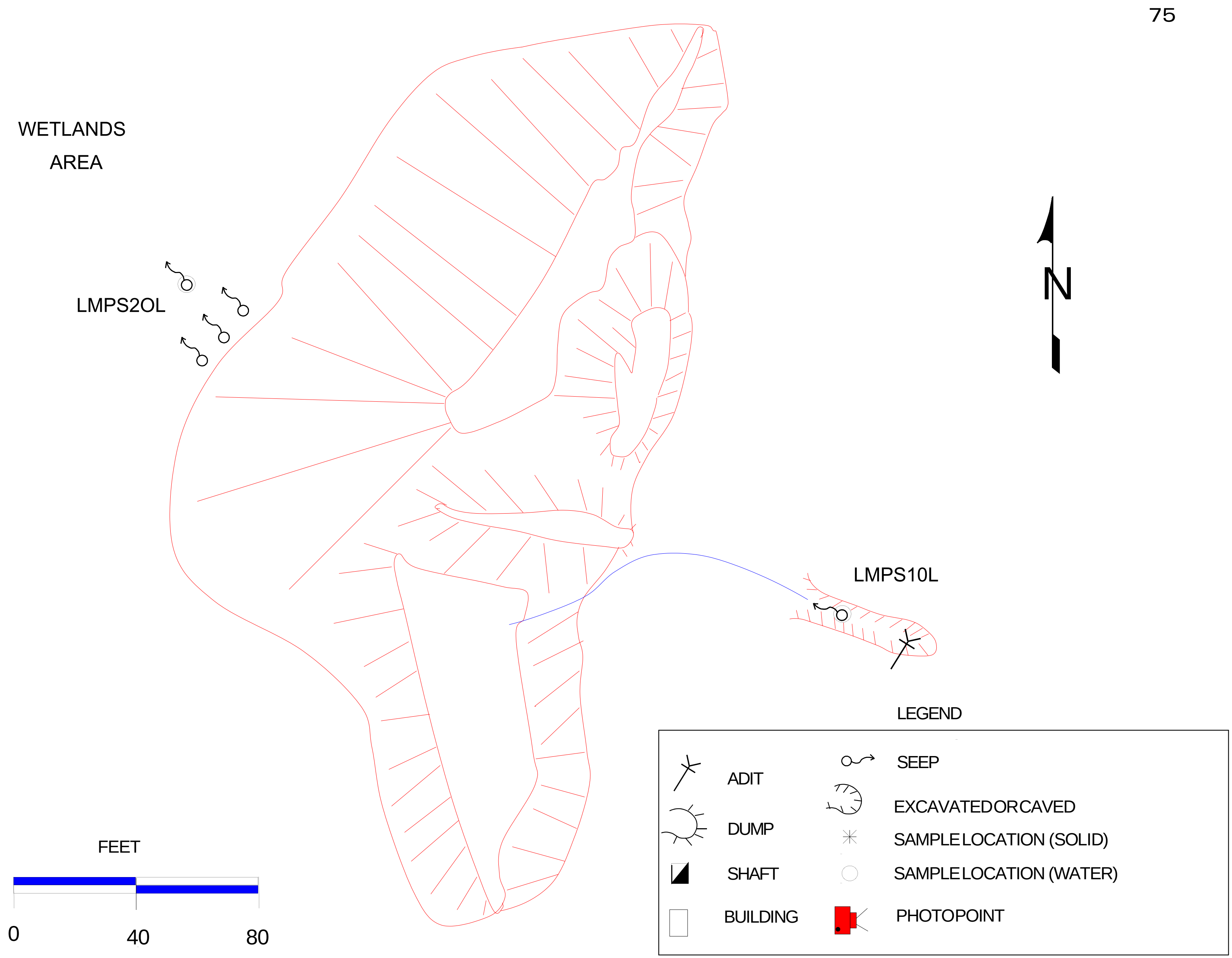

Figure 12. The Memphis mine (8/12/92) had a small caved adit that discharged water to the waste-rock dump and infiltrated. Samples were collected for the adit discharge and the seep.

2.12.3.2 Soil

The waste-rock dump was barren, but erosion of this material during storm or runoff events appeared unlikely.

2.12.3.3 Water

Water discharging from the adit had manganese, mercury, and zinc concentrations that exceeded water-quality criteria. Water seeping from the waste-rock dump had concentrations of mercury and zinc that exceeded water-quality criteria (table 25).

Table 25. Water-quality exceedences, Memphis mine.

Sample Site	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**	**Cl**	**F**	**NO_3**	**SO_4**	**Si**	**pH**
Adit discharge (LMPS10L)									S	C			A,C						
Waste-rock seep (LMPS20L)										C			A,C						

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.12.3.4 Vegetation

The waste-rock dump was barren. None of the vegetation away from the waste-rock dump appeared to be stressed.

2.12.3.5 Summary of Environmental Condition

Although the waste rock at the site was barren, it did not appear to be eroding onto or impacting adjacent areas. Water discharging from the adit exceeded the secondary standard for manganese, the chronic aquatic life standard for mercury, and the acute and chronic life standards for zinc. Water discharging from the seep exceeded the chronic aquatic life standard for mercury and the acute and chronic life standards for zinc. Vegetation outside of the disturbed area did not appear to be stressed.

2.12.4 Structures

Two buildings and a granby dump arch were present on the site. All structures were in fair condition.

2.12.5 Safety

The safety of the site was not evaluated.

2.13 Leadville Mine

2.13.1 Site Location and Access

The Leadville mine (T7N R8W Section 36DBDA) is on DNF-administered land near the head of Rock Creek, which is a tributary to the Boulder River. Access to the site is limited to an ATV trail that begins about two miles southwest of the site.

2.13.2 Site History - Geologic Features

The Leadville area, actually a group of several mines, has been extensively described because it lies within the Electric Peak Wilderness study area. The area is underlain by andesitic Elkhorn Mountain volcanics and contains three parallel, mineralized, east-trending shear zones (U.S. Bureau of Mines 1988). Veins of brecciated quartz, tourmaline, pyrite, galena, chalcopyrite, sphalerite, and arsenopyrite (0.5–12 feet thick) occur within the shears over strike distances of up to 1,400 feet. Forty-seven workings, including 5 adits and 12 shafts, explored these veins.

The USBM (1988) identified 10,000 tons of indicated and inferred subeconomic (underground mining required) resources with an average grade of 0.32 oz/ton gold, 16.42 oz/ton silver, 19.65% copper, 0.13% lead, 0.68% zinc, and 0.15% antimony. Production when the site was active was less than 100 tons. The ore contained 50% lead, 20 oz/ton silver, and $6 in gold (Pardee and Schrader 1933).

2.13.3 Environmental Condition

Figure 13 shows the locations of some of the shafts, adits, and pits located in the area. Three of the shafts were partially or completely flooded and one of the adits had a small discharge that flowed around the edge of a waste-rock dump before sinking into the ground. A small spring-fed stream ran through the central part of the site and received runoff from nearby waste-rock dumps. Several hundred feet to the north, the stream discharged to a small wetlands.

2.13.3.1 Site Features - Sample Locations

Water-quality samples were collected at the site on August 18, 1993. Samples RLVG10H, RLVS30M, and RLVS60L were collected from each of the three flooded shafts. Sample RLVS10L was collected from the northeast adit discharge, which had a flow rate of less than 0.5 gpm. Three samples were collected along the spring-fed stream that passes through the site. The first sample (RLVS20L) was from the springs upgradient (south) of the middle adit. The flow rate at this location was 7.5 gpm. The second sample (RLVS50L) was collected near the adit waste-rock dump. Here, the flow rate was 8.6 gpm. The third sample (RLVS40L) was collected downstream of the site. The flow rate at this location was 1.2 gpm.

2.13.3.2 Soil

No soil samples were collected at the site because erosion of waste materials did not appear to be a problem.

2.13.3.3 Water

With the exception of the discharge from the middle adit, all of the water samples had pH values less than 6.5. Also, many of the samples contained high concentrations of lead and/or arsenic. The water sampled from the flooded north shaft (RLVS60L) had the poorest quality, exceeding standards for not only arsenic, lead, and pH, but also cadmium, silver, and zinc.

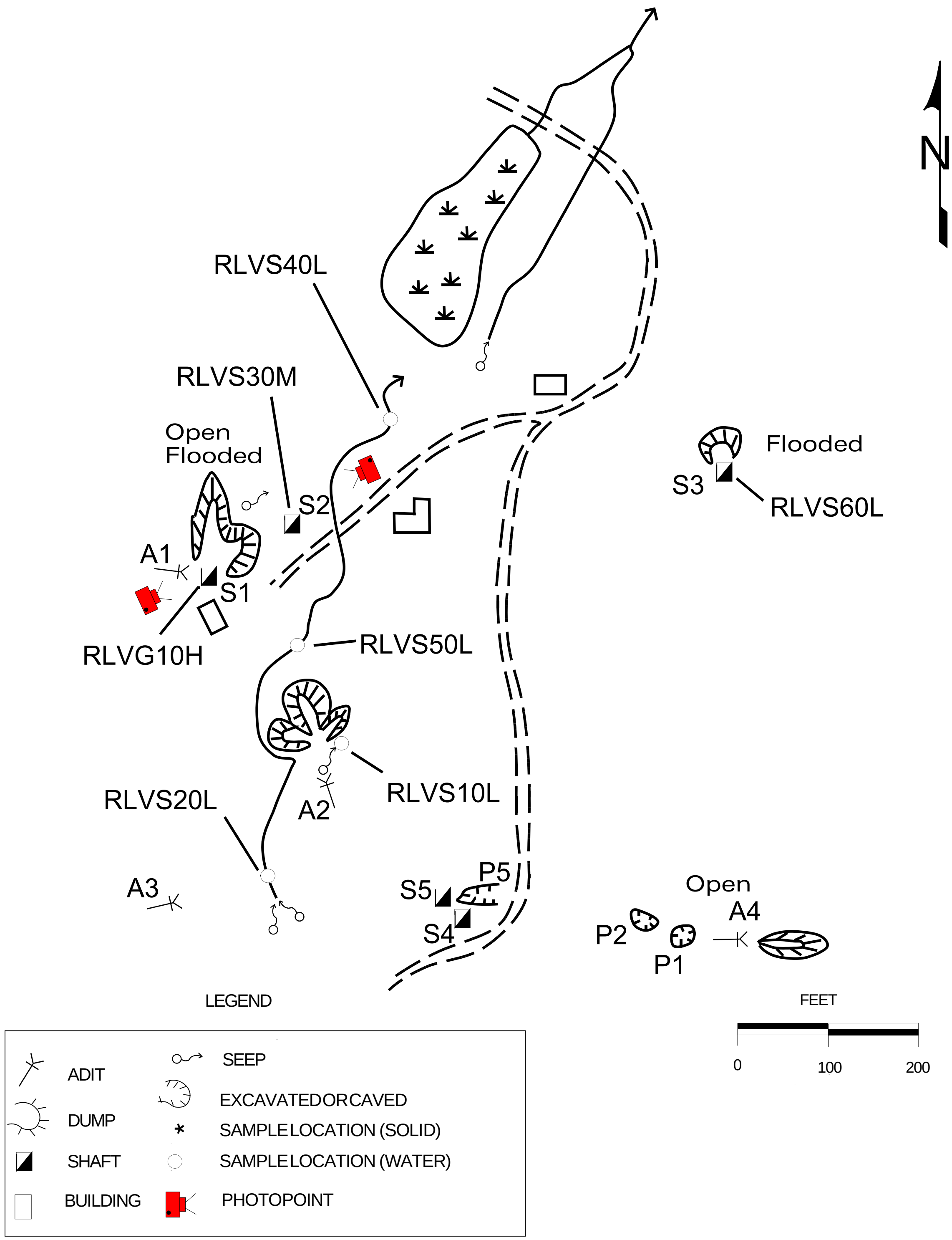

Figure 13. The Leadville mine (8/18/93) had several small shafts and adits; three of the shafts and one of the adits were discharging water.

Figure 13A. The west shaft, which was partially flooded and open, is a safety concern at the Leadville mine.

Figure 13B. The middle shaft was open and flooded to the surface; a discharge probably occurs in periods of runoff.

Table 26. Water-quality exceedences, Leadville mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Springs upgradient of middle adit (RLVS20L)								C											S
Middle adit discharge (RLVS10L)		p						C											
Stream near middle adit waste-rock dump (RLVS50L)																			S
Flooded shaft (west) (RLVG10H)		P																	S
Flooded shaft (middle) (RLVS30M)		P																	S
Flooded shaft (north) (RLVS60L)		P		C				C				C	A,C						S
Stream - below site (RLVS40L)								C											S

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.13.3.4 Vegetation

The larger waste-rock dumps in the area were generally barren to sparsely vegetated. The vegetation in the wetlands below the site appeared to be healthy.

2.13.3.5 Summary of Environmental Condition

Water near the mine was generally acidic and contained elevated levels of several contaminants, including arsenic and lead. The areal extent of the contamination was not well defined; the findings of the preliminary assessment suggests that water quality could be degraded for some distance downgradient of the site.

2.13.4 Structures

Two cabins, a mine building, and some rusting machinery were observed at the site. The cabins and mine building were in poor condition.

2.13.5 Safety

The open shaft on the west end of the site poses the most serious safety concern at the site. It has near-vertical sides and is flooded to within 10 or 15 feet of the ground surface. The partially collapsed adit on the southwest end of the sites and the open adit on the southeast end of the site are also hazardous. Other openings probably exist in the area but were not found during the preliminary site assessment.

2.14 North Boulder Lead Mine

2.14.1 Site Location and Access

The North Boulder Lead mine (T6N R7W Section 14DDAD) is a private holding located along Alta Gulch, west of Bernice. Alta Gulch is a tributary to the Boulder River. Access to the site is via a 4-wheel-drive road (No. 513) that begins about two miles west of the Lady Smith National Forest picnic ground.

2.14.2 Site History - Geologic Features

Workings at the site include a partially collapsed shaft and a collapsed adit (figure 14). Quartz-pyrite-galena breccia in a gouge zone was mined, probably for its silver and lead content. A select sample contained 0.005 oz/ton gold, 1.65 oz/ton silver, 0.022% copper, 0.48% lead, and 0.145% zinc. No historical information was found for this site.

2.14.3 Environmental Condition

The shaft at the north end of the site is flooded to the surface and discharges water to a small wetland and Alta Gulch. At the south end of the site, there is a small waste-rock dump that straddles the DNF-administered land / private land boundary. The dump is within the flood plain of Alta Gulch and may contribute slightly to sediment-loading during major runoff events.

2.14.3.1 Site Features - Sample Locations

Water-quality samples were collected from Alta Gulch upstream (ABLS10H) and downstream (ABLS20M) of the site (figure 14). The flow rate at the upstream location was 46 gpm; at the downstream location, the flow rate was 66 gpm. Also, a soil sample was collected from the edge of the waste-rock dump in the flood plain at the south end of the site. All samples were collected on 8/19/93.

2.14.3.2 Soil

Lead and zinc concentrations in the soil at the base of the streamside dump were well above phytotoxic levels. In addition, arsenic, cadmium, and copper concentrations were above one or more Clark Fork Superfund background levels.

Table 27. Soil sampling results, North Boulder lead mine (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Soil from waste-rock dump at south end of site (ABLD10L)	93.5[1]	8.39[1]	37.6[1]	2190[1,2]	2330[1,2]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.14.3.3 Water

Mercury was the only analyte that exceeded water-quality standards. It occurred in concentrations of 0.12 µg/L upstream and downstream of the site.

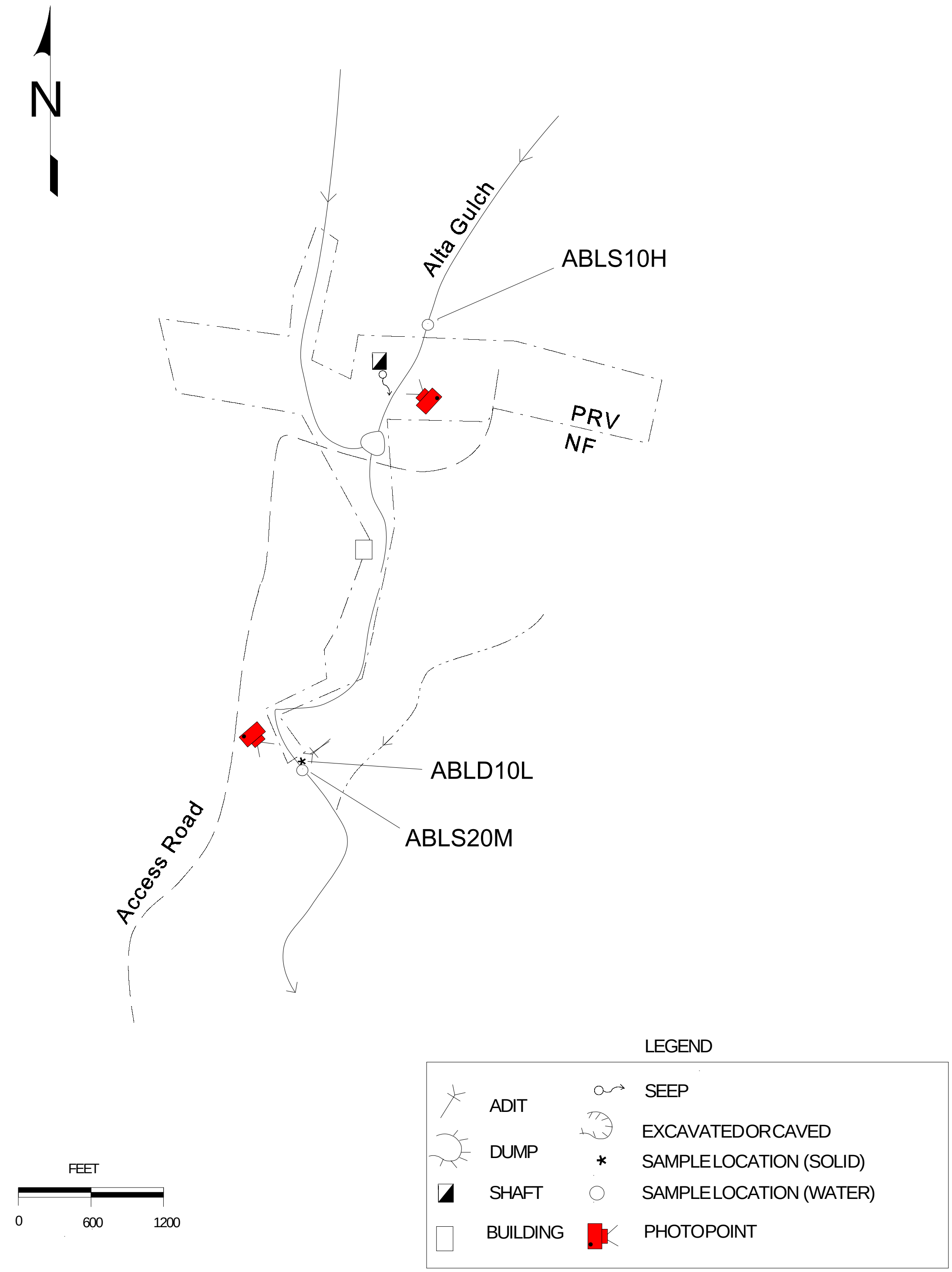

Figure 14. The North Boulder Lead mine (8/19/03) is in the flood plain of Alta Gulch. The flooded shaft discharged to the stream and waste rockwas in contact with the stream.

Figure 14A. The discharge from the flooded shaft (beneath the head frame) at the North Boulder Lead mine flowed into a small wetland adjacent to Alta Gulch.

Figure 14B. Soil sample ABLD10L was collected from a small waste-rock dump that extended into the flood plain of Alta Gulch.

Table 28. Water-quality exceedences, North Boulder lead mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Alta Gulch, upstream of site (ABLS10L)										C									
Alta Gulch, downstream of site (ABLS20M)										C									

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.14.3.4 Vegetation

The two waste-rock dumps at the site are sparsely to moderately vegetated. Away from the dumps, grasses, brush, and trees are abundant and appear healthy.

2.14.3.5 Summary of Environmental Condition

The discharge from the flooded shaft does not appear to affect the water quality of Alta Gulch. The slightly elevated mercury concentrations in the stream may be due to high natural background levels or mining activities farther up the drainage. Soil around the edge of the small dump at the south end of the site contains high levels of metals, especially lead and zinc. Under normal flow conditions, the potential for erosion from the dump is slight. However, during large runoff events, there is a chance that this material could be carried into Alta Gulch, thus degrading water quality.

2.14.4 Structures

A small head frame is located above the flooded S1 shaft. Along the drainage between the shaft and the collapsed adit, there is a cabin in poor condition. The head frame and the cabin are on private property.

2.14.5 Safety

The flooded shaft is a safety concern, but it is on private property. No apparent safety problems were identified on DNF-administered land.

2.15 Jib-Katie Mill Tailings

2.15.1 Site Location and Access

The Jib-Katie mill tailings (T6N R5W Section 18DADD) are located next to the Boulder River in the town of Basin. Part of the three-acre site is on a sliver of DNF-administered land that is surrounded by private property. No site map was prepared.

2.15.2 Site History - Geologic Features

A large (300 tons/day capacity) gravity concentration and flotation mill was built in 1924 to treat ore from the Jib group, which included the Hope, Katie, and Katie Extension mines (Ruppel 1960). Production records indicate that about 100,000 tons of ore were treated before the mill closed in 1926 (Roby *et al.* 1960). Property boundaries and the extent of the tailings were difficult to distinguish; the site was not mapped.

2.15.3 Environmental Condition

Because the sparsely vegetated Jib-Katie tailings are adjacent to the Boulder River, they are highly susceptible to erosion. During major storm and runoff events, large quantities of the silt and sand-sized tailings are likely washed into the river. Water ponding inside the tailings impoundment is another environmental concern. As water infiltrates the tailings, it may be leaching metals that could degrade ground-water quality in the area.

2.15.3.1 Site Features - Sample Locations

Soil and water-quality samples were collected at the site on October 25, 1994. Soil sample BJBD10M was collected along the bank of the river immediately downstream of the tailings impoundment. Water samples BJBS10L and BJBS20L were collected from the river upstream and downstream of the site. The flow rate of the river was approximately 14 cfs.

2.15.3.2 Soil

Although none of the analytes in sample BJBD10M exceeded phytotoxic levels, their concentrations were all greater than the Clark Fork Superfund background levels.

Table 29. Soil sampling results, Jib-Katie mill tailings (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Soil downstream of tailings (BJBD10M)	29.3[1]	4.92[1]	45.3[1]	167[1]	120[1]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.15.3.3 Water

Mercury was the only analyte that exceeded water-quality standards in the river. Upstream and downstream of the site, the concentration was 0.12 µg/L.

Table 30. Water-quality exceedences, Jib-Katie mill tailings.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Boulder River, upstream of site (BJBS10L)										C									
Boulder River, downstream of site (BJBS20L)										C									

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.15.3.4 Vegetation

Most of the tailings at the site were devoid of vegetation. Only near the river bank had some grasses and brush taken hold.

2.15.3.5 Summary of Environmental Condition

Under low flow conditions, the tailings impoundment appeared to have little if any impact on the water quality of the Boulder River. However, during storm and runoff events, it is likely that tailings are flushed into the river, thus contributing to the suspended sediment and metal load. The lack of vegetation over most of the site suggests that metal concentrations in the tailings were fairly high. Metals are probably leaching into the ground water at the site, but because of the limited scope of this investigation, no samples were collected to verify this speculation.

2.15.4 Structures

No structures were observed on the site.

2.15.5 Safety

No safety problems were identified on DNF-administered land at the site.

2.16 Galena Gulch

2.16.1 Site Location and Access

The Galena Gulch mine, also known as the Boulder West mine, is on Galena Gulch (T6N R5W Section 33DCBB) and is on private land above administered by the DNF. The site is about 3.5 miles upstream from Interstate 15 and about 5.5 miles west of Boulder. The area around the mine is a high-use recreation area. The mine site is on the east side of the main road.

2.16.2 Site History - Geologic History

At this large operation, several adits investigated a north-trending quartz breccia zone with 1% pyrite surrounded by iron-stained granitic rocks. A sample of the mineralized material contained 0.01 oz/ton gold, 0.74 oz/ton silver, 0.017% copper, 0.012% lead, and 0.024% zinc. A composite sample was taken of the streamside dump: it contained only 0.005 oz/ton gold, 0.35 oz/ton silver, 0.011% copper, 0.009% lead, and 0.010% zinc. No site history was available for this site.

2.16.3 Environmental Condition

The mine site consisted of a caved adit, a waste-rock dump and at least five test pits. The adit was dry and did not show any indication that water flows from it. The waste-rock dump was adjacent to a stream that flowed at about 10 gpm. A seep emerged at the base of the waste-rock dump and flowed into the stream. Material from the waste-rock dump did not appear to have washed onto DNF-administered land.

2.16.3.1 Site Features - Sample Locations

Samples were collected at the Galena Gulch mine on 8/11/92. The seep from the waste-rock dump was sampled (GNNS10L) where it flowed onto DNF-administered land. The seep was flowing at about 0.6 gpm. Soil samples were not collected because the soils at the site did not appear to be adversely impacted from waste material. Site features and sample locations are shown in figure 15.

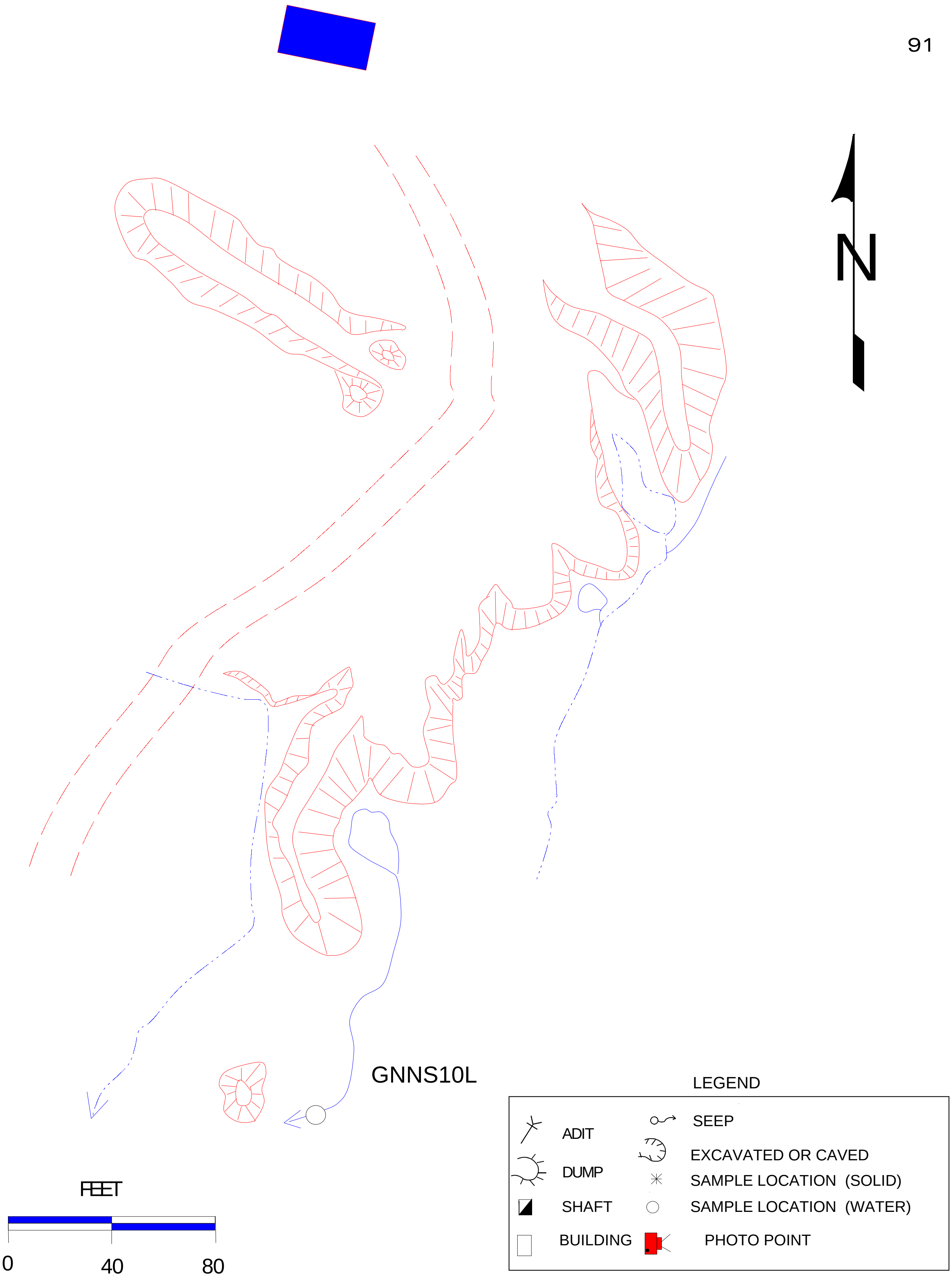

Figure 15. The Galena Gulch mine (8/11/92) was on private land above DNF-administered land. The seeps emerging for the base of the dump were flowing onto DNF-administered land.

