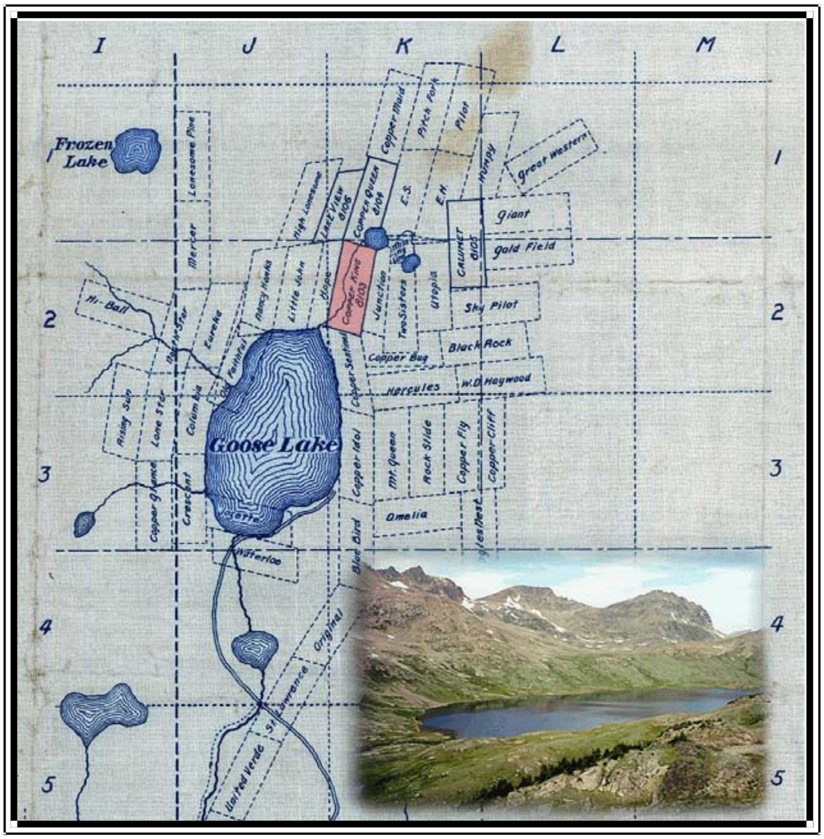
Abandoned-Inactive Mines on Custer National Forest-Administered Land



Montana Bureau of Mines and Geology
Abandoned-Inactive Mines Program
Open-File Report MBMG 421

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Montana Bureau of Mines and Geology
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Earth Science Information

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

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2003

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by
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1.0 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 of the USFS administers National Forest System lands in Montana and parts of Idaho and North Dakota and South Dakota. Concurrently, 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 a series of participating agreements to accomplish this work. The first forest inventoried was the Deerlodge National Forest, followed by the Helena National Forest, then the Beaverhead, the Kootenai, and the Lewis and Clark Forests (table 1).

Table 1. List of previous inventories and open-file report (OFR) numbers.

National Forest-Volume	Drainage	MBMG OFR #
Deerlodge-Volume I	Basin Creek	321
Deerlodge-Volume II	Cataract Creek	344
Deerlodge-Volume III	Flint Creek and Rock Creek	345
Deerlodge-Volume IV	Upper Clark Fork River	346
Deerlodge-Volume V	Jefferson River	347
Helena-Volume I	Upper Missouri River	352
Helena-Volume II	Blackfoot-Little Blackfoot Rivers	368
Beaverhead	Entire Forest	379
Kootenai	Entire Forest	395
Lewis and Clark	Entire Forest	413
Bureau of Land Management	Entire State	365

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. Objectives of this discovery process, as defined by the USFS, were to

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 obtained 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 therefore 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, 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 Mines

Abandoned and inactive mines may host various safety, health, and environmental problems that 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; 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 (appendix I-Field Form), the hydrologic environment appears to be affected to the greatest extent. Therefore, this investigation focused most heavily on impacts to surface and ground water from the mines.

Metals are often transported from a mine by water (ground-water or surface-water runoff), either by being dissolved, suspended, or carried as part of the bedload. When sulfides are present, acid can form, which in turn increases the 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 and others (1975) identified six components that govern the formation of metal-laden acid-mine waters. They are as follows:

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 that affect the other five elements.

Most geochemists would add to this list mineral availability, such as calcite, which can neutralize the acidity. These six components occur not only within the mines but can exist within mine dumps and mill-tailings piles making waste material sources of contamination as well.

Acid-mine drainage 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 Solubilities of Selected Metals

At a pH above 2.2, ferric hydroxide($Fe[OH]_3$) precipitates to produce a brown-orange stain in surface waters and forms a similarly 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 ($MnCO_3$) and its weathering products.

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 silver solubility 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 present in solution in higher pH waters. At a pH 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, cadmium solubility is controlled by the carbonate species octavite ($CdCO_3$) 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 in soil such as sulfate and phosphates also may control copper solubility. 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 (Hg), and as Hg 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 a pH 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 a pH 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.

1.3.3 The Use of pH and SC to Identify Problems

In mine evaluation studies, pH and specific conductance (SC) have at times 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 also may exceed standards in waters having pH values within acceptable limits.

Reliance on SC as an indicator of site conditions also can 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% possible-error range. Further, 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 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 analysis of trace elements, and major 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. Published location(s) of the mines were plotted on USFS maps. From the maps, an inventory was developed of all known mines located on, or that could affect, National Forest System lands in Montana. The following data sources were used:

1) the MILS (mineral industry location system) data base [U.S. Bureau of Mines(USBM)],

2) the MRDS (mineral resource data systems) data base [U.S. Geological Survey(USGS)],
3) published compilations of mines and prospects data,
4) state publications on mineral deposits,
5) USGS publications on the general geology of some quadrangle maps,
6) recent USGS/USBM mineral resource potential studies of proposed wilderness areas,
7) MBMG mineral property files and CRIB (computerized resource information bank [USGS]).

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 located in the field.

1.4.2 Pre-Field Screening

Field crews visited only sites having the potential to release hazardous substances and sites that lacked 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. Sites on dry ridgetops were assumed to have no mechanism for water transport and mines described in the literature as small prospects were considered to have inconsequential hazardous-materials sources; thus neither type was visited.

In addition, the MBMG and the USFS developed screening criteria (table 2) 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.

Table 2. 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 investigated further. Physical hazards alone (question 7) were not a basis for a site visit.

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

Placer mines were not studied as part of this project. Although mercury was used in amalgamation of placer gold, the complex nature of placer deposits makes detection of mercury 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

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 and gathered information on environmental degradation, hazardous mine openings, presence of historical structures, and land ownership. Some site locations were refined using conventional field methods. Each site is located by latitude/longitude and by Tract-Section-Township-Range (see figure 1 for explanation).

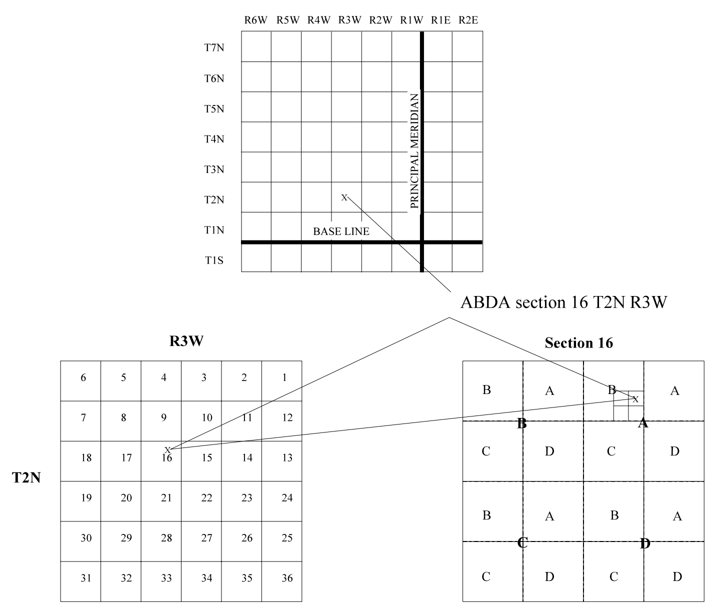


Figure 1. The location of a mine is found as shown using a counterclockwise progression of decreasing quarters of a section of land. The resulting tract in this case is ABDA.

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

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 2). 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.

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

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; and

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

The 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 only taken to provide some information on the types of metals present and a rough indication of their concentrations. Outcrops and mine waste were not sampled extensively enough to provide reliable estimates of tonnages, grades, or economic feasibility.

1.4.4 Field Methods

An MBMG hydrogeologist visited all of the sites that 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. The reasoning behind this approach was that a mine disturbance 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 be releasing metals in concentrations that adversely impact the environment.

The hydrogeologist selected and marked water and/or soil sampling locations based on field parameters (SC, pH, Eh, etc.) and observations (erosion and staining of soils/streambeds), and 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, all 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 that ownership boundaries were known.

Because monitoring wells were not installed as part of this investigation, the evaluations of impacts to ground water were based solely upon 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 Collection of Water and Soil Samples

Sampling crews collected soil and water samples, and took field measurements (streamflow) in accordance with the following:

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

Quality Assurance Project Plan (QAPP) (Metesh, 1992)–This plan guides the overall collection, transportation, storage, and analysis of samples, and the collection of field measurements.

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

1.4.4.3 Marking and Labeling Sample Sites

Each sample location was plotted on the site map or topographic map; each sample site was given a unique seven-character identifier based on its location, sample type, interval, and relative concentration of dissolved constituents. The characters of the unique identifier were defined as follows:

D	DA	T	U	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,
- U: 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.

1.4.4.4 Existing Data

Data collected in previous investigations were neither qualified nor validated under this project. The quality-assurance managers and project hydrogeologists 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, U.S. EPA, Environmental Monitoring and Support Laboratory, Las Vegas, NV

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

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

If a contract laboratory procedure 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, U.S. EPA, Washington D.C.

EPA Method 1312 Acid-rain Simulation Leach Test Procedure-Physical/Chemical Methods, SW-846, 3rd edition, U.S. 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 concentrations of various metals. To 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 3. 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.

Table 3. 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(9)		0.34	0.15
Barium	2			
Cadmium	0.005		0.0043(6)	0.0022(6)
Chromium	0.1		1.7(6,7)	0.21(6,7)
Copper	1.3[8]	1	0.013(6)	0.009(6)
Iron		0.3		1
Lead	0.015[8]		0.065(6)	0.0025(6)
Manganese		0.05		
Mercury	0.002		0.0014	0.00077
Nickel			0.47(6)	0.52(6)
Silver		0.1	0.0034(6)	
Zinc		5	0.12(6)	0.12(6)
Chloride		250	860	230
Fluoride	4.0	2.0		
Nitrate	10 (as N)			
Sulfate		250		
Radium 226, 228 combined	5pCi/L			
Uranium	30 µg/L			
pH (Standard Units)		6.5-8.5		6.5-9.0

(1) 40 CFR 141; revised through 7/1/99.
(2) 40 CFR 143; revised through 7/1/99.
(3) Priority Pollutants, EPA Region VIII, April 1999.
(4) Maximum concentration not to be exceeded more than once every 3 years.
(5) 4-day average not to be exceeded more than once every 3 years.
(6) Hardness dependent. Values are calculated at 100 mg/L.
(7) Cr^{+3} species.
(8) Action level, EPA Current Drinking Water Standards, National Primary and Secondary Drinking Water Regulations, April, 1999.
(9) The Safe Drinking Water Act, as amended in 1996, requires EPA to revise the existing drinking water standard for arsenic. Planned for Spring 2000.

1.4.6.2 Soil Standards

There are no federal standards for metal concentrations 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, metal concentrations in soils were compared to the limits postulated by the EPA and the Montana Department of Environmental Quality for sites within the Clark Fork River basin in Montana. The proposed standard for lead in soils is 1,000 mg/kg to 2,000 mg/kg, and 80 to 100 mg/kg for arsenic in residential areas. The Clark Fork Superfund Background Levels (Harrington-MDHES, oral commun., 1993) are listed in table 4.

Table 4. Clark Fork Superfund background levels (mg/kg) for soils.

Reference	As	Cd	Cu	Pb	Zn
U.S. Mean soil	6.7	0.73	24	20	58
Helena Valley Mean soil	16.5	0.24	16.3	11.5	46.9
Missoula Lake Bed Sediments	-	0.2	25	34	105
Blackfoot River	4	<0.1	13	-	-
Phytotoxic Concentration	100	100	100	1,000 (500*)	500

*A more recent level of 500 mg/kg for lead was provided for state superfund programs (Judy Reese, oral commun., 1999). The 1,000 level is an upper limit for lead and not used at CFR sites.

For reference, Reese also provided the following Clark Fork Superfund phytotoxicity levels:

Table 5. Various levels of toxicity for lead (ARWWS : Anaconda Regional Water and Waste Standards, a part of the Anaconda National Priorities List).

Source		ppm
ARWWS ecological RA	low pH<6.5	94 (Natural Resource Damage #)
ARWWS ecological RA	low pH>6.5	179 (Natural Resource Damage #)
ARWWS ecological RA	high pH<6.5	250
ARWWS ecological RA	high pH>6.5	250
Kabata-Pendias & Pendias (1992)		100-400
CH2MHill (1987)		1000

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, soil chemistry are presented in appendix IV.

The data for this project were collated with existing data and incorporated into a new MBMG abandoned-inactive mines data base. The data base will eventually include information on mines and prospects throughout Montana. It is designed to be the most complete compilation available for information on the location, geology, production history, mine workings, references, hydrogeology, and environmental impact of each of Montana's mining properties.