2.16.3.2 Soil

The waste-rock dump was moderately vegetated. Erosion of this material during storm or runoff events appeared unlikely.

2.16.3.3 Water

The water emerging from the base of the waste-rock dump exceeded only the mercury MCL. The concentration of mercury was at the detection limit of 0.1 µg/L. The concentration of other dissolved metals and arsenic were well below MCLs if detected at all.

Table 31. Water-quality exceedences, Galena Gulch mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Waste-rock seep (GNN10L)										C									

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.16.3.4 Vegetation

The waste-rock dump was moderately to well vegetated; vegetation near the base of the waste-rock dump did not appear stressed.

2.16.3.5 Summary of Environmental Condition

All of the disturbed area of the Galena Gulch mine is on private land. Overall, the mine appeared to have little impact on surface-water quality; mass wasting or other movement of material toward the small stream appears unlikely.

2.16.4 Structures

One cabin was observed on DNF-administered land and appeared to be in good condition.

2.16.5 Safety

As noted, the single adit on the site was caved; however, the depressions caused by the collapse and the test pits may pose a safety concern.

2.17 Queen of the Hills Mine

2.17.1 Location and Access

The Queen of the Hills mine (T5N R5W Section 20ABAD) is on DNF-administered land about 250 feet south of Wilson Creek. A patented claim of the same name lies on either side of Wilson Creek about 350 feet northeast. The Mount Pisgah/Wilson Creek trail cuts across the waste-rock dumps and the northeast corner of the non-patented claim. Access to the site is from the Little Boulder River road across the Wilson Creek trail about 2.5 miles. The trail crosses Jerry Creek and turns north toward Mount Pisgah.

2.17.2 Site History - Geologic Features

There area two adits on the site, both with a northeast orientation about 90 feet apart with an elevation difference of 40 feet. Based on the volume of the water-rock dumps and the visible length of the lower caved adit, both adits were probably about 100 feet long. The adits lie in the Boulder Batholith, and the geology of the site is similar to that of the Eureka mine (T5N R5W Section 19DCBB) 1.5 miles west. Both waste-rock dumps at the Queen of the Hills mine were composed of decomposed and altered quartz monzonite. No site history was available for this site.

2.17.3 Environmental Condition

There are two caved adits and associated waste-rock dumps on the site. The lower adit was the focus of the site investigation.

2.17.3.1 Site Features - Sample Locations

Both adits were caved; the lower adit was discharging less than one gpm across the waste-rock dump. The discharge infiltrated the dump near the edge about 20 feet from the point of origin; a water sample was collected near the origin. The was no visible evidence of past discharges extending past the edge of the dump. Soils did not appear to have been impacted by erosion; no soil samples were collected. Site features and sample locations are presented in figure 16.

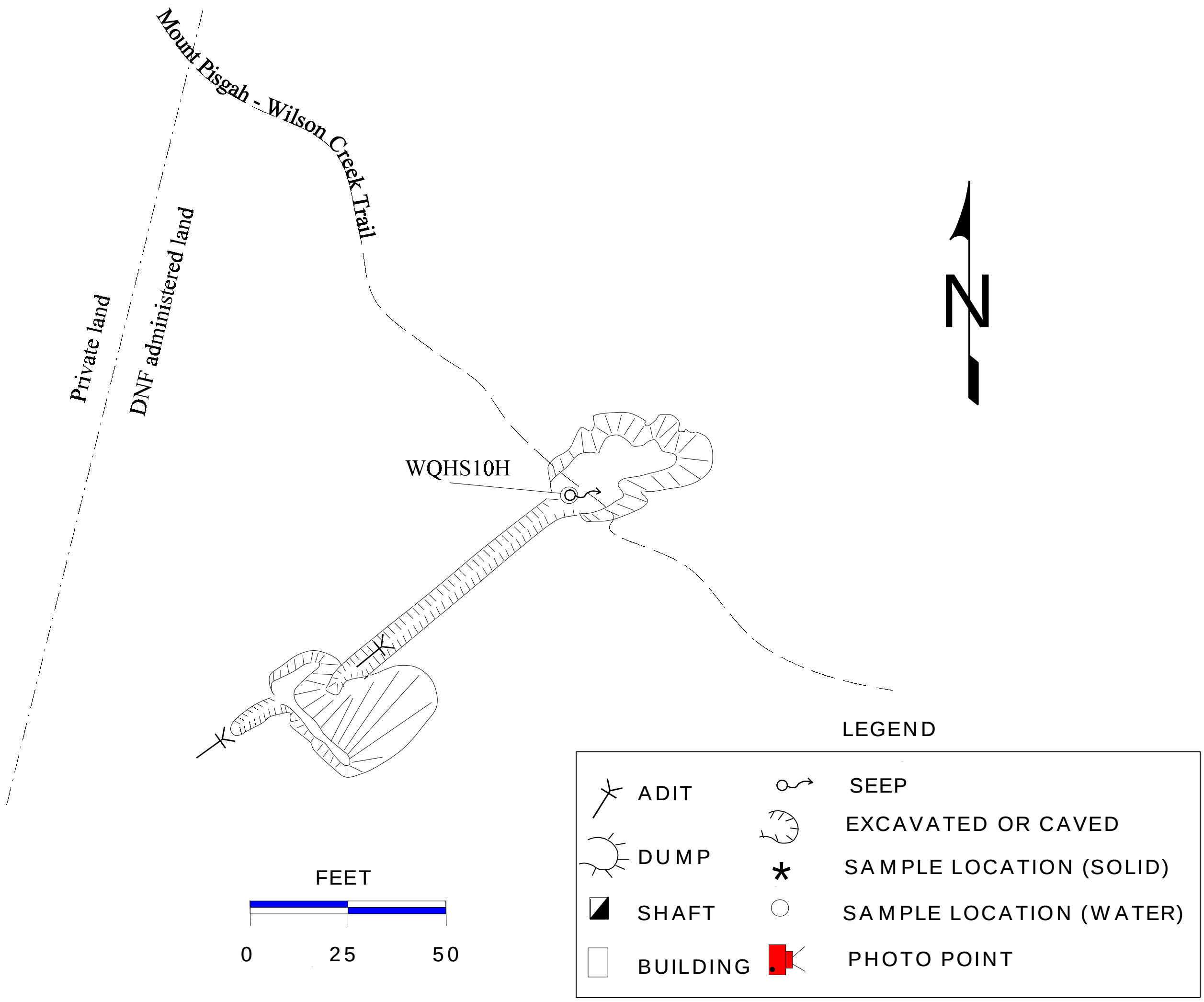

Figure 16. The Queen of the Hills mine (1993) on the Mount Pisgah/Wilson Creek trail. Visitors to the site are frequent.

2.17.3.2 Soil

There were several inches of snow in areas on and near the dump at the time of the visit. Although melting was occurring, there was no evidence of active erosion. The base of the dump was vegetated and showed no signs of impacts to native soils.

2.17.3.3 Water

As noted, the only water on or near the site was the small amount of water discharging from the adit. The discharge stream did not indicate the presence of acid mine drainage or metals precipitation. None of the constituents analyzed exceeded the MCLs considered (table 32).

Table 32. Water-quality exceedences, Queen of the Hills mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Adit discharge (WQHS10L)																			

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.17.3.4 Vegetation

The vegetation on the dumps was sparse to barren with a few small conifers; the vegetation at the base of the dumps, near the adits, and outside the disturbed area was healthy and showed no signs of impacts.

2.17.3.5 Summary of Environmental Condition

The Queen of the Hills mine is a small site on DNF-administered land in Wilson Creek. The lower adit discharged a small amount of water onto the associated waste-rock dump. There appeared to be little impact on soils caused by the mine and no impact to water quality.

2.17.4 Structures

There were no structures such on the site. There were several collapsed cabins about 100 feet north of the site that may have been associated with the mine.

2.17.5 Safety

The waste-rock dumps were quite steep and footing poor. The edges of the caved adits appeared unstable with several overhanging boulders.

2.18 Elkhorn Iron Mine

2.18.1 Site Location and Access

The Elkhorn Iron mine is about 0.3 miles northwest of Elkhorn Peak and about three miles northwest of Elkhorn, Montana (T7N R3W Section 36CDBA), and is on private property. The area around the mine is a high-use recreation area. The mine site is just south of a 4-wheel-drive road that leads to the site from Elkhorn.

2.18.2 Site History - Geologic History

The mine was studied intensively by the USGS (1978) and also described by Roby *et al.* (1960), Klepper *et al.* (1957), and Knopf (1913). The geology of the site is characterized by limestone underlain by Elkhorn Mountains andesite, both of which have been intruded by alaskite and aplite of the Boulder Batholith. The ore exists as replacement lenses within the andesite at the NE-striking, 20°–45°southeast-dipping contact between the andesite and limestone. These zones are from 8 to 65 feet thick and persist for 2,600 feet along strike. They consist of brecciate andesite, hematite, magnetite, garnet, pyrite, and chalcopyrite. The USGS estimated that a resource of 4.2 million tons of 0.03 /ton gold, 0.2 oz/ton silver, 0.15% copper, 0.06% zinc, and 28.7% iron exists here, so the property may be of interest to modern exploration companies.

Most ore from the Elkhorn Iron mine was used as flux at the East Helena smelter from 1890 to 1900. Between 1908 and 1915, 256 tons were shipped for their metal content, and relinquished 10 oz of gold, 2,924 oz of silver, and 190 lbs of copper. Numerous caved adits, pits, and trenches are scattered across the property. Underground workings total 1,500 feet. Most dumps consisted of oxidized gossanous material, limestone, and calc-silicate rocks; sulfide content is low. All samples representing dump composition (USGS 1978) had very low metal values.

2.18.3 Environmental Condition

The mine site consisted of at least three caved adits, a shaft, various open cuts, and waste-rock dumps. An adit on the west end of the site and an adit on the east end of the site were discharging water. The waste-rock dumps did not appear to have eroded onto DNF-administered land. An ore bin and several cabins were present on the site, all of which were in poor condition.

2.18.3.1 Site Features - Sample Locations

Samples were collected at the Elkhorn Iron mine on 8/14/92. The adit at the west end of the site was sampled where it flowed onto DNF-administered land (EEIS10L). The seep was flowing at about five gpm. The adit at the east end of the site was sampled where it flowed onto

DNF-administered land (EEIS20L). The seep was flowing at about four gpm. Soil samples were not collected because the soils on DNF-administered land did not appear to be adversely impacted from waste material. Site features and sample locations are shown in figure 17.

2.18.3.2 Soil

The waste-rock dump was sparsely vegetated. Erosion of this material during storm or runoff events appeared unlikely.

2.18.3.3 Water

Water discharging from the west adit had concentrations of aluminum, copper, and mercury that exceeded water quality criteria. Water discharging from the east adit had a mercury concentration that exceeded water quality criteria (table 33).

Table 33. Water-quality exceedences, Elkhorn Iron mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
West adit(EEIS10L)	S					C				C									
East adit (EEIS20L)										C									

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

Note: The analytical results are listed in appendix IV.

2.18.3.4 Vegetation

The waste-rock dumps are sparsely vegetated. None of the vegetation away from the waste-rock dump appeared to be stressed.

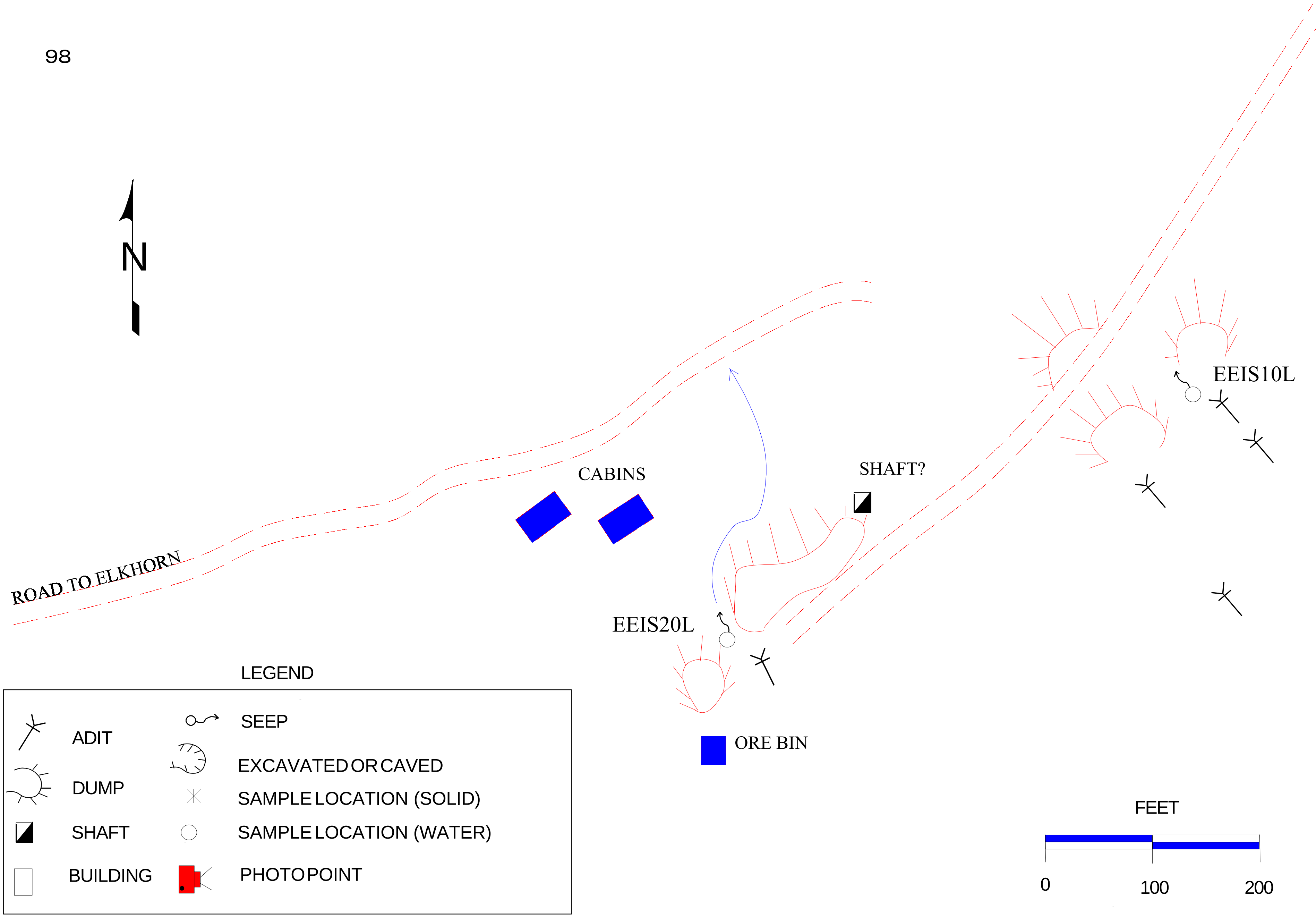

Figure 17. The Elkhorn Iron mine (8/14/92) is on private land. Water was discharging for the site onto DNF-administered land.

2.18.3.5 Summary of Environmental Condition

All of the disturbed area of the Elkhorn Peak Iron mine is on private land. Mass wasting or other movement of material toward DNF-administered land appeared unlikely. Water discharging from the west adit exceeded the secondary standard for aluminum, and the chronic aquatic life standard for copper and mercury. Water discharging from the east adit exceeded the chronic aquatic life standard for mercury.

2.18.4 Structures

Several cabins and an ore bin at the site, on private land, appeared in poor condition. No structures were seen on DNF-administered land.

2.18.5 Safety

No safety concerns were identified on DNF-administered land.

2.19 Elkhorn Skyline Mine

2.19.1 Site Location and Access

The Elkhorn Skyline mine (T6N R2W Section 8BCBD) is about five miles above the town of Elkhorn on a primitive road; the site is about 0.25 miles above Leslie Lake in the Elkhorn Mountains. The mine drains toward Leslie Lake and Queen Gulch, which flow into Elkhorn Creek. All of the site is on DNF-administered land.

2.19.2 Site History - Geologic History

At the Skyline mine, folded and faulted Elkhorn Mountains andesite encloses a small mineralized breccia pipe containing andesite clasts cemented by quartz, tourmaline, arsenopyrite, galena, sphalerite, chalcopyrite, and pyrrhotite (USGS 1978, Klepper *et al.* 1957). The andesite surrounding the pipe contains kaolinite, epidote, and pyrite alteration products and some lenses of quartz and sulfides. Maps and cross sections (Klepper *et al.* 1957) indicate the pipe plunges 64° N70°E. A select sample from the stockpile contained 0.22 oz/ton gold, 4.1 oz/ton silver, 0.2% copper, 2.8% lead, and 3.0% zinc (USGS 1978). However, all samples from the pipe and surrounding mineralization were very low grade, and the USGS assigned a low potential for undiscovered resources of metallic minerals to the site.

The mineralization was explored by three adits, one shaft, and some pits and trenches. Workings total 600 feet with 300 feet of vertical extent. The dumps have low metal values.

2.19.3 Environmental Condition

There are three adits, one shaft, and several shallow pits across the disturbed area of the Elkhorn Skyline mine (figure 18). The dumps are composed of andesite breccia with little or no alteration. The largest dump on the north end of the disturbed area contained 1–2% pyrite, arsenopyrite, galena, and sphalerite. The middle adit discharges water to a small stream that originates above the workings and flows through the workings. The lower dump has a small seep at the base of the waste-rock dump that discharges to this same stream, which flows to Leslie Lake.

2.19.3.1 Site Features - Sample Locations

The site was sampled on 8/13/92. Surface-water samples were collected from the spring at its origin above the disturbed area (ESKS10L), from the discharge from the middle adit (ESKS20L), and downstream of the lower adit (ESKS30L). The stream was discharging about one gpm at its source, about 30 gpm from the caved middle adit, and about 200 gpm on the stream below the disturbed area. The base of the waste-rock dumps were generally well vegetated, and no soils appeared to have been washed toward the stream; no soil samples were collected. Site features and sample locations are shown in figure 18.

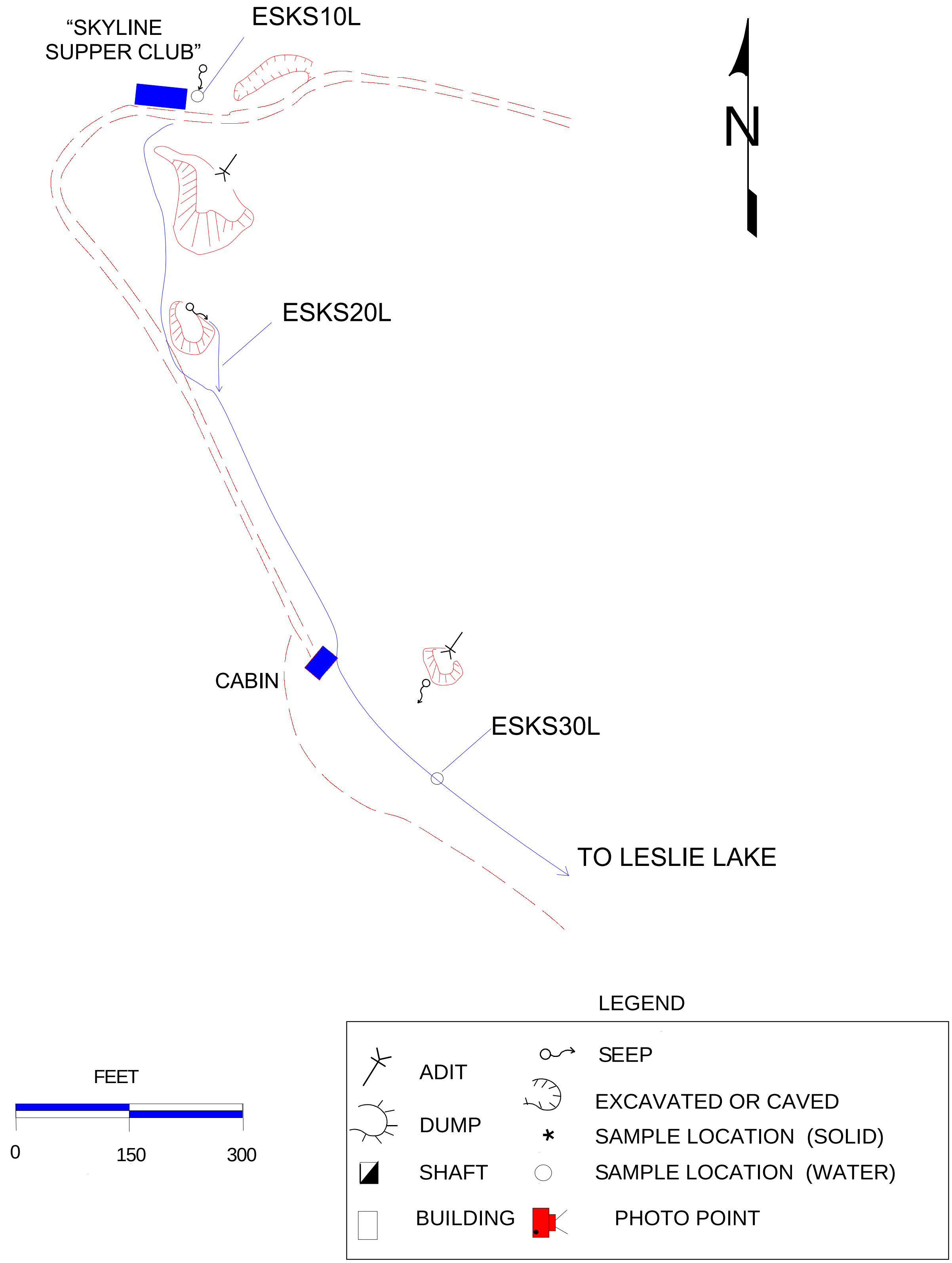

Figure 18. The Elkhorn Skyline (8/13/92) is just above Leslie Lake and is subject to frequent visits by hikers and campers.

Figure 18A. The stream flowed through the disturbed area of the Skyline mine. The discharge from the middle adit flowed into the stream, which flowed into Leslie Lake.

Figure 18B. The “Skyline Supper Club” is frequently visited and apparently maintained by hikers and campers.

2.19.3.2 Soil

As noted, soils in the disturbed area were generally stable and there was no indication that soils had been washed into the stream. Most of the near-stream material was coarse rock.

2.19.3.3 Water

The concentrations of nearly all dissolved metals in all three samples were below detection limits; sulfate was nearly undetectable at less than 3 mg/L. Only mercury exceeded an MCL, but the concentration in all three samples (0.1 µg/L) was at the detection limit. The concentration of zinc, which was detected in all three samples, was greatest in the middle adit discharge (50.2 µg/L) and least in the spring above the workings (10 µg/L).

Table 34. Water-quality exceedences, Elkhorn Skyline mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Spring above workings (ESKS10L)										C									
Middle adit discharge (ESKS20L)										C									
Downstream of workings (ESKS30L)										C									

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.19.3.4 Vegetation

Most of the waste-rock dumps were composed of coarse material, and no soils had formed. Where soils had formed, vegetation appeared healthy and showed little or no stress.

2.19.3.5 Summary of Environmental Condition

The greatest impact of the Elkhorn Skyline mine is the disturbance. Water quality is affected only slightly and did not exceed MCLs. Soils at the base of the waste-rock dumps appeared unaffected by sedimentation or mass wasting. Vegetation was good where soils were available.

2.19.4 Structures

The largest structure on the site was a cabin that had apparently been maintained by hikers. The cabin had been dubbed the “Skyline Supper Club” and showed ample evidence of recent and frequent visits complete with a guest sign-in book. There was also a small dilapidated cabin across the stream from the lower adit; there was no evidence of recent occupation. Wood and metal debris from other buildings were scattered through out the development area.

2.19.5 Safety

Although the “Supper Club” building was generally in good repair, the high number of visitors could be of concern. There also was wood and metal debris throughout the disturbed area.

2.20 Snyder’s Mine

2.20.1 Site Location and Access

The Snyder’s mine (T3N R4W Section 4DDCB) is near the head of the west fork of the South Boulder River about six miles above the town of Mammoth in the Tobacco Root Mountains. Access to the site is by way of a primitive road from the main road from Mammoth and is near the trail head to Sailor Lake. The entire site is on DNF-administered land.

2.20.2 Site History - Geologic History

This has been the only productive mine in the proposed Tobacco Root–Middle Mountain Wilderness area, so it was the subject of a detailed investigation by O'Neill *et al.* (1983). The mine follows a west-striking, south-dipping quartz-pyrite-copper carbonate vein within a shear zone 3.3 feet thick enclosed in Archean gneiss. The vein is at least 760 feet long and is explored by approximately 1,500 feet of workings from five portals. Production in 1934 was 10 ounces of gold, 75 ounces of silver, and 326 pounds of copper. A stockpile sample carried 0.641 oz/ton gold, 6 oz/ton silver, and 0.46% copper. The dumps are composed of unaltered gneiss with no visible sulfides, and dump samples showed only a trace of metals (O'Neill *et al.* 1983).

2.20.3 Environmental Condition

The site consisted of six caved adits and a small pit, each with a waste-rock dump. The lower two adits were discharging water, and a third adit, although dry, was near a spring.

2.20.3.1 Site Features - Sample Locations

Water samples were collected on 9/9/92 from the south adit discharge (JSNS10L), the north adit discharge (JSNS20L), from the spring near the northernmost adit (JSNS40L), and from the stream below the disturbed area (JSNS30L) (figure 19). The south adit was discharging about 9 gpm, the north adit about 40 gpm, and the spring near the northernmost adit about 1.5 gpm. It was apparent that the stream was losing flow in the rubble below the disturbed area; the stream below the disturbed area was flowing at about 15 gpm. No impacts to soils below the disturbed area were observed; no soil samples were collected.

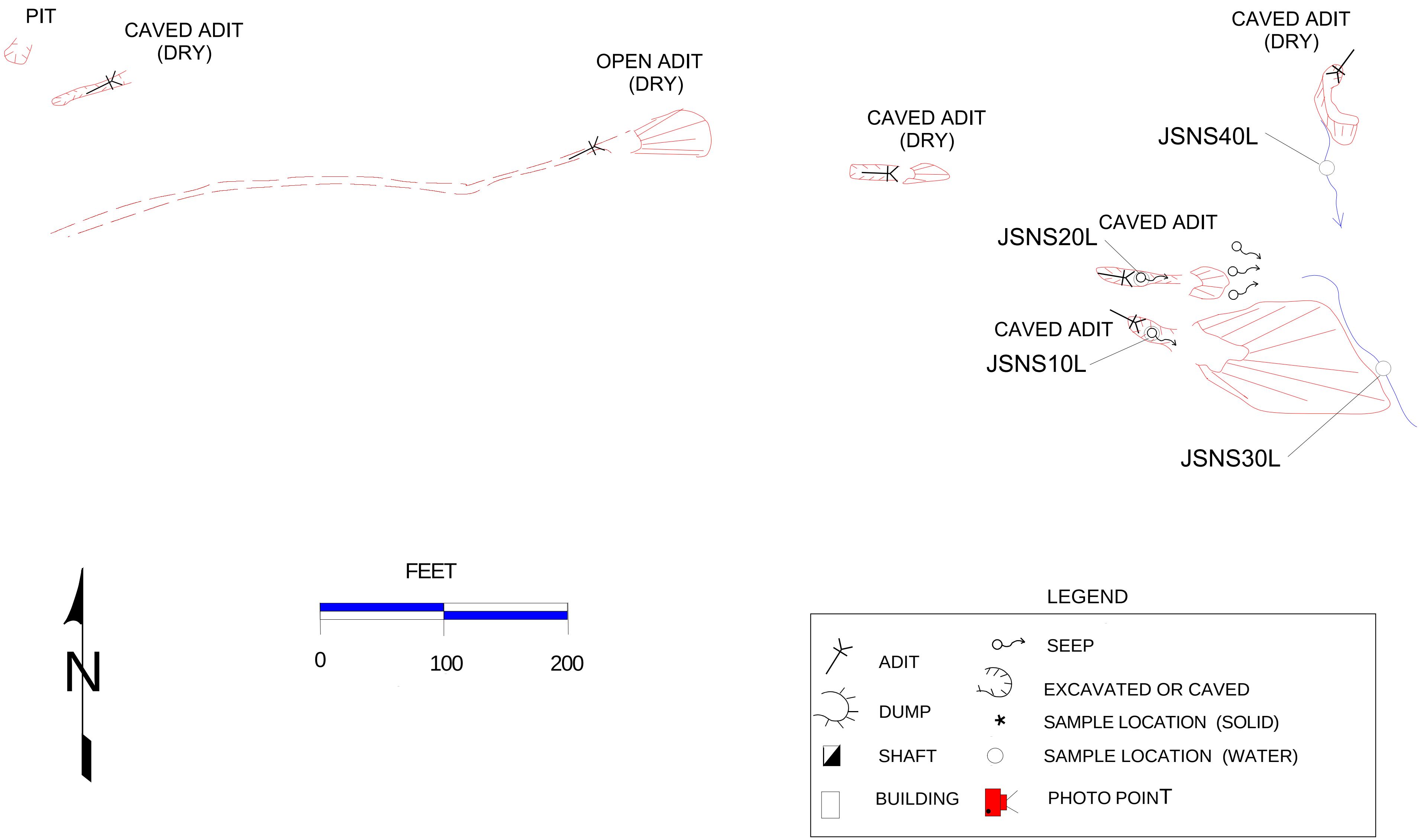

Figure 19. The Snyder's mine (9/9/92) is near the head of the west fork of the South Boulder River. There were at least six adits, two of which discharged water.

Figure 19A. The lower adits of the Snyder's mine were discharging about 50 gpm and formed the headwaters of the tributary.

Figure 19B. The waste-rock dumps of the Snyder's mine were vegetated and stable.

2.20.3.2 Soil

Soils had not formed on the coarse material of the waste-rock dumps nor on the talus slopes around the disturbed area. The base of the lower dumps and the area below showed no indication of soil washing or mass movement.

2.20.3.3 Water

Only the mercury concentration in the sample collected downstream of the site exceeded the MCL; the concentration was at the detection limit of 0.1 µg/L. The standard for pH of the stream below the site was higher than the recommended limits (pH = 8.71). Overall, the total dissolved solids were low; the highest was in the adit discharges, the lowest was in the spring north of the site and in the stream below the site. Sulfate was much lower (14.2 mg/L) in the spring north of the site than the adit discharges and the stream below the site (32.3 to 31.8 mg/L).

Table 35.Water-quality exceedences, Snyder's mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
South adit discharge (JSNS10L)																			
North adit discharge (JSNS20L)																			
Spring above workings (JSNS30L)																			S
Downstream of site (JSNS40L)										C									

Exceedence codes:

- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.20.3.4 Vegetation

The talus slopes were generally barren or sparsely vegetated. The base of the lower dumps and the area below were moderately to well vegetated. No impacts to vegetation related to mining activities were observed below the disturbed area.

2.20.3.5 Summary of Environmental Condition

The adit discharges of the Snyder's mine had a notable impact on streamflow but not a significant impact on surface-water quality. The pH of the stream below the site exceeded the recommended limit, but pH was generally high in all of the samples collected. Vegetation on the base of the dumps appeared healthy, and no impacts to soils were observed.

2.20.4 Structures

The only structures observed on the site were the adit entrance frames, which were partially collapsed. No other structures were observed on the site.

2.20.5 Safety

No safety concerns were identified on this site.

2.21 Mogullion Mine

2.21.1 Site Location and Access

The Mogullion mine (T3S R3W Section 7ABAD) is on a tributary of the east fork of the South Boulder River about five miles above the town of Mammoth. Access to the site is limited to a closed road from the South Boulder River road or by trail from the active Nicholson mine, which is accessible by road from the town of Pony. The Mogullion mine is on DNF-administered land above private land.

2.21.2 Site History - Geologic History

On strike with the operational Nicholson mine just to the east, the Mongolian examines two west-trending shear zones that include quartz-pyrite-galena veins up to 2.6 feet thick (O'Neill *et al.* 1983). However, unlike the Nicholson, gold values are low, with 16 samples having negligible gold , 0.9–2.4 oz/ton silver, and minor lead and zinc. Five-hundred-eighty feet of workings are supposedly present behind a caved portal. The waste-rock dump is composed of mainly gray to yellow clays with low metal values.

2.21.3 Environmental Condition

The site consisted of a single caved adit with the associated waste-rock dump. An ore bin was at the bottom of the dump above an old haul road. Only a minor amount of pyrite was observed in the clay-rich dump.

2.21.3.1 Site Features - Sample Locations

The site was sampled on 9/30/92. The only water on or near the site was the adit discharge; a tributary of the east fork of the South Boulder River was several hundred feet away on private land. The caved adit was discharging about one gpm and was sampled (JMOS10L). Site features and sample locations are shown in figure 20.

The waste-rock dump contained coarse material with little soil, and the base of the dump was vegetated and showed no erosion; no soil samples were collected.

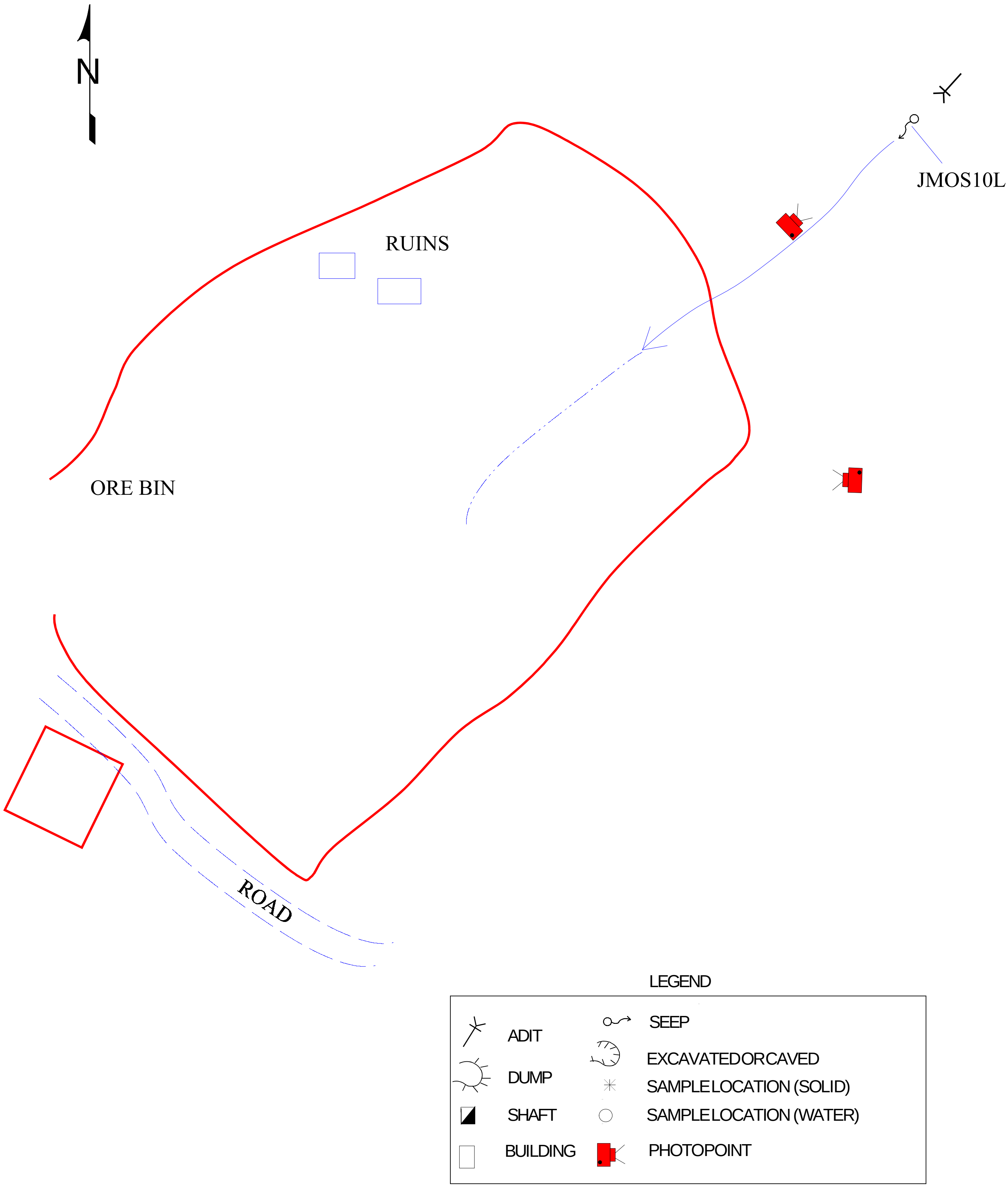

Figure 20. The Mogullion mine (9/30/92) is a single caved adit with a small discharge that infiltrated the top of the waste-rock dump. No seeps were observed at the base of the dump.

Figure 20A. The Mogullion mine adit discharged to the top of the dump and infiltrated within a few feet.

Figure 20B. The waste-rock dump of the Mogullion mine was sparsely vegetated but appeared stable. The ore bin was the only structure observed on the site.

2.21.3.2 Soil

As noted, the waste-rock dump contained little soil. The base of the dump appeared stable, and there was no indication of significant erosion or mass wasting.

2.21.3.3 Water

The adit discharge water of the Mogullion mine did not exceed any of the MCLs considered (table 36). All of the metals considered were well below MCLs, and arsenic was below the detection limit of 0.1 µg/L. The pH of the discharge was slightly above neutral.

Table 36. Water-quality exceedences, Mogullion mine.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Adit discharge (JMOS10L)																			

Exceedence codes:
P - Primary MCL
S - Secondary MCL
A - Aquatic Life Acute
C - Aquatic Life Chronic
(1) Laboratory pH did not exceed standard
Note: The analytical results are listed in appendix IV.

2.21.3.4 Vegetation

The vegetation in the disturbed area was sparse to barren due to lack of soil and water. The vegetation outside the disturbed area consisted of conifers with sparse to barren ground vegetation.

2.21.3.5 Summary of Environmental Condition

The soils associated with the waste-rock dump of the Mogullion mine contained relatively high amounts of clay. The dump appeared stable and contained only a small amount of sulfide minerals, but soils had not formed. The quality of water discharging from the adit was good and did not appear to have an adverse impact on vegetation.

2.21.4 Structures

The ore bin near the base of the waste-rock dump was in poor condition. No other structures were observed on DNF-administered land.

2.21.5 Safety

The poor condition of the ore bin is a safety concern; it was apparent that the site had been visited in the recent past. There was also wood debris scattered around the top of the dump and near the adit.

2.22 Bismark Tailings

2.22.1 Site Location and Access

The Bismark tailings (T2S R4W Section 36CCCC) are on private and DNF-administered land just below the Bismark mill and Bismark mine which are on private land. All are adjacent to the South Fork Boulder River about 3.5 miles above the town of Mammoth in the Tobacco Root Mountains. The site is easily accessed by crossing the river from the main road from Mammoth.

2.22.2 Site History - Geologic History

A broad area of discontinuous vein segments and disseminated mineralization in altered (feldspar to sericite and epidote, Winchell 1914) granitic rock sits astride the northwest-striking Bismark fault. The Bismark fault is one of several high-angle faults in the Tobacco Root Mountains that may have determined the locations of plutonic bodies, and with continued movement, the location of mineralization. Veins and wallrock contain pyrite, chalcopyrite, and molybdenite (O'Neill *et al.* 1983). Mineralization is probably continuous with that of the Quartz City property across the valley. The best values for 12 samples were 0.0 (zero) oz/ton gold, 4.1 oz/ton silver, and 1.91% copper. Molybdenum averaged less than 0.05% (O'Neill *et al.* 1983). Production totals for 1913, 1916, and 1917 are 58,000 pounds of Cu, 7,000 pounds of lead, and 12,000 ounces of silver. The deposit is developed by four adits on four levels with 1,850 feet of total workings.

The lowermost adit, on private land, releases water onto the mill tailings. Springs also contribute some water to the flooded tailings. It is impossible to estimate the volume of tailings present because some portions are overgrown with thick vegetation and others covered with water. A composite sample of the accessible tailings contained 0.25% copper but was very low in other metals.

2.22.3 Environmental Condition

Because the mine, mill, and part of the tailings were on private land, the investigation of this site was limited to the tailings and impacted areas below on DNF-administered land. The extent of the tailings was hard to determine; tails had mixed with soils and part of the area was under about 8–12 inches of water. Tailings had apparently washed down out of a breached dam on private land along the nearby road and then ponded. A small amount of tailings were found mixed with soil on the river side of the road. There was no water flowing on DNF-administered land at the time of visit; however, during snowmelt and storms runoff events there are several areas that are probably subject to runoff.

2.22.3.1 Site Features - Sample Locations

The site was sampled on 9/10/92. Because there was no flowing water at the time of the visit, surface-water sampling was limited to the South Fork Boulder River (JBIS10L). A composite soil sample was collected below the breached dam on DNF-administered land (JBID10H) and a grab soil sample was collected from a small channel where tailings and soil had been washed toward the river (JBID20H). Site features and sample locations are shown in figure 21.

2.22.3.2 Soil

The concentration of copper in the composite sample below the dam and the grab sample near the river exceeded the phytotoxic limits by an order of magnitude. The concentration of the other metals considered and arsenic were not nearly as high. The grab sample represents the material available for transport into the South Fork Boulder River.

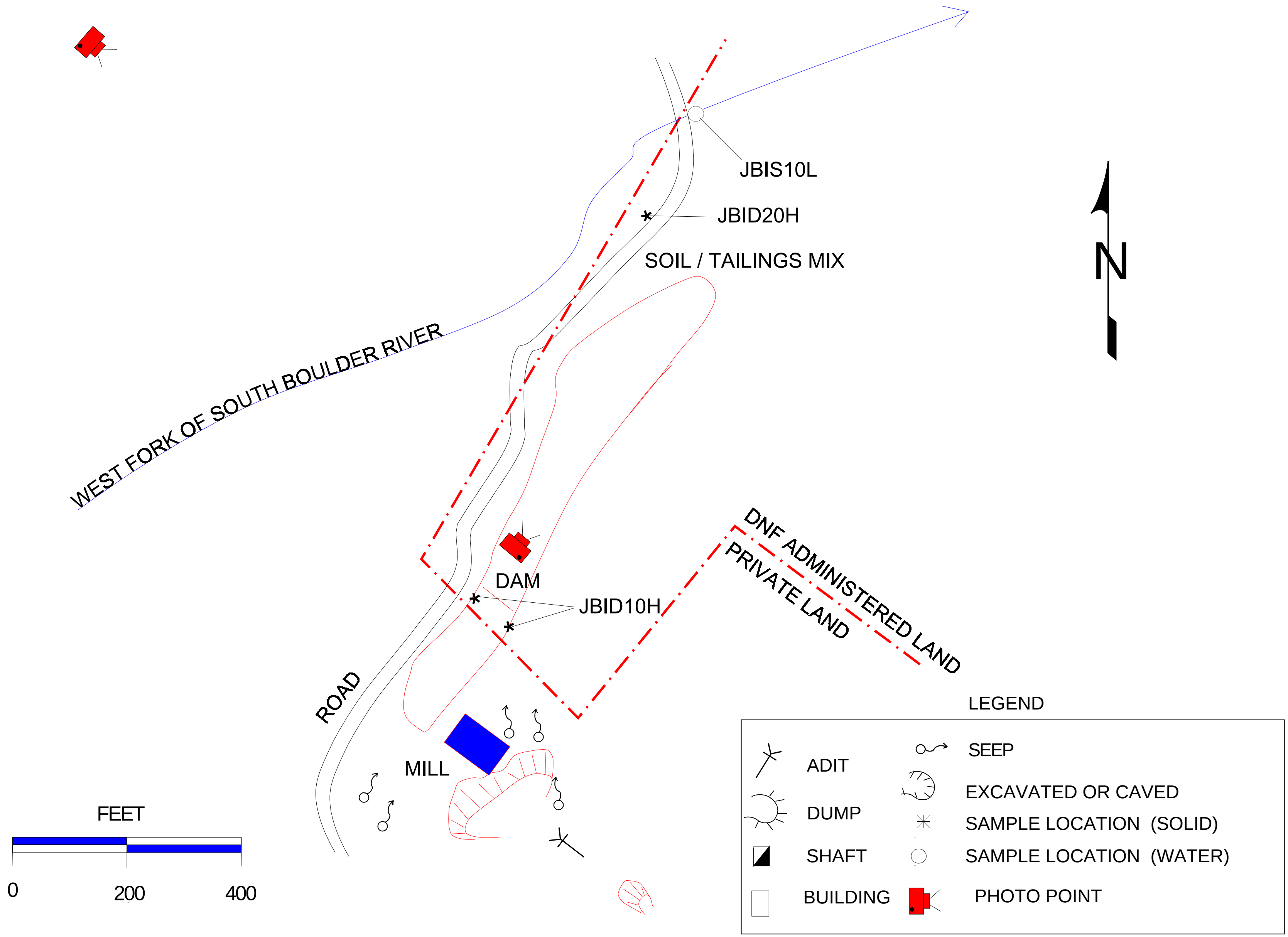

Figure 21. The Bismark tailings (9/10/92) are on private and DNF-administerd land. The main development area is on private land above the tailings.

Figure 21A. The Bismark mine and mill site are quite evident from across the valley of the South Fork Boulder River.

Figure 21B. The tailings of the Bismark mill are partially vegetated and partially submerged. Barren areas also have ferric hydroxide deposits.

Table 37. Soil sampling results, Bismark mill tailings (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Composite below breached dam (JBID10H)	9.42[1]	0.566[1]	1304[1,2]	25.0[1]	28.0
Grab sample near S. F. Boulder River (JBID20H)	11.4[1]	0.688[1]	1159[1,2]	30.6[1]	139[1]

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.22.3.3 Water

All of the constituents with which standards were compared were well below MCLs with the exception of mercury. Mercury concentration was at the detection limit of 0.1 µg/L. Total dissolved solids were low and pH was near neutral. In addition to downstream of the Bismark tailings, this sample also represents concentrations downstream of the Bismark mine and the Snyder's mine.

Table 38. Water-quality exceedences, Bismark mill tailings.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
S.F. Boulder River Downstream (JBIS10L)																			

Exceedence codes:
- P - Primary MCL
- S - Secondary MCL
- A - Aquatic Life Acute
- C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.22.3.4 Vegetation

Much of the lower portion of the tailings were covered with several inches of water. The main area of the tailings were generally well vegetated with some ferric hydroxide precipitates, but areas where tailings were recently deposited were barren.

2.22.3.5 Summary of Environmental Condition

The Bismark tailings appeared stable and partially submerged at the time of visit; however, there was evidence of stormwater/snowmelt transport of tailings into the river. There also were areas where acid generation and subsequent buffering had occurred; the result was barren areas of iron hydroxide staining near the margins of the tails. The adverse impact to ground water is probably significant but could not be assessed.

2.22.4 Structures

There were no structures on DNF-administered land; structures related to the mill and mine were on private land.

2.22.5 Safety

There were no safety concerns identified for the portion of the tailings on DNF-administered land.

2.23 Atlantic & Pacific and Viking–Western Pacific Mines and Mill

2.23.1 Site Location and Access

These mines are treated as one site because geology and environmental problems are continuous and related across the area. The Atlantic & Pacific mine is on private and DNF-administered land on the drainage divide between Willow Creek and the South Fork Boulder River. The lower mine workings and mill tailings of the Atlantic & Pacific and the Viking–Western Pacific mine are on DNF-administered land in the South Fork Boulder River drainage. The entire area covers about 1/4 of a section; Atlantic & Pacific mine is in T2S R3W Section 21BCCD, the lower workings and tailings of the Atlantic & Pacific mine and mill are centered in T2S R3W Section 20ADDB, and the Viking–Western Pacific mine is in T2S R3W Section 20CAAA. Access to the site is by improved road about six miles from the town of Pony on Willow Creek or by primitive road about three miles up Park Creek from the town of Mammoth.

2.23.2 Site History - Geologic History

The area lies along the northwest striking Mammoth fault, a major high-angle structure which played a part in localizing the Tobacco Root batholith (Reid 1957) and mineralization. The Atlantic & Pacific has been the only productive mine at the site. Gold ore was mined from a fractured aplite dike bounded on and associated with Cretaceous granodiorite on the north, and in contact with Archean gneiss on the south (Winchell 1914, Tansley *et al.* 1933). The ore contains quartz and auriferous pyrite and occurs in veins and disseminated in the country rock. Most was mined from surface workings, but there are more than 600 feet of underground workings. Approximately 75,000 tons of tailings are also present at the site. The tailings contain high gold values (0.026 oz/ton) but low silver and base-metal values. They are being eroded during storm events into an adjoining drainage where they contaminate springs feeding Park Creek.

On the Viking–Western Pacific property, granodiorite and aplite with mineralized shear zones and disseminated pyrite were also mined, although metal values from samples taken were low (see USBM MLA-95-83). Despite the poor sample values and the low potential assigned to the property by O'Neill *et al.* (1983), explorers have done some recent drilling. Probably the extensive area of altered rock and anomalous gold have generated some optimism for finding low-grade bulk tonnage gold deposits.

2.23.3 Environmental Condition

The visible impacts caused by mining and milling are varied and widespread in the Park Creek drainage. The portal of the Atlantic & Pacific is on private land near the top of the ridge and discharged water onto DNF-administered land; the discharge stream was continuous to Park Creek about 1,000 feet downhill. This adit had been bulkheaded and sealed several years prior but had blown out; waste material had washed down to at least Park Creek. The source of water for the underground workings is probably, in part, a large open cut above. The waste material in the dump comprised iron-stained aplite and granodiorite strongly mineralized with pyrite.

The tailings pile covered the ridge between Park Creek and its tributary to the north and extended into the bottom of the tributary. Ripple marks and other indications of wind erosion and deposition were evident. Although dry at the time of the visit, it was evident that during wetter periods, springs emanated above and within the tailings in the tributary drainage. On Park Creek about 2,000 feet downstream, tailings up to four feet thick had been deposited; a breached dam in the flood plain was also noted but not mapped.

The Viking–Western Pacific, in the Park Creek drainage consisted of at least nine adits and associated waste-rock dumps; springs discharging to Park Creek were observed at four of the adits and dumps. The dumps associated with the Western Pacific contained only weakly iron-stained aplite and clays; the dumps are small and amount to only a few hundred tons.

2.23.3.1 Site Features - Sample Locations

The site was sampled on 9/16/92; nine surface water, one tailings sample, and one soil sample were collected:

JAPS10M: The tributary drainage to Park Creek below the tailings wash area. The stream was flowing at about 0.2 gpm.

JAPD10H: A grab sample next to JAPS10M where tailings and soils had been mixing and washing into the stream.
JAPS20H: At the adit discharge point; the adit was discharging about 4.5 gpm.
JAPS30L: A spring below the discharging adit of the Atlantic & Pacific mine, but above the workings of the Viking–Western Pacific. The stream was discharging about 25 gpm.
JAPS80L: Park Creek above the Viking–Western Pacific workings. The stream was discharging about 18 gpm.
JAPS90L: Park Creek above the confluence of Park Creek and the stream from the Atlantic & Pacific mine. The stream was discharging about 19 gpm.
JAPS40M: The discharge from the caved-adit adjacent to Park Creek. The discharge was about 1.5 gpm.
JAPS50L: Park Creek upstream of adit discharge. The stream discharge was about 110 gpm.
JAPS70L: Located on Park Creek above the confluence with the dry tributary stream to Park Creek.
JAPS60M: Park Creek downstream of the main portion of the tailings on the tributary and below all workings on Park Creek. The stream discharge was about 52 gpm.
JAPD20H: A sample of the tailings at the breached dam near JAPS60M on Park Creek.

Sample locations and site features are shown in figure 22.

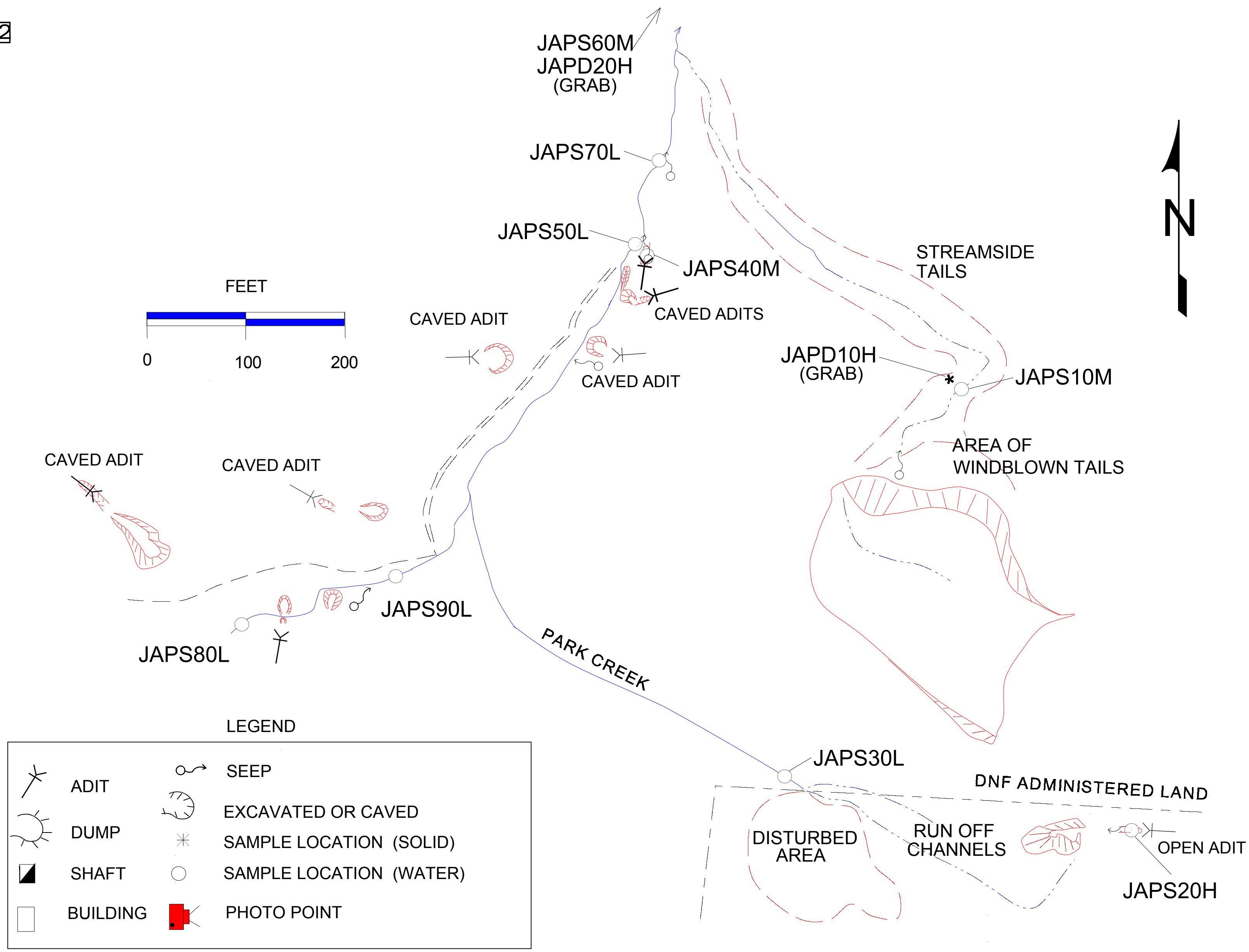

Figure 22. The Atlantic & Pacific and Viking–Western Pacific mines (9/16/92) covered a large area at the top of Park Creek. Several adits were discharging to the creek that flowed into the South Fork Boulder River.

Figure 22A. The tailings of the Atlantic & Pacific are subject to water and wind erosion, as well as small-scale mass wasting.

Figure 22B. The tailings impoundment on Park Creek below the Atlantic & Pacific and Viking–Western Pacific development has been eroded by Park Creek.

Figure 22C. The Atlantic & Pacific adit discharged acidic water to Park Creek. Waste material was washed into Park Creek when the adit seal blew out.

Figure 22D. The adit discharge streams of the Viking–Western Pacific mine were generally well vegetated.

2.23.3.2 Soil

The concentrations of metals in the soils below the main tailings pile were generally low. None of the constituents exceeded phytotoxic limits; zinc was below Clark Fork background levels. In the tailings sample adjacent to Park Creek below the site, the concentrations of cadmium, copper, and lead were elevated but well below phytotoxic limits.

Table 39. Soil sampling results, Atlantic & Pacific and Viking–Western Pacific (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Grab sample below tailings (JAPD10H)	7.02[1]	0.428[1]	19.3[1]	19.3[1]	32.2
Tailings on Park Creek (JAPD20H)	0.895	0.487[1]	49.0[1]	43.0[1]	18.1

(1) Exceeds one or more Clark Fork Superfund background levels (table 3)
(2) Exceeds phytotoxic levels (table 3)

2.23.3.3 Water

The discharge from the Atlantic & Pacific adit and the spring below it were the only waters that exceeded the standards considered (table 40). The concentration of aluminum, copper, iron, manganese, and sulfate exceeded secondary drinking water MCLs in the sample from the adit discharge, often by a large margin. The concentration of metals in the spring below the adit were much lower; only the concentration aluminum exceeded the secondary MCL.