1.5 Custer National Forest

The Custer National Forest covers approximately 2.5 million acres consisting of a number of discontinuous tracts of land. The western most part of the Forest includes the eastern portion of the Beartooth Mountains in south-central Montana, and it borders the Gallatin and Shoshone National Forests, and Yellowstone National Park. Other sections of the Custer National Forest extend eastward across Montana and into South Dakota (figure 2). The USFS regional office is located in Missoula, Montana, with the Custer Forest Supervisor’s office in Billings. The Custer National Forest has three district offices; the Beartooth Ranger District in Red Lodge, Montana, the Ashland Ranger District in Ashland, Montana, and the Sioux Ranger District in Camp Crook, South Dakota.

The topography within the Custer National Forest is diverse, ranging from Montana’s highest mountain, Granite Peak (12,799 ft), to grassland- and ponderosa-covered buttes of the eastern districts. Topographically the northeast flank of the Beartooth Mountains consists of broad plateaus at altitudes of more than 10,000 feet, deeply dissected by steep-walled glaciated valleys. The Pryor Mountains to the east were never glaciated, are rather dry, and rise out of the semi-arid grass-sagebrush-vegetated valleys to coniferous forests and alpine peaks, the highest reaching an altitude of 8,786 feet.

1.5.1 History of Mining

Some knowledge of the local mining history is helpful in understanding the problems created by abandoned and inactive mines in the area. Simons and others (1979) states that the first mining claims were recorded in 1881 for the Goose Lake area north of Cooke City. Since that time, 400 claims have been recorded for the mining district. The Copper King claim was located in 1904 and patented in 1906 along with three other claims. A 100-foot shaft was dug intersecting copper- rich ore, and an 18-ton shipment of ore was made in 1907, but the grade and destination are not known (Simons and others, 1979). During this same time, considerable prospecting was done in the area, numerous cuts and pits were dug exposing copper ore of good grade (Lovering, 1929). As outlined by Simons and others (1979), the area was again explored in the late 1950's and early 1960's. This consisted of drilling, and using geochemical and geophysical methods. No

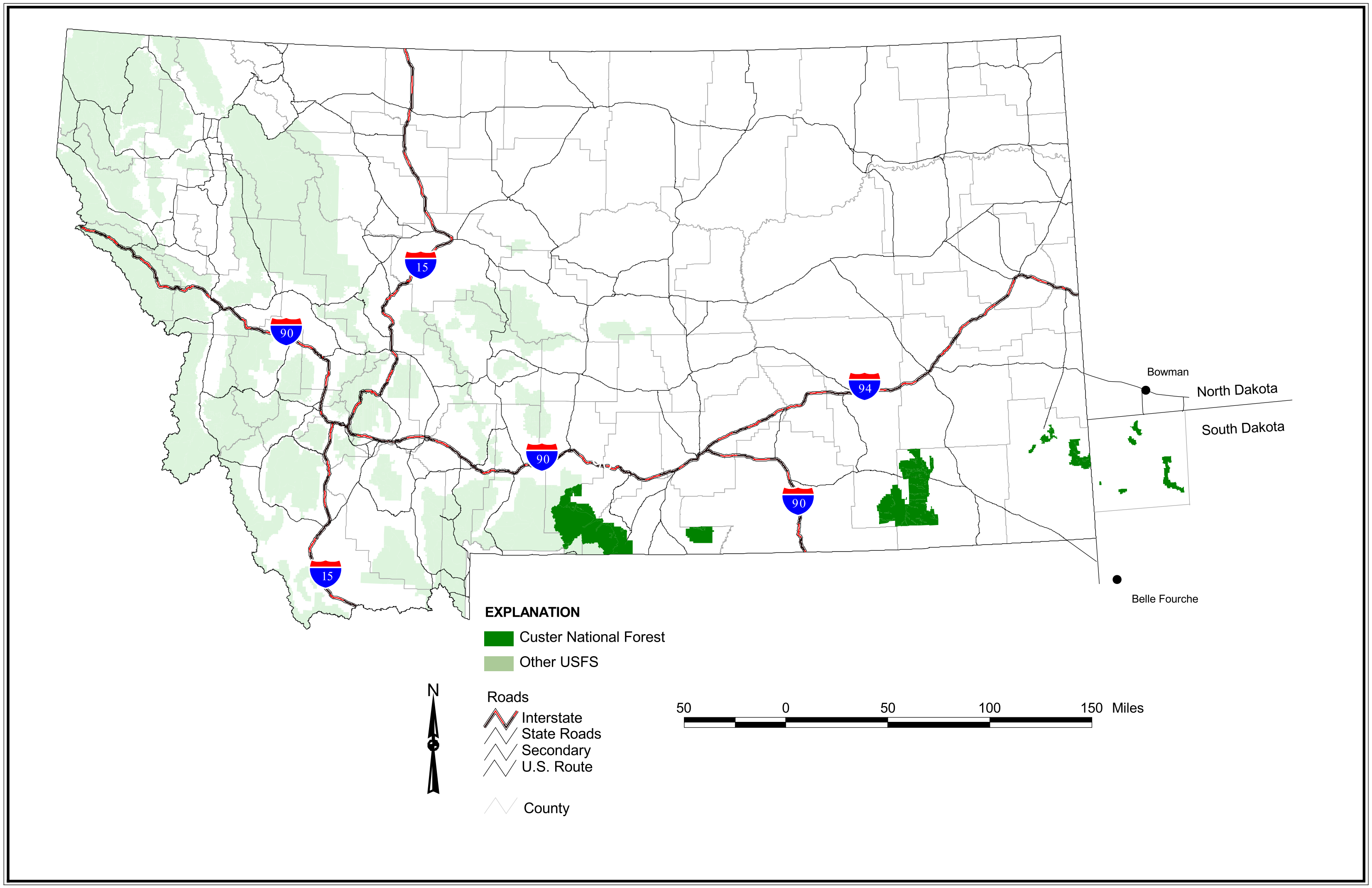


Figure 2. The Custer National Forest extents in discontinous tracts across south-central Montana and north-western South Dakc

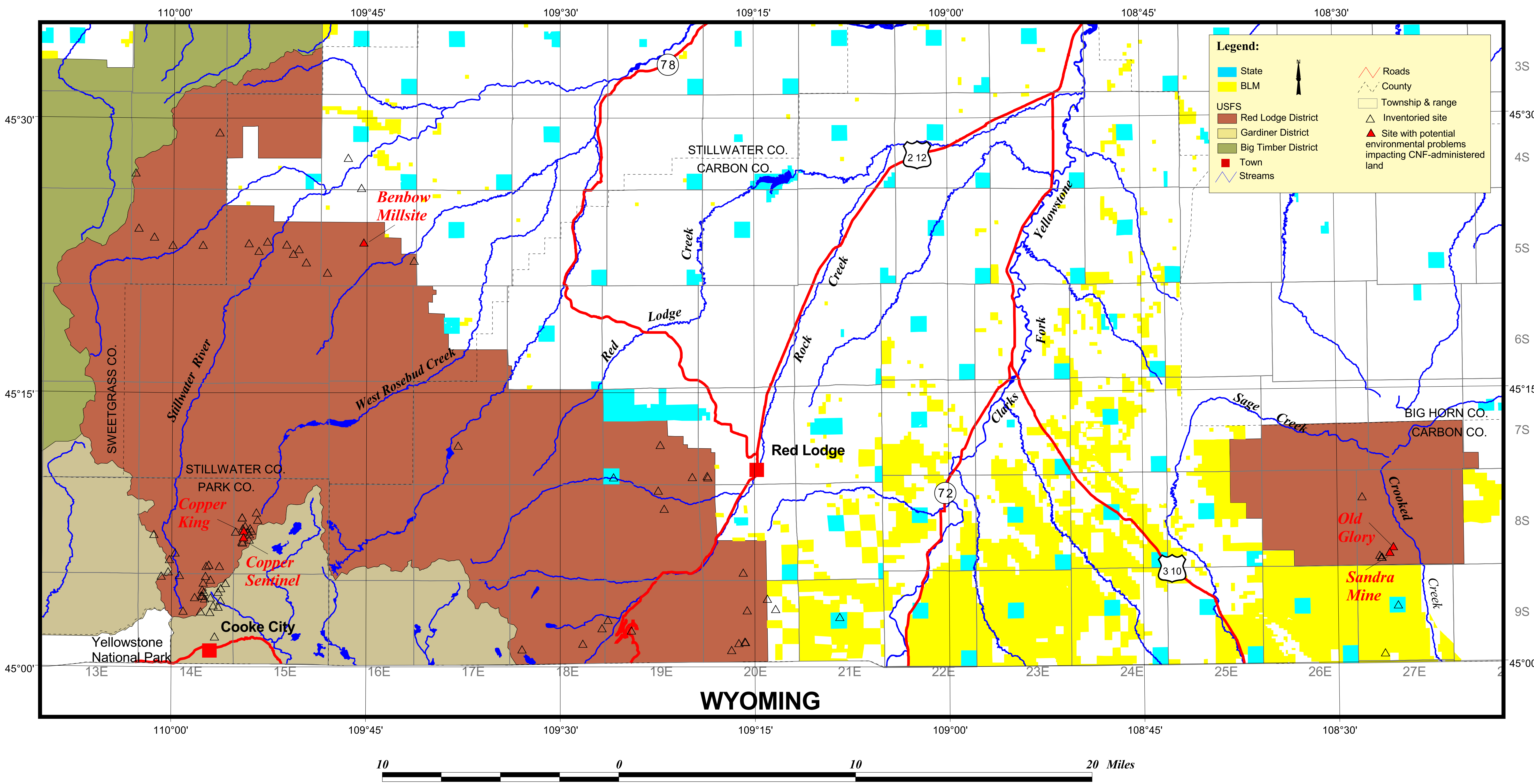


Figure 3. The Benbow Mill, Copper King, Copper Sentinel, Old Glory and Sandra Mine were the five sites sampled on the Red Lodge Ranger District.

large ore body was found that could be economically mined at the time. The area was again explored in the early 1970's by the Kerr-McGee Corporation by trenching and exploratory drilling. The Goose Lake mining district is now part of the Absaroka-Beartooth Wilderness Area signed into legislation by President Jimmy Carter on March 27, 1975.

The northern edge of the New World mining district northwest of Cooke City lies within the boundaries of the Custer National Forest. Overall production from the district is estimated at 66,000 oz of gold, 500,000 oz of silver, 4,000,000 lb of copper, 3,000,000 lb of lead, and 1,200,000 lb of zinc (Simons and others, 1979). The history of the mining around Cooke City is well documented by Lovering (1929) summarized here, " The district was part of the Crow Indian Reservation until April 13, 1882 when the area was opened to settlement. The first mining claims were located in 1870, and by 1875 a mill had been built smelting lead ore from Miller Mountain. In 1884 the Republic smelter was in operation, and it operated off and on until 1886 when the Republic mine and smelter was abandoned for 20 years due to the high cost of shipping and no railroad lines into the area. Around 1888, gold ore was found on Henderson Mountain, and a few years later a stamp mill was erected. Exploration and mining continued through the 1900's with numerous mines and smelters being developed and opened, like the Gold Dust, Homestake, Glengary and others".

An open pit gold mine, the McLaren, began operating in 1933 on the west side of Fisher Mountain. Milling was done in Cooke City until a fire destroyed the mill in 1953. The McLaren pit was closed, and mining ceased in the district. Exploration has continued in the area until 1996 when the United States signed an agreement with Crown Butte Mining, Inc. to purchase its holdings, creating the New World Mining District Response and Restoration Project conceived to remediate historic mining impacts to the district.

Chromite deposits within the Custer National Forest boundary were discovered as far back as 1888, but were not explored until the early 1900's when World War I created a demand for domestic chromite (Wimmler, 1948). Deposits were first discovered outside of Red Lodge, Montana in 1916, and in 1933. The Montana Chrome Inc. was organized to develop these deposits. In 1941, the U.S. Vanadium Corporation obtained the lease on the properties and began mining the ore bodies by open-cut methods, and trucking the ore to the mill in Red Lodge. They were the only producer in the district until 1943 when operations ceased. Most of the ore in the larger discovered ore bodies within the district has been mined out (James, 1946).

Deposits of chromite were also extensively explored south of Nye, Montana along the eastern edge of the Stillwater Complex early in the 1900's. After the war had ended in June 1919, little further exploration was done in the district except for the Benbow property. By 1929, the property was ready for mining, and seven claims were patented in 1933 (Wimmler, 1948). The property sat idle until foreign chromite supplies were cut off at the beginning of World War II, so the Anaconda Copper Mining Company, acting as an agent for the government, began developing the Benbow property. Soon after, it also developed the Mouat-Sampson and Gish mines. The government spent more than 12 million dollars on camps, plants, development, and other improvements at these three properties. By 1943, the sea lanes were reopened and high-quality imported ore was once again available. Consequently, the properties were closed by government orders; equipment and supplies were removed or sold.

The Mouat mine was reopened in 1953 by the American Chrome Company, again contracted by the U.S. Government, extending the underground workings. The mine operated until 1961, stockpiling just over 920,000 long tons of concentrate (Czamanske and Zientek, 1985). Mining and exploration have continued in the Stillwater Complex to present day. The Anaconda Minerals Company started the Minneapolis adit around 1979 (Czamanske and Zientek, 1985), mining platinum-group elements. In 1983, the Stillwater Mining Company continued underground mining and exploration in the area, and is still actively mining. Stillwater Mining is the only significant primary producer of palladium in the world and the only producer of palladium and platinum in the United States. It mines the world's richest known deposits of platinum group metals (Stillwater Annual Report, 1999).

Mining in the Ashland District of the Custer National Forest was limited to coal mines This report looked at mines, mills, or other processing facilities related to hardrock locatable mineral extraction and not at leasable minerals. For this reason the Ashland District was not investigated for this report.