Table 40. Water-quality exceedences, Atlantic & Pacific and Viking–Western Pacific.

Sample Site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Downstream of upper tailings (JAPS10M)																			
A&P adit discharge (JAPS20H)	S,A C			C		S,A C	S,A	C	S	C							S		S
Spring below A&P adit (JAPS30L)	S					C				C									
Upstream of Viking–W. Pacific (JAPS80L)																			
Above confluence with A&P adit stream (JAPS90L)																			
Upper adit discharge-Viking (JAPS40M)																			
Lower adit discharge-Viking (JAPS50L)																			
Above confluence with dry tributary (JAPS70L)																			
Park Creek below site (JAPS60M)																			

Exceedence codes:

P - Primary MCL
S - Secondary MCL
A - Aquatic Life Acute
C - Aquatic Life Chronic

(1) Laboratory pH did not exceed standard

Note: The analytical results are listed in appendix IV.

2.23.3.4 Vegetation

The area near the adit discharge and on the dumps of the Atlantic & Pacific was barren most of the way to Park Creek. The tailings and where tailings had mixed with soils were barren. The base of the dumps and adit areas of the Viking–Western Pacific were generally well vegetated as was the stream bank; the tops of the dumps were generally sparsely vegetated. The tailings below the main development area on Park Creek were sparse to barren; vegetation outside the tailings was sparse.

2.23.3.5 Summary of Environmental Condition

Based on sampling results, the appearance of the Atlantic & Pacific and Viking–Western Pacific is deceptive. The quality of water downstream of the site is generally good; the effects of the poor-quality adit discharge from the Atlantic & Pacific mine was limited to the upper drainage. The concentrations of metals in the soils below the main tailings impoundment was low, and the concentrations of metals in the tailings near Park Creek also were low.

2.23.4 Structures

There were several cabins in poor repair, and ruins of buildings, in the area of the Viking–Western Pacific workings. No other structures were observed on DNF-administered land.

2.23.5 Safety

The safety concerns at this site are varied. Deep cuts caused by the adit blow-out appear unstable and windblown tailings were evident. The tailings pile behind the main impoundment were steep and sandy in some areas; small-scale mass wasting had occurred and may occur again. The poor condition of some of the cabins on the Viking–Western Pacific development area also may be of concern.

2.24 Summary of Mine and Mill Sites on DNF-Administered Land in the Jefferson River Basin

There were 19 sites on or affecting DNF-administered land in the Jefferson River drainage; 17 of these sites had one or more surface-water discharges. With the exception of the Atlantic & Pacific and Viking–Western Pacific mines, all of the mines were isolated with only one per tributary. The adverse environmental impacts of the mines in the Jefferson River drainage are often local; within a few hundred feet of the disturbed area, surface-water quality improves to background levels, and contaminated soils are limited.

The two sites with the largest extent of impact are the Highland mill and the Atlantic & Pacific mine and mill tailings. These cover several acres and have been extensively eroded by surface water during snowmelt and storm events. However, the concentrations of dissolved metals downstream of both sites were not significantly higher than background. This may not be true during periods of high runoff.

Acid mine drainage (pH<6) was found at the Atlantic & Pacific mine, the Leadville mine, and the Montreal Star mine. The pH values of adit discharges and seeps from waste material at others sites were generally near neutral or slightly alkaline.

Safety concerns at each site varied from none to several. Open adits and shafts were found at several sites, but the most common safety concern was dilapidated structures. Most sites showed evidence of recent and frequent visits; one site, the Elkhorn Skyline mine, is maintained by visitors as an overnight camping area.

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Appendix I

Field Form

PART A

(To be completed for all identified sites)

LOCATION AND IDENTIFICATION

ID# ________________ Site Name(s) ________________________________
FS Tract # ____________________ FS Watershed Code ____________________
Forest ___________________ District ___________________
Location based on: GPS___ Field Map___ Existing Info___ Other______________
Lat___________ Long___________ xutm_________ yutm_________ zutm_________
Quad Name ______________________ Principal Meridan ____________________
Township __________ Range __________ Section _____ ¼_____ ¼_____ ¼_____
State _____ County ___________________ Mining District ____________________

Ownership of *all* disturbances:

_____ National Forest (NF)
_____ Mixed private and National Forest (or unknown)
_____ Private.

If private only, impacts from the site on National Forest Resources are
____Visually apparent ____Likely to be significant ____Unlikely or minimal

If all disturbances are private <u>and</u> impacts to National Forest Resources are unlikely or minimal - STOP

PART B

(To be completed for all sites on or likely effecting National Forest lands)

SCREENING CRITERIA

Yes	No	
_____	_____	1. Mill site or Tailings present
_____	_____	2. Adits with discharge or evidence of a discharge
_____	_____	3. Evidence of or strong likelihood for metal leaching, or AMD (water stains, stressed or lack of vegetation, waste below water table, etc.)
_____	_____	4. Mine waste in floodplain or shows signs of water erosion
_____	_____	5. Residences, high public use area, or environmentally sensitive area (as listed in HRS) within 200 feet of disturbance
_____	_____	6. Hazardous wastes/materials (chemical containers, explosives, etc)
_____	_____	7. Open adits/shafts, highwalls, or hazardous structures/debris
_____	_____	8. Site visit *(If yes, take picture of site)*, Film number(s) __________

If yes, provide name of person who visited site and date of visit
Name: ____________________________ Date: ____________
If no, list source(s) of information (If based on personal knowledge, provide name of person interviewed and date):

____

If the answers to questions 1 through 6 are <u>all</u> No - STOP

PART C

(To be completed for all sites not screened out in Parts A or B)

Investigator ______________________________ Date ______________
Weather ____

1. GENERAL SITE INFORMATION

Take panoromic picture(s) of site, Film Number(s) __________
Size of disturbed area(s) __________acres Average Elevation __________feet
Access: _____No trail _____Trail _____4wd only _____Improved road
_____Paved road
Name of nearest town (by road): ____________________
Site/Local Terrain: _____Rolling or flat _____Foothills _____Mesa _____Mountains
_____Steep/narrow canyon
Local undisturbed vegetation (*Check all that apply*): _____Barren or sparsely vegetated
_____weeds/grasses _____Brush _____Riparian/marsh _____Deciduous trees
_____Pine/spruce/fir
Nearest wetland/bog: ___On site, ___0-200 feet, ___200 feet - 2 miles, ___> 2 miles
Acid Producers or Indicator Minerals: ___Arsenopyrite, ___Chalcopyrite, ___Galena,
___Iron Oxide, ___Limonite, ___Marcasite, ___Pyrite, ___Pyrrhotite,
___Sphalerite, ___Other Sulfide
Neutralizing Host Rock: ___Dolomite, ___Limestone, ___Marble, ___Other Carbonate

2. OPERATIONAL HISTORY

Dates of significant mining activity________________________________

MINE PRODUCTION

Commodity(s)							
Production (ounces)							

Years that Mill Operated________________________________
Mill Process: ___Amalgamation, ___Arrastre, ___CIP (Carbon-in-Pulp), ___Crusher only,
___Cyanidation, ___Flotation, ___Gravity, ___Heap Leach, ___Jig Plant,
___Leach, ___Retort, ___Stamp, ___ No Mill, ___Unknown

MILL PRODUCTION

Commodity(s)							
Production (ounces)							

3. HYDROLOGY

Name of nearest Stream __________________ which flows into ____________________
Springs (*in and around mine site*): ____ Numerous ____ Several ____ None
Depth to Groundwater ______ ft, Measured at: ____shaft/pit/hole ____well ____wetland
Any waste(s) in contact with active stream ____Yes ____No

4. TARGETS *(Answer the following based on general observations only)*

Surface Water
Nearest surface water inake ________miles, Probable use ________________________
Describe number and uses of surface water intakes observed for 15 miles downstream of site: ____

____

____

Wells
Nearest well ______miles, Probable use ______________________
Describe number and use of wells observed within 4 miles of site:

____

____

____

Population
Nearest dwelling ______miles, Number of months/year occupied ______ months
Estimate number of houses within 2 miles of the site *(Provide estimates for 0-200ft, 200ft-1mile, 1-2miles, if possible)*

____

____

____

Recreational Usage
Recreational use on site: ____High *(Visitors observed or evidence such as tire tracks, trash, graffiti, fire rings, etc.; and good access to site)*, ____Moderate *(Some evidence of visitors and site is accessible from a poor road or trail)*, ____Low *(Little, if any, evidence of visitors and site is not easily accessible)*
Nearest recreational area ______miles, Name or type of area: ______________________

5. SAFETY RISKS

______Open adit/shaft, ______Highwall or unstable slopes, ______Unstable structures, ______Chemicals, ______Solid waste including sharp rusted items, ______Explosives

6. MINE OPENINGS

Include in the following chart all mine openings located on or partially on National Forest lands. Also, include mine openings located entirely on private land if a point discharge from the opening crosses onto National Forest land. In this case, enter data for the point at which the discharge flows onto National Forest land; you do not need to enter information about the opening itself.

TABLE 1 - ADITS, SHAFTS, PITS, AND OTHER OPENINGS

Opening Number						
Type of Opening						
Ownership						
Opening Length (ft)						
Opening Width (ft)						
Latitude (GPS)						
Longitude (GPS)						
Condition						
Ground water						
Water Sample #						
Photo Number						

Comments *(When commenting on a specfic mine opening, reference opening number used in Table 1)*:

____

____

____

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Type of opening: ADIT=Adit, SHAFT=Shaft, PIT=Open Pit/Trench, HOLE=Prospect Hole, WELL=Well

Ownership: NF=National Forest, MIX=National Forest and Private (Also, for unknown), PRV=Private

Condition *(Enter all that apply)*: INTACT=Intact, PART=Partially collapsed or filled, COLP=Filled or collapsed, SEAL=Adit plug, GATE=Gated barrier,

Ground water (*Water or evidence of water discharging from opening*): NO=No water or indicators of water, FLOW=Water flowing, INTER=Indicators of intermittant flow, STAND= Standing water only (*In this case, enter an estimate of depth below grade*)

7. MINE/MILL WASTE

Include in the following chart all mine/mill wastes located on or partially on National Forest lands. Also, include mine/mill wastes located entirely on private land if is visually effecting or is very likely to be effecting National Forest resources. In this case enter data for the point at which a discharge from the waste flows onto National Forest land, or where wastes has migrated onto National Forest land; only enter as much information about the waste as relevant and practicable.

TABLE 2 - DUMPS, TAILINGS, AND SPOIL PILES

Waste Number						
Waste Type						
Ownership						
Area (acres)						
Volume (cu yds)						
Size of Material						
Wind Erosion						
Vegetation						
Surface Drainage						
Indicators of Metals						
Stability						
Location with respect to Floodplain						
Distance to Stream						
Water Sample #						
Waste Sample #						
Soil Sample #						
Photo Number						

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Waste Type: WASTE=Waste rock dump, MILL=Mill tailings, SPOIL=Overburden or spoil pile, HIGH=Highwall, PLACER=Placer or hydraulic deposit, POND=Settling pond or lagoon, ORE=Ore Stockpile, HEAP=Heap Leach

Ownership: NF=National Forest, MIX=National Forest and Private (*Also, for unknown*), PRV=Private

Size of material (*If composed of different size fractions, enter the sizes that are present in significant amounts*): FINE=Finer than sand, SAND=sand, GRAVEL=>sand and <2", COBBLE=2"-6", BOULD=>6"

Wind Erosion, Potential for: HIGH=Fine, dry material that could easily become airborne, airborne dust, or windblown deposits, MOD=Moderate, Some fine material, or fine material that is usually wet or partially cemented; LOW=Little if any fines, or fines that are wet year-round or well cemented.

Vegetation (*density on waste*): DENSE=Ground cover > 75%, MOD=Ground cover 25% - 75%, SPARSE=Ground cover < 25%, BARREN=Barren

Surface Drainage (*Include all that apply*): RILL=Surface flow channels mostly < 1' deep, GULLY=Flow channels >1' deep, SEEP=Intermittant or continuous discharge from waste deposit, POND=Seasonsal or permanent ponds on feature, BREACH=Breached, NO=No indicators of surface flow observe

Indicators of Metals (*Enter as many as exist*): NO=None, VEG=Absence of or stressed vegetation, STAIN=yellow, orange, or red precipitate, SALT=Salt deposits, SULF=Sulfides present

Stability: EMER=Imminent mass failure, LIKE=Potential for mass failure, LOW=mass failure unlikely

Location w/respect to Stream: IN=In contact with normal stream, NEAR=In riparian zone or floodplain, OUT=Out of floodplain

8. SAMPLES

Take samples only on National Forest lands.

TABLE 3 - WATER SAMPLES FROM MINE SITE DISCHARGES

Sample Number						
Date sample taken						
Sampler (*Initials*)						
Discharging From						
Feature Number						
Indicators of Metal Release						
Indicators of Sedimentation						
Distance to stream (ft)						
Sample Latitude						
Sample Longitude						
Field pH						
Field SC						
Flow (*gpm*)						
Method of measurement						
Photo Number						

Comments: ***(When commenting on a specfic water sample, reference sample number used in Table 3)*:**

____

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Discharging From: ADIT=Adit, SHAFT=Shaft, PIT=Pit/Trench, HOLE=Prospect Hole, WASTE=Waste rock dump, MILL=Mill tailings, SPOIL=Overburden or spoil pile, HIGH=Highwall, PLACER=Placer or hydraulic deposit, POND=Settling pond or lagoon, WELL=Well

Feature Number: Corresponding number from Table 1 or Table 2 (*Opening Number or Waste Number*)

Indicators of Metal Release (*Enter as many as exist*): NO=None, VEG=Absence of, or stressed vegetation/ organisms in and along drainage path, STAIN=yellow, orange, or red precipitate, SALT= Salt deposits, SULF=Sulfides present, TURB=Discolored or turbid discharge

Indicators of Sedimentation (*Enter as many as exist*): NO=None, SLIGHT=Some sedimentation in channel, banks and channel largely intact, MOD=Sediment deposits in channel, affecting flow patterns, banks largely intact, SIGN=Sediment deposits in channel and/or along stream banks extending to nearest stream

Method of Measurement: EST=Estimate, BUCK=Bucket and time, METER=Flow meter

TABLE 4 - WATER SAMPLES FROM STREAM(S)

Location relative to mine site/features	Upstream (Background)	Downstream		
Sample Number				
Date sample taken				
Sampler (Initials)				
Stream Name				
Indicators of Metal Release				
Indicators of Sedimentation				
Sample Latitude				
Sample Longitude				
Field pH				
Field SC				
Flow (gpm)				
Method of measurement				
Photo Number				

Comments: ***(When commenting on a specfic water sample, reference sample number used in Table 4)***:

____

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Indicators of Metal Release (*Enter as many as exist*): NO=None, VEG=Absence of, or stressed streamside vegetation/organisms in and along drainage path, STAIN=yellow, orange, or red precipitate, SALT=Salt deposits, SULF=Sulfides present, TURB=Discolored or turbid discharge

Indicators of Sedimentation (*Enter as many as exist*): NO=None, SLIGHT=Some sedimentation in channel, natural banks and channel largely intact, MOD=Sediment deposits in channel, affecting stream flow patterns, natural banks largely intact, SIGN=Sediment deposits in channel and/or along stream banks extending ½ a mile or more downstream

Method of Measurement: EST=Estimate, BUCK=Bucket and time, METER=Flow meter

TABLE 5 - WASTE SAMPLES

Sample Number				
Date of sample				
Sampler (*Initials*)				
Sample Type				
Waste Type				
Feature Number				
Sample Latitude				
Sample Longitude				
Photo Number				

Comments: *(When commenting on a specfic waste or soil sample, reference sample number used in Table 5)*:

____

____

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Sample Type: SING=Single sample, COMP=composite sample (enter length)

Waste Type: WASTE=Waste rock dump, MILL=Mill tailings, SPOIL=Overburden or spoil pile, HIGH=Highwall, PLACER=Placer or hydraulic deposit, POND=Settling pond or lagoon sludge, ORE=Ore Stockpile, HEAP=Heap Leach

Feature Number: Corresponding number from Table 2 (*Waste Number*)

TABLE 6 - SOIL SAMPLES

Sample Number				
Date of sample				
Sampler (*Initials*)				
Sample Type				
Sample Latitude				
Sample Longitude				
Likely Source of Contamination				
Feature Number				
Indicators of Contamination				
Photo Number				

Comments: (*When commenting on a specfic waste or soil sample, reference sample number used in Table 6*):

____

____

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Sample Type: SING=Single sample, COMP=composite sample (enter length)

Likely Source of Contamination: ADIT=Adit, SHAFT=Shaft, PIT=Open Pit, HOLE=Prospect Hole, WASTE=Waste rock dump, MILL=Mill tailings, SPOIL=Overburden or spoil pile, PLACER= Placer or hydraulic deposit, POND=Settling pond or lagoon, ORE=Ore Stockpile, HEAP=Heap Leach

Feature Number: Corresponding number from Table 1 or 2 (*Opening or Waste Number*)

Indicators of Contamination (*Enter as many as exist*): NO=None, VEG=Absence of vegetation, PATH=Visible sediment path, COLOR=Different color of soil than surrounding soil, SALT=Salt crystals

9. HAZARDOUS WASTES/MATERIALS

TABLE 7 - HAZARDOUS WASTES/MATERIALS

Waste Number				
Type of Containment				
Condition of Containment				
Contents				
Estimated Quantity of Waste				

Comments: *(When commenting on a specfic hazardous waste or site condition, reference waste number used in Table 7)*:

____

____

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Type of Containment: NO=None, LID=drum/barrel/vat with lid, AIR=drum/barrel/vat without lid, CAN=cans/jars, LINE=lined impoundment, EARTH=unlined impoundment

Condition of Containment: GOOD=Container in good condition, leaks unlikely, FAIR=Container has some signs of rust, cracks, damage but looks sound, leaks possible, POOR=Container has visible holes, cracks or damage, leaks likely, BAD=Pieces of containers on site, could not contain waste

Contents: from label if available, or guess the type of waste, e.g., petroleum product, solvent, processing chemical.

Estimated Quantity of Waste: Quantity still contained and quantity released

10. STRUCTURES

For structures on or partially on National Forest lands.

TABLE 8 - STRUCTURES

Type						
Number						
Condition						
Photo Number						

Comments:

____

____

____

Codes Applicable for all entries: NA= Not applicable, UNK=Unknown, OTHER=Explain in comments, NO=NO or none

Type: CABIN=Cabin or community service (*store, church, etc.*), MILL=mill building, MINE=building related to mine operation, STOR=storage shed, FLUME=Ore Chute/flume or tracks for ore transport

Number: Number of particular type of structure all in similar condition or length in feet

Condition: GOOD=all components of structure intact and appears stable, FAIR=most components present but signs of deterioration, POOR=major component (*roof, wall, etc*) of structure has collapsed or is on the verge of collapsing, BAD=more than half of the structure has collapsed

11. MISCELLANEOUS

Are any of the following present? (Check all that apply): _____Acrid Odor, _____Drums, _____Pipe, _____Poles, _____Scrap Metal, _____Overhead wires, _____Overhead cables, _____Headframes, _____Wooden Structures, _____Towers, _____Power Substations, _____Antennae, _____Trestles, _____Powerlines, _____Transformers, _____Tramways, _____Flumes, _____Tram Buckets, _____Fences, _____Machinery, _____Garbage

Describe any obvious removal actions that are needed at this site:

____

____

____

____

General Comments/Observations (not otherwise covered)

____

____

____

____

____

____

____

12. SITE MAP

Prepare a sketch of the site. Indicate all pertinent features of the site and nearby environment. Include all significant mine and surface water features, access roads, structures, etc. Number each important fearue at the mine site and use these number throughout this form when referring to a particular feature (Tables 1 and 2). Sketch the drainage routes off the site into the nearest stream.

13. RECORDED INFORMATION

Owner(s) of patented land
Name: ______________________________
Address: ______________________________
Telephone Number: ______________________________

Claimant(s)
Name: ______________________________
Address: ______________________________
Telephone Number: ______________________________

Surface Water (*From water rights*)
Number of Surface Water Intakes within 15 miles downstream of site used for:
_____Domestic, _____Municipal, _____Irrigation, _____Stock,
_____Commerical/Industrial, _____ Fish Pond, _____Mining,
_____Recreation, _____Other

Wells (*From well logs*)
Nearest well _____miles
Number of wells within _____0-¼ miles _____¼-½ miles _____½-1 mile _____1-2 miles
_____2-3 miles _____3-4 miles of site

Sensitive Environments
List any sensitive environments (as listed in the HRS) within 2 miles of the site or along receiving stream for 15 miles downstream of site (*wetlands, wilderness, national/state park, wildlife refuge, wild and scenic river, T&E or T&E habitat, etc*):
____
____
____

Population (*From census data*)
Population within _____0-¼ miles _____¼-½ miles _____½-1 mile _____1-2 miles
_____2-3 miles _____3-4 miles of site

Public Interest
Level of Public Interest: _____Low, _____Medium, _____High
Is the site under regulatory or legal action? _____Yes, _____No

Other sources of information (MILs #, MRDS #, other sampling data, etc):
____
____
____
____
____

Appendix II

Abandoned–Inactive Mines and Mills
with Potential to Affect
the Deerlodge National Forest

CODE	MINE NAME	QUADRANGLE
V	16:1	DELMOE LAKE
X	2 PERCENT	PHILIPSBURG
X	2ND CHANCE ORE	MAXVILLE
U	6354	DELMOE LAKE
X	A&B	LOCKHART MEADOWS
V	A&M PROSPECT	MAXVILLE
V	ABBOT	SILVER LAKE
V	ADA	BASIN
V	ADELAIDE	BASIN
S	ADIT	MOUNT HUMBUG
S	AIREDALE PROSPECT	WHETSTONE RIDGE
V	AJAX	RATIO MOUNTAIN
V	ALBION MINE	PIKES PEAK
S	ALDER GULCH PLACER	ALDER GULCH
X	ALGONGUIN	PHILIPSBURG
V	ALLPORT	BISON CANYON
U	ALTURAS	SILVER LAKE
X	AM SELEY MINE	ALDER GULCH
V	AMAZON	POZEGA LAKES
S	AMERICAN BEAUTY	PIKES PEAK
S	AMERICAN FLAG	FRED BURR LAKE
S	AMETHYST PROSPECT	PIKES PEAK
X	ANACONDA QUARRIES	WEST VALLEY
X	ANACONDA QUARRIES	WEST VALLEY
U	ANDERSON PROSPECT	WHETSTONE RIDGE
S	ANNIE	HENDERSON MOUNTAIN
V	ANTELOPE	WEST VALLEY
X	ANTELOPE CHROMITE	PONY
X	ANTONIOTI QUARRY	TUCKER CREEK
X	APEX	SILVER LAKE
X	APEX #2	WICKIUP CREEK
V	APOLLO	MOUNT THOMPSON
V	APRIL	SHEEPSHEAD MOUNTAIN
V	AQUIRIUS	BASIN
S	ARCHEGAN	MAXVILLE
S	AREA NORTH	WEST VALLEY
V	ARGO	SPINK POINT
V	ARGUS	BAGGS CREEK
S	ARROWHEAD & SOUTH AMERICA	MOUNT POWELL
V	ATLANTIC AND PACIFIC MINE	PONY
V	ATLANTIC AND PACIFIC TAILINGS	PONY
V	ATTOWA	RATIO MOUNTAIN
V	AURORA	BASIN
X	AUTUMN PLACER	SILVER LAKE
X	B GROUP	SILVER LAKE
V	B&H	OLD BALDY MOUNTAIN
V	B&H TAILINGS	OLD BALDY MOUNTAIN
X	BAIER	PHILIPSBURG
V	BAKAMA	MOUNT THOMPSON
U	BALLARAT	PIPESTONE PASS
S	BALLARD	ROCK CREEK LAKE
V	BANKER CLAIM	MAXVILLE
V	BANKER GROUP	LOCKHART MEADOWS
V	BANNER MINE	MOOSE LAKE
S	BANNER TAILINGS	MOOSE LAKE
S	BARBARA ANN	CARPP RIDGE
U	BARICH MINE	PIKES PEAK
X	BARRY DEAN	SUGARLOAF MOUNTAIN
V	BASIN	PHILIPSBURG
S	BASIN BELL	BASIN
S	BASIN CREEK PLACER	BASIN
U	BASIN CREEK PLACER	MOUNT HUMBUG
V	BASIN GOLD & SILVER	BASIN
X	BASIN GOLDFIELDS	BASIN
X	BASIN JIBE MINE	BASIN
X	BASIN QUARRY	BASIN
S	BASIN TOWNSITE	BASIN
U	BATTERTON BAR	ROCK CREEK LAKE
S	BAYARD	WATERLOO
S	BEAL LODE	DICKIE PEAK
U	BEAR & FLOAT	HENDERSON MOUNTAIN
S	BEAR CAT	PIPESTONE PASS
S	BEAR CREEK PLACER	MOUNT HUMBUG
S	BEAR GULCH PLACER	OLD BALDY MOUNTAIN
V	BEAVER PLACER	RATIO MOUNTAIN
X	BEE BEE	MAUKEY GULCH
V	BEEF STRAIGHT	DELMOE LAKE
V	BEEF STRAIGHT NORTH	DELMOE LAKE
S	BELL	BAGGS CREEK
S	BELLAIRE MINE	DUNKLEBERG CREEK
X	BELLEFLOWER MINE	HENDERSON MOUNTAIN
X	BELLUM	PHILIPSBURG
U	BEN HARRISON FRACTURE	PONY
V	BENTZ	MAUKEY GULCH
X	BERG	SILVER LAKE
S	BERKIN FLAT	THUNDERBOLT CREEK
X	BERNICE	LOCKHART MEADOWS
V	BERTHA MAY	BAGGS CREEK
V	BI-METALLIC	FRED BURR LAKE
V	BIELENBERG LAKE PROSPECT	PIKES PEAK
X	BIESNAHAN & FENNER	WEST VALLEY
X	BIG & LITTLE GOLDIE	BOULDER EAST
V	BIG BEAR	WEST VALLEY
S	BIG BILL	FRED BURR LAKE
S	BIG BILL PROSPECT	PIKES PEAK
U	BIG CHIEF	DELMOE LAKE
X	BIG EXPECTATION	FRED BURR LAKE
V	BIG FOOT	RATIO MOUNTAIN
S	BIG FOOT CREEK PLACER	RATIO MOUNTAIN
V	BIG FOUR	RATIO MOUNTAIN
V	BIG MAJOR - NEW BALD EAGLE	BOULDER WEST
S	BIGFOOT CREEK PLACER	BOULDER WEST
V	BILLIE GOAT	FRED BURR LAKE
V	BILLIE T.	MOUNT THOMPSON
X	BIMETALLIC TUNNEL	PHILIPSBURG
V	BISHOP IRON	WEST VALLEY
S	BISMARK IRON PROPERTY	POZEGA LAKES
V	BISMARK MINE	NOBLE PEAK
V	BISMARK TAILINGS	NOBLE PEAK
V	BISON CANYON MINE	BISON CANYON
V	BLACK BEAR	MOUNT THOMPSON
X	BLACK CHIEF IRON	WEST VALLEY
U	BLACK EAGLE	FRED BURR LAKE
X	BLACK MOON	SILVER LAKE
S	BLACK SHIRT	SILVER LAKE
V	BLACK-EYED MAY	BAGGS CREEK
S	BLACKBIRD CLAIM	ELKHORN
X	BLACKMAIL	PHILIPSBURG
X	BLER	WEST VALLEY
V	BLOOMINGTON	PIKES PEAK
V	BLOOMINGTON MILL	PIKES PEAK
S	BLUE BIRD MINE	PIKES PEAK
V	BLUE BOTTLE	WEST VALLEY.
V	BLUE DIAMOND	MOUNT THOMPSON
S	BLUE DIAMOND PROSPECT	PIKES PEAK
V	BLUE ROCK LODE	DELMOE LAKE
V	BLUE-EYED NELLIE	WEST VALLEY
V	BLUEBELL - MARSH	DELMOE LAKE
X	BLUEBELL HEALTH	BASIN
S	BLUEBIRD	CARPP RIDGE
V	BLUEBIRD	PIKES PEAK
S	BLUEBIRD CLAIM PROSPECT	PIKES PEAK
S	BLUESTREAK	PIKES PEAK
S	BM COR	PIKES PEAK
X	BOAZ	CHESSMAN RESERVOIR
X	BOB EVANS MINE	GEORGETOWN LAKE
U	BOB LODE - 1KM	ELKHORN
X	BOMES MINE	MAXVILLE
V	BONANZA	BAGGS CREEK
X	BONANZA	HENDERSON MOUNTAIN
X	BONANZA JACK	BASIN
X	BONANZA MINE	MANHEAD MOUNTAIN
V	BOULAWAY - BULWER	ELKHORN
V	BOULDER	BASIN
U	BOULDER	BOULDER WEST
V	BOULDER CHIEF	MOUNT THOMPSON
V	BOULDER COBALT	NOBLE PEAK
V	BOULDER COBALT SHAFT	NOBLE PEAK
V	BOULDER COBALT WEST	OLD BALDY MOUNTAIN
S	BOULDER CREEK	MAXVILLE
U	BOULDER CREEK	PIKES PEAK
S	BOULDER CREEK GRAPHITE	POZEGA LAKES
X	BOULDER IRON	TACOMA PARK
X	BOULDER RIVER PLACER	BASIN
S	BOURARD LODE	DUNKLEBERG CREEK
U	BRONZE LODE	SILVER LAKE
V	BROOKLYN MILL TAILINGS	PIKES PEAK
V	BROOKLYN MINE	PIKES PEAK
V	BROOKS	PIPESTONE PASS
X	BROWN PROSPECT	TUCKER CREEK
S	BROWNS QUARRY	WEST VALLEY
X	BRYAN	PHILIPSBURG
V	BUCKEYE	THREE BROTHERS
V	BULL ELK	WEST VALLEY
V	BULLION	BASIN
X	BUNKER HILL	HENDERSON MOUNTAIN
X	BUSTER	BASIN
U	BUTTE & PHILADELPHIA	SHEEPSHEAD MOUNTAIN
U	BUTTE - ELK PARK or EUREKA	SHEEPSHEAD MOUNTAIN
U	BUTTE TUNGSTEN	ELK PARK PASS
V	C&D	ELKHORN
X	CABE	SILVER LAKE
S	CABLE MINE	SILVER LAKE
S	CABLE PLACER	SILVER LAKE
X	CADGIE TAYLOR	PHILIPSBURG
X	CALCABE	SILVER LAKE
X	CALVIN MINE	BASIN
X	CAMBELL PROSPECT	SILVER LAKE
S	CAMERON	WEST VALLEY
V	CAMP VERDE PLACER	ROCK CREEK LAKE
S	CARBONATOR	WEST VALLEY
V	CARLA, PAULINE, & FAITH GROUP	SHEEPSHEAD MOUNTAIN
X	CARLESON MINE	BASIN
S	CARLSON MINE	THREE BROTHERS
S	CARMICHAEL CLAIMS	PONY
X	CARMODY GROUP	ELKHORN
S	CAROLINE & WILLIAM COLEMAN	SUGARLOAF MOUNTAIN
S	CAROLINE CLAIM	MAXVILLE
V	CASCADE	BISON CANYON
V	CASTLE ROCK	NOBLE PEAK
V	CATORACT	MOUNT THOMPSON
S	CATORACT CREEK PLACER	MOUNT THOMPSON
V	CATORACT TAILINGS	MOUNT THOMPSON
V	CETO	STORM LAKE
V	CHAMPION MILL TAILINGS	LOCKHART MEADOWS
V	CHAMPION MINE	LOCKHART MEADOWS
V	CHAMPION PASS PROSPECT	LOCKHART MEADOWS
S	CHAMPION SHAFT	LOCKHART MEADOWS
U	CHIEF JOSEPH COPPER - 1KM	ELKHORN
X	CHINESE DIGGINGS	BOULDER WEST
X	CLIFF	PHILIPSBURG
U	CLIFF	WEST VALLEY
X	CLIFF GULCH	PHILIPSBURG
X	CLIMAX	PHILIPSBURG
X	CLIMAX	TUCKER CREEK
X	CLIMAX GROUP	TUCKER CREEK
S	CLIPPER	KELLY LAKE
S	CLIPPER	PIKES PEAK
X	CLIPPER	WICKIUP CREEK
V	COAL CREEK	OLD BALDY MOUNTAIN
S	COBERLY SYNCLINE	PIKES PEAK
V	COLUMBIA	SHEEPSHEAD MOUNTAIN
X	COLUMBIA	WICKIUP CREEK
V	COLUMBUS	BASIN
X	COMANCHE EXT	PHILIPSBURG
V	COMBINATION MILL TAILINGS	BLACK PINE RIDGE