In the late 1940's and early 1950's, uranium mining and exploration were active within the Custer National Forest in Montana and South Dakota. Minor uranium exploration was conducted in the Goose Lake area, but the largest production of uranium for Montana came from the Pryor Mountains; both are within the Beartooth Ranger District. Initial discovery was made in 1955 on the Old Glory Claim. The largest deposits were found on Big Pryor Mountain along the west flank of an anticline (Minobras, 1977). Most of the old mine workings, like the Dandy, Marie and Swamp Frog mines, are along the lower flanks of the Pryor Mountains on BLM land bordering National Forest. Only the Old Glory and Sandra mines were found to be within land administered by the Custer National Forest, but there has been extensive exploration within the forest. Exploration consisted of surface trenches and pits, and enlargements of naturally occurring limestone caverns where the ore bodies are found in collapsed areas that have been brecciated and re-cemented by silica (Minobras, 1977). During this same period, uranium exploration and mining were being conducted in and around land administered by the Custer National Forest in South Dakota.

Uranium production in South Dakota came from two types of ore deposits: sandstone deposits, and uraniferous lignite beds. Originally the lignite was mined for their coal resources prior to the 1920. It wasn't known until 1951 that many of the lignite beds contained uranium, but it was not until 1954 that commercial uranium deposits were mined in the Cave Hills, and Slim Buttes areas in Harding County, both of which are within land administered by the Custer National Forest. Carnotite was also found in sandstone-claystone formations in the South Cave Hills and Slim Buttes area in 1953 (Minobras, 1977). By 1955, all of the Cave Hills and Slim Buttes area had been claimed covering 65,000 acres (Christensen and Manchester, 1964). As stated by Minobras (1977), ores were shipped out of state until 1955 when a 250 ton per day mill was built at Edgemont, South Dakota. Ore was processed at the mill until its closure in 1972.

1.5.1.1 Production

Gold, silver, lead, and copper were some of the first metals mined and first ore produced in the Custer National Forest. It is impossible to say how much was produced in the early history of the mining activity, but production records obtained for individual mining districts are given in table 6.

Table 6. Production from mining districts within the Custer National Forest.

Mining District	Principal Producers	Past Production
New World-Cooke City (Northern edge of district is in Custer National Forest)	McLaren Mine Homestake Mine Irma-Republic Mines	District production for 1886 to 1953: Gold: 46,224 oz Silver: 692,386 oz Copper: 1,963,800 lbs Lead: 3,242,615 lbs Zinc: 920,200 lbs [1].
Goose Lake	Copper King Mine	Small amount of ore mined and stockpiled during initial exploration in 1904 to 1907; no ore shipped [1].
Stillwater	Benbow Mine Gish Mine (Gallatin Forest) Mouat Mine Stillwater Mine	**Benbow and Mouat mines:** Production for 1941 to 1943 Ore: 364,196 long tons Milled chromium concentrates: 91,164 long tons **Mouat Mine:** Production for 1953 to 1961 Ore: 2.1 million st Milled chromium concentrates: 920,000 st **Stillwater Mine:** Production since mine opening to 1990: estimated at 2,058,000 st Production from 1996 to 1999: total palladium-platinum 1,463,000 oz [1].
Red Lodge	Hellroaring group Highline group	Production 1940's: Ore: 61,600 ton of chromite ore averaged 24 to 40 percent Cr_2O_3 [1].
Pryor Mountains	Old Glory Mine Sandra Mine Dandy Mine (BLM) Swamp Frog Mine (BLM)	Production has been reported from 19 properties, each with small ore shipments from 100 to 1,000 tons [2].

Cave Hills-Slim Butte, South Dakota	Susan Becky Mink Windy Jim Hilton Mine Hinds Cat Tail	Production for 1954 to 1966 Tons of ore: 89,700, tons U_3O_8 370 [3].

[1] Hammarstrom and others, 1993.
[2] Minobras,1977.
[3] Shaw and others,1991.

1.5.1.2 Milling

Knowledge 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 off site to other facilities for further refinement, and 2) mill waste, which is called tailings.

In the 1800's, 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 USFS-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 reagents to liberate the ore-bearing minerals from the barren rock.

Overall then, 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 environment.

1.6 Summary of the Custer National Forest Investigation

A total of 124 sites were identified in or near the Custer National Forest (CNF) by using the USBM MILS data base as a basic reference. Other sources of information include James (1946), Lovering (1929), Minobras (1977), Reed (1950), Simons and others (1979), and Wimmler (1948). Table 7 summarizes the process by which the final results were achieved in the Custer National Forest inventory. These numbers are accurate to the extent that the current data base is updated. The numbers will change reflecting progress in database entry and additional information. A complete list of the sites can be found in appendix II.

Table 7. Summary of Custer National Forest investigation.

Total number of abandoned/inactive mines sites that were:	
PART A - Field Form	
Located in the general area from MILS	78
PART B - Field Form (Screening Criteria)	
Screened out by CNF minerals administrator or by description in literature	47
Location inaccurate	15
Visited by MBMG geologist	66
Screened out by geologist	55
PART C - Field Form	
Sampled (water and soil)	6

1.7 Mining Districts and Drainage Basins

The Custer National Forest includes all or part of seven mining districts as defined by several authors. These boundaries are subject to interpretation and change; often the same district is known by various names. Some mines are not located in traditional districts, so for the purposes of this study, all the mines studied have been organized by drainage basin. This is a convenient way to separate the National Forest into manageable areas for discussion of geology and hydrogeology, and perhaps more important, it is an aid to the assessment of cumulative environmental impacts on the drainage.

2.0 Stillwater and Clarks Fork Yellowstone River Drainages

The upper Stillwater and Clarks Fork Yellowstone River drainages are in the Custer National Forest, and both flow into the upper Yellowstone River. Major tributaries of the Stillwater River within the Custer National Forest include the Rosebud and East Rosebud Rivers. The West Fork of Rock Creek and Rock Creek drain into the Clarks Fork Yellowstone.

2.1 Geology

One of the most dramatic geologic features in the Custer National Forest is the Beartooth Plateau. Most of the plateau was mapped and is well described by Simons and others (1979) in the study of mineral resources of the Beartooth Primitive Area and vicinity. The plateau is made up of Archean rocks, mainly granitic gneisses and migmatites that have been intruded by a Cretaceous syenite stock along with related rhyolite and quartz latite porphyry sills and dikes in the Goose Lake area (Hammarstrom and others, 1993). The area was originally covered by a thick sequence of Paleozoic and Mesozoic sediments, but following uplift of the region, these sediments were stripped away by post-Laramide erosion. Paleozoic and Mesozoic sediments are preserved along the margins of the northeastern and eastern edge of the Beartooth Plateau block.

The Beartooth Plateau is bounded on the northwest by the Mill Creek-Stillwater Fault and the Stillwater Complex, a series of layered ultramafic and mafic intrusive rocks. Archean in age, this Complex is exposed for almost 30 miles along the northern border of the Beartooth Mountains. The Complex is economically important because it hosts ore deposits containing chromium, nickel, copper, titanium, and platinum group elements (PGE). The history and geology of the Stillwater Complex is well described in the Montana Bureau of Mines and Geology Special Publication 92, Stillwater Complex (Czamanske, G.K., and Zientek, M. L., eds, 1985).

2.2 Economic Geology

The Custer National Forest, within the Stillwater and Clarks Fork Yellowstone River drainages, contains all or part of several mining districts: Goose Lake, New World, Stillwater, and Red Lodge, with a few small unnamed outliers. Types of ore deposits within the districts are varied, from contact-metamorphic gold-copper deposits, to sideritic calcite veins containing silver, gold-quartz veins, to magmatic segregation deposits found at the Copper King Mine (Lovering, 1929). Adjacent to the Custer and Gallatin National Forest boundary, mineable gold-silver-copper deposits continue to be found and were recently found in the New World mining district in the late 1980's. Reserves are estimated at over four million tons of ore (Crown Butte Resources, Ltd). The properties have been purchased by the U.S. government, and now are part of the New World Mining District Response and Restoration Project, organized to clean up historic mining impacts in the district and to preserve and protect the ecosystem of Yellowstone National Park.

Chromite was a strategic metal during World Wars I and II, and there has been extensive exploration and mining for the metal. In the Red Lodge district, the chromite deposits consist of lenses and pods scattered in sill-like masses of serpentine, unlike the stratiform deposits 30 miles to the northwest of the Stillwater Complex. The pods range in size from only a few pounds of ore to those containing as much as 35,000 tons of ore with an average grade of 20 percent or more Cr_2O_3 (James, 1946).

In the Stillwater Complex, the Stillwater Mining Company is currently mining platinum group metals from the J-M Reef, the highest grade known palladium-platinum deposit in the world. It is the only significant source of platinum group metals outside of South Africa. Stillwater Mining's proven and probable reserves total 41.9 million tons at a grade of 0.60 ounce per ton, amounting to 25.3 million ounces of palladium and platinum (Stillwater Mining Company Annual Report, 2002).

2.3 Hydrology and Hydrogeology

Average annual precipitation in the Beartooth Ranger District ranges from 16 to 20 inches per year at lower elevations and 40 to 60 inches per year on the higher plateaus and mountains. The highest peaks get as much as 60 to 80 inches per year. Temperatures in the Forest vary from well below 0°F during the winter to greater than 80°F during the summer.

The USGS currently maintains only one stream-flow gaging station within the Custer National Forest; Station 06209500, Rock Creek near Red Lodge. Drainage area for the station is 124 sq. miles with an daily mean flow, based on 52 years of record, of 113 cfs. Records from discontinued stream-flow gaging stations on the Stillwater River, West Rosebud Creek, and East Rosebud Creek can be found in "USGS Water Resources Data-Montana".

2.4 Summaries of the Stillwater and Clarks Fork Yellowstone River Drainages

There are 81 sites on or near the Custer National Forest within the Stillwater and Clarks Fork Yellowstone River drainages (figure 3). Of these, 36 sites were visited, but only 2 sites were found to have adit discharges; 5 sites have open or partially open adits.

In the summaries, the sites listed in **bold** were sampled for potential 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 on CNF-administered land, 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 81 sites inventoried, only 3 sites: Benbow Mill, Copper King, and Copper Sentinel are on or partially on CNF-administered land were identified as having potential safety problems with in the Stillwater and Clarks Fork Yellowstone River drainages.

Table 8. Summary of sites in the Custer National Forest within Montana.

Name	Visit	Owner	Sample	Hazard	Remarks
Beartooth Ranger District					
Acme	N	P	N	NE	Screened out: private patented claim.
Anaconda PGM Deposit-Stillwater Mine	Y	P	N	NE	Screened out: currently active.
Beavertail	N	NF	N	NE	Surface prospects, screened out.
Benbow Mill	Y	NF	Y	Y	Mill site mostly reclaimed.
Benbow Mine	Y	P	N	NE	Screened out: private.
Bluebird	N	NF	N	NE	Screened out: shallow surface pits and trenches.
Bluebird No. 2 Claim	Y	NF	N	NE	No workings on claim.
Chromium Occurrence	N	UNK	N	NE	No site, general occurrence.
Cole Creek Quarry	N	UNK	N	NE	Screened out: limestone quarry.
Copper Glance	Y	NF	N	NE	Two collapsed adits, one trench.
Copper Idol, same as Copper Index	Y	NF	N	NE	Caved adit, ground was damp.
Copper Index, same as Copper Idol	Y	NF	N	NE	Caved adit, ground was damp.
Copper King	**Y**	**P**	**Y**	**Y**	**Sampled on land administered by Custer Forest.**
Copper Queen	Y	M	N	NE	One collapsed adit.
Copper Sentinel	**Y**	**NF**	**Y**	**NE**	**Adit discharge.**
Drill Claim	Y	NF	N	NE	Open pit on north rim of Hellroaring Plateau.
Drinkard Property	N	UNK	N	NE	Screened out: +/- 1km accuracy, no references.
Edison, Jo Dandy, Fear Not	Y	NF	N	NE	Workings within New World mining district.
Edsel Group	Y	NF	N	Y	One open adit.
Elizabeth	N	UNK	N	NE	Screened out: uncertain location.
Fishtail Creek Mine	N	NF	N	NE	No access thru private land, not known by locals.

Four Chromes	Y	NF	N	NE	No workings, shallow pits dug by USBM.
Gallon Jug No. 1and 2	Y	NF	N	Y	Open pit and several trenches.
Gallon Jug No. 4	Y	NF	N	Y	Open pit on southern rim of Hellroaring Plateau.
Giant Extension	Y	NF	N	NE	Two partially caved adits.
Golden Grizzly	N	UNK	N	NE	Screened out: +/-10 km accuracy.
Great Rift Claim	N	NF	N	NE	Part of New World mining district.
Green Lease	N	UNK	N	NE	Screened out: +/-1km accuracy, no references.
Greenback	N	NF	N	NE	Screened out: shallow pit on dry ridge.
Hecela-Flora	N	UNK	N	NE	Screened out: +/-1km accuracy.
Hercules	Y	NF	N	NE	Visited general area, uncertain of exact loc.
Highline Group	Y	NF	N	Y	Three large open pits.
Hudson Mine	N	NF	N	NE	Part of New World mining district.
Iron Mountain Chrome Group	N	NF	N	NE	Trenches and pits by USBM.
Josephine Mine	N	UNK	N	NE	Screened out: uncertain location.
Lake View	Y	P	N	NE	Private patented claim, shallow prospects.
Little Nell Group	N	NF	N	NE	Visited area but did not find site.
Lorraine	Y	NF	N	Y	One short adit partially open.
Lula Mine	Y	NF	N	NE	Patented claim, New World mining district.
McLaren Gold Company	Y	NF	N	NE	Part of New World District.
Mercer Group	N	NF	N	NE	Screened out: high on dry ridge.
Mouat Iron Titanium Group	N	P	N	NE	Screened out: private.
Mouat Nickle-Copper	N	P	N	NE	Screened out: private.
Mutt Lake	Y	NF	N	NE	Visited general area, no workings found.
North Star Claim	Y	NF	N	NE	Open pit on rim of Hellroaring Plateau.
Nye Basin, Alice	N	UNK	N	NE	Within active Stillwater mining area.
Nye Basin, Big Seven Fault	N	P	N	NE	Screened out: private.
Nye Basin, Lip	N	UNK	N	NE	No workings, part of active Stillwater mining area.
OBW	Y	NF	N	NE	Visited general area, did not find for certain.
Old Glory Mine	Y	NF	N	Y	Three partially caved adits, two open adits.
Pick Mine	Y	NF	N	NE	Open pit below rim of Hellroaring Plateau.
Psenda Asbestos Prospect	N	UNK	N	NE	Screened out: inaccurate location, no references.
Rosebud	Y	NF	N	NE	One collapsed adit.
Rosebud Asbestos Claim	N	UNK	N	NE	Visited general area, unable to locate.
Royse Claim	N	NF	N	NE	Unable to locate.
Sandra Mine	Y	NF	N	Y	Collapsed adit reopened by daylighting.
Shovel	Y	NF	N	Y	One caved adit, reopened.
Skyline Claim Chalcopyrite	Y	NF	N	NE	Reclaimed, part of New World mining district.
Skyline Mine	Y	NF	N	NE	Reclaimed, part of New World mining district.
Stillwater Complex Chromite Deposit	N	P	N	NE	Screened out: private.
Stillwater River	N	NF	N	NE	Screened out: placer deposit.
Tandy's Coal Mine	N	P	N	NE	Screened out: private.
Taylor-Fry-Tuttle	N	NF	N	NE	No workings, trenching by U.S. Bureau of Mines.
Thom Property	N	UNK	N	NE	Screened out: inaccurate location, no references.
U.S. Treasury	Y	P	N	NE	Screened out: private patented claim.
Unamed Uranium (CB000069)	N	UNK	N	NE	Screened out: inaccurate location, no references.
Unnamed	N	NF	N	NE	Screened out: one prospect.
Unnamed Coal Mine	N	P	N	NE	Screened out: private.
Unnamed Copper Mine	N	NF	N	NE	Screened out: location inaccurate.
Unnamed Uranium (CB000039)	N	NF	N	NE	Screened out: state land, +/-1km accuracy.
Unnamed Uranium (CB000075)	N	UNK	N	NE	Screened out: inaccurate location, no references.
Unnamed Uranium (CB000381)	N	UNK	N	NE	Screened out: inaccurate location, no references.
Unnamed Uranium (CB000381)	N	UNK	N	NE	Screened out: inaccurate location, no references.

Unnamed Uranium (CB000441)	N	UNK	N	NE	Screened out: inaccurate location, no references.
Unnamed Vanadium	N	UNK	N	NE	Screened out: inaccurate location, no references.
Unus	Y	NF	N	NE	Visited general area.
US Mint / US Treasury	Y	P	N	NE	Part of New World mining district.
Vijak Quartz Lode	N	UNK	N	NE	Screened out: +/- 1km, copper, silver, gold.
Wally Jr	N	UNK	N	NE	Screened out: inaccurate location.
Weaver Property	Y	NF	N	Y	Two adits and several surface trenches.
West of Como Trench	Y	NF	N	NE	Small prospects and a trench.

2.5 Benbow Mill

Site Location and Access

To reach the Benbow mill site (figure 3 and 4), take Forest Route 2414 off of Highway 419 at the town of Dean for 4.3 miles. The turnoff to the left leads to the concrete foundations of the mill with the remains of the tailings ponds in the drainage below on the north side of the road.

Site History - Geologic Features

According to Wimmler (1948), construction began in 1941 on a gravity concentration mill, camp site, and an aerial tram 3½ - miles long for the Benbow chromite mine by the Anaconda Copper Mining Co. The Benbow mill was designed to treat 1,000 tons of ore a day, but only a single 500-ton unit was completed. The mill operated for approximately 14 months treating 186,369 dry tons of ore before operations were suspended and the mill was placed on a stand-by basis in June 1943. The mill, in development stage, never reached its maximum capacity or efficiency before being shut down. Wimmler recorded in 1948 that the mill-camp buildings had been removed and all equipment sold or stored, but that the mill and tram were still intact at that time. Today, all that remains are the concrete foundations of the mill buildings, and remnants of the tailings ponds.

Environmental Condition

The site around the mill appears to have been previously reclaimed by recontouring and reseeding. No obvious visible signs of environmental problems were noted. The tailings ponds do not appear to have been reclaimed, but are predominantly vegetated. An unnamed tributary of Little Rocky Creek runs through the tailings and in several places the earthen dams are eroded.

Site Features - Sample Locations

An upstream water-quality sample (LBES20M) was taken upstream the tailing ponds and previous mill camp on the unnamed tributary of Little Rocky Creek, and a downstream sample was collected (LBES10H) below the holding ponds. A composite soil sample (LBED10H) was collected on 10-foot centers across one of the unvegetated areas below the eroded earthen dams. Site features and sample locations are shown in figure 4.

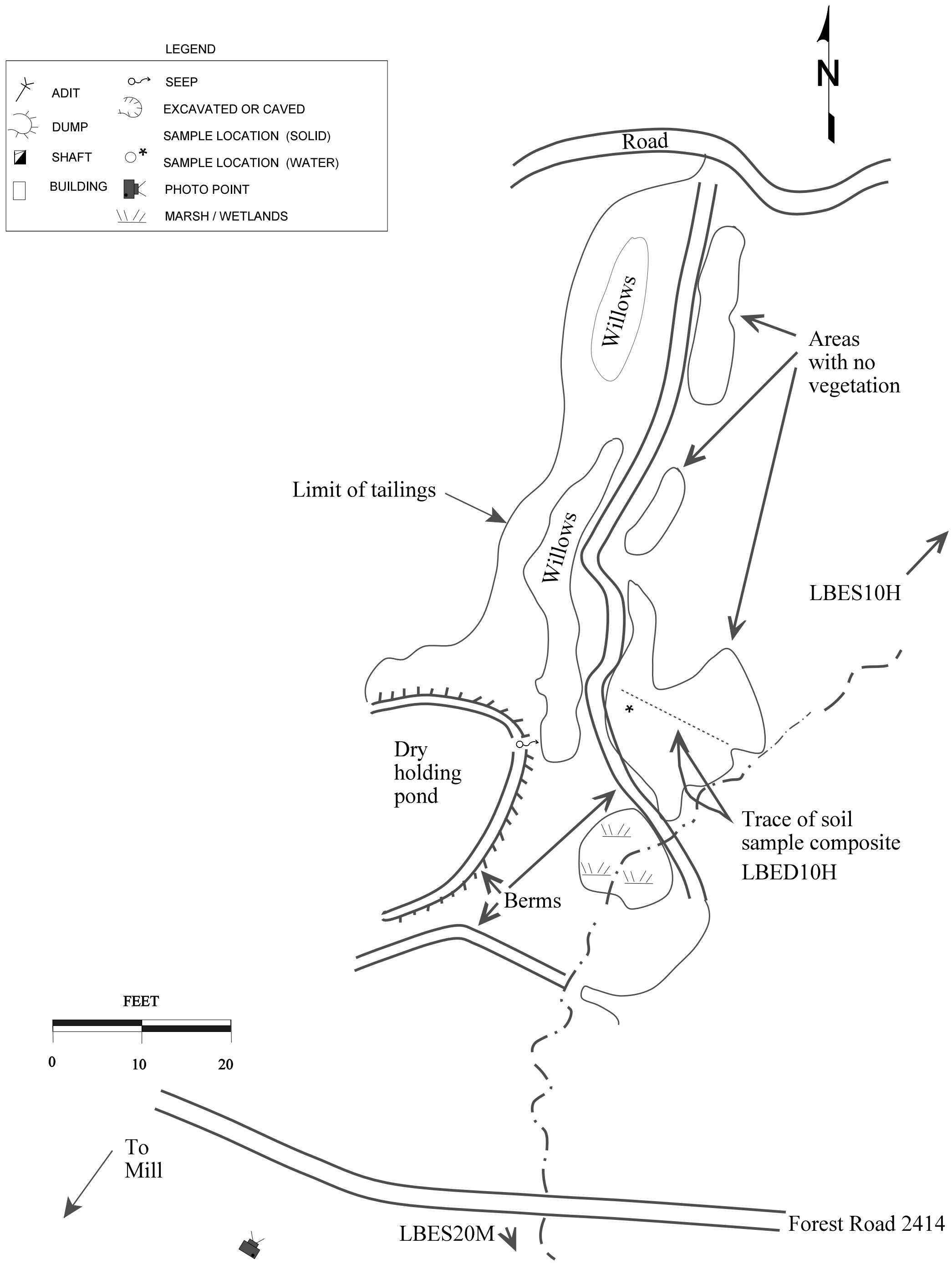


Figure 4. The abandoned tailings ponds below the Benbow mill site along unnamed tributary of Little Rocky Creek, as observed 10/26/99.

Figure 4a. Concrete mill foundation at the Benbow Mill site.

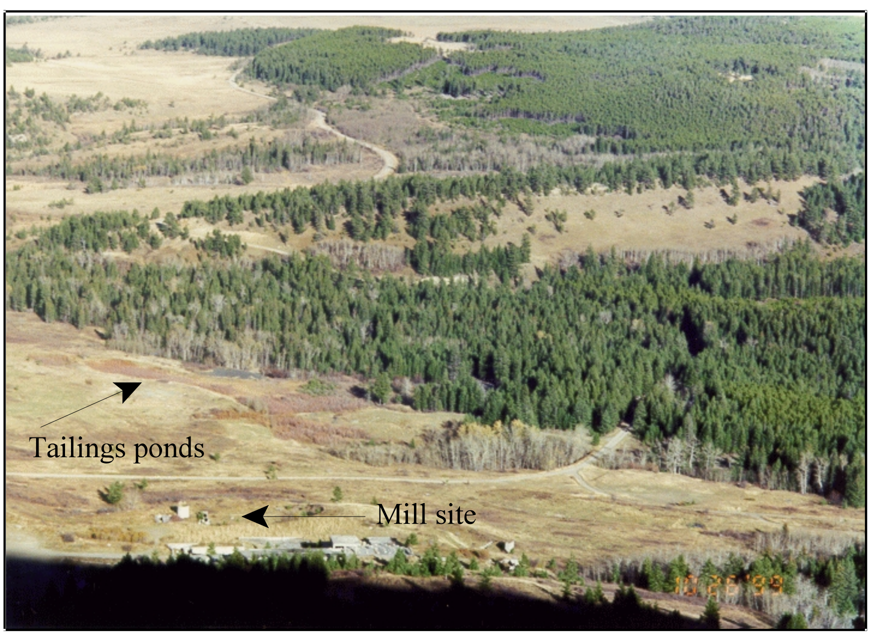


Figure 4b. Distance view of Benbow mill sitelower center, former camp and tailings ponds.

Soil

A soil sample was collected below the tailing ponds in an eroded area of the earthen dam near the unnamed tributary of Little Rocky Creek. The soil was composed of a black sand, but did not exceed any of the Clark Fork Superfund background levels. The sample did show measurable levels of chrome Appendix IV (809 mg/kg), nickel (1,070 mg/kg), zinc (25.4 mg/kg), and copper (15.7 mg/kg).

Table 9. Soil sample results at the Benbow mill tailing ponds (mg/kg).

Sample Location	**As**	**Cd**	**Cu**	**Pb**	**Zn**
LBED10H composite sample	<1.0	<2.1	15.7	<2.1	25.4

(1) Exceeds one or more Clark Fork Superfund Background Levels (table 3).
(2) Exceeds Phytotoxic Levels (table 3).

Water

Neither the upstream sample (LBES20M) nor the downstream sample (LBES10H) exceeded any water quality-standards (table 2). Both upstream and downstream samples had similar concentrations of constituents.

Table 10. Benbow mill water-quality exceedences.

Sample site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
LBES20M upstream																			
LBES10H downstream																			

Note: The analytical results are listed in appendix IV.

Vegetation

Vegetation at the site does not appear to be impacted. The area around the mill foundations has been recontoured and seeded with natural grasses. Willows, sagebrush, and grasses have re-established themselves over most of the tailing ponds, and small trees have begun to encroach and revegetate the area.

Summary of Environmental Conditions

The Benbow mill site showed no effects on the water quality of the unnamed tributary of Little Rocky Creek. Samples collected by Pioneer Technical Services (1995) showed similar results no exceedences of MCL's .

Structures

No wooden structures remain at the site. Only the concrete foundations of the mill buildings remain. A grassy meadow with a dirt road running through the middle of it is now where the former mill camp was.

Safety

Sections of the mill concrete foundations have walls as high as 20 feet, as well as an open pit approximately 15 to 20 feet deep.

2.6 Copper King Mine

Site Location and Access

The Copper King (figure 3 and 5) can be reached by traveling east on Highway 212 from Cooke City for 1.6 miles. Turn left on Forest Route 6943, travel for 2.3 miles then take Forest Route 3230 (which is strictly a four wheel drive road) for 4.5 miles to the Absaroka-Beartooth Wilderness boundary. From here it is a 1.5 mile hike to the upper end of Goose Lake and the Copper King mine.

Site History - Geologic Features

The Copper King claim was located in 1904 by the Copper King Mining and Development Co. and patented in 1906. This company constructed a road from Cooke City to the mine and operations were carried on until the financial panic of 1907 (Lovering, 1929). According to Simons and others (1979), a two-compartment shaft was reported to have been dug to a depth between 60 to 100 feet, all on private land, intersecting a 20-foot thick copper-rich syenite near the collar and bottoming out in copper ore. Lovering (1929) stated that the shaft was flooded by the time he visited the site in 1925. The area around the Copper King was not explored again until 1959 when the Bear Creek Mining Co conducted geochemical and geophysical exploration, and drilled seven exploration holes in 1960. All holes intersected sulfide minerals, but only one core intersect had economic grades. It was drilled approximately 2,300 ft northeast of the Copper King shaft, cutting through a gabbro-syenite contact. Simons and others (1979) reported Kerr-McGee Corporation optioned the property again in 1970 and relocated the claims covering both sides of Goose Lake. Numerous trenches were dug and exploration drilling was conducted. The property has been idle since then and now is inside the Absaroka-Beartooth Wilderness boundary.