V: Visited X: On DNF land - no effects S: Screen in office U: Location in

CODE	MINE NAME	QUADRANGLE
X	NEEDLE GUN CLAIM	FRED BURR LAKE
V	NELLIE BARNES	MAXVILLE
U	NELSON PROSPECT	SUGARLOAF MOUNTAIN
S	NEVADA	OROFINO MOUNTAIN
X	NEW HOPE	SILVER LAKE
X	NEW HOPE CLAIM	PHILIPSBURG
U	NEW MORNING MINE	BOULDER WEST
X	NEW SEATTLE	MAXVILLE
V	NEW YEAR	SILVER LAKE
S	NEW YORK	PIKES PEAK
X	NEWCOMB	DICKIE PEAK
S	NFK FLINT CREEK PLACER	SILVER LAKE
V	NICHOLSON	NOBLE PEAK
U	NICKELODEON	BOULDER WEST
S	NIKI	ELK PARK PASS
S	NILES GULCH PLACER	ALDER GULCH
V	NINETEEN HUNDRED	FRED BURR LAKE
V	NON-PARIEL MILL TAILINGS	MAXVILLE
X	NORTH ATLANTIC	SILVER LAKE
V	NORTH BOULDER LEAD	THUNDERBOLT CREEK
S	NORTH FORK GRANITE CREEK	PIKES PEAK
U	NORTH LOUISE PROJECT	ELKHORN
V	NORTH STAR	MAXVILLE
V	NORTHERN CROSS (CARLIN ONE DIL	POZEGA LAKES
S	NUGGET	PIKES PEAK
V	O'BRIEN	WHETSTONE RIDGE
X	OBELISLE	MOUNT THOMPSON
V	OHIO LODE MINE	WATERLOO
S	OHIO PROSPECT	WHETSTONE RIDGE
S	OKOREOKA	SILVER LAKE
X	OLD BONANZA	SILVER LAKE
V	OLD CABIN PROSPECT	NOBLE PEAK
V	OLD DOMINION MINE	MOOSE LAKE
V	OLD DOMINION TAILINGS	MOOSE LAKE
X	OLD KENTUCK	PHILIPSBURG
S	OLSON GULCH	WEST VALLEY
S	OLYMPIC MINE	POZEGA LAKES
S	ONE HUNDRED ACRE MEADOW PROSP	STORM LAKE
X	ONTARIO	GEORGETOWN LAKE
U	OPHIR	PIKES PEAK
U	ORAFINE CREEK PLACER	SUGARLOAF MOUNTAIN
U	OROFINE CREEK PLACER	LOCKHART MEADOWS
U	ORPHAN BOY	ROCK CREEK LAKE
X	ORPHAN BOY - OROFINO	SILVER LAKE
V	OVERLAND CREEK MINE	CHESSMAN RESERVOIR
V	OVERLOOK	PIPESTONE PASS
V	OVERLOOK MILL	PIPESTONE PASS
V	OZARK	PIPESTONE PASS
X	PANDORA	WICKIUP CREEK
V	PARK CREEK TAILINGS	MANHEAD MOUNTAIN
X	PARNELL	PHILIPSBURG
X	PATSY ANN MINE	DICKIE PEAK
V	PAY DAY	WEST VALLEY
X	PAYOFF	SILVER LAKE
V	PEACOCK GROUP	HENDERSON MOUNTAIN
X	PEARL	PHILIPSBURG
V	PEARL	THREE BROTHERS
S	PEARL MINE	DUNKLEBERG CREEK
V	PEN YAN	MOUNT THOMPSON
S	PERRY PARKS PLACER	THREE BROTHERS
V	PETE & JOE	OLD BALDY MOUNTAIN
V	PETERSON MEADOW PROSPECT	GEORGETOWN LAKE
V	PHANTOM	MOUNT THOMPSON
X	PHILLIPSBURG AREA	PHILIPSBURG
S	PHOSPHATE PROSPECT UPPER	POZEGA LAKES
V	PIERMONT NO. 1 EAST	BASIN
S	PINEAU MINE	PIKES PEAK
S	PIONEER GULCH	ROCK CREEK LAKE
X	PLACER FIRE CLAY PIT	ANACONDA NORTH
X	PLEIDUS	SILVER LAKE
U	POHNDERF DEPOSIT - GEMS	MOUNT HUMBUG
X	POHNDORF AMETHYST	GRACE
S	POLLOCK	SUGARLOAF MOUNTAIN
X	POLO	PHILIPSBURG
X	POMEROY	SILVER LAKE
U	PONY VERMICULITE	PONY
V	PORCUPINE	SILVER LAKE
X	PORNELL GROUP	HENDERSON MOUNTAIN
X	PORPHRYRY DIKE	THREE BROTHERS
V	PORT ROYAL	PIKES PEAK
V	PORT ROYAL MILL	PIKES PEAK
V	PORT ROYAL TAILINGS	PIKES PEAK
V	PORTER	FRED BURR LAKE
V	POTOSI	PIKES PEAK
S	POWDER GULCH - RE PLACER	BUXTON
S	PRICE PLACER - RE	BUXTON
S	PRICES GULCH - RE PLACER	BUXTON
V	PRINCESS	LOCKHART MEADOWS
V	PRINCETON MINE	MAXVILLE
S	PRINCETON PLACER	MAXVILLE
S	PROSPECT	BOULDER WEST
S	PROSPECTS	MOUNT HUMBUG
S	PROSPECTS	MOUNT THOMPSON
X	PURITAN	FRED BURR LAKE
X	PURITAN	PHILIPSBURG
X	PYRITE	SILVER LAKE
V	QUARTZ CITY PROSPECT	NOBLE PEAK
V	QUARTZ CREEK	THREE BROTHERS
S	QUEEN	PIKES PEAK
V	QUEEN ANN CLAIM	ELKHORN
S	RACETRACK CREEK IRON	POZEGA LAKES
S	RAINBOW PASS OCCURENCE	STORM LAKE
S	RAINBOW PROSPECT	MOOSE LAKE
U	RANDY	WEST VALLEY
V	READY CASH	PIPESTONE PASS
V	RED LION	FRED BURR LAKE
V	RED LION MILL	FRED BURR LAKE
S	RED ROCK CREEK	BASIN

CODE	MINE NAME	QUADRANGLE
V	RED ROCK MINE	BASIN
X	RED ROSE	SILVER LAKE
V	RED WING	PIPESTONE PASS
V	REDEEMER	BAGGS CREEK
X	REDEMPTION	PHILIPSBURG
X	REDFERN	MOUNT HUMBUG
X	RELIANCE	SILVER LAKE
U	RELIEF	ELKHORN
X	REVENUE	SILVER LAKE
S	RICH STRIKE	WEST VALLEY
S	RICHMOND OR ONTARIO	SILVER LAKE
X	RIDGEWAY	PONY
S	RISING STAR	SILVER LAKE
V	ROBINSON MINE	SILVER LAKE
V	ROCK CREEK CLAIM	SUGARLOAF MOUNTAIN
X	ROCK CREEK MINE JILL MILL	PHILIPSBURG
X	ROCK CREEK PROPERTY	MAUKEY GULCH
S	ROCK CREEK PROSPECTS	PIKES PEAK
S	ROCK RABBIT & SUNBEAM	WARREN PEAK
V	ROCKER	MOUNT THOMPSON
V	ROCKER EXTENSION	MOUNT THOMPSON
V	ROMBAUER	PIKES PEAK
V	ROSE	MOUNT THOMPSON
V	ROYAL GOLD MILL	PIKES PEAK
X	ROYAL METALS TUNNEL	FRED BURR LAKE
V	RUBY	SHEEPSHEAD MOUNTAIN
V	RUBY MINE	LOCKHART MEADOWS
X	RUMSEY MILL	PHILIPSBURG
X	RUSSEL	HENDERSON MOUNTAIN
V	RUTH	MOUNT THOMPSON
X	RUTH & COPPER	WICKIUP CREEK
V	RYAN MINE	PIKES PEAK
X	S. BOULDER RIVER PLACERS	MANHEAD MOUNTAIN
S	S. CLIPPER	KELLY LAKE
S	S. FK ROCK CREEK PLACER	WHETSTONE RIDGE
X	S. FRANK HILL	PHILIPSBURG
X	S. HIDDEN LAKE PROSPECT	ELKHORN
V	SABBATH	BAGGS CREEK
U	SAGER-MURPHY	WEST VALLEY
V	SALLIE MELLEN	HENDERSON MOUNTAIN
V	SALLY ELLEN	PIKES PEAK
X	SALMON	PHILIPSBURG
S	SAMUEL	DUNKLEBERG CREEK
S	SAMUEL LODE	DUNKLEBERG CREEK
X	SAN FRANCISCO	PHILIPSBURG
V	SARANAC	MAXVILLE
V	SARATOGA	THUNDERBOLT CREEK
V	SATURDAY NIGHT	BASIN
X	SAUNDERS	PHILIPSBURG
S	SAWPIT GULCH PLACER	ALDER GULCH
U	SCENIC	PIPESTONE PASS
S	SCHERMERHORN GULCH PLACER	ROCK CREEK LAKE
S	SCHRAMM	ROCK CREEK LAKE
X	SCRATCH ALL	PHILIPSBURG
S	SE SECTION 5	MAXVILLE
V	SEATTLE	MOUNT THOMPSON
V	SEC 36 SHAFT	DELMOE LAKE
V	SECTION 18 PROSPECT	OROFINO MOUNTAIN
V	SECTION 8 SHAFT	LOCKHART MEADOWS
V	SENATE	KELLY LAKE
S	SEPTEMBER SNOW	PIKES PEAK
V	SHAMROCK	PIKES PEAK
X	SHAPLEIGH	PHILIPSBURG
V	SHEILA	SILVER LAKE
V	SHORT STUFF	STORM LAKE
X	SHOULETOWN	PHILIPSBURG
S	SILEA BUTTE	TABLE MOUNTAIN
U	SILVER BELL	RATIO MOUNTAIN
V	SILVER CHAIN	WEST VALLEY
X	SILVER CHIEF	PHILIPSBURG
V	SILVER GLANCE	MOUNT HUMBUG
V	SILVER HEART	SILVER LAKE
S	SILVER HILL	SILVER LAKE
V	SILVER KING	WEST VALLEY
V	SILVER KING PLACER	PIPESTONE PASS
V	SILVER PROSPECT	WEST VALLEY
V	SILVER QUEEN	DELMOE LAKE
V	SILVER QUEEN	WEST VALLEY
X	SILVER REEF	SILVER LAKE
X	SILVER SPIKE	PHILIPSBURG
V	SILVERSMITH	BISON CANYON
V	SIRIUS	MOUNT THOMPSON
V	SIXTEEN TO ONE CLAIM	PIKES PEAK
V	SKYLINE MINE/LESLIE LAKE GROUP	ELKHORN
U	SMITH PROSPECT	WEST VALLEY
V	SNOW BUNNY	PIKES PEAK
S	SNOW WHITE QUARRY	ANACONDA NORTH
S	SNOW WHITE QUARRY	MOUNT POWELL
V	SNYDER'S MINE	NOBLE PEAK
V	SOLAR MINE	THREE BROTHERS
U	SOLEDADA & IRON CROWN CLAIMS	WEST VALLEY
V	SOUTH BOULDER MILL	MAXVILLE
V	SOUTH FORK STATE CREEK MINE	RATIO MOUNTAIN
V	SOUTH SILVERSMITH	BISON CANYON
V	SOUTH SUICIDE CABIN MINE	DELMOE LAKE
X	SOUTHERN CROSS	SILVER LAKE
S	SPARKLING WATER	BASIN
V	SPORT LODE (LAME BEAR)	ELKHORN
S	SPRING HILL	SILVER LAKE
V	SPRINGTIME	BOULDER WEST
S	SQUARE GULCH PIT	ROCK CREEK LAKE
V	ST MARY'S	BAGGS CREEK
V	ST. ANTHONY	RATIO MOUNTAIN
V	ST. LAWRENCE	BASIN
V	ST. NICK	BASIN
V	ST. THOMAS	FRED BURR LAKE
X	STAR POINT	PHILIPSBURG
V	STARLIGHT	PIKES PEAK

CODE	MINE NAME	QUADRANGLE
V	HOMESTAKE	PIKES PEAK
V	HOMESTAKE	WEST VALLEY
X	HONORAH G	SILVER LAKE
U	HOPE	BISON CANYON
X	HOPE HILL	PHILIPSBURG
X	HOPE KATIE, KATIE EXT	BASIN
V	HORSHOE BEND	SILVER LAKE
X	HORTON & SANDERS	PHILIPSBURG
X	HOWARD CLAIM	MAXVILLE
X	HUFFFMAN	PHILIPSBURG
V	HUGHES	PIKES PEAK
U	HUMBOLT	WHITETAIL PEAK
X	IB	PHILIPSBURG
V	IDA M.	MOUNT THOMPSON
V	IDA MAY	CHESSMAN RESERVOIR
X	ILLGON	PHILIPSBURG
S	INCLINE	BAGGS CREEK
V	INDEPENDENCE	PIKES PEAK
V	INDIAN HEAD ROCK DEPOSITS	BASIN
A	INDIANA PROSPECT	WHETSTONE RIDGE
X	INDUSTRIAL SILICA	MOUNT THOMPSON
V	INFINITE	THUNDERBOLT CREEK
V	INHA PROSPECT	NOBLE PEAK
X	IRON AGE MINE	PHILIPSBURG
V	IRON CLIFF	PIPESTONE PASS
X	IRON KING	WHITEHALL
S	IRON MOUNTAIN	THUNDERBOLT CREEK
S	IRON MOUNTAIN PLACER	TABLE MOUNTAIN
X	ISABELLA	PHILIPSBURG
X	ISABELLE	SILVER LAKE
U	IVANHOE LAKE	KELLY LAKE
S	IVANHOE MINE	PIKES PEAK
U	JACK CREEK	WILSON PARK
S	JACK CREEK RIDGE	BASIN
U	JACK MINE	RATIO MOUNTAIN
S	JACK MTN IRON	BASIN
X	JACQUELINE	DICKIE PEAK
X	JAMES R. KEENE	ELKHORN
S	JASPER & MATTHICH	WARREN PEAK
V	JEFFERSON	MAXVILLE
V	JESSIE	BASIN
X	JETTY MINE	WEST VALLEY
X	JIB SHAFT	BASIN
V	JIM JR.	WHITETAIL PEAK
X	JOE HANKS CLAIM	HENDERSON MOUNTAIN
X	JOE METESH LESSEE	BASIN
V	JOHN G. CARLISLE	PIKES PEAK
V	JOHN T.	MOUNT THOMPSON
S	JOHNSON CLAIM	HENDERSON MOUNTAIN
V	JOKER PROSPECT	WHETSTONE RIDGE
S	JOLEAN PROSPECT	PIKES PEAK
S	JOSEPHINE	THREE BROTHERS
S	JP PROSPECT	WHETSTONE RIDGE
V	JULIA LEE	TABLE MOUNTAIN
V	JUMBO	MOUNT THOMPSON
X	JUPITER	DELMOE LAKE
X	KASERMAN	WICKIUP CREEK
V	KELLERS HEM DEPOSIT	BASIN
S	KELLY & IRVING PITS	ROCK CREEK LAKE
X	KENNEDY MINE	MAUKEY GULCH
V	KENT	MOUNT EMERINE
U	KENTUCKY IRISHMAN	DELMOE LAKE
X	KING & QUEEN CLAIMS	WICKIUP CREEK
V	KING MINE	DELMOE LAKE
V	KIRKENDAL / KOSKI	PIKES PEAK
V	KIT CARSON	SHEEPSHEAD MOUNTAIN
V	KLONDYKE	MOUNT THOMPSON
S	KOHRS & BIELENBERG PIT	ROCK CREEK LAKE
S	KOHRS & BIELENBERG PLACER	ROCK CREEK LAKE
X	KRUEGER	OLD BALDY MOUNTAIN
S	KURT PEAK OCCURRENCE	STORM LAKE
X	L. FROST CREEK	PHILIPSBURG
S	LADY HENNESY	THREE BROTHERS
V	LADY LEITH	THREE BROTHERS
S	LAKE VIEW PROSPECT	ROCK CREEK LAKE
S	LANCASTER PROSPECT	PIKES PEAK
V	LARK	POZEGA LAKES
X	LAST CHANCE	BASIN
X	LAST CHANCE	HENDERSON MOUNTAIN
S	LAST CHANCE MINE	HENDERSON MOUNTAIN
S	LAST CHANCE PROSPECT	WHETSTONE RIDGE
S	LEAD STREAK	MAXVILLE
V	LEADVILLE	SUGARLOAF MOUNTAIN
U	LEROY QUARTZ LODE	TACOMA PARK
S	LETUS	FRED BURR LAKE
X	LEVI BURR	PHILIPSBURG
X	LIMESTONE	DICKIE PEAK
S	LIMESTONE PROSPECTS	SILVER LAKE
V	LIMESTONE QUARRY	PIPESTONE PASS
X	LITTLE DANDY	PHILIPSBURG
S	LITTLE DARLING	OROFINO MOUNTAIN
X	LITTLE EMMA & HOMESTEAD	PHILIPSBURG
S	LITTLE GOLD CREEK PLACER	PIKES PEAK
S	LITTLE JOE	CARPP RIDGE
S	LITTLE WONDER PROSPECT	WHETSTONE RIDGE
V	LIZZIE OSBORNE	MOUNT THOMPSON
V	LOG CABIN	WHETSTONE RIDGE
V	LOIS	PIKES PEAK
X	LONDON BERRY	MAXVILLE
S	LOOKOUT	WARREN PEAK
S	LOOKOUT PROSPECT	HENDERSON MOUNTAIN
X	LOST CREEK PLACER	ANACONDA NORTH
X	LOTTA	BASIN
V	LOUISE	BASIN
S	LOUISE MINE	ELKHORN
V	LOWER BROOKLYN	MAXVILLE
V	LOWER BUCKEYE MILL TAILINGS	THREE BROTHERS
X	LOWER GEORGETOWN	GEORGETOWN LAKE

CODE	MINE NAME	QUADRANGLE
V	LOWER HATTIE FERGUSON	MOUNT THOMPSON
V	LOWER HIDDE HAND	BAGGS CREEK
V	LOWER VERA & MARIE	MOUNT THOMPSON
V	LOWER WHITE CHIEF	MANHEAD MOUNTAIN
V	LUCKY ARROWHEAD	WEST VALLEY
X	LUCKY BLUE	SILVER LAKE
S	LUCKY SEVEN	CARPP RIDGE
U	LUCKY STRIKE	MOOSE LAKE
X	LUCY	PHILIPSBURG
S	LUKE	WARREN PEAK
S	LUKE SI QUARRY	WEST VALLEY
V	LULA BELL	THREE BROTHERS
X	LUXANBURG	ELKHORN
X	LUXEMBURG	SILVER LAKE
S	LYON PLACER	MAXVILLE
V	M&M PLACER	PIKES PEAK
V	M&T + MYERS	MOOSE LAKE
V	M. FK. DOUGLAS CREEK PHOSPHATE	PIKES PEAK
S	MACFARLAND PLACER	PIKES PEAK
S	MAIN RANGE BERYL	MOUNT EVANS
X	MAMMOTH MINE	MANHEAD MOUNTAIN
V	MANHATTAN	MOUNT THOMPSON
V	MANTLE & S. MANTLE	MOUNT THOMPSON
V	MARGUERITE	BASIN
X	MARIE CLAIM	PHILIPSBURG
X	MARONEY CLAIM	PHILIPSBURG
S	MARY ANN	MOUNT HUMBUG
V	MARY ANNE	BASIN
X	MARY B	PHILIPSBURG
X	MARY FRANCIS CLAIM	TUCKER CREEK
V	MASCOT	DELMOE LAKE
V	MASCOT EXTENSION	DELMOE LAKE
S	MASTER MINE	PIKES PEAK
V	MATHESON	BAGGS CREEK
X	MAXVILLE TAILINGS	MAXVILLE
V	MAY DAY	BOULDER WEST
S	MAY LITTY	THREE BROTHERS
X	MAYFLOWER / GOLD CROWN	WEST VALLEY
S	MAYFLOWER LODE	KELLY LAKE
S	MAYFLOWER PROSPECT	WHETSTONE RIDGE
V	MAYFLOWER VEIN	MAXVILLE
S	MAYVILLE PHOSPHATE	MAXVILLE
S	MAYWOOD PLACER	MAXVILLE
X	MCDONALD MINE	MAUKEY GULCH
U	MCKAY ADIT	SILVER LAKE
V	MEMPHIS	SHEEPSHEAD MOUNTAIN
X	MERRY WIDOW	MOUNT THOMPSON
X	MIDDLE OF THE ROAD PYRENEES	SILVER LAKE
V	MIDNIGHT	NOBLE PEAK
V	MIKE	MOUNT THOMPSON
V	MILLERS PROSPECT	WHETSTONE RIDGE
X	MINE	ALDER GULCH
S	MINER'S GULCH PLACER	ALDER GULCH
U	MINERAL HILL	PONY
X	MINNCHAHA & HORSHOE GROUP	SILVER LAKE
V	MINNEAPOLIS	MOUNT THOMPSON
V	MINNIE LEE	STORM LAKE
X	MITCHELL	PHILIPSBURG
U	MOCCASON	BASIN
S	MODESTY CREEK	MOUNT POWELL
V	MODOC	FRED BURR LAKE
V	MOGULLIAN	NOBLE PEAK
V	MOHAWK	WEST VALLEY
V	MONARCH MINE	DUNKLEBERG CREEK
S	MONITOR MINE	DUNKLEBERG CREEK
S	MONK - HEADACHE	STORM LAKE
V	MONTANA MINE	FRED BURR LAKE
X	MONTANA MINE	SILVER LAKE
V	MONTREAL STAR	ELK PARK PASS
S	MOONDYNE	PIKES PEAK
S	MOONEY CLAIM - UR	BUXTON
S	MOONLIGHT	SILVER LAKE
S	MOOSE CREEK	MOUNT HUMBUG
S	MOOSE FISH CREEK TRAVERSE	PIPESTONE PASS
V	MOOSE LAKE TAILINGS	MOOSE LAKE
S	MOOSE TRAIL	MAUKEY GULCH
X	MOREAU	ELKHORN
V	MORGAN EVANS	WEST VALLEY
V	MORNING GLORY	MOUNT THOMPSON
V	MORNING GLORY TAILINGS	MOUNT THOMPSON
V	MORNING MARIE	MOUNT THOMPSON
V	MORNING MINE	BASIN
V	MORNING STAR	PIKES PEAK
V	MORNING STAR MINE?	BASIN
X	MOSCOW MINE	GRACE
S	MOTHER VEIN CLAIM	HENDERSON MOUNTAIN
X	MOUNTAIN BOY	MANHEAD MOUNTAIN
S	MOUNTAIN CHIEF	DUNKLEBERG CREEK
V	MOUNTAIN LION MINE	MAXVILLE
S	MOUNTAIN PARK TUNGSTEN	PIKES PEAK
V	MOUNTAIN QUEEN	RATIO MOUNTAIN
S	MOUNTAIN TOP CLAIMS	PIKES PEAK
U	MOUNTAIN VIEW COPPER	HENDERSON MOUNTAIN
V	MT THOMPSON	MOUNT THOMPSON
X	MTN BOY & WEHGER #2	PHILIPSBURG
V	MTN CHIEF	MOUNT THOMPSON
X	MTN VIEW	GEORGETOWN LAKE
S	MUDHOLE	PIKES PEAK
X	MULLEN & LITTLE GEM	PHILIPSBURG
S	MULONEY BASIN PROSPECT	CARPP RIDGE
S	MULONEY MINE	CARPP RIDGE
V	MYSTERY	OROFINO MOUNTAIN
X	MYSTERY NG	PHILIPSBURG
V	McPHAIL	PIPESTONE PASS
U	N462741	BASIN
S	NANCY LEE PROSPECT	WHETSTONE RIDGE
S	NATIONAL TUNGSTEN & SILVER CO	POZEGA LAKES
S	NE SEC 7 GIRD CREEK PROS	MAXVILLE