Environmental Condition

The Copper King mine consists of a wooden structure over a flooded shaft next to Goose Creek near its mouth at Goose Lake. There is also a small waste dump and several shallow bulldozer cuts and trenches. All development is on private land.

Site Features - Sample Locations

Because the site is on private property, no adit discharge or soil samples were collected but upstream (GHES10L) and downstream surface-water samples (GHES20L) were collected on Goose Creek. Site features and sample locations are shown in figure 5.

Soil

The mine and associated waste dumps are on private property. No soil samples were collected.

Water

Water appeared to be flowing out of the shaft at the time the site was visited, but analyses of both the downstream and upstream surface water samples showed no constituents tested exceeded MCL's and there was no iron staining or other visual evidence of poor water quality.

Vegetation

The waste dumps on private land were barren of any vegetation.The vegetation on CNF-administered land did not appear to be impacted by the site. Vegetation is re-establishing itself on the old roads leading to the site.

Summary of Environmental Condition

No adverse effects were observed from the mining activity on CNF-administered land from the Copper King. There were no exceedences in water quality and no evidence of metal loading in the streambed.

Structures

The only structure at the Copper King mine is on private property; it consists of a single wooden structure in poor condition over the shaft.

Safety

There are no safety concerns on CNF-administered land near the Copper King. The mine is on private property, although it is inside the Absaroka-Beartooth Wilderness with no signs designating the claim as private. Recreationists maybe tempted to explore the shaft and workings.

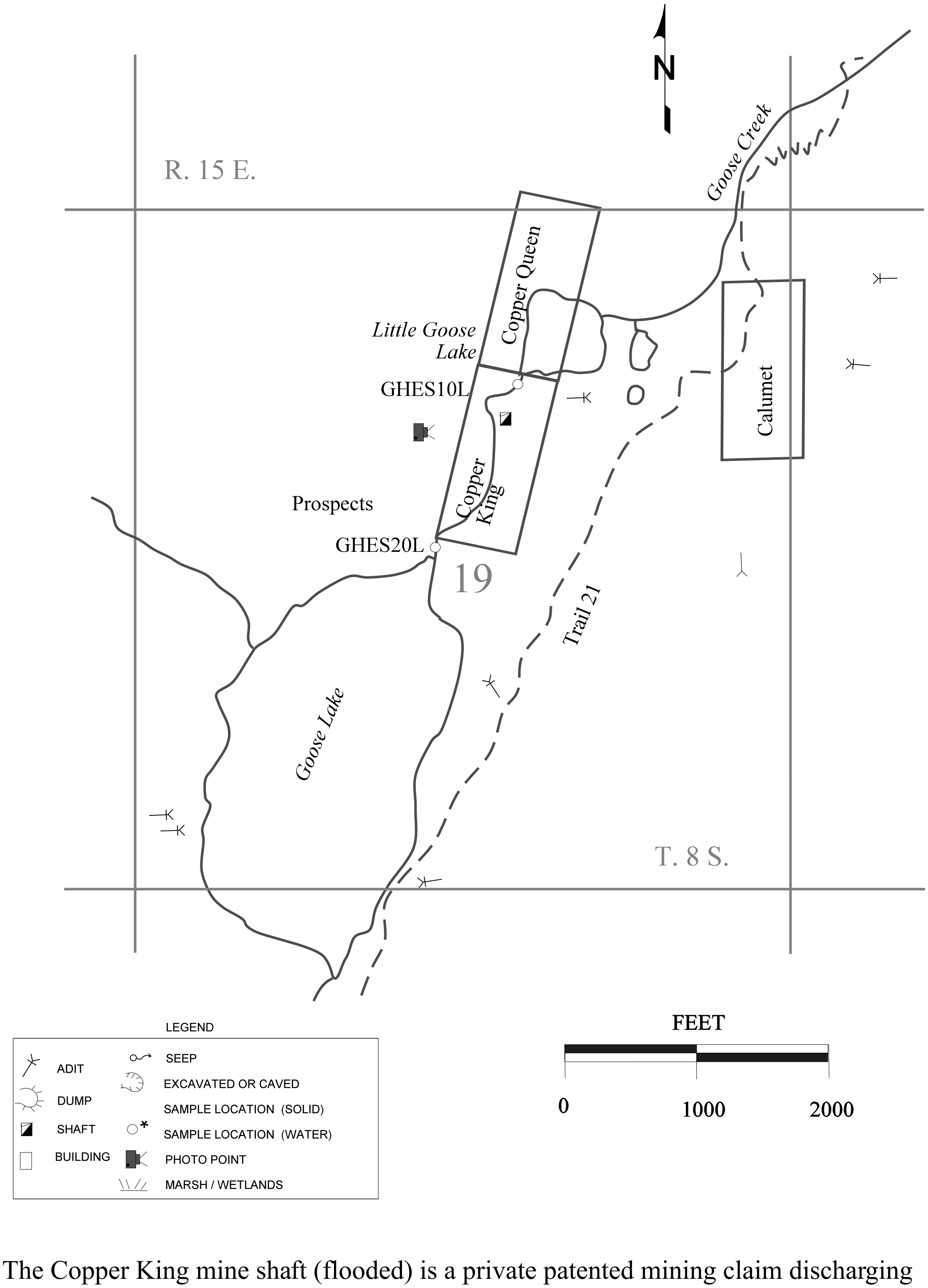


Figure 5. The Copper King mine shaft (flooded) is a private patented mining claim discharging into Goose Lake. Surface-water samples were collected on 7/24/99 to evaluate any impact.

Figure 5a. Area view of Goose Lake, the Copper King shaft is to the right of the photo.

Figure 5b. The private Copper King shaft is flooded and was discharging into Goose Creek.

2.7 Copper Sentinel Mine

Site Location and Access

The Copper Sentinel (figure 3 and 6) access is the same as that for the Copper King mine. It can be reached by traveling east on Highway 212 from Cooke City for 1.6 miles. Turn left on Forest Route 6943, travel for 2.3 miles then take Forest Route 3230 (which is strictly a four wheel drive road) for 4.5 miles to the Absaroka-Beartooth Wilderness boundary. From here, it is approximately a 1.2 mile hike to the east shore of Goose Lake and the Copper Sentinel mine.

Site History - Geologic Features

There is limited historic information in the literature on the Copper Sentinel. Simons and others (1979) noted presence of a syenite containing sulfides and collected a grab sample from the stockpile. It contained a trace of gold and 0.3 oz of silver per ton. Most likely, the Copper Sentinel was prospected early in the history of the Goose Lake Basin along with many other claims. Simons stated that 400 claims had been recorded in the Goose Lake area since the first mining claim was recorded in 1881. A map from Park County records dated 1916 showed the Copper Sentinel as an unpatented claim.

Environmental Condition

The site consists of a single collapsed adit with a discharge and an associated waste-rock dump. Discharge from the mine adit was 1-2 gallons per minute at the time of visit. It dissipated into the ground near the toe of the waste-rock dump 120 feet from Goose Lake's eastern shoreline. There was no evidence of groundwater discharge, seeps, or staining along the lake shore.

Site Features - Sample Locations

An adit discharge sample (GCSS10L) was collected near the collapsed adit portal. The mine is on an hillslope some 120 feet east of Goose Lake and not in direct contact with any surface water. Site features and sample location are shown in figure 6.

Soil

There was no evidence of impact to the soil at the toe of the dump, and there were no signs of sediment being washed from the dump. No soil samples were collected.

Water

The concentration of constituents tested in the adit discharge sample did not exceed water-quality standards. The laboratory pH was below acceptable levels (6.16), but the field pH (7.23) met water-quality standards.

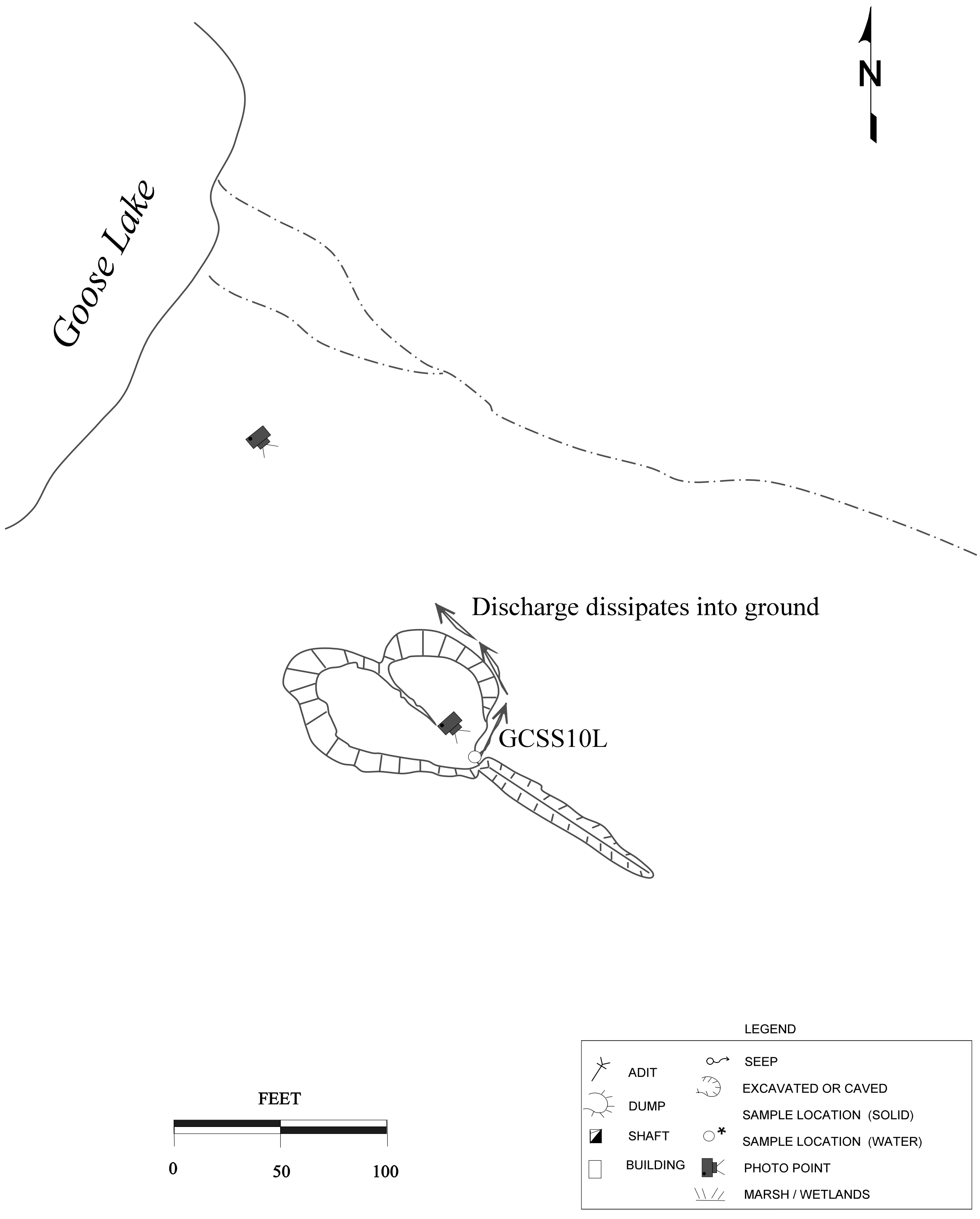


Figure 6. The adit discharge from the Copper Sentinel mine infiltrated into the ground before entering Goose Lake. Inventoried on 8/24/99.

Figure 6a. Copper Sentinel collapsed adit and associated waste dump adjacent to Goose Lake.

Figure 6b. Adit discharge sample GCSS10L being collected from the Copper Sentinel.

Table 11. Water-quality exceedences for the Copper Sentinel.

Sample site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	Si	pH
Adit GCSS10L																			S

Exceedence code: P-Primary MCL, S-Secondary MCL, C-Aquatic Life Chronic, A-Aquatic Life Acute.
Note: The analytical results are listed in appendix IV.

Vegetation

The waste-rock dump at the site is barren of vegetation, but the hillslope surrounding the site is densely vegetated in high altitude flora that shows no signs of stress adjacent to the dump.

Summary of Environmental Condition

The overall impact is slight. None of the water-quality standards were exceeded with the exception of possible pH. Natural ground waters have pH values ranging from about 6.0 to 8.5 (Hem, 1985) so a pH of 6.16 may be normal for the area.

Structures

There are no structures at the site, only a few rotting timbers at the adit portal.

Safety

The adit on CNF-administered land has completely caved, forming a long shallow trench that is not considered hazardous at this time. The hiking trail for the Absaroka-Beartooth Wilderness passes near the site making it accessible to recreationists.

3.0 Shoshone and Bighorn Lake Drainages

The Pryor Mountains, where extensive uranium exploration and mining has been conducted, are within the Shoshone and Bighorn Lake watersheds. These basins cross the Montana Wyoming border, draining into the Bighorn River. The Bighorn Lake watershed covers 1,800 square miles and there are 29 river and streams, and 36 lakes within the basin. The Shoshone watershed covers 1,510 square miles, and there are 20 rivers and streams and 40 lakes within the Shoshone watershed. Only the headwaters of these two basins are in Montana. Many of the smaller tributaries flowing out of the Pryor Mountains are ephemeral streams.

3.1 Geology

The geologic setting of the Pryor Mountains has been described by Blackstone (1940) and was mapped by the same author in 1974 and 1975. The mountain mass forms part of the northeastern margin of the Bighorn Basin and is contiguous to the northern portion of the Bighorn Range (Blackstone, 1940). The Mississippian Madison Limestone is the major rock unit exposed in the Pryor Mountains along with dolomite, sandstone, siltstone, and shale of the Amsden, Tensleep, Park City, and Chugwater Formations.