V: Visited X: On DNF land - no effects S: Screen in office U: Location in

CODE	MINE NAME	QUADRANGLE
S	COMET	PIKES PEAK
S	COMINCO PHOSPHATE	MAXVILLE
V	CONGDON MINE	MOUNT EMERINE
V	CONNIE JOE	DELMOE LAKE
U	CONSTELLATION VERMICULITE	PONY
V	CONTACT #1	PIKES PEAK
U	COPPER CLIFF	BAGGS CREEK
V	COPPER CREEK	MAXVILLE
X	COPPER JACK	PHILIPSBURG
U	COPPER LODE	MAXVILLE
S	COPPER LODE	MOUNT POWELL
S	COPPER MTN LODE	KELLY LAKE
U	COPPER QUEEN	BLACK PINE RIDGE
S	COPPER RIDGE PROSPECTS	PIKES PEAK
X	COPPER STATE MINE	BLACK PINE RIDGE
S	COPPER STATE MINE	HENDERSON MOUNTAIN
S	COSMOPOLITAN	ROCK CREEK LAKE
V	COTTONWOOD MINE	LOCKHART MEADOWS
S	COUGAR	ROCK CREEK LAKE
X	COYLE	PHILIPSBURG
V	CRACKER	MOUNT THOMPSON
V	CRAIG PROSPECT	NOBLE PEAK
U	CREDIN MINES?	BASIN
V	CRESCENT	CHESSMAN RESERVOIR
U	CRYSTAL BUTTE	NOBLE PEAK
V	CRYSTAL MINE	BASIN
S	CULUER MINE	DUNKLEBERG CREEK
V	CURLY BILL	NOBLE PEAK
V	CURLY GULCH ADITS	MOUNT HUMBUG
V	CUSTER	MOUNT THOMPSON
V	DAILY WEST MINE	BASIN
X	DALY GULCH	SILVER LAKE
X	DALY PLACER	SILVER LAKE
V	DANIELSVILLE	POZEGA LAKES
V	DARK HORSE	MOUNT POWELL
V	DARK HORSE MILL	MOUNT POWELL
S	DAUGHTERS PROSPECT	PIKES PEAK
X	DAY & HARVEY	MOUNT HUMBUG
V	DEAD COW ADIT	OROFINO MOUNTAIN
S	DEAD END	THUNDERBOLT CREEK
U	DECIEVER	ROCK CREEK LAKE
S	DEER HUNTER PROSPECT	HENDERSON MOUNTAIN
S	DEER LODGE BASIN PROSPECTS	PIKES PEAK
S	DELTA	SILVER LAKE
V	DENNY PROSPECT	PIPESTONE PASS
X	DERBY MORNING	PHILIPSBURG
S	DEWEY PROSPECT	PIKES PEAK
U	DG CLAIMS	POZEGA LAKES
V	DIAMOND CITY	RATIO MOUNTAIN
X	DIAMOND PLACER	ANACONDA NORTH
V	DING BAT & BLUE-EYED MAGGIE	BAGGS CREEK
V	DING BAT - BLUE EYED MAGGIE	SUGARLOAF MOUNTAIN
X	DISSETT MINE	PHILIPSBURG
S	DOLE PROSPECT	ROCK CREEK LAKE
U	DORA LEIGH & MCCAULEY LEAD	WILSON PARK
U	DORA LEIGH & MCCAULEY LEAD	WILSON PARK
V	DORIS	BASIN
V	DOUBLE EAGLE PROSPECT	BLACK PINE RIDGE
V	DOUGHERTY MILL	SILVER LAKE
X	DOUGLAS CREEK	PHILIPSBURG
S	DOUGLAS CREEK SYNCLINE	MAXVILLE
V	DOUGLAS MILL	HENDERSON MOUNTAIN
V	DOUGLAS MINE	HENDERSON MOUNTAIN
V	DRY BOULDER IRON	NOBLE PEAK
X	DRY COTTONWOOD CREEK	OROFINO MOUNTAIN
S	DRY GULCH PLACER	MOUNT POWELL
X	DUMAS	GRACE
V	DUMERTIORITE PROSPECT	BASIN
U	DUNKLEBERG	DUNKLEBERG CREEK
X	DUNSTONE	ELKHORN
X	DURAND	MAXVILLE
X	DURANGO	PHILIPSBURG
X	DURANGO & MOONLIGHT GROUP	PHILIPSBURG
U	E.X.L.	PIPESTONE PASS
V	EAGER	WICKIUP CREEK
X	EAGLE BUTTE MINE	ELKHORN
S	EAGLE CLAIM	HENDERSON MOUNTAIN
U	EAGLE HILL & IRON BAR LODES	ELKHORN
V	EAST MOUNTAIN LION	MAXVILLE
S	EAST RIDGE GROUP	ELK PARK PASS
X	EAST SOAP GULCH IRON	WICKIUP CREEK
U	ECLIPSE CLAIM	ELKHORN
X	EDNA - KIBLER PROSPECT	PIPESTONE PASS
S	EDWIN E. GRAUPHER PROSPECT	PIKES PEAK
V	ELDERADO	PIKES PEAK
X	ELIZABETH	PHILIPSBURG
V	ELIZABETH - LITTLE EMERY	BAGGS CREEK
X	ELIZABETH SHAFT	PHILIPSBURG
V	ELKHORN BUCKHORN	MOUNT HUMBUG
S	ELKHORN CREEK PLACER	TACOMA PARK
X	ELKHORN MINE	ELKHORN
V	ELKHORN PEAK IRON	ELKHORN
S	ELKHORN QUEEN	TACOMA PARK
X	ELKHORN RIDGE PROSPECT	ELKHORN
V	ELMER	BASIN
V	EMERY	SUGARLOAF MOUNTAIN
S	EMERY RIDGE PROSPECT	ROCK CREEK LAKE
V	EMMA DARLING	BAGGS CREEK
V	ENTERPRISE	THREE BROTHERS
V	ERUBSTAKE	DELMOE LAKE
S	EUREKA	BISON CANYON
V	EVA MAY	MOUNT THOMPSON
V	EVA MAY TAILINGS	MOUNT THOMPSON
U	EVENING STAR & GOLDEN ASSETS M	BASIN
X	FAST KATIE	BASIN
X	FIELD	PHILIPSBURG
X	FIELDS	MAXVILLE
S	FINLAY BASIN PROSPECT	POZEGA LAKES

CODE	MINE NAME	QUADRANGLE
S	FIRST SHOT-LAST SHOT	BASIN
V	FISH CREEK MINE	MOUNT HUMBUG
S	FISH CREEK PLACERS	PIPESTONE PASS
X	FLAGSTAFF HILL	PHILIPSBURG
S	FLEECER MTN AREA	DEWEY
S	FLINT CREEK	SILVER LAKE
X	FLORENCE	WHITEHALL
V	FLUME GULCH MINE	OROFINO MOUNTAIN
V	FOREST ROSE MILL TAILINGS	DUNKLEBERG CREEK
V	FOREST ROSE MINE	DUNKLEBERG CREEK
V	FOX	WEST VALLEY
V	FRANKLIN	THUNDERBOLT CREEK
X	FRANKLIN HILL IRON	PHILIPSBURG
S	FRANZ	HARVEY POINT
V	GALENA GULCH MINE	BOULDER WEST
S	GARDINER	KELLY LAKE
S	GARNTY HILL AREA	WEST VALLEY
V	GARRETT	SILVER LAKE
U	GENERAL JACKSON MINE	NOBLE PEAK
X	GENERAL WHASHINGTON PLACER	HENDERSON MOUNTAIN
V	GEORGE	WEST VALLEY
X	GEORGETOWN PLACERS	SILVER LAKE
X	GERMAN GULCH	DICKIE PEAK
X	GERTRUDE	PHILIPSBURG
V	GIANT	OLD BALDY MOUNTAIN
S	GILT EDGE PROSPECT	PIKES PEAK
X	GIRD CREEK	MAXVILLE
X	GIRD CREEK SYNCLINE	MAXVILLE
S	GMLC FRIDAY	SPINK POINT
S	GOAT MOUNTAIN	PIKES PEAK
S	GOLD CREEK SYNCLINE	PIKES PEAK
X	GOLD DUST	MOUNT HUMBUG
V	GOLD HILL	MOUNT HUMBUG
V	GOLD HILL MILL	MOUNT HUMBUG
X	GOLD HILL MINES	WHITEHALL
V	GOLD KING MINE	MAXVILLE
V	GOLD LEAF	WHETSTONE RIDGE
U	GOLD PRINCE	MAUKEY GULCH
V	GOLD REEF MINE	MAXVILLE
X	GOLDEN CURRY MINE	ELKHORN
V	GOLDEN EAGLE	SILVER LAKE
V	GOLDEN GIRL #4	WHITETAIL PEAK
V	GOLDEN GLOW	THREE BROTHERS
V	GOLDEN JUBILEE	FRED BURR LAKE
V	GOLDEN MOSS MINE	ELKHORN
U	GOLDEN SURPRISE	MOUNT HUMBUG
X	GOLDEN VALLEY/MINNIE WILSON	DELMOE LAKE
V	GOSPEL HILL ADIT	LOCKHART MEADOWS
S	GOULD CARRY LODE	FRED BURR LAKE
V	GRANITE	FRED BURR LAKE
X	GRANITE BELL	FRED BURR LAKE
S	GRANITE CREEK PROSPECT	POZEGA LAKES
V	GRANITE RUBY SHAFT	FRED BURR LAKE
X	GRANITE TAILING	PHILIPSBURG
X	GRAVEL PIT	PHILIPSBURG
V	GRAY LEAD	MOUNT THOMPSON
X	GRAY ROCK / BUNG YOUR EYE	WEST VALLEY
V	GREAT EASTERN	ANACONDA NORTH
S	GREAT SHIELD URANIUM	MOUNT THOMPSON
X	GREAT WEST/SHOOFLY	PHILIPSBURG
V	GREATER NEW YORK	FRED BURR LAKE
V	GROUSE MINE	OLD BALDY MOUNTAIN
S	GRUBSTAKE	SILVER LAKE
X	GYP PROSPECT	SILVER LAKE
X	H & H CLAIM	PHILIPSBURG
S	H.O. GROUP	PIKES PEAK
V	HALFWAY PARK PLACER	WHITETAIL PEAK
S	HAM GULCH	MAXVILLE
S	HAMILTON	OLD BALDY MOUNTAIN
V	HANNA	FRED BURR LAKE
V	HANNA	MOUNT THOMPSON
V	HANNA TAILINGS	FRED BURR LAKE
V	HANNON - CLAY CHARLIO	SILVER LAKE
V	HANSON MELOY SILVER MOSS	SILVER LAKE
X	HARDCASH	ELKHORN
S	HARRY MILLER CLAIM	MAXVILLE
S	HATTA MINE & MAGNET MINES	DUNKLEBERG CREEK
V	HATTIE FERGUSON	MOUNT THOMPSON
V	HAWKEYE	THREE BROTHERS
X	HEADLIGHT	PHILIPSBURG
X	HEAGAN	ELKHORN
V	HEANEY MINE	WHETSTONE RIDGE
V	HECTOR	BASIN
X	HEILMAN CLAIM	MAXVILLE
X	HELEHAN PROSPECT	DEWEY
S	HELL'S CANYON PLACER	TABLE MOUNTAIN
V	HELPER MINE	BASIN
X	HENDERSON CREEK	HENDERSON MOUNTAIN
X	HENDERSON MINE	HENDERSON MOUNTAIN
V	HENRY	DUNKLEBERG CREEK
U	HENRY THOMAS	GRIFFIN CREEK
V	HERCULESE	BAGGS CREEK
X	HESPARIA & MINORIA	WEST VALLEY
V	HIDDEN LAKE TAILINGS	SILVER LAKE
S	HIDDEN LAKE TUNGSTEN	KELLY LAKE
V	HIDDEN TREASURE	BASIN
V	HIGH UP	ELKHORN
V	HIGHLAND	BASIN
V	HIGHLAND	MOUNT HUMBUG
S	HIGHLAND MARY PROSPECT	MANHEAD MOUNTAIN
S	HIGHLAND MOUNTAINS AREA	MOUNT HUMBUG
V	HIGHLAND TAILINGS	MOUNT HUMBUG
V	HIGHLAND VIEW	PIPESTONE PASS
V	HLM	SILVER LAKE
U	HOBO GULCH PROSPECT	ELKHORN
V	HOBO/T HAYES	PHILIPSBURG
X	HOLDFAST	SILVER LAKE
S	HOMER CLAIM	MAXVILLE

V: Visited X: On DNF land - no effects S: Screen in office U: Location in

CODE	MINE NAME	QUADRANGLE
V	STATE	FRED BURR LAKE
V	STATE	RATIO MOUNTAIN
V	STERRETT	BAGGS CREEK
S	STEVE CLAIM	ELKHORN
X	STEVEN'S PLACER	MAUKEY GULCH
S	STORM LAKE DEPOSITS	STORM LAKE
S	STORM LAKE TUNGSTEN	STORM LAKE
V	STORMWAY	WEST VALLEY
U	STRAW HAT	WEST VALLEY
X	STRAWN MILL	WATERLOO
X	STRAWN MINE	WATERLOO
X	STRIP MINE	PHILIPSBURG
S	STUCKY RIDGE	ANACONDA NORTH
V	STUMPTOWN SMELTER	WEST VALLEY
V	SUICIDE CABIN MINE	DELMOE LAKE
V	SULTANA	NOBLE PEAK
S	SUMMIT MINE	DUNKLEBERG CREEK
U	SUMMIT MINE	THUNDERBOLT CREEK
S	SUMMIT PLACER	WEST VALLEY
S	SUN MINE	DUNKLEBERG CREEK
V	SUNDAY	PIKES PEAK
V	SUNDAY EXTENSION	PIKES PEAK
V	SUNDAY MILL	PIKES PEAK
V	SUNLIGHT - COPPER QUEEN	PIKES PEAK
V	SUNRISE MINE	HENDERSON MOUNTAIN
X	SUNSET	MOUNT HUMBUG
V	SUNSET MINE	DUNKLEBERG CREEK
V	SUNSET PLACER	MAXVILLE
X	SURPRISE MINE	WHITEHALL
V	SWAMP GULCH AMAGALMATION MILL	MAXVILLE
S	SWAMP GULCH PROSPECTS	FRED BURR LAKE
X	SWEETHORN	PHILIPSBURG
X	SWISSMONT	ELKHORN
V	SYLVAN	BASIN
V	T MCKAY/HOBO	PHILIPSBURG
S	TACOMA	TACOMA PARK
S	TAMARACK LAKE	CARPP RIDGE
V	TEMPLEMAN	PIPESTONE PASS
S	THOMPSON LAKE PROSPECT	PIKES PEAK
X	THREE METALS	FRED BURR LAKE
S	THUNDERBOLT MOUNTAIN PROSPECT	THUNDERBOLT CREEK
V	THURSDAY FRIDAY MINE	PIKES PEAK
S	TIBBET PLACER	PIKES PEAK
V	TIBBETTS	PIKES PEAK
V	TIM THIRD CHANCE	STORM LAKE
V	TIP TOP	SILVER LAKE
S	TITANIUM PLACER	MOUNT EMERINE
S	TMT PROSPECT	WHETSTONE RIDGE
S	TODD PROSPECT	WHETSTONE RIDGE
V	TOLL MTN LODE-WAR EAGLE-LENY	PIPESTONE PASS
S	TOMMY PROSPECT	SILVER LAKE
S	TOURMALINE QUEEN MINE	ELKHORN
V	TOWNSEND PLACER	WHETSTONE RIDGE
V	TOWNSEND PROSPECT	WHETSTONE RIDGE
X	TREVILLION - JOHNSON	GRACE
V	TRIGGER	SILVER LAKE
X	TRIGGER MILL	SILVER LAKE
X	TRILBY CHAMPAIGN	SILVER LAKE
X	TROUT	PHILIPSBURG
X	TRUE	PHILIPSBURG
S	TUCKER CREEK	MOUNT HUMBUG
S	TUNGSTEN MINES	POZEGA LAKES
S	TUSCAVORA PROSPECT	WHETSTONE RIDGE
V	TUSSLE MINE	PIKES PEAK
X	TWILIGHT	SILVER LAKE
X	TWILIGHT CYANIDE PLANT	GEORGETOWN LAKE
X	TWIN BUTTES	MAXVILLE
S	TWIN PEAKS PROSPECT	FRED BURR LAKE
V	TWOHY	RATIO MOUNTAIN
V	UNAMED BEAR GULCH ADIT CLUSTER	OLD BALDY MOUNTAIN
V	UNCLE SAM	BASIN
V	UNION	ELKHORN
X	UNKNOWN	DRY MOUNTAIN
V	UNKNOWN LOWLAND	SHEEPSHEAD MOUNTAIN
S	UNKNOWN MILL CREEK MINE	MANHEAD MOUNTAIN
U	UNNAMED	BAGGS CREEK
X	UNNAMED	BUXTON
S	UNNAMED	ELK PARK PASS
S	UNNAMED	MANHEAD MOUNTAIN
V	UNNAMED	MOUNT HUMBUG
V	UNNAMED	MOUNT THOMPSON
V	UNNAMED	MOUNT THOMPSON
V	UNNAMED	MOUNT THOMPSON
V	UNNAMED	MOUNT THOMPSON
X	UNNAMED	WHITEHALL
U	UNNAMED QUARTZ	RATIO MOUNTAIN
U	UNNAMED RE	BUXTON
X	UNNAMED SMOKEY QUARTZ PROSPEC	RATIO MOUNTAIN
S	UNNAMED URANIUM	BISON CANYON
S	UNNAMED URANIUM	THREE BROTHERS
X	UNNAMMED	PONY
V	UPPER BUCKEYE MILL TAILINGS	THREE BROTHERS
S	UPPER GRANITE PROSPECT	PIKES PEAK
V	UPPER MTN LION	PIKES PEAK
V	UPPER WHITE CHIEF PROSPECT	NOBLE PEAK
S	UPPER WILLOW CREEK PLACER	BLACK PINE RIDGE
V	VALLEY VIEW	MOUNT POWELL
V	VAN DORSTEN	MOUNT HUMBUG
V	VELLEJO	SILVER LAKE
S	VENUS	THREE BROTHERS
V	VERA & MARIE	MOUNT THOMPSON
V	VIKING WESTERN PACIFIC	PONY
V	VINDICATOR	BASIN
X	W. GRANITE STAFF	PHILIPSBURG
V	WAKE UP JIM	BAGGS CREEK
U	WAR EAGLE	GEORGETOWN LAKE
S	WARREN PEAK PROSPECT	WARREN PEAK
X	WARREN PROSPECT	TUCKER CREEK
V	WASA	PIKES PEAK
V	WATER GULCH PROSPECT	BOULDER WEST
V	WELCH QUARRY	DELMOE LAKE
V	WELCOME HILL	SILVER LAKE
V	WELCOME LODE	SILVER LAKE
X	WEST EXP. MN PROS & LAMONT	FRED BURR LAKE
V	WEST GALENA GULCH	BOULDER WEST
V	WEST STORMWAY	WEST VALLEY
X	WHITE	PHILIPSBURG
U	WHITE SWAN MINE	LOCKHART MEADOWS
V	WHITETAIL PARK VEIN	WHITETAIL PEAK
X	WIGHT MN MINE	MAXVILLE
U	WILD CAT	MOUNT HUMBUG
U	WILLIAM BARTH	WHITETAIL PEAK
S	WILSON CREEK PLACER	BOULDER WEST
V	WINTERS CAMP	BASIN
U	WJ BRYAN	MAXVILLE
X	WOODROW WILSON	THREE BROTHERS
U	WOODVILLE DEPOSIT	ELK PARK PASS
X	YELLOW JACKET	OROFINO MOUNTAIN
U	YELLOW MODUL	FRED BURR LAKE
S	YOUNG AMERICAN	PHILIPSBURG
X	ZEUS	PHILIPSBURG
V	ROCKER GULCH	SUGARLOAF MT.
S	CATLSON & BERKIN FLAT	THUNDERBOLT CREEK
V	HIDDEN HAND	BAGGS GREEK
S	CARPP	CARPP RIDGE
V	ELDORADO & PLATEAU	CHESSMAN RESERVOIR
V	NELLIE-MASCOT	HOMESTAKE
V	MONTANA	HOMESTAKE
V	GOLD BUG	HOMESTAKE
S	PAY ROCK	HOMESTAKE
S	GLOWING STAR PLACER	HOMESTAKE
S	HOMESTAKE CREEK PLACER	HOMESTAKE
V	HARRIET	HOMESTAKE
V	NORTH HARRIET	HOMESTAKE
S	FLAG PLACER	HOMESTAKE
S	MOUNTAIN CHEIF	HOMESTAKE
S	NAMMIE BROWN	HOMESTAKE
S	IRENE	HOMESTAKE
S	EVENING STARE	HOMESTAKE
S	THOMPSON PARK	HOMESTAKE
V	DELAWARE	MAXVILLE
V	SNOW CAP	MAXVILLE
V	BARNES	MAXVILLE
V	NELLIE	MAXVILLE
V	MOONLIGHT	MAXVILLE
V	TRAVONIA	MAXVILLE
V	NON PAREIL	MAXVILLE
V	MOFFET JOHNSON	OLD BALDY MTN.
V	LOWER COAL CREEK	OLD BALDY MTN.
V	QUARTZETTE	PIKES PEAK
V	SUNSHINE	STORM LAKE
V	DOUBLE SHAFT	THREE BROTHERS
V	MONTANA PRINCES	WHETSTONE RIDGE
V	JIB MILL TAILINGS	BASIN
V	UPPER BULLION MILL TAILINGS	BASIN
V	BULLION TAILINGS ADIT	BASIN
V	SMELTER CREEK ADIT	BASIN
V	JACK CREEK MILL TAILINGS	BASIN
V	JOE'S BOWER'S MINE	BASIN
V	MORNING STAR	BASIN

V: Visited X: On DNF land - no effects S: Screen in office U: Location in

Appendix III

Mines and Prospects Descriptions
Deerlodge National Forest/ Jefferson River Drainage

A & B

A few hundred feet of underground workings were accessible through a shaft, now caved. A quartz-rich altered rhyolite hosts a white banded quartz vein. A sample of altered rhyolite and vein ran 0.008 oz/ton gold, 1.08 oz/ton silver, 0.016% copper, 0.02% lead, 0.03% zinc, and 0.19% arsenic.

Alport

Three dry caved shafts up to 110 feet deep investigate a 5–6 foot wide N36°E vertical vein of blue-gray fine-grained quartz, pyrite, and sphalerite (Pardee and Schrader 1933). Shipping reports (unpublished information, MBMG files) indicate a high silver-to-gold ratio. Host is granitic rock of the Boulder Batholith with disseminated pyrite and sericite alteration products. A composite sample containing vein and wallrock contained 0.032 oz/ton gold, 1.62 oz/ton silver, 0.013% copper, 0.04% lead, 0.039% zinc, and 0.15% arsenic.

Aluise-Section 36 Shaft

A short shaft is located on a N30°E 85°SE fault zone containing brecciated quartz within quartz monzonite. Loen and Pearson (1989) stated that gold was the commodity.

April

Several small prospects and short adits investigate a N10°E 70°SE zone of quartz veins and quartz-cemented breccia that may be the northern extension of the same zone sought by the Kit Carson (unpublished information, MBMG files). If it is continuous with the Kit Carson, the zone is at least 2,800 feet long. The host rock is Lowland Creek welded tuff with sericite and pyrite alteration products.

Arcturus

Dry reclaimed pits and trenches mark the site of the Arcturus. Little geology is visible today, but the USGS (1978) describe it in some detail. Apparently ore containing gold, pyrite, arsenopyrite, galena, and chalcopyrite was mined from the north-striking, 30°–80°E dipping contacts of limestone, sandstone, and shale within the Three Forks Formation. Some disseminated mineralization also exists in the limestone and sandstone. Exposures of the Cretaceous, gabbroic Black Butte Stock lie a few hundred feet away. Seven samples averaged a trace of gold, 0.1 oz/ton silver, 0.29% copper, 0.01% lead, and 0.57% zinc. The USGS stated that the low metal content does not preclude the existence of resources. Recent exploration drilling has taken place in the area, but results have not been released.

Ballarat

The Ballarat area has been completely reclaimed and covered, and the information presented here was compiled by Sahinen (1950). Low grade brecciate limestone with a quartz-limonite matrix was mined from several adits. Host rock is the Cambrian Meagher Limestone.

Banker

Two dry open adits with several hundred feet of workings follow at least two north trending veins containing quartz, pyrite, and chalcopyrite. Silver was the prospective commodity. Williams (1951) reported fluorite and black hematite in the vein.

Bear Gulch Adit Cluster

Four caved adits presumably explore small high-grade gold-quartz veins similar to those at the nearby B & H. There are no outcrops in the area, but dump material indicates that the wallrock comprises Archean metamorphics and pegmatite, and alteration is weak. Vein consists of quartz and pyrite. Land ownership is mostly private. The lowest and largest adit has a small discharge, which immediately sinks into the ground.

Beefstraight

An open adit with a S40°W orientation apparently followed a vein of fine-grained white quartz and minor pyrite. Other small caved workings lie on trend ¼-mile southwest. A vegetated dump of unaltered granite extends across the dry wash.

Beefstraight North

A short, dry, open shaft examines a N84°E 78°SE vein of quartz, calcite, and pyrite enclosed in altered granite containing silica and chlorite. A sample of vein material assayed 0.510 oz/ton gold, 0.86 oz/ton silver, 0.014% copper, 0.21% lead, 0.056% zinc, and <0.04% arsenic.

Big Four

Two dry open shafts with several thousand feet of workings that follow a N72°E striking vein of quartz, pyrite, galena, sphalerite, and chalcopyrite. Much altered granite with 1–2% disseminated pyrite is present on the dump, which is adjacent to a wetland. The dump contains 3–5000 tons of material of 0.026 oz/ton gold, 1.28 oz/ton silver, 0.028% copper, 2.64% lead, and 0.090% zinc. Roby *et al.* (1960) stated that between 1902 and 1945, the State mine produced 1,577 tons of ore, 82 oz of gold, 7,236 oz of silver, 4,037 pounds of copper, 272,203 pounds of lead, and 123,699 pounds of zinc. Our own sample of vein material indicated a similar grade, containing 0.084 oz/ton gold, 1.92 oz/ton silver, 0.229% copper, 4.20% lead, 7.18% zinc, and 6.60% arsenic.

Big Major (New Bald Eagle, Summit)

The Big Major is marked by numerous prospect pits and a caved dry shaft with several hundred feet of workings. A near vertical vein strikes N65°E and is composed of blue-gray, fine-grained quartz and up to 50% pyrite and arsenopyrite.

Blue Rock

A short, dry caved adit is present at the Blue Rock. It trends N50°E and its dump contains some quartz-pyrite as well as unaltered quartz monzonite. Loen and Pearson (1989) list its commodities as gold and silver.

Bluebell-Marsh

Roby *et al.* (1960) described this property in some detail. Workings consist of a shaft and two adits with 700 feet of drifts (the shaft and one adit are caved). A 3–4 foot thick N80°W vertical vein of quartz, pyrite, chalcopyrite, and galena was mined. There is also some disseminated pyrite and galena disseminated in the quartz monzonite wallrock. Total production between 1909 and 1949 was 98 tons of ore, 84 oz of gold, 402 oz of silver, 1,228 lbs of copper, 19,285 lbs of lead, and 665 lbs of zinc.

Today, a small discharge issues from the caved, lower adit on private land, and some mill tailings are present along the stream on DNF land.

Boulaway (Bulwer)

Two dry caved adits with a combined length of 560 feet, and one 180-foot shaft explore a vertical north trending contact between Cretaceous granodiorite porphyry and Cambrian and Devonian carbonate rocks (Roby *et al.* 1960). The site was mined for its copper content and from 1913 to 1920 produced 587 tons of ore yielding 53.6 tons of copper (Klepper *et al.* 1957). The only mineralization presently visible is some limestone with garnet, epidote, and copper carbonates.

Boulder Cobalt

This property was described in detail by Cather and Linne (1983), who also mapped the one open adit. On the property, veins, shears, and altered areas in Archean gneiss extend for at least 1/4 mile. The veins have diverse orientations, and contain quartz, pyrite, secondary copper minerals, and siderite, and average 1.4 feet thick. Some very high gold values occur sporadically, with the best values from 27 samples being 2.140 oz/ton gold, 1.2 oz/ton silver, and 0.35% copper (Cather and Linne 1983). A northeast-striking breccia zone contains no sulfides and low metal values. Mineralization may be related to a small granitic stock nearby.

Today there are five caved adits and one locked portal. Total length of workings is just over 1,000 feet. All workings are dry. Dumps contain unaltered gneiss and gneiss with siderite as an alteration product.

Boulder Cobalt Prospect

A 67-foot adit and a trench explore a discontinuous northwest-trending shear zone at the gneiss-amphibolite contact (Cather and Linne, 1983). The highest grade sample of six was a 3.1-foot chip sample across the vein with 0.272 oz/ton gold and 0.3 oz/ton silver. The property was given a low rating for gold and silver potential. The workings appear to be covered by talus today.

Boulder Cobalt West

Most workings at this property, which is probably an extension of the B & H system, are covered by talus. One short open adit in Archean gneiss follows an irregular vein on a N20°W 22°SW shear that cross cuts foliation. A select sample of this quartz-pyrite-siderite-calcite vein had 0.824 oz/ton gold, 1.46 oz/ton silver, 0.16% copper, 0.046% lead, and 0.034% zinc. There are small bodies of quartz monzonite within ½ mile of the site.

Baseman (Park Creek) Tailings

An accumulation of about 10,000 tons of tailings are present in the Park Creek valley. Their source was the Baseman Mill ½ mile upstream. Metal values are low and the tailings are mostly vegetated, but Park Creek is actively eroding the pile.

Brooks

A caved adit and a prospect pit explore a N30°W fault zone in Devonian Jefferson Dolomite near its contact with diorite related to the Boulder Batholith. The zone and the surrounding limestone contain quartz, garnet, calcite, chlorite, tremolite, and secondary copper minerals. Supposedly there were some small pockets of very rich gold ore, worth $4–5 per pound (Sahinen 1950). There is a spring below the workings, but waste dumps do not appear to affect it.

C & D

The C & D mined a three-foot thick N35°E 45°-90°SE (Roby *et al.* 1960) replacement zone along bedding in Mission Canyon limestone near the contact with Boulder Batholith quartz monzonite. The ore is brecciate quartz and limestone with pyrite, galena and cerrusite in an iron oxide matrix (USGS 1978, Weed 1901). The highest values from 27 samples taken by the USGS were 0.13 oz/ton gold and 2.7 oz/ton silver, and apparently the ore was used principally as a flux at the smelter. Underground maps (USGS 1978) show one open adit with 500 feet of workings and three caved shafts up to 250 feet deep and three levels (Klepper *et al.* 1957).

Carla, Pauline, and Faith

One prospect and one short caved adit follow a N15°E(?) trend in Lowland Creek welded tuff. The wallrock is weakly iron stained.

Castle Rock

The Castle Rock prospect is covered with talus. O'Neill *et al.* (1983) reported that it consisted of one pit with a 0.8-foot-thick quartz-pyrite-galena vein. The best of two samples had 0.278 oz/ton gold and 4.0 oz/ton silver.

Coal Creek Mine

One caved shaft, four caved adits, and one open inclined shaft explore steep NW(?)-trending structures for 200–300 feet along strike and 100 feet across strike that contain dark brown siliceous gossan with pyrite casts and secondary copper minerals. The discontinuous mineralization is hosted by white to tan, coarsely crystalline limestone that is mapped as the Meagher Limestone; although, it appears no geologist has completed a traverse through this valley. On the dump is some feldspar porphyry with <1% disseminated pyrite. On the north side of Coal Creek this porphyry is exposed on the surface. It also contains some disseminated pyrite and some small prospects. A select sample of gossanous ore contained 0.008 oz/ton gold, 0.84 oz/ton silver, 3.87% copper, 0.03% lead, 0.106% zinc, and 0.08% arsenic. The pyrite-bearing porphyry ran <0.006 oz/ton gold, 0.18 oz/ton silver, 0.019% copper, 0.01% lead, 0.025% zinc, and 0.08% arsenic.

Coal Creek, Lower

An open adit and several prospects explore a structure that trends approximately N20°E 45°NW in Madison Group (?) limestone. There are a few pieces of gossanous material on the dump. The hillside south of the creek is covered with float of intrusive rock with which the mineralization may be related.

Columbia

The Columbia occupies the southern end of the Ruby zone. In fact, underground maps (MBMG files) indicate that the two mines were connected along the zone. Refer to the Ruby mine description for a synopsis of the geology. All three adits on the Columbia property are caved and dry today.

Connie Joe (Spire Rock)

An adit, still open, sought gold (Loen and Pearson 1989) in a N70°W 50°SW fault zone in alaskite. Workings extend only about 75 feet.

Craig

An open, dry, 195-foot adit explores a west-striking, steeply dipping fracture zone with discontinuous segments of quartz-sphalerite-galena-chalcopyrite vein up to 0.5 feet thick (O'Neill *et al.* 1983). The best of four samples taken by the USBM ran 0.068 oz/ton gold, 5.8 oz/ton silver, 0.40% copper, 0.49% lead, and 2.21% zinc. They rated it as having a low potential for minable resources.

Curly Bill #3

Three dry caved adits with 600 feet of total length and a few prospect pits compose the Curly Bill #3. They trace a northeast-striking, steeply dipping quartz-pyrite-chalcopyrite vein up to one foot thick (O'Neill *et al.* 1983). The best values from five samples taken by the USBM were as follows: 0.280 oz/ton gold, 4.4 oz/ton silver, and 1.65% copper. The property was rated as having a moderate potential for the existence of minable mineral resources.

Curly Gulch Adits

Three caved adits less than 100 feet long each explore three parallel east-west striking near vertical shear zones that contain discontinuous quartz veins up to six inches wide. The shear zones are weakly iron stained, and country rock is unaltered quartz monzonite of the Boulder Batholith.

Dead End

Only two prospect pits are present in an area of Elkhorn Mountains volcanics exposed in a moraine. The rock is altered to fine grained quartz, sericite and up to 5% disseminated pyrite.

Denny

A short caved adit follows bedding striking S25°E in fine-grained Paleozoic? metasediments that are probably enclosed by quartz monzonite of the Boulder Batholith. There are a few calcite veinlets present.

Eager

A caved shaft probably less than 100 feet deep and two pits prospect iron- and copper-stained breccia and quartz veins. Country rock is dark gray shale of the Greyson Formation, which contains some minor quartz-sericite alteration.

Elkhorn-Buckhorn

Irregular veins of quartz that contain black streaks with sphalerite are present in some small surface prospects. They are enclosed in quartz monzonite of the Boulder Batholith, and contain very little gold or silver (Sahinen 1950).

Franklin

Two caved adits, one less than 50 feet long, the other less than 200 feet long, were driven on a breccia zone of unknown orientation containing black quartz, tourmaline, pyrite, and sphalerite. It appears to be a typical but weak Boulder Batholith vein. A select sample assayed 0.153 oz/ton gold, 1.25 oz/ton silver, 0.060% copper, 0.038% lead, and 0.031% zinc.

Galena Gulch West

Here, about 200 feet of workings examine a N5°E striking structure containing blue-grey breccia and re-cemented quartz surrounded by unaltered country rock.

Giant

Three caved adits, one with an open stope, mined small replacement bodies in Meagher Limestone in contact with a porphyritic syenite sill (Johns 1961). Reportedly, the ore was argentiferous galena, but slightly silicified gossan is all that is present on the dumps today.

Gold Bug

Two adits, three shafts, and a row of prospect pits (less than 200 feet of total workings) along an extension of the Nellie-Mascot structure (N60°-80°W 80°SW) are present at the Gold Bug. Veins are 2-5 feet wide, consist of coarse-grained quartz and minor fine-grained pyrite, and contain high gold values. According to Roby *et al.* (1960), the mine produced only 30 tons of ore, but it contained 98 oz of gold, 2,639 oz of silver, and 22 lbs of copper. Apparently, in 1911, one ton of ore yielded 55 oz of gold and 298 oz of silver. These high gold values are unusual in the Boulder Batholith.

Golden Girl #4

Several short caved adits and shafts follow a N70°W trending vein that may be continuous with the Jim Jr vein one mile west. Vein consists of a breccia of altered green granitic clasts in a vuggy quartz matrix, and is 2.5 feet wide. However, it assayed only 0.036 oz/ton gold, 0.14 oz/ton silver, 0.028% copper, 0.15% lead, 0.086% zinc, and 0.36% arsenic.

Golden Moss

Most of the Golden Moss property has been reclaimed, and it is difficult to see any geology. This was apparently a small mine that produced a small tonnage of high grade (>1 oz/ton Au) gold ore (Roby *et al.* 1960, Klepper *et al.* 1957). The ore is located at a N65°E limestone-shale contact within the Three Forks Formation. It was mined through a 100-foot inclined shaft. Ore consisted of silicified limestone with galena and iron oxides.

Grouse

A short open adit follows a N78°W 45°NE structure in gray mottled limestone just above a feldspar porphyry dike. A sample of slightly silicified gossan contained 0.018 oz/ton gold, 0.09 oz/ton silver, 0.041% copper, 5.20% lead, and 1.67% zinc. The mineralization is probably similar to that of the nearby Giant, where small replacement zones containing silver-bearing galena occur adjacent to Cretaceous syenite sills.

Grubstake

A caved adit investigates a vein of fine-grained quartz and minor pyrite that strikes N60°E and dips 77°SE within unaltered quartz monzonite. Loen and Pearson (1989) stated that gold, silver, copper, and lead were produced. The dump, composed of unaltered quartz monzonite, is located within a wetland; a sample contained 0.016 oz/ton gold, 0.11 oz/ton silver, 0.018% copper, 0.178% lead, and 0.004% zinc.

Harriet-North Harriet

Seven adits and one shaft were driven on a northwest (?) striking vein of coarse-grained quartz and rare pyrite. A discharge issues from one adit; the associated dump of quartz monzonite contained .038 oz/ton gold, 0.64 oz/ton silver, 0.019% copper, 0.030% lead, and 0.016% zinc. Gold and silver were the commodities (Loen and Pearson 1989).

High Up

The High Up explores mineralized limestone and quartzite of the Amsden and Quadrant formations adjacent to quartz monzonite of the Boulder Batholith. Pyrite, chalcopyrite, arsenopyrite, and galena are disseminated in the sedimentary rocks. The best values from seven samples taken by the USGS (1978) were a trace of gold, 0.2 oz/ton silver, 0.01% copper, 0.27% lead, and 0.1% zinc. The USGS assigned a low potential to the property for undiscovered metallic resources. The mineralization is explored by three dry caved adits totaling 600 feet long.

Infinite (Blackbird)

The main adit, recently reopened and several hundred feet long, drifts on a east-west trending vein of quartz, abundant tourmaline, pyrite, chalcopyrite, sphalerite, and clay. A carefully selected sample contained 0.136 oz/ton gold, 0.05 oz/ton silver, 0.056% copper, 0.012% lead, 0.001% zinc. There is also a pit exposing a thick iron stained siliceous breccia zone in aplite that appears to be podiform and discontinuous. This is probably the "pyrite-bearing pipe" described in MBMG files (unpublished) within which six samples were taken ranging from 0.002 to 0.030 oz/ton gold, 0.01 to 0.6 oz/ton silver, and 0.025 to 0.035% copper.

Inha

One small prospect investigates a quartz vein within the Bismark fault zone, which separates Archean metamorphic rocks from tonalite of the Cretaceous Tobacco Root Batholith. The entire fault zone is iron stained and several hundred feet wide. O'Neill *et al.* (1983) provided the following information. The vein segment has a N80°W 55°NE attitude, is only 0.2 feet thick, and contains quartz, galena, pyrite, sphalerite, calcite, and copper carbonates. Although a chip sample across the vein contained 11.6 oz/ton silver, 0.77% lead, and 0.92% zinc, it was deemed too small to ever be minable.

Iron Cliff

Two adits at the diorite-marble contact produced no metals (Sahinen 1950). The adits are dry and caved.

Klondike (Elkhorn District)

Replacement zones in silicified Jefferson Dolomite along bedding and cross-cutting shears in silicified Jefferson Dolomite adjacent to the Cretaceous, gabbroic Black Butte Stock was mined at the Klondike (Klepper and *et al.* 1957). The ore contained diopside, tremolite, calcite, pyrite, chalcopyrite, and gold-bearing tellurides. The mine was a small producer; from 1915 to 1957 it produced 609 tons of ore from which 539 oz of gold, 309 oz of silver, 8,640 lbs of copper, and 567 lbs of lead were recovered (Roby and others, 1960). The property contains only dry workings that include a 100-foot adit and 3 shafts.

Limekiln Hill Prospects

This is probably the extension of the Highland View system ½-mile to the southwest. Three prospect pits trace a N10°E zone of iron-stained marble near its contact with the Boulder Batholith.

Jim Jr

Two caved shafts and three caved adits with 500–1000 feet of workings follow a N88°W trending vein. The vein consists of quartz, up to 20% pyrite, and a trace of sphalerite and is hosted by quartz monzonite with a narrow alteration zone. A select sample contained 0.106 oz/ton gold, 1.51 oz/ton silver, 0.226% copper, 0.168% lead, and 0.018% zinc.

King

A short open adit bears N85°W, presumably along a polymetallic Boulder Batholith vein. A sample of the mineralized rock from the dump, which was mostly iron and manganese oxide stained alaskite with quartz veinlets, contained only 0.056 oz/ton gold, 0.58 oz/ton silver, 0.032% copper, 0.20% lead, 0.033% zinc, and 0.09% arsenic. Loen and Pearson (1989) stated that commodities sought here were silver and lead.

Kit Carson

Several prospect pits and short adits follow a N20°E 80°SE zone of quartz veins and quartz cemented breccia in Lowland Creek welded tuff (unpublished information, MBMG files). The zone has an extensive sericite-pyrite alteration halo.

Legged Hill Prospects

A caved shaft, one caved adit, trenches, and a series of prospect pits cover an extensive area of N72°W striking veins in aplite and granite. Veins comprise granitic breccia clasts cemented with coarse-grained quartz and rare pyrite.

Mascot-Mascot Extension

Two caved adits of less than 100 feet, one bearing S65°E, the other due west, investigate light gray quartz veins in quartz monzonite. Loen and Pearson (1989) remarked that gold and silver were the commodities.

Mayday

A gated adit investigates a vein of brecciate quartz and minor pyrite.

McPhail

Two adits that are each 100-200 feet long are located near a marble-granite contact. The upper one is presently operating and follows a S30°W iron-stained shear zone within the marble. The lower portal was locked.

Midnight

Two quartz-pyrite veins striking N18°W in Archean gneiss were examined by O'Neill *et al.* (1983). One is ½ foot thick and 1000 feet long; the other is 0.7-1.5 feet thick and exposed for only 60 feet. A select stockpile sample ran an impressive 4.1 oz/ton gold and 2.8 oz/ton silver, but several chip samples across the vein outcrop contained only a trace to 0.126 oz/ton gold. The four adits, 30–100 feet long, and all currently dry and caved.

Montana

A dry caved adit along the extension of the east-west striking Nellie-Mascot structure operated intermittently between 1914 and 1925. Roby *et al.* (1960) recorded 162 tons of ore produced yielding 31 oz of gold and 8,679 oz of silver.

Mountain Queen

This extensively developed property contains at least seven mine openings with at least 1000 feet of associated workings. They trace a N74°E 40°NW vein. The mine operated for five years between 1939 and 1956, producing 839 tons of ore, 162 ounces of gold, 4,884 ounces of silver, 4096 pounds of copper, 110,161 pounds of lead, and 7,911 pounds of zinc (Roby *et al.* 1960).

Mystery

Workings here consist of a boarded adit and a dry caved shaft; total extent is probably 500–1000 feet. The adit discharges water, and the associated dump is located in a wetland. A vein of brecciate quartz and quartz monzonite with 2–3% pyrite was mined. It appears to strike N40°E.

Nellie-Mascot

A N75°E trending vein, in aplite, of quartz and minor fine-grained pyrite was mined through two shafts and six adits (one is still open) with about 3000 feet of total workings. Roby *et al.* (1960) give production figures for 1911 to 1940 as 125 tons of ore containing 50 ounces of gold, 8,053 oz of silver, and 178 pounds of lead.

Nicholson (Ridgeway)

This mine is currently covered under an operating permit. Information in MBMG files and O'Neill *et al.* (1983) indicates it may have a discharge, but the adit portals are located on a talus slope and water may percolate through the talus before surfacing. The mine contains some high grade pockets of gold ore (up to 9 oz/ton), and has produced at least 420 oz of gold since 1939 (O'Neill *et al.* 1983). Mineralization was probably localized by the Bismark fault zone, and country rock is tonalite of the Tobacco Root Batholith near its fault contact with the Archean gneiss.

A gravity concentration and amalgamation mill apparently existed on the property at one time (Reyner and Trauerman 1949), but no trace of a mill or tailings could be found today.

Old Cabin

A thin (1–2 inches) quartz-pyrite vein in bleached Archean gneiss is explored by the a caved 100-foot inclined shaft and an open 20-foot adit at the Old Cabin mine. The vein is concordant with foliation and contains about 30% pyrite. The best values in four samples taken by O'Neill *et al.* (1983) contained only 0.0346 oz/ton gold and 2.2 oz/ton silver.

Overlook Mine and Mill

One open adit and one caved adit explore a skarn with quartz, garnet, calcite, chlorite, actinolite, and tremolite in Mission Canyon Formation. The only evidence of metals are some secondary copper minerals. Mill ruins are located below the mine, but no tailings are present.

Ozark

A 15-foot shaft, a caved 65-foot adit, and extensive prospects follow two faults with different orientations and randomly oriented fissures in marble of the Cambrian Meagher Limestone (Sahinen 1950). Sahinen's sample of the ore carried 0.12 oz/ton gold, 0.3 oz/ton silver, and 23.9% iron.

Quartz City

The Quartz City prospect probes the probable northwestern extension of the Bismark ore body along the Bismark fault in Archean metamorphic rocks near their fault contact with Cretaceous granitic rocks. O'Neill *et al.* (1983) studied the property in detail. They found vein segments up to 1.5 feet wide containing quartz, chalcopyrite, galena, and molybdenite. The best values from 36 samples were 0.27 oz/ton gold and 2.56% copper. A moderate potential for the discovery of gold and copper resources was assigned to the property. There are 4 caved adits with a total length of 240 feet. The lowermost adit, which is probably less than 50 feet long, discharges a small volume of water that immediately seeps into the ground.

Queen Ann

Although the surficial geology is obscured by talus, three open adits with 560 feet of workings allowed the USGS (1978) to gather some information. The mine is located at the contact of limestone and Elkhorn Mountains andesite with aplite of the Boulder Batholith nearby. The limestone contains disseminated pyrite and arsenopyrite and limonite stringers. Some vein vuggy quartz is present on the dump and ran 0.26 oz/ton gold, 16.5 oz/ton silver, a trace of copper, 1.4% lead, and a trace of zinc. Sample of the mineralized limestone had very low metal values.

Ready Cash

A skarn was the target of this property, which contains a caved 100-foot shaft and an open 35-foot shaft (Sahinen 1950). Quartz, tremolite, garnet, epidote, diopside, and secondary copper minerals are present in a north striking, west dipping shear zone in metamorphosed Mission Canyon Formation. Granitic rock is exposed a few hundred feet away. Sahinen (1950) took an ore sample that ran 0.20 oz/ton gold, 1.3 oz/ton silver, and 5.23% copper.

Red Wing

A caved adit less than 100 feet long heads N48°E. Only unaltered diorite is present on the dump. There has been extensive placer mining in the area, especially up a tributary drainage to the west.

Rock Creek Claim

This small site was studied in detail by the U.S. Bureau of Mines (1988) because it is within the Electric Peak Wilderness Study Area. They found a N80°E 85°SE vein three feet wide containing pods of massive pyrite, arsenopyrite, galena, and sphalerite, and speculated that the property contained 15,000 tons of inferred subeconomic resources at 0.09 oz/ton gold and 3.44 oz/ton silver. Host rocks are latitic and andesitic Elkhorn Mountains volcanics that contain narrow alteration bands of kaolinite, chlorite, and pyrite about the vein. We also noted abundant calcite and siderite within the veins. Two dry caved adits are present, but the extent of the workings probably totals less than a few hundred feet.

Ruby

The Ruby has been well described numerous times, by Knopf (1913), Pardee and Schrader (1933), Roby and others (1960), Foster (1987), and in numerous unpublished studies included in MBMG files. The following description is a compilation of all previous studies.

The Ruby was discovered in 1883 and worked until at least 1920. Total value of gold and silver produced was $1.25 million at the time of production. Underground maps show more than

3,000 feet of underground workings on several levels. The workings were apparently connected with those of the Columbia to the south. The mine followed a N10°W 75°NE zone 150 feet wide and 4800 feet long containing vuggy quartz veins and quartz cemented breccia. Wallrock is welded ash-flow tuff of dacitic composition which contains sericite and pyrite as alteration products over a large area. Adularia and quartz are alteration products near the veins. In addition to quartz, the veins contain calcite, pyrite, galena, sphalerite, chalcopyrite, and silver sulfides, but all of these were relatively minor constituents. Within the mineralized zone, base metal sulfides increase and precious metals decrease with depth. The average grade for the 4700 tons of ore produced between 1906 and 1910 was 1.9 oz/ton Au and 34 oz/ton Ag. Foster (1987) speculated that the mineralization was formed in fumaroles that developed with compaction and cooling of the ash.

The Memphis adit to the west is a 3000-foot cross cut to the Ruby zone at the 600-foot level. A discharge issues from the portal and it is described separately in this paper. The Ruby workings consist of one locked portal with standing water inside, several open stopes, a caved shaft, and several caved adits. There are no environmental problems present.

Ruby Mill

In 1896, an inefficient gravity concentrator and amalgamation mill was built downstream from the Memphis adit. Cyanidation was later added. However, the mill still proved to be inefficient and there was probably little ore run through it. No tailings are evident today, and with the exception of national forest land many miles downstream, only private land is affected.

Saratoga

A short caved shaft investigates aplite containing kaolinite and chlorite alteration products, with secondary copper minerals along fractures. Quartz-pyrite veinlets are also present. A sample of altered aplite and veinlets contained 0.002 oz/ton gold, 0.42 oz/ton silver, 0.82% copper, 5.85% lead, and 0.69% zinc.

Shamrock

Geology of the Shamrock is dominated by a brecciate, fractured silicified zone of altered Elkhorn Mountains porphyritic andesite of unknown geometry and orientation. The zone contains discontinuous quartz-tourmaline-sericite-iron oxide veins and quartz breccia. All exposed rocks are oxidized. Three to five hundred feet of workings were present beyond a caved incline(?).

Silver Queen

Quartz breccia within granodiorite was mined through a shaft (now caved) at the Silver Queen. A select sample contained significant silver, but other metal values were low (0.010 oz/ton gold, 4.58 oz/ton silver, 0.047% copper, 0.02% lead, 0.030% zinc, 0.09% arsenic).

Silversmith

The Silversmith lies on the same N55°E 60°–70°NE structure as the Alport. MBMG files (unpublished) indicate a caved shaft 60–100 feet deep and an adit 440 feet long were present at the now reclaimed site. A composite of the dump material, consisting of silicified granite with 1% pyrite, ran 0.084 oz/ton gold, 2.04 oz/ton silver, 0.020% copper, 0.42% lead, 0.096% zinc, and 0.08% arsenic, so, as its name implies, the Silversmith was probably worked for its silver content. MBMG files report mineralized the structure to be 3–9 feet wide.

Smokey Quartz Prospect

One prospect pit exposes some poor quality smokey quartz crystals.

South Fork State Creek

A dry caved shaft with a few hundred feet of workings is present on the property. It pursued a high-sulfide polymetallic quartz vein typical of the Boulder Batholith.

Sport (Lone Bear)

The Sport Lode is located on the contact between quartz monzonite of the Boulder Batholith and Mission Canyon limestone. Ore occurs as replacement lenses parallel to bedding (N45°W 60°SW) and contains jasperoid, hematite, limonite, garnet, magnetite, and galena (USGS 1978). The ore exposed is oxidized and of low grade; a secondarily enriched zone may occur below. The mine includes four caved adits with a combined length of less than 1,000 feet, two open shafts, and several pits and trenches. A large volume of water emerges from beneath one dump, but this appears to be a pre-existing natural spring.

Springtime

This prospect examines a N40°W 78°NE shear zone in unaltered, weathered granite.

St. Anthony-Twohy

Roby *et al.* (1960) described this small mine with no recorded production. Workings consist of three caved adits, an open adit, and a caved shaft, with a total length of less than 700 feet. They mined a vertical N87°W black quartz vein 2–4.5 feet wide for 200 feet of strike length. Host rock is quartz monzonite with some disseminated galena near the vein. One adit discharges water; a composite sample of the associated dump ran 0.007 oz/ton gold, 0.54 oz/ton silver, 0.044% copper, 0.760% lead, and 0.663% zinc.

State

This site has been disturbed and covered by recent bulldozer work. Roby *et al.* (1960) state that an east-west vertical vein of quartz, pyrite, chalcopyrite, and galena in quartz monzonite was mined. During intermittent work between 1905 and 1940, 544 tons of ore were mined and yielded 384 ounces of gold, 2,594 ounces of silver, 5,075 pounds of copper, and 6,885 pounds of lead.

Suicide Cabin

A quartz-tourmaline-limonite vein strikes N65°E(?) within silicified granitic rocks. A select vein sample contained 0.133 oz/ton gold, 0.19 oz/ton silver, 0.018% copper, 0.020% lead, and 0.004% zinc.

Suicide Cabin South

One to two hundred feet of underground workings were still accessible through an open adit follow a N80°E vein of brecciate quartz.

Sultana

Located in Cretaceous quartz monzonite, the Sultana property contains some quartz-pyrite-galena veins that are at least 2-3 feet thick as indicated by pieces on the dump. The best sample of 14 taken by O'Neill *et al.* (1983) contained 1.22 oz/ton gold and 21.7 oz/ton silver, so there is a high potential for small high grade shoots.

The three adits present are caved and dry, and total length of workings is probably less than 100 feet.

Templeman

Two 65–75-foot tunnels, one of which is open, explore a N42°–60°W 57°–70°NE trending fault zone in Meagher Limestone (Sahinen 1950). A chip sample across this seven foot wide galena and sphalerite-bearing zone ran a trace of gold, 0.5 oz/ton silver, no copper, 4.4% lead, and 6.7% zinc. The limestone has been brecciated and recrystallized, and there are no metallic minerals on the dumps.

Union

Much data exists in publications by the USGS (1978), Weed and Barrell (1901), Klepper and others (1957), and Roby *et al.* (1960). The Union is a N50°W 70°NE replacement zone between Lodgepole limestone and Elkhorn Mountains andesite near Boulder Batholith granodiorite. The zone consists of iron-stained brecciated andesite, limestone, and granodiorite with lenses of siderite, ankerite, galena, sphalerite, pyrite, and azurite. It is 320 feet long and 7 feet thick, and was mined through 500 feet of workings over 365 vertical feet. Production was minimal. From 1905 to 1922 the Union produced 422 tons of ore with 11 oz of gold, 13,439 oz of silver, 1062 lbs of copper, and 75,870 lbs of lead (Roby *et al.* 1960). Seven samples taken by the USGS (1978) averaged a trace of gold, 0.5 oz/ton silver, a trace of copper, 0.7% lead, and 0.6% zinc. However, they stated that subsurface work may disclose resources, and indeed the Union has been the site of a recent extensive drilling program.

Unknown Upper Lowland #1

One caved adit and one caved shaft in quartz monzonite tests a quartz-tourmaline breccia with bright red and green oxidation products. The breccia strikes N13°E. A select sample contained only 0.044 oz/ton gold, 0.27 oz/ton silver, 0.034% copper, 0.29% lead, and 0.15% zinc.

Van Dorstan

A replacement zone in Hasmark Dolomite was mined at the Van Dorstan. The zone is parallel to bedding at N70°W 65°NE, and consists of vuggy banded quartz with copper stain. A sample ran 0.005 oz/ton gold, 34.4 oz/ton silver, and 1.09% copper (Sahinen 1950). There is one open shaft 20 feet deep and one caved stope.

War Eagle-Leroy

A dry caved adit extends N40°E for a few hundred feet along a two-inch-wide quartz pyrite vein in granitic rocks of the Boulder Batholith.

Water Gulch

This a prospect pit on a N4°W-trending shear zone.

White Chief, Lower

The lower White Chief includes one open inclined adit and one caved adit. They investigated a W- to NW- striking vein of quartz, pyrite, chalcopyrite, bornite, and galena that is less than 0.5 feet thick (O'Neill *et al.* 1983). The mineralization is spotty and narrow, with the best values for 15 samples being 0.16 oz/ton gold, 2.5 oz/ton silver, 0.33% copper, 2.93% lead, and 0.15% tungsten. The country rock is Archean gneiss.

White Chief, Upper

The upper White Chief is the site of a caved 450 foot adit that presumably explores a west-striking quartz vein. It is included in O'Neill *et al.* (1983) description of the White Chief.

Whitetail Park Vein

Numerous small prospect pits follow a N6°W vein with a strike length of several miles visible on air photos. The vein contains quartz, chalcedony, pyrite, and yellow-green and black oxidation products, and some is brecciate. A narrow zone of quartz-sericite-pyrite oxidation surrounds the vein. Despite its strike length, a select sample indicated metal values are low--0.035 oz/ton gold, 1.45 oz/ton silver, 0.10% copper, 0.27% lead, and 0.022% zinc.

Appendix IV

Water-Quality and Soil Chemistry Data
Jefferson River Drainage

Appendix IV. Water-quality chemistry - Jefferson and Boulder River Drainages.