3.2 Economic Geology

No mining claims were held in the Pryor Mountains before 1955, but many were filed for uranium and vanadium in 1956 and 1957, and in the late 1970's. A total of 315 claims were staked in the Pryor Mountains (Patterson and others, 1988). They describe the ore deposits as occurring within the upper 200 feet of the Madison Limestone, a 10-60 foot zone of solution cavities formed along joints, fractures, bedding planes, or evaporite beds. The uranium minerals, tyuyamunite and metatyuyamunite, occur as coatings or an earthy crust within the solution cavities in the Madison Limestone and in small depressions at the Madison Limestone and Amsden Formation contact. Yellow and green secondary uranium minerals, uranophane and liebigite, also occur as thin coatings on brecciated rocks filling some solution cavities in the Madison Limestone.

Production and reserve data for the Pryor Mountain district report about 223,000 pounds of U_3O_8, with an ore grade of 0.36 percent, were produced from 19 properties. Also 236,000 pounds of V_2O_5, at an average ore grade of 0.416 percent, were produced from 15 properties. Average mining rates were less than 500 tons per month. Ore was shipped to the long-since dismantled Susquehanna-Western Mill in Riverton, Wyoming (Patterson and others, 1988).

3.3 Hydrology and Hydrogeology

Subterranean drainage in the Madison Limestone, plus low rainfall do not allow for perennial streams in the Pryor Mountains. Average annual precipitation for the Pryors ranges from only 10-14 inches in the lower valleys surrounding the Pryors, 18-22 inches along the flanks of the mountains, and 30-40 inches on some of the higher peaks. Temperatures vary from well below 0°F in the winter to more than 100°F during the summer in the canyons and valleys surrounding the Pryors.

There are no USGS stream gaging stations within the Custer National Forest of the Pryor Mountains, but there is a station on Pryor Creek at Pryor and there are stations on the Shoshone and Bighorn Rivers.

The Pryor Mountains act as a ground-water recharge area where highly transmissive units such as the Madison Group, Pryor Conglomerate, and Tensleep Formation crop out. Wheaton and Lopez (1999) report the Madison as having a transmissivity of 3,000 to 17,000 square feet per day. The Madison Group limestones, Pryor Conglomerate, and the unconsolidated sediments of Pryor Creek are the primary aquifers of the area north of the Pryor Mountains. Some of the ground water flowing through these units escapes as springs along fault contacts, impervious beds, and fractures in the bedrock. One of the largest springs in the area in sec. 22, T.6S., R.24E. reported by Knappen and Moulton (1930) has a daily flow of 800,000-1,000,000 gallons, and artesian water from a well drilled for oil in sec. 16, T.7S., R.24E. reportedly has flowed constantly for 15 years.

3.4 Summary of the Shoshone and Bighorn Lake Drainages

Even though 315 claims were staked in the Pryor Mountains (Patterson and others, 1988) only two mine sites were found within the Custer National Forest: the Old Glory Mine and Sandra Mine. These sites are presented in table 8. All other claims consist of shallow surface disturbances from bulldozer trenching, backhoe digging and hand trenching. Several of the entrances of the naturally formed caves were found to have been explored and enlarged by prospecting. A survey of the caves in the Pryor mountains by Northwest Cave Research Institute (1993) documented radioactivity in Blasted cave, and noted that past work has shown radon gas exist in levels exceeding safe levels in caves around the Big Horn Basin. Caves with the highest levels of radon were in close proximity to known uranium mining areas. Many caves in the Pryor Mountains are near past uranium mining sites and one should expect radon to occur in these caves. The Old Glory mine was documented to intersect a naturally occurring cave by Northwest Cave Research Institute (1993), but the cave was not tested for radon gas. Concern over the possible safety and human health affects from radioactivity related to past uranium mining and exploration additional sampling was conducted for uranium and radium-226 and is covered under uranium sampling in this report.

4.0 North and South Forks Grand, and Upper Moreau River Drainages

Three discontinuous tracts, the North Cave Hills, South Cave Hills, and Slim Buttes areas of the Custer National Forest fall within three different watersheds: the North Fork Grand, South Fork Grand, and Upper Moreau River drainages of South Dakota. The North Cave Hills area is within the North Fork Grand and South Fork Grand River drainages while the South Cave Hills area is inside the South Fork Grand watershed. Slim Buttes area borders the South Fork Grand and Moreau River drainages.

4.1 Geology

Five tracts of land make up the Custer National Forest in South Dakota; 3 tracts were visited in this report (figure 7). These tracts are comprised of buttes, mesas, and highlands rising 400 to 500 feet out of the rolling grassland prairies of South Dakota. Along the margins of these buttes, many landslide blocks have been carved by erosion into intricate badlands with numerous steep-walled gullies and ridges.

Tertiary gray to white calcareous sandstones of the Arikaree and White River Formations cap most of the buttes. North and South Cave Hills are capped by the Tongue River Member of the Fort Union Formation, a massive fine-grained yellowish-tan sandstone interbedded with shale, siltstone, claystone, and uraniferous lignite. Sandstone, shale, and uraniferous lignite of the

Ludlow and Cannonball Members underlie the Tongue River Member. The grassland prairies surrounding the highlands consist of the soft shale of the Hell Creek Formation.

4.2 Economic Geology

Of the 5 tracts of land administered by the Custer National Forest, 3 have been mined and explored for uranium: North Cave Hills, South Cave Hills, and Slim Buttes (figure 7). The information on the economic geology of the districts is taken from Minobras (1977). Uraniferous-lignite deposits were first discovered in the North Cave Hills in 1954. Similar uraniferous lignites were also discovered in the Slim Buttes area along with carnotite in sandstone-claystone formations within the southern portion of the Slim Buttes area in 1953. Total production for the three districts has been 738,638 lbs of uranium oxide (U_3O_8). Ore was shipped out of state for milling until 1955 when a 250 tpd mill was built in Edgemont, South Dakota.

It is no longer operating. The largest deposits of uraniferous lignite in the Cave Hills district occur in the basal unit of the Tongue River Member of the Fort Union Formation. The uranium-bearing lignites occur as thin beds from one- to two-feet thick above a massive sandstone bed. The uranium-bearing lignites showed no discernible uranium minerals. Other associated minerals are gypsum, analcite, jarosite, limonite, and quartz. In the Slim Buttes area, uraniferous lignites occur in the Ludlow Member of the Fort Union Formation, also in one- to two-foot thick beds. Carnotite was found as thin coatings in a silicified sandstone and claystone at Cedar Canyon near the top of the Chadron Formation.

4.3 Hydrology and Hydrogeology

Annual precipitation is about 15 inches per year, but there are no perennial streams within South Dakota land administered by Custer National Forest. There are numerous springs along the base of the plateaus, many of which have a stock tank for watering cattle grazing on Forest land. All of the springs visited during field investigations flowed for only a short distance before dissipating back into the ground. There are no lakes or ponds on tops of the buttes; water must be trucked or pumped for cattle grazing on tops of the plateaus.

4.4 Summary of the North and South Forks Grand, and Upper Moreau River Drainages

A total of 44 sites were found, all of which are open pit or strip mines, on land administered by the Custer National Forest in the North and South Forks Grand, and Upper Moreau River drainages (figure 7). Minobras (1977) listed these sites as former mines, prospects or occurrences. Within the Custer National Forest, 35 were visited, and 3 were screened out because they were private land. All of the workings except the larger mines near Riley Pass are revegetated by natural grasses and sage brush, making some of the workings barely discernable from the undisturbed surroundings. The general area for ten sites were visited, but no workings could be found. This may be because time and revegetation have covered any signs of previous mining, or because some sites may have been only an occurrence, and were staked as a mining claim but never worked. Of the 35 sites visited, three were sampled because runoff from rainfall had collected on the former mine benches creating ponds holding water for several months out of

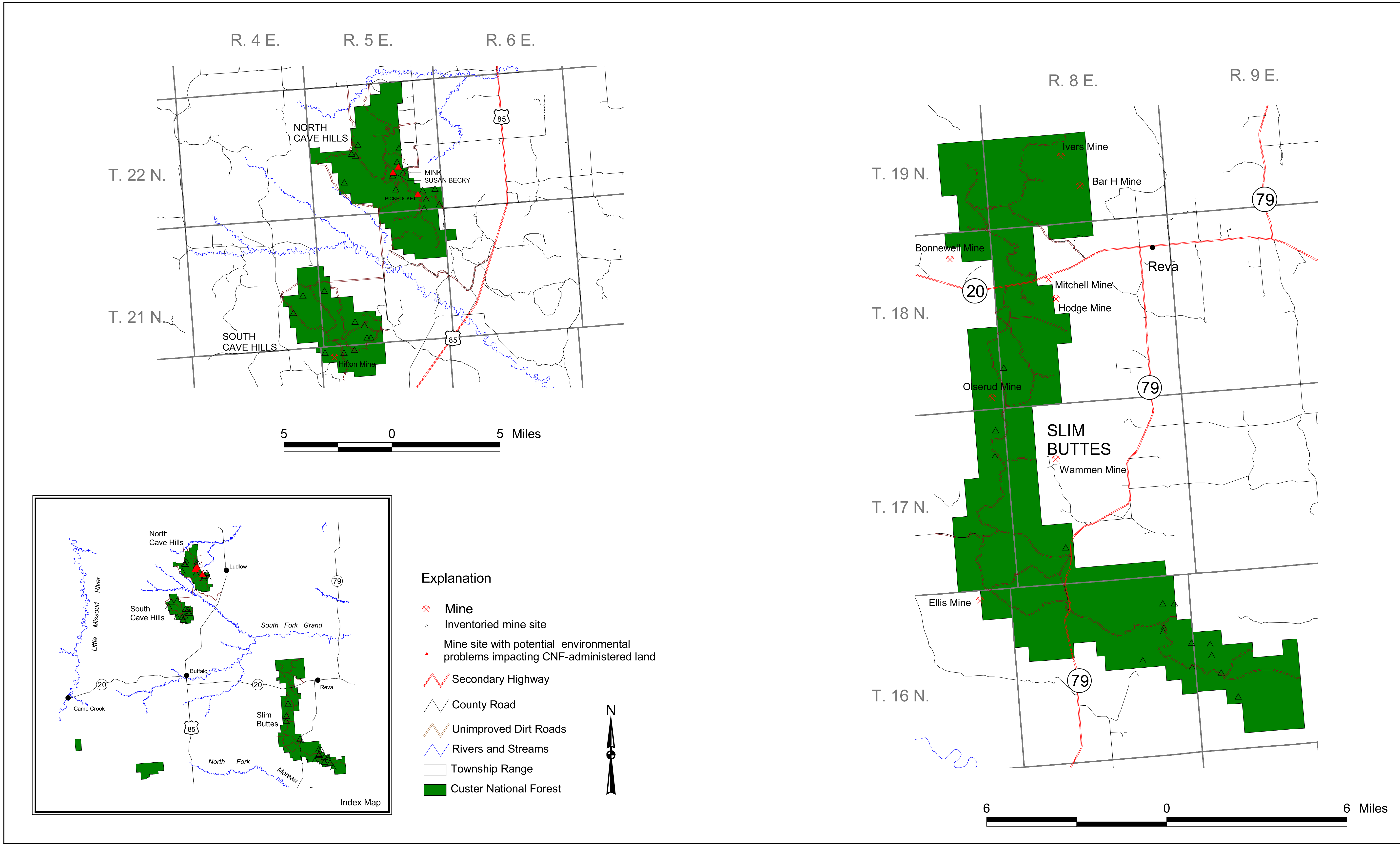


Figure 7. The Mink, Pickpocket, and Susan Becky were the three sites sampled in the Custer National Forest of South Dakota.

the year. Cattle and wildlife drink from these ponds. Pioneer Technical Services collected soil samples from these 3 sites in support of CERCLA actions. These sites are presented in Table 12.

Table 12. Summary of sites in the North and South Forks Grand, and Upper Moreau River drainages.