National Forest Service - Deerlodge National Forest
Jefferson and Boulder River Drainages
Water-quality results - dissolved constituents

Mine/ Sample ID	Lab ID	Sample location	Al ug/L	As ug/L	Ba ug/L	Cd ug/L	Cr ug/L	Cu ug/L	Fe mg/L	Pb ug/L	Mn mg/L	Hg ug/L	Ni ug/L	Ag ug/L	Zn ug/L	Cl mg/L	F mg/L	NO3_n mg/L	SO4 mg/L	SiO2 mg/L	field_ph (SU)	field_sc umhos/cm	Temp (C)
ATLANTIC-PACIFIC MINE AND TAILINGS																							
JAPS10M	92Q1189	A and P mine site * Downstream of upper tailings	<30.	<1.	30.5	<2.	<2.	<2.	0.014	<2.	0.003	<0.1	<2.	<1.	3.2	0.45	<.05	0.066	21.7	13	7.28	143.3	9.8
JAPS20H	92Q1172	A and P mine site * A & P adit discharge	29180 S A C	<1.	17.7	3.2 C	<2.	3760 S A C	14.22 S A	3.6 C	14.16 S	0.1 C	9.1	<1.	76.5	3.8	<.50	0.13	465 S	29	3.2 S	1011.4	8
JAPS30L	92Q1176	A and P mine site * Spring below A & P adit	71.5 S	<1.	29.7	<2.	<2.	15.2 C	0.025	<2.	0.003	0.1 C	<2.	<1.	72.2	3.3	0.068	0.27	8.1	13	7.09	136.3	4.8
JAPS40M	92Q1184	A and P Mine site * Viking upper adit discharge	<30.	<1.	42.4	<2.	<2.	<2.	0.15	<2.	0.021	<0.1	<2.	<1.	3.7	0.52	0.085	0.22	6.9	15	6.92	36.8	5.3
JAPS50L	92Q1182	A and P Mine site * Viking lower adit discharge	<30.	<1.	34.9	<2.	<2.	<2.	0.009	<2.	<.002	<0.1	<2.	<1.	2.1	1.8	0.097	0.3	27.5	14	7.34	141.6	5.9
JAPS60M	92Q1187	A and P Mine site * Park Creek below site	<30.	<1.	34.2	<2.	<2.	<2.	<.003	<2.	<.002	<0.1	<2.	<1.	2.1	1.7	0.104	0.295	25.5	14	7.92	148.8	10.2
JAPS70L	92Q1185	A and P Mine site * Park Creek above confluence	<30.	<1.	36.7	<2.	<2.	<2.	0.003	<2.	0.004	<0.1	<2.	<1.	7.8	1.66	0.091	0.31	26.1	14	7.81	144.7	5.9
JAPS80L	92Q1180	A and P Mine site * Above Viking mine	<30.	<1.	17.8	<2.	<2.	<2.	0.006	<2.	0.002	<0.1	<2.	<1.	6.4	<.5	0.067	0.084	3.7	13	7.85	76.6	6.9
JAPS90L	92Q1178	A and P Mine site * Viking above confluence with A & P discharge	<30.	<1.	17.2	<2.	<2.	<2.	<.003	<2.	0.002	0.1	<2.	<1.	2.8	<.5	0.055	0.077	3.86	13	7.81	80	5.5
B and H TAILINGS																							
JBHS10M	92Q1471	B and H Mine site * downstream	<30.	<1.	19.6	<2.	<2.	<2.	0.005	<2.	0.014	<0.1	<2.	<1.	5.3	0.29	0.086	0.048	50.1		8.2	250.9	4
JBHS20L	92Q1473	B and H Mine site * upstream	<30.	<1.	19.9	<2.	<2.	<2.	0.007	<2.	0.003	<0.1	<2.	<1.	37.9	0.51	0.078	<.05	47.8	10	8.24	221.5	5
BISMARK																							
JBIS10L	92Q1144	Bismark Mine site * S.F. Boulder River below site	<30.	<1.	9.8	<2.	<2.	<2.	0.004	<2.	<.002	0.1 C	<2.	<1.	10.2	0.36	0.09	0.083	15.2	5	7.47	121.1	7.1
BOULDER-COBALT MINE																							
JBCG10M	92Q1480	Boulder-Cobalt Mine * shaft sample	<30.	<1.	19.9	<2.	<2.	<2.	0.247	<2.	0.116 S	<0.1	<2.	<1.	11.8	0.57	0.097	0.092	61.7	8	6.74	385.6	5
JBCS10M	92Q1478	Boulder-Cobalt Mine * spring at base of dump	<30.	1.5	11.3	<2.	<2.	<2.	0.03	3.6 C	0.021	<0.1	<2.	<1.	23.5	0.54	0.055	0.68	72.3	8	6.69	252	5.5
ELKHORN IRON MINE																							
EEIS10L	92Q0877	Elkhorn Peak Iron Mine * west adit discharge	58	<1.	1.2	<2.	<2.	14.6 C	0.031	<2.	0.002	0.1 C	<2.	<1.	25.4	0.18	0.1	0.12	10.8		7.72	144.4	1.4
EEIS20L	92Q0878	Elkhorn Peak Iron Mine * spring at base of dump	<50	1.6	<2.	<2.	<2.	<2.	<.003	2.1	<.002	0.1 C	<2.	<1.	9.7	0.28	0.05	0.33	5.9	6	8.31	125.4	
QUEEN OF THE HILLS																							
WQHS10H	96Q0549	Adit discharge from Queen of the Hills	<30.	<1.	6.7	<2.	<2.	<2.	0.009	<2.	0.003	<.1	<2.	<1.	2.7	0.5	0.3	<.05	32.5	14	7.68	297	2.6
SILVER GLANCE MINE																							
MSGS10L	94Q0245	Unnamed stream, immediately below patented claim	44	7.2	22.7	<2.	<2.	<2.	0.345 S	<2.	0.051 S		<2.	<1.	4.6	0.88	0.15	0.062	5.8	22	6.8	78.2	14.1
MSGS20L	94Q0241	Unnamed stream, downstream of all disturbances	<30.	23.6	18.2	<2.	<2.	<2.	0.595 S	<2.	0.138 S	<0.1	<2.	<1.	3.9	0.62	0.2	<.05	4	21	7.05	86	15.8
MSGS30L	94Q0240	Discharge below adit A1	<30.	1.5	20	<2.	<2.	<2.	0.008	<2.	0.043	<0.1	<2.	<1.	11.1	0.9	0.24	0.11	15.7	24	6.61	101	11.8
MSGS40L	94Q0243	East branch of unnamed tributary, above site	<30.	3.8	10.5	<2.	<2.	2	0.022	<2.	0.005	<0.1	<2.	<1.	10.5	0.56	0.14	0.4	4.8	15	6.27 S	57	14
MSGS50L	94Q0247	West branch of unnamed tributary, above site	37	5.4	16	<2.	<2.	4.4	0.053	<2.	0.008	<0.1	<2.	<1.	10.2	0.62	0.1	0.058	2.7	18	6.28 S	79	13.5
SNYDER'S MINE																							
JSNS10L	92Q1130	Snyder's Mine site * sample 1	<30.	<1.	3.2	<2.	<2.	<2.	0.005	<2.	<.002	<0.1	<2.	<1.	3.5	1.08	<.4	0.49	32	7	8.24	166	4.3
JSNS20L	92Q1131	Snyder's Mine site * sample 2	<30.	<.8	3	<2.	<2.	<2.	0.008	<3.	<.002	<0.1	<2.	<1.	2.9	1.1	<.4	0.14	32.3	7	8.32		6
JSNS30L	92Q1132	Snyder's Mine site * sample 3	<30.	<1.	5.5	<2.	<2.	<2.	0.009	<2.	<.002	<0.1	<2.	<1.	2.9	1.1	<.40	0.085	31.8	7	8.71 S	17.5	9
JSNS40L	92Q1134	Snyder's Mine site * sample 4	<30.	<1.	8.8	<2.	<2.	<2.	<.003	<2.	<.002	0.1 C	<2.	<1.	4.9	1.1	<.40	0.15	14.2	8	7.54	182	6.2
SOUTH FORK BOULDER RIVER BELOW ALL MINES																							
JBSBS10L	92Q1514	South Boulder River * sample 1	<30.	<1.	16.2	<2.	<2.	<2.	0.01	<2.	0.002	0.1 C	<2.	<1.	7	0.5	0.062	0.093	18.4	8.7	7.78	139	6
ELKHORN SKYLINE MINE																							
ESKS10L	92Q0876	Skyline Mine * spring above workings	<50	<1.	<2.	<2.	<2.	<2.	<.003	<2.	<.002	0.1 C	<2.	<1.	10	0.37	<.10	<.10	1.7	7	7.1	2.5	21.6
ESKS20L	92Q0875	Skyline Mine * Middle adit discharge	<50	11.1	<2.	<2.	<2.	<2.	<.003	<2.	<.002	0.1 C	<2.	<1.	50.2	0.17	<.10	<.10	2.4	8	6.92	34	18.1
ESKS30L	92Q0874	Skyline Mine * Below lower adit	<100	4.5	<2.	<2.	<2.	2.1	<.003	<2.	0.002	0.1 C	<2.	<1.	15	0.29	0.13	<.10	2.5	9	6.53	45	16.2
GALENA GULCH																							
GNNS10L	92Q0855	Boulder W Mine * Seep at base of dump	<50	<1.	20.4	<2.	<2.	<2.	<.003	<2.	0.013	0.1 C	<2.	<1.	4.1	2.1	0.31	0.24	30.4	16	7.33	507.3	5.8
GOLD HILL MINE AND TAILINGS																							
MGHS10L	94Q0231	Gold Hill Mine * Unnamed stream near property boundary	91 S C	5.3	7.7	<2.	<2.	<2.	0.1	<2.	0.01	<0.1	<2.	<1.	5	0.64	0.13	0.13	6.2	21	7.48	80	13.1
MGHS20L	94Q0238	Gold Hill Mine * Unnamed stream below tailings on DNF-administered la	90 S C	6.2	8.6	<2.	<2.	2.4	0.075	<2.	0.003	<0.1	<2.	<1.	4.1	0.61	0.16	0.064	6.6	20	6.82	76	12.2

HIGHLAND TAILINGS																																		
MHTG10H	94Q0273	Highland Mill * Discharge at base of impoundment	<30.		8.2		51.6	<2.		<2.	4.4		0.051		<2.		0.096	S	<0.1		2.5	<1.		<2.		1.87	0.404	0.207	19.3	25	8.06		497	16.7
MHTS10H	94Q0268	Highland Mill * Mid. Fk. Moose Cr. below site	<30.		2.8		26.5	<2.		<2.	6.2		0.046		<2.		0.044		<0.1		2.7	<1.		13.8		1.9	0.257	0.07	53	18	7.29		555	8.5
MHTS20H	94Q0270	Highland Mill * Mid. Fk. Moose Cr. above site	<30.		4.1		32.2	<2.		<2.	<2.		0.033		<2.		0.071	S	<0.1		2.1	<1.		4.2		1.4	0.146	<.05	7.11	17	8.49		433	17.5
MHTS30H	94Q0258	Highland Mill * Stream that drains impoundments, lower end	<30.		4.3		39.7	<2.		<2.	6.2		0.029		<2.		0.02		0.14	C	3	<1.		4.5		2.3	0.3	0.08	186	18	7.99		757	10.5
MHTS40H	94Q0267	Highland Mill * Tributary that drains middle of impoundment	<30.		<1.		23.8	<2.		<2.	6.2		0.02		<2.		0.021		<0.1		2.8	<1.		2.1		1.7	0.32	0.5	92.1	19	8.01		535	10.9
MHTS50H	94Q0274	Highland Mill * Mid. Fk. Moose Cr. near confluence with site discharges	<30.		2.6		24.2	<2.		<2.	3.6		0.043		<2.		0.051	S	<0.1		2.2	<1.		<2.		1.43	0.26	0.54	35.8	18	8.18		478	11.1
MHTS60L	94Q0259	Highland Mill * Small tributary east of tailings	49		6.9		22.3	<2.		<2.	11.9		0.28		<2.		0.034		<0.1		<2.	<1.		15.4		0.87	0.28	2.29	9.1	25	8.01		148	19.1
MHTS70H	94Q0275	Highland Mill * Discharge through breach in impoundment	<30.		6.5		50	<2.		<2.	5.1		0.032		<2.		0.072	S	<0.1		2.9	<1.		2		2.26	0.43	0.303	72.6	25	8.3		587	15.2
MHTS80H	94Q0265	Highland Mill * Drain where spring collects	<30.		4.4		57.3	<2.		<2.	7.2		0.038		<2.		0.038		<0.1		2.5	<1.		2.3		1.9	0.35	0.25	17	24	8.32		502	19.9
MHTS90H	94Q0263	Highland Mill * Spring above impoundment	<30.		6.8		44.6	<2.		<2.	3.8		0.009		<2.		0.039		<0.1		2.5	<1.		2.1		1.9	0.29	4.54	12.1	26	8.24		462	15.3
JIB-KATIE TAILINGS																																		
BJBS10L	95Q0300	Jib-Katie Mill * Boulder River, upstream of site	<30.		3		14	<2.		<2.	<2.		0.173		<2.		0.009		0.12	C	<2.	<1.		6		2.5	0.146	0.3	15	20	7.91		204	3.9
BJBS20L	95Q0298	Jib-Katie Mill * Boulder River, downstream of site	<30.		2.8		14	<2.		<2.	5.2		0.014		<2.		0.011		0.12	C	<2.	<1.		11.9		2.5	0.16	0.1	17.5	19	7.96		195	4.9
LEADVILLE																																		
RLVG10H	94Q0209	Leadville Mine * Flooded shaft	<30.		84.4	P	<2.	<1.		<2.	<2.		0.008		<2.		0.038		<0.1		<2.	<1.		68.5		0.3	0.097	0.19	6.2	11	6	S	60	5.8
RLVS10L	94Q0210	Leadville Mine * Adit discharge	<30.		50.1	P	<2.	<2.		<2.	<2.		<.003		3.8	C	0.003		<0.1		<2.	<1.		21		6.2	0.115	0.12	3.9	18	6.76		81	5.8
RLVS20L	94Q0204	Leadville Mine * Springs upgradient of adit	<30.		4.1		2.5	<2.		<2.	5		<.003		11	C	<.002		<0.1		<2.	<1.		4.7		1.6	0.043	0.1	2.25	12	5.95	S	28.6	7.5
RLVS30M	94Q0212	Leadville Mine * Flooded shaft	<30.		89.3	P	2.4	<2.		<2.	<2.		0.032		<2.		0.033		<0.1		<2.	<1.		9.8		<.2	0.124	0.085	<.1	12	5.95	S	32.2	13.2
RLVS40L	94Q0207	Leadville Mine * Spring-fed stream, below site	<30.		13.6		2.4	<2.		<2.	3.9		<.003		5.3	C	<.002		<0.1		<2.	<1.		13.5		1.2	0.067	0.53	2.2	12	6.3	S	30.7	11.9
RLVS50L	94Q0211	Leadville Mine * Spring-fed stream, near waste-rock dump	<30.		8.4		2	<2.		<2.	<2.		<.003		<2.		<.002		<0.1		<2.	<1.		3.5		0.3	0.144	0.09	2.5	13	6.35	S	33.2	8.8
RLVS60L	94Q0206	Leadville Mine * Flooded shaft	28		73.1	P	<2.	1.8	C	<2.	5.8		0.061		14	C	0.043		<0.1		<2.	1.9	C	246	A C	2.9	0.09	0.1	5.2	9	5.96	S	24.4	8
MEMPHIS/RUBY MINE																																		
LMPS10L	92Q0856	Memphis Mine * Discharge from adit	<50		2.2		24.3	<2.		<2.	2.8		0.049		<2.		0.275	S	0.1	C	3.6	<1.		320	A C	1.7	0.5	<.10	176	27	7.36		627	10.3
LMPS20L	92Q0857	Memphis Mine * Waste-rock seep	<50		3.3		18.6	<2.		<2.	5.6		0.009		<2.		0.006		0.1	C	3.7	<1.		180	A C	1.7	0.56	<.10	179	26	8.05		676	10.6
MOGULLION MINE																																		
JMOS10M	92Q1513	Mogullion Mine Site * Sample 1	<30.		<1.		3.5	<2.		<2.	2.5		0.038		<2.		0.016		<0.1		<2.	<1.		17.9		0.36	0.48	0.121	26.2	14	8.28		140	5.5
MONTREAL STAR MINE																																		
LMSS10M	94Q0201	Lowland Creek, upstream of site	37		6		8.2	<2.		<2.	6.5		0.275		3		0.012		0.16	C	<2.	<1.		7.8		2	0.18	1.3	6	22	6.4	S*	113	12.1
LMSS20M	94Q0195	Lowland Creek, downstream of site	31		5.8		7.3	<2.		<2.	18.3	A C	0.258		4.6		0.024		0.12	C	<2.	<1.		9.8		1.8	0.11	1.4	8.8	21	6.6		132	10.5
LMSS30H	94Q0200	Seep at edge of wetlands	28900	S A C	2		13.9	24	P A C	<2.	10540	S A C	0.12		39	C	6.68	S	<0.1		62	<1.		2700	A C	7.2	1.39	<.25	801 P,S	68	4.3	S	1318	10.7
LMSS40H	94Q0203	Ponded water in trench P8	8260	S A C	23.8		16	35.7	P A C	<2.	4480	S A C	2.94	S A	13	C	9.51	S	<0.1		55	<1.		5570	S A C	4.4	0.33	0.138	535 P,S	23	3.71	S	1015	10.1
LMSS50H	94Q0197	Ponded water in trench P7	<30.		8		17.1	<2.		<2.	7.2		0.201		4.8	C	0.048		<0.1		2.7	3.5	C	28.6		14.1	0.118	1.08	107	10	8.55		296	10.9
NORTH BOULDER LEAD MINE																																		
ABLS10H	94Q0216	Alta Gulch, upstream of site	<30.		2.1		22	<2.		<2.	<2.		0.181		<2.		0.013		0.12	C	<2.	<1.		2.3		3	0.203	0.054	6.6	21	7.83		211	12.8
ABLS20M	94Q0214	Alta Gulch, downstream of site	<30.		2.2		17.6	<2.		3.8	<2.		0.005		<2.		<.002		0.12	C	<2.	<1.		<2.		1.9	0.2	0.086	9.2	22	7.6		212	18.8
OHIO LODE MINE																																		
JOHS10L	92Q1165	Ohio Mine site * Sample 1	36		<1.		59.6	<2.		<2.	6		0.022		<2.		0.015		<0.1		<2.	<1.		28		0.78	0.21	<.05	13.2	11	7.38		165	8.2

[UG/L = micrograms/liter; MG/L = milligrams/liter; < = below method detection limit; P = primary drinking water standard exceeded;
S = secondary drinking water standard exceeded; A = acute aquatic standard exceeded; C = chronic aquatic standard exceeded
SC = specific conductance in micromhos/centimeter; Temp = temperature in degrees Celcius; GPM = gallons/minute]
– = analyte not reported; not analyzed for by laboratory. S*= laboratory pH was not ourside acceptable limit.

Appendix IV. Soil sample results for the Deerlodge National Forest.
Big Hole, Boulder, and Jefferson River Drainages

Soil Analyses (Qualified soil)
(Concentrations in mg/kg)

Mine and Sample	Lab ID	Description	Ag mg/Kg	C	Q	As mg/Kg	C	Q	Ba mg/Kg	C	Q	Cd mg/Kg	C	Q	Cr mg/Kg	C	Q	Cu mg/Kg	C	Q	Ni mg/Kg	C	Q	Pb mg/Kg	C	Q	Zn mg/Kg	C	Q	Hg mg/Kg	C	Q
Atlantic-Pacific Mine and Tailings - 09/16/92																																
JAPD10H	92S1192		0.21	U		7.02			146			0.428	U		17.3			19.3			11			19.3			32.2			NR		
JAPT20H	92S1193		0.24	U		0.895	B		207			0.487	U		2.55			49			1.08	B		43			18.1			1.4		
B and H Tailings - 10/19/92																																
JBHD10M	92S1475		8.51			124			86.7			1.88			23.7			292	ICP		12.6			650	ICP		263	ICP		2.9		
Bismark Mine - 09/10/92																																
JBID10H	92S1147		0.46	S		0.45	B		80.1			0.566	U		0.57	U		1304	ICP		0.57	U		24.9			28			1		
JBID20H	92S1148		0.3	U		0.3	U		135			0.688	B		60.8			1159	ICP		32			30.6			139			NR		
Gold Hill Mine and Tailings - 08/20/93																																
MGHD10L	94S0049	Streamside tailings	1.18	B		1244			98.54			1.12	B		3.64	B		193.24			2.68			57.32			58.46			0.46		
Highland Tailings - 08/25/93																																
MHTD10H	94S0050	Tailings in impoundment M1	0.76	B		495.7			33.15			1.09	B		9.95			1263.6			9.14			64.26			190.57			0.42		
MHTD20H	94S0051	Soil and tailings in impoundment M2	0.52	U		339.8			41.21	B		1.86			20.23			797.04			22.4			89.55			943.59			0.14		
MHTD30H	94S0052	Tailings in breach through impoundment M3	0.72	B		218.3			21.95			0.83	B		13.61			499.78			5.41			11.07			108.24			0.25		
MHTD40H	94S0053	Tailings along seep path in impoundment M4	0.94	B		552.8			29.96			1.02			10.25			1140.6			11.8	B		123.15			152.64			0.3		
Jib-Katie Tailings - 10/25/94																																
BJBD10M	95S0027	Soil along banks of Boulder River, downstream of tailings impoundment	6.54	B		29.3			159	B		4.92	U		4.92	U		45.3	B		4.92	U		167			120	B		0.35		
Montreal Star Mine - 08/17/93																																
LMSD10H	94S0047	Sediments deposited along haul road gully	12.04			2388			84.46			1.04			3.31	B		127.39			3.65	B		122.59			62.73			0.05	B	
North Boulder Lead Mine - 08/19/93																																
ABLD10L	94S0046	Streamside waste-rock dump at south end of site	2.9			93.5			20.71			8.39	B		22.35			37.63			11.3			2194.4			2330.2			0.07		

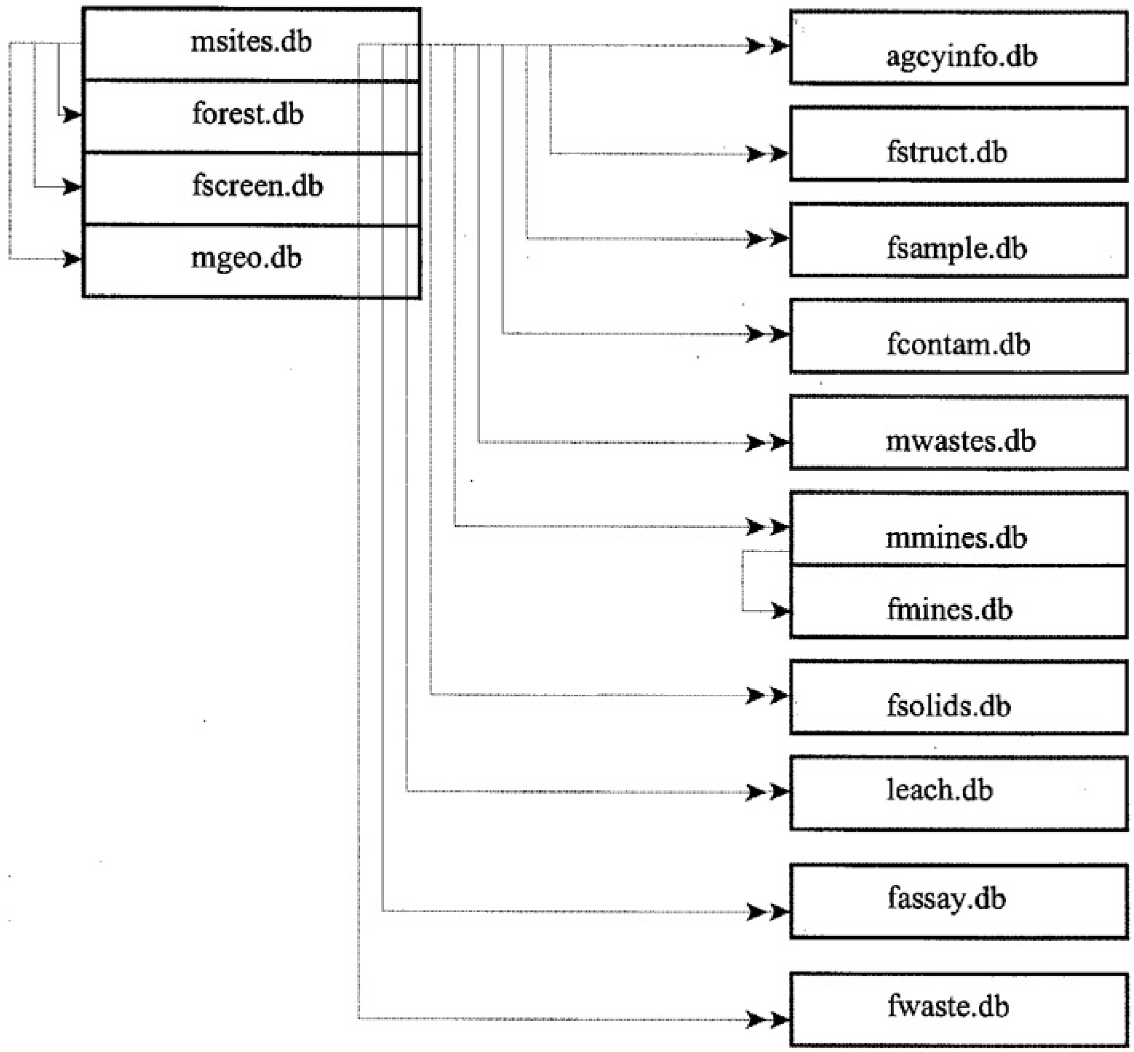
B - Detected but below method detection limit.
U - Analyzed for but below instrument detection limit.
N - Spike sample recovery not within control limits.
* - Duplicate sample not within control limits.
ICP - Outside of calibrated range of ICP

Appendix V

Database Fields
MBMG-USFS AIM Program

AIM data base tables.

Data Model: FORESTR2.FSL



Sites Table
Id Number
Name
Alt Name
Mine District
County
Mrds #
Amli #
Mils #
Latitude
Longitude
Township
Range
Section
Tract
Utm Northing
Utm Easting
Utm Zone
Average Elevation
Elevation Units
Land Owner
1:250K Map
1:100K Map
1:24K Map
Property Type
Disturbance Type
Current Status
Mine Method
Map
Scale
Year of Production
Process Method
Process Capacity
Published Reserves - Measured
Published Reserves - Indicated
Published Reserves - Geological
Description of Workings
Depth of Workings
Width of Workings
Length of Workings
Disturbed Area of Workings
Surface Map
Surface Agency
Surface Address
Surface City
Surface Zip
Underground Map
Underground Agency
Underground Address
Underground City
Underground Zip
Date of Update
Longview
Plan View
Bibliography

Mines Tables
Id
Type Opening
Latitude
Longitude
Utm Northing
Utm Easting
Utm Zone
Waste Production Rate
Ore Production Rate
Opening Type
Condition
Size Open Length
Size Open Width
Status Rank
Elevation
Elevation Unit

Mine Open Table
Id
Type
Condition
Ground Water
Photo
Ownership
Comments

Wastes Table
Id
Type Waste
Rock Type
Au oz
Ag oz
Cu lb
Pb lb
Zn lb
As lb
Tons
Mineralized

Agency Table
Id
Agency
Division
District/Area
Ftract
Fwatershed Code
Forest
District
Owner
Own Impacts
Report

Forest Table
Id
Investigator
Date
Photos
Access
Nearest Wetlands
Drainage Basin
Waste Contact Stream
Nearest Surface Intake
Num of Surface Intakes
Uses of Surface Intake
Nearest Well
Nearest Dwelling
Number of Months Occupied
Number Houses 2 Miles
Recreational Usage
Nearest Rec Area
Name of Area
Hmo Adit
Hmo Wall
Hmo Struct
Hmo Chem
Hmo Solid
Hmo Explosives
Sensitive Environments
Pop Within .25 Miles
Pop Within .5 Miles
Pop Within 1 Miles
Pop Within 2 Miles
Pop Within 3 Miles
Pop Within 4 Miles
Public Interest

Fwastes Table
Id
Type
Wind Erosion
Vegetation
Surface Drainage
Stability
Location/Flood Plain
Distance to Stream
Photos

Fcontamination
Id
Type of Contamination
Estimated Quantity

Fstructure
Id
Type
Condition

Samples
Id
Sample Id
pH
Sc
Temp
Flow Rate
Flow Units
Flow Method
Soil Interval
Remarks

Water
Id
Sample Id
Source