Name	Visit	Owner	Sample	Hazard	Remarks
Sioux Ranger District					
Billy Dale Group / Kermac Operation	Y	NF	N	Y	Strip mine, highwall ~60 to 80 feet high .
Blue Jay	Y	NF	N	NE	Small bulldozer cut, one prospect.
Bob Cat	Y	NF	N	NE	Four bulldozer prospects.
Bobcat Mine	Y	NF	N	NE	General area visited, no workings found.
Bone / Kermac Operation	Y	NF	N	NE	Bulldozer cut next to Susan Becky.
Buckhorn Group	Y	NF	N	NE	No workings, road tracks in landslide area.
Cap 2	Y	NF	N	NE	General area visited, no workings found.
Carbonate Prospect	N	NF	N	NE	Screened out: prospect.
Cat Tail 1/ Hanson Operation H-1	Y	NF	N	NE	Strip mine, three digs.
D-2	N	P	N	NE	Screened out: private.
Daisy Mae No. 6	Y	NF	N	NE	Small strip mine below plateau rim.
Divide 1	N	UNK	N	NE	General area visited, no workings found.
Eleanor	Y	NF	N	NE	Two bulldozer prospects.
Hawkeye	Y	NF	N	NE	No workings or disturbances found.
Hilltop Mine	Y	NF	N	NE	No workings, center post found.
Hilton Mine	N	P	N	NE	Screened out: private.
Hinds 1	N	NF	N	NE	General area visited, no workings found.
Hoop and Holler	Y	NF	N	NE	Three small areas strip mined.
Jeffery Lynn	Y	NF	N	NE	Prospects on top of butte.
L & L NO. 3 / Kermac Operation	Y	NF	N	NE	Strip mine along plateau rim.
Last Chance	Y	NF	N	NE	Cut in hillslope, revegetated.
Lonesome Pete NO. 2	Y	NF	N	NE	Revegetated mine bench 150x500 feet.
Margery	Y	NF	N	NE	One small bulldozer cut, revegetated.
Marion	Y	NF	N	NE	Three bulldozer cuts, end of ridge lines.
Mendenhall Mine	N	P	N	NE	Screened out: private.
Mink / Kermac Operation	**Y**	**NF**	**Y**	**NE**	**Pond on mine bench sampled.**
Moonshine 1	N	UNK	N	NE	Mine bench below rim.
Olesrud Mine	Y	NF	N	NE	No workings or disturbances found.
Olserud Bed	Y	NF	N	NE	Single bulldozer prospect.
Pickpocket / Munkers Operation	**Y**	**NF**	**Y**	**NE**	**Pond on mine bench sampled.**
Quad 2	N	NF	N	NE	Screened out: on dry ridge top.
Relf Mine / Kermac Operation	Y	NF	N	NE	Strip mine on top of small butte.
Riley	Y	NF	N	NE	No workings or disturbances found.
Rock Spring / Hanson Operation H-2	Y	NF	N	NE	Revegetated mine bench.
Ruth Lode	Y	NF	N	NE	General area visited, no workings found.
Ruth Marie	N	P	N	NE	Screened out: private several bulldozer cuts.
Snake Eye	Y	NF	N	NE	No workings or disturbances found.
Square Top Butte	Y	NF	N	NE	No workings or disturbances found.
Susan Becky / Kermac Operation	**Y**	**NF**	**Y**	**Y**	**Pond on mine bench sampled.**
Travers Ranch	Y	NF	N	NE	Seven small workings and prospects.
Tree Stump	Y	NF	N	NE	General area visited, no workings found.
Trio Lode 4	N	NF	N	NE	Screened out: dry ridge top.
Windy Jim / Kermac Operation	Y	NF	N	NE	Strip mine along plateau rim.
Yeb	Y	NF	N	NE	Single bulldozer prospect.

4.5 Mink / Kermac Operation

Site Location and Access

The Mink mine (figure 7 and 8) lies in the North Cave Hills of South Dakota and can be reached by taking the Tufte road off of Highway 85 for 6.3 miles to the top of Riley Pass. The last half a mile has to be hiked because of a road closure. Travel north following the plateau rim, cross the Susan Becky and Windy Jim workings, until the Mink Mine in CCCA section 23, T. 22 N., R. 5 E. is reached.

Site History-Geologic Features

The only reference found for the Mink mine is in a list of former mines and prospects by Minobras (1977). The description for the Cave Hills area is summarized here. Uranium was first discovered in the Riley Pass area in 1954, in an autunite-bearing lignite of the Tongue River Member of the Fort Union Formation (Paleocene). The Tongue River Member consists of a massive, cross-bedded sandstone interbedded with coal, siltstone, claystone, and carbonaceous shale. The uranium-bearing lignites occur as thin beds, from 1- to 2-feet thick within the basal unit of the Tongue River Member. The lignites are underlain by a cliff-forming sandstone. These lignite beds can be seen in the former working face of the Mink mine. Sometime prior to 1963 the Mink mine was being worked under the name “Kermac Operation” along with the Susan Becky, Windy Jim, L&L #3, and others. All of these are strip mines meet, forming one continuous mine bench following the contour of the plateau rim.

Environmental Condition

Overburden and mine waste were moved away from the working face to the back side of the mine bench along the plateau rim. The waste dumps spill over the plateau rim and are subject to gully erosion. Gullies from 4 to 8 feet deep incise the waste piles. Some show signs of possible mass movement.

Depressions on the mine bench collect runoff from rainfall, forming ponds from which cattle and wildlife drink. Two of these depressions contained water at the time the site was visited; they appeared to hold water for several months out of the year.

Site Features-Sample Locations

A water-quality sample (PCMKS10H) was collected from one of the ponds on the mine bench. Field pH was 8.35, and specific conductance was 1,174 µmhos/cm. Site features and sample location are shown in figure 6.

Soil

One soil sample was collected along the mine bench where sediment has washed across the bedrock towards the pond. The concentration of arsenic exceeded all of the Clark Fork Superfund background levels, and copper and lead exceeded one or more background levels. None of the constituents exceeded phytotoxic levels (table 13).

Table 13. Soil sampling results at the Mink / Kermac Operation (mg/kg).

Sample Location	As	Cd	Cu	Pb	Zn
Mine bench (PCMKW10H)	48.91	<4.1	17.01	13.31	30.1

(1) Exceeds one or more Clark Fork Superfund Background Levels (Table 4)
(2) Exceeds Phytotoxic Levels (Table 4)

Water

Analysis of the water-quality sample taken from the pond on the mine bench showed high concentrations of aluminum, arsenic, iron, and lead. These metals exceeded drinking water and aquatic life MCLs. Copper exceeded aquatic acute and chronic MCLs (table 14). In addition to the standard water-quality sample, a water sample was collected and analyzed for radon. The reported value was 30 pCi/L. To date, there is no federally enforced drinking water standard for radon. The Environmental Protection Agency (EPA) has proposed a standard of 4,000 pCi/L for communities with and EPA-approved State indoor air program, and a standard of 300 pCi/L for communities that do not have an indoor air program. EPA proposed the rule in October, 1999 and plans to finalize the ruling early in the year 2001.

Table 14. Water-quality exceedences for the Mink / Kermac Operation.

Sample site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	pH
Pond PCMKS10H	SC	PAC				AC	SC	PC										

Exceedence code: P-Primary MCL, S-Secondary MCL, C-Aquatic Life Chronic, A-Aquatic Acute
Note: The analytical results are listed in appendix IV

Vegetation

Vegetation does not appear to be affected by the site. Native grasses, sagebrush, and mustard weed have re-established themselves on much of the disturbed areas and mine bench.

Summary of Environmental Conditions

Despite the poor water quality of the pond on the mine bench, the effects are primarily physical disturbances. Vegetation has re-established itself over most of the workings. Sediment has been spread to undeveloped areas due to erosion of the waste piles and mine bench.

Structures

There are no structures or mine debris at the site.

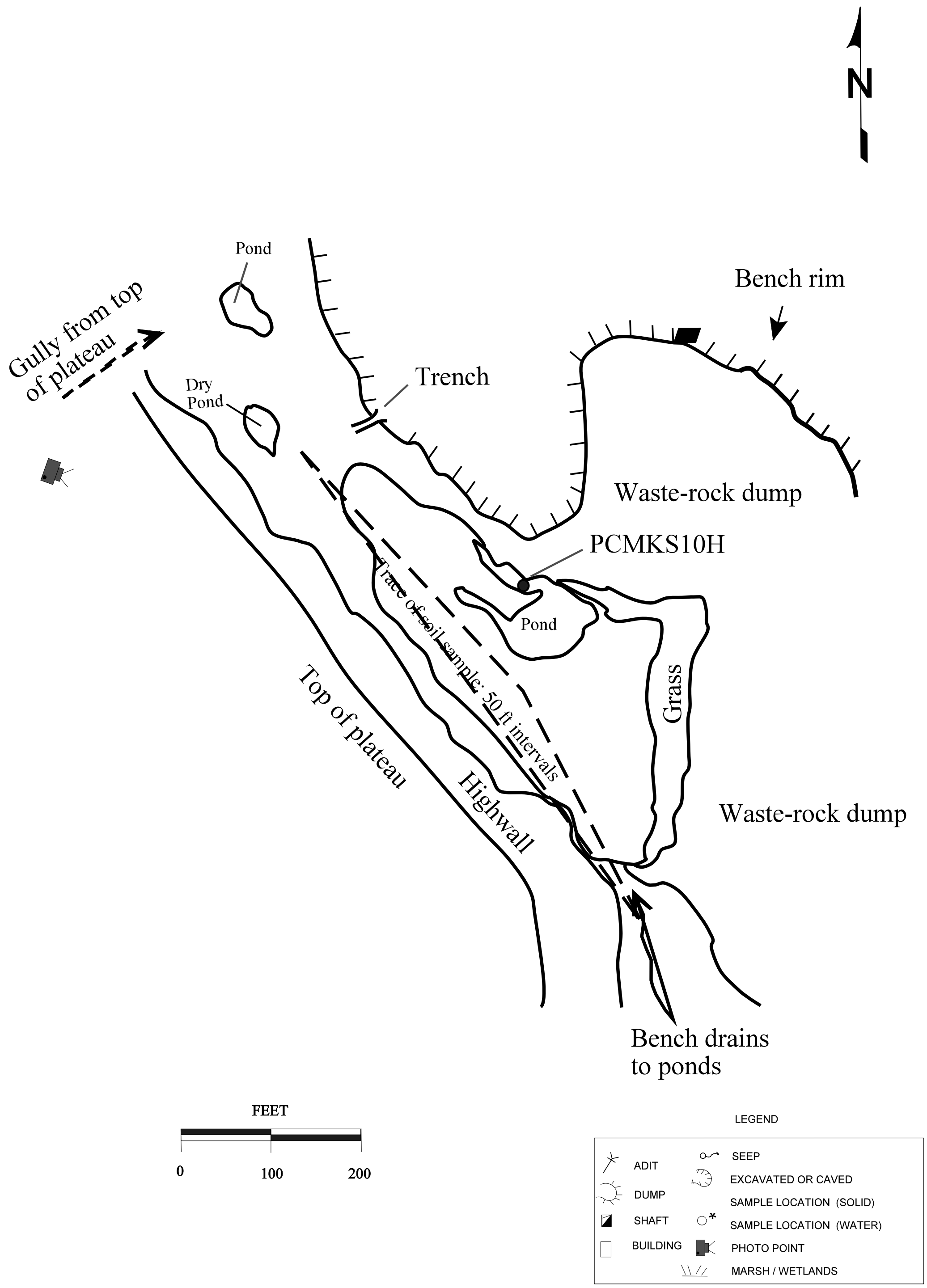


Figure 8. Tracks on mine bench suggest wildlife visit the pond to water. A water-quality sample was collected from the pond; as inventoried 6/26/00.

Figure 8a. Pond on mine bench of the Mink / Kermac Operation.

Figure 8b. View of Mink Mine, standing above L & L No. 3 and looking across draw.

Safety

The highwall at the mine face may be considered a safety hazard. The walls are 40-60 feet tall and fractured, with recent rock rubble at the base. They are no higher than the naturally formed cliffs of the Cave Hills area, but the mine walls appear less stable. Pioneer Technical Services (2002) showed radioactivity is a safety concern.

4.6 Susan Becky / Kermac Operation

Site Location and Access

To reach the Susan Becky (figure 7), take Tufte road off of Highway 85 for 6.3 miles to the top of Riley Pass. The mine is at the head of the unnamed drainage north of the road just past the summit in AACB section 27, T.22N., R.5E.

Site History-Geologic Features

Minobras (1977) lists the Susan Becky under a list of former mines, prospects, and occurrences. No other references were found. Summarizing Minobras (1977) description of the Cave Hills area: uranium was first discovered in the Riley Pass area in 1954, in an autunite-bearing lignite of the Tongue River Member of the Fort Union Formation (Paleocene). The Tongue River Member consists of a massive, cross-bedded sandstone interbedded with coal, siltstone, claystone, and carbonaceous shale. The uranium-bearing lignites occur as thin beds, 1- to 2-feet thick within the basal unit of the Tongue River Member, which includes at the base a cliff-forming sandstone. Sometime prior to 1963, the Susan Becky Mine was being worked under the Kermac Operation along with the Mink, Windy Jim, L&L #3, and others. All of these are strip mines that have been worked until their workings met forming one continuous mine bench following the contour of the plateau rim.

Environmental Condition

A pond has formed on the mine bench from runoff, collecting in a depression that appears to hold water for most of the year. There are two other ponds approximately 700 yards below the mine in the drainage bottom. These have filled with sediment from runoff off the mine bench. Whether these were originally stock ponds or were designed to catch sediment is unclear.

Site Features-Sample Location

A water-quality sample (SDSBS10H) was collected from the pond on the mine bench. Field pH was 8.7, and specific conductance was 1,345 μmhos/cm. Site features and sample location are shown in figure 9.

Soil

A composite soil sample (SDSBW10H) was collected across the mine bench where sediment is washed towards the pond. This is a composite of samples collected every 50 feet, the location is shown in figure 9. Arsenic and cadium exceeded one or more of the Clark Fork superfund background levels. None of the constituents exceeded phytotoxic levels (table 15).

Table 15. Soil sampling results at the Susan Becky / Kermac Operation (mg/kg).

Sample Location	**As**	**Cd**	**Cu**	**Pb**	**Zn**
Mine bench (SDSBW10H)	20.01	0.4131	9.95	7.28	18.1

(1) Exceeds one or more Clark Fork Superfund Background Levels (Table 4).
(2) Exceeds Phytotoxic Levels (Table 4).

Water

Concentrations of arsenic, chromium, and lead exceeded primary drinking and chronic aquatic life standards, while copper and zinc exceeded acute and chronic aquatic life standards (table 16). In addition to the standard water-quality sample, a pond sample was collected and analyzed for radon content. The analysis showed no radon, with a reported value of 0 pCi/L. To date, there is no federally-enforced drinking water standard for radon. The EPA has proposed a standard of 4,000 pCi/L for communities with and EPA-approved State indoor air program, and a standard of 300 pCi/L for communities that do not have an indoor air program. EPA proposed the rule in October, 1999 and plans to finalize the ruling early in the year 2001.

Table 16. Water-quality exceedences for the Susan Becky / Kermac Operation.

Sample site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	pH
Pond SDSBS10H		PC			P	AC		PC					AC					

Exceedence code: P-Primary MCL, S-Secondary MCL, C-Aquatic Life Chronic, A-Aquatic Life Acute.
Note: The analytical results are listed in appendix IV.

Vegetation

Vegetation does not appear to be affected by the site. Native grasses, sagebrush, and mustard weed have re-established themselves on much of the disturbed areas and mine bench.

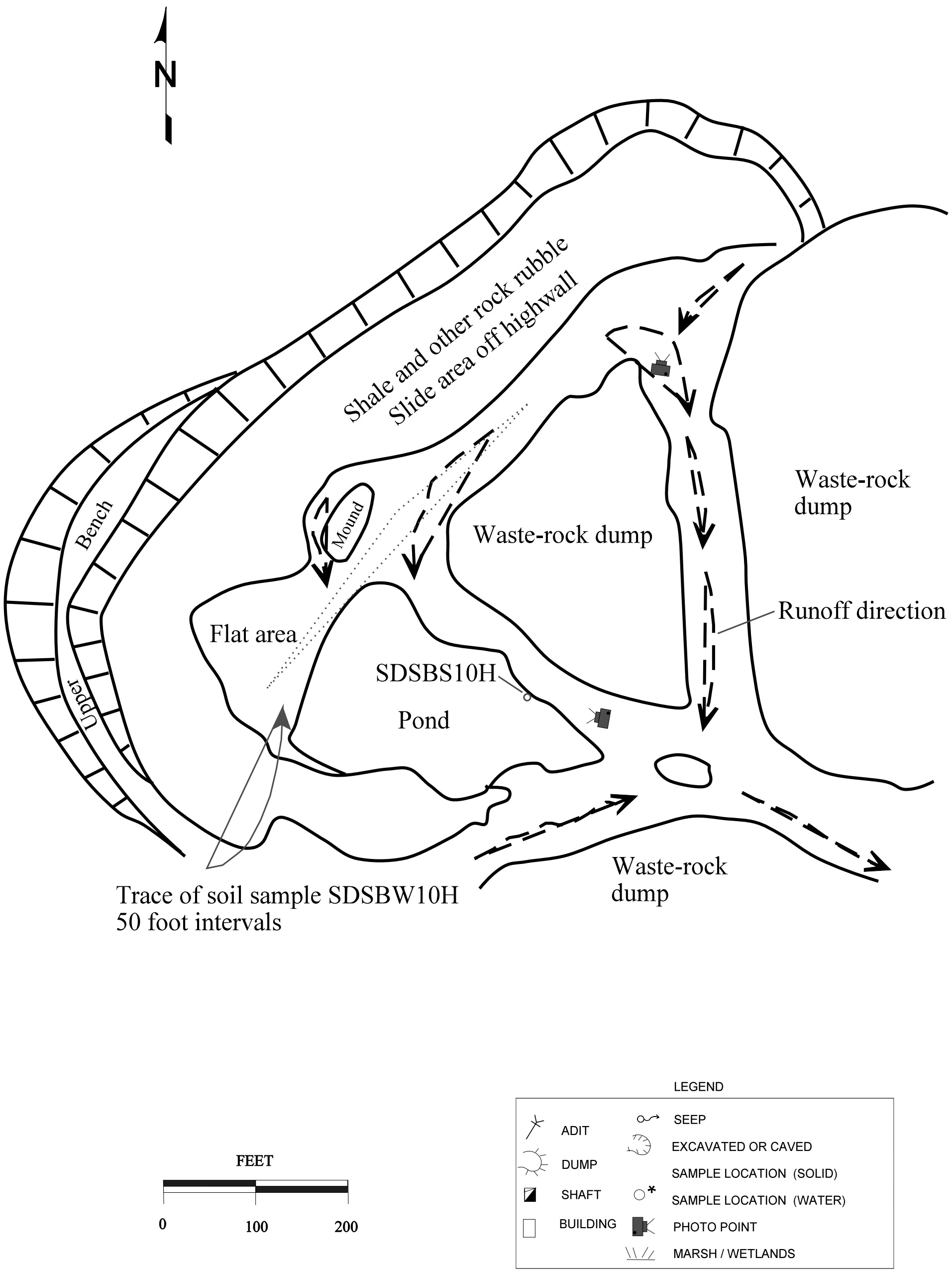


Figure 9. Sketch map of the Susan Becky / Kermac Operation as mapped on 6/26/2000.

Figure 9a. View of pond on the former mine bench of the Susan Becky.

Figure 9b. Photo showing highwall, rock rubble and landslide area of the Susan Becky.

Summary of Environmental Conditions

The area mined at the Susan Becky is quite extensive. Storm events and runoff have washed sediment off the mine bench and waste piles, filling two ponds below the plateau rim at the head of Schleichart Draw.

Structures

There are no structures or mine debris at the site.

Safety

The highwalls of the former working face may be a safety concern. At the highest point, the highwall is more than 80 feet tall, and at the east end of the highwall landsliding has occurred. Pioneer Technical Services (2002) showed radioactivity is a safety concern.

4.7 Pickpocket No. 1 / Munkers Operation

Site Location and Access

The Pickpocket No. 1 lies in the North Cave Hills area of South Dakota (figure 7 and 10). To reach the mine, take the Tufte road off of Highway 85 for 6.3 miles to the top of Riley Pass. From there, continue down the west side of the pass for another 0.1 miles, and take the four-wheel drive road on the left for 1.1 miles. The mine is on the left.

Site History-Geologic Features

Minobras (1977) lists the Pickpocket No. 1 under a list of former mines, prospects, and occurrences. No other references were found. Summarizing Minobras' (1977) description of the Cave Hills area: uranium was first discovered in the Riley Pass area in 1954, in an autunite-bearing lignite of the Tongue River Member of the Fort Union Formation (Paleocene). The Tongue River Member consists of a massive, cross-bedded sandstone, interbedded with coal, siltstone, claystone, and carbonaceous shale. The uranium-bearing lignites occur as thin beds, from 1- to 3-feet thick. These beds have been mined at the Pickpocket No.1 mine, under less than 10 feet of overburden. Sometime prior to 1963 the Pickpocket No. 1 mine was being worked under the name "Munkers Operation"which mined the north side of a hill along the plateau rim. The south side of the hill was also explored as well as an area just north of the mine.

Environmental Condition

There is a pond on the former mine bench that collects rainfall runoff. Cattle and wildlife drink from this pond, which appears to hold water for several months of the year.

Site Features-Sample Locations

A water-quality sample (PCPPS10H) was collected from the pond. Field pH was 8.59, and specific conductance was 938 µmhos/cm. A soil sample (PCPPW10H) was collected along the mine bench to evaluate what was being washed into the pond. Site features and sample locations are shown in figure 10.

Soil

A composite soil sample (PCPPW10H) was collected across the mine bench where sediment is washed towards the pond. This is a composite of intervals collected every 50 feet; the location is shown in figure 10. Analysis of the soil sample showed arsenic and lead exceeded one or more Clark Fork Superfund background levels. None of the constituents exceeded phytotoxic levels (table 17).

Table 17. Soil sampling results at the Pickpocket / Munkers Operation (mg/kg).

Sample Location	**As**	**Cd**	**Cu**	**Pb**	**Zn**
Mine bench (PCPPW10H)	56.51	<4.1	9.89	14.11	37.1

(1) Exceeds one or more Clark Fork Superfund Background Levels (Table 4).
(2) Exceeds Phytotoxic Levels (table 4).

Water

Several constituents exceeded water-quality standards. Arsenic, iron, and lead exceeded drinking water and chronic aquatic life standards. Copper exceeded aquatic acute and aquatic life chronic MCLs (Table 18). In addition to the standard water-quality sample, a sample was collected for radon analysis. The reported value was 20 pCi/L. To date, there is no federally enforced drinking water standard for radon. The EPA has proposed a standard of 4,000 pCi/L for communities with and EPA-approved State indoor air program, and a standard of 300 pCi/L for communities that do not have an indoor air program. EPA proposed the rule in October, 1999 and plans to finalize the ruling in 2001.

Table 18. Water-quality exceedences for the Pickpocket / Munkers Operation.

Sample site	Al	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn	Cl	F	NO_3	SO_4	pH
Pond PCPPS10H		PC				AC	SC	PC										

Exceedence code: P-Primary MCL, S-Secondary MCL, C-Aquatic Life Chronic, A-Aquatic Acute.
Note: The analytical results are listed in appendix IV.

Vegetation

Vegetation does not appear to be impacted by the site. Native grasses and shrubs have re-established themselves on many parts of the mine bench and waste piles.

Summary of Environmental Conditions

The Pickpocket No. 1 has only a local effect on the environment; the effects are primarily physical disturbances.

Structures

There are no structures or mine debris at the site.

Safety

The highwalls may be a safety concern. These are no higher than the naturally formed cliffs of the area, but the mined cliff faces appear less stable. Pioneer Technical Services (2002) showed radioactivity is a safety concern.

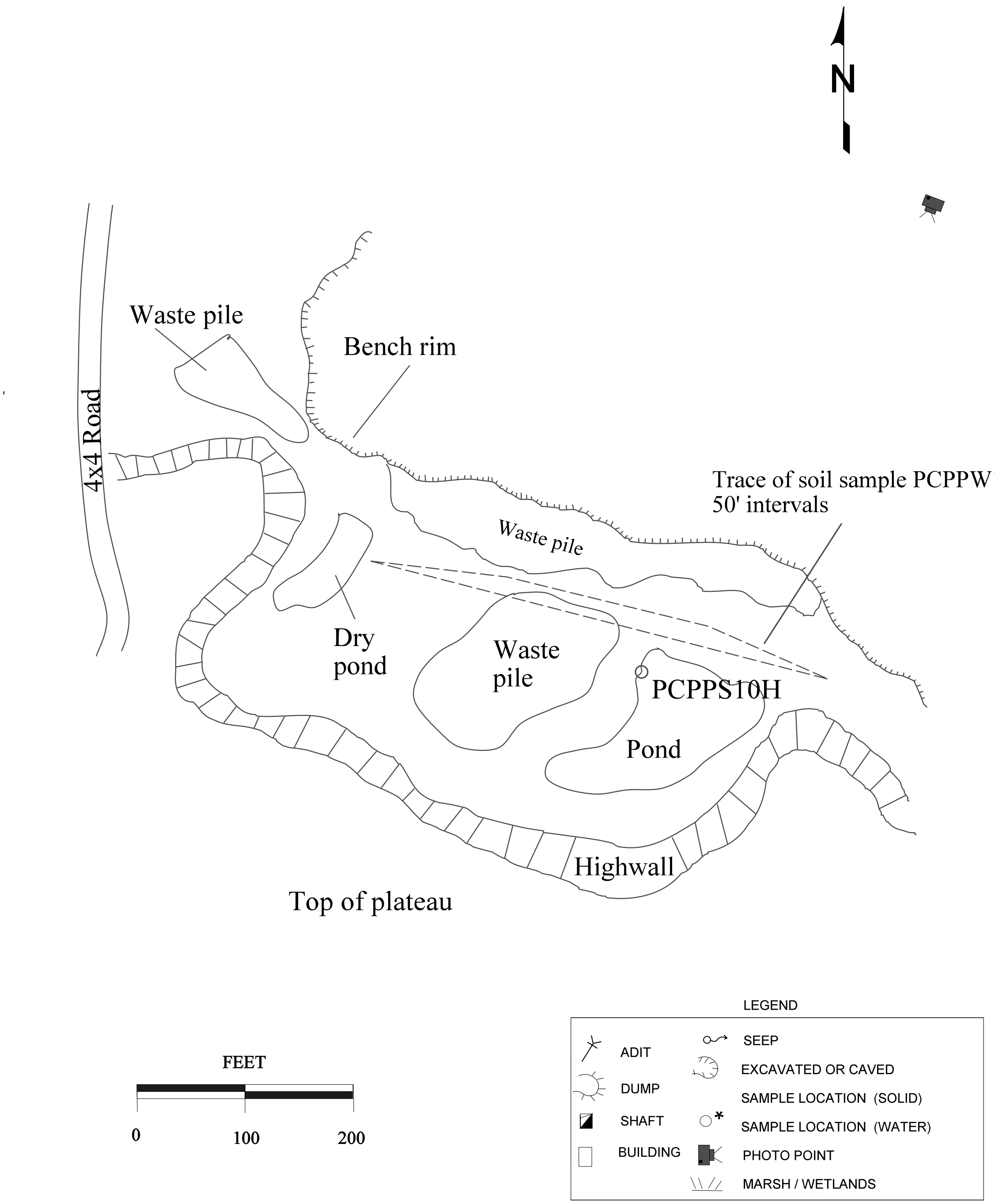


Figure 10. Wildlife and cattle drink from pond on the former mine bench of the Pickpocket as mapped 6/26/2000.

Figure 10a. View of cuts into hillside of the Pickpocket No. 1/Munkers Operation. Photo is taken from standing on the stripped area of the Relf Mine/Kermac Operation.

Figure 10b. Area view of the North Cave Hills and surrounding lowlands.

5.0 Uranium Sampling

Extensive uranium mining and exploration was conducted in the Sioux Ranger District and in the Pryor Mountains of the Beartooth Ranger District of the Custer National Forest. Initially this report and investigations were intended to deal with hardrock locatable minerals and focus on impacts to surface and ground water from acid mine drainage. It did not deal with leasable minerals; uranium is a leasable mineral. However, given the possible impact, and magnitude of uranium exploration and mining in the Sioux Ranger District and Pryor Mountains further investigations were warranted. These areas were revisited for reconnaissance to identify and characterize possible environmental, health, and/or safety problems associated with past uranium exploration and mining. Field work was conducted in the summers of 2001 and 2002.

A hand held SC-132 Mount Sopris scintillation meter was used to help characterize and detect gamma radiation levels at abandoned mines and prospects. A scintillation meter registers radioactivity, but it can not distinguish between the radiation coming from uranium or if it is coming from another source. Scintillation detectors count total gamma radiation from all sources that emit gamma rays and are not capable of directly measuring uranium concentrations. Soil samples were collected from selected sites to determine total uranium and radium-226 concentrations from abandoned mine sites and prospects.

Three soil samples were collected at each site:

1) a composite sample taken from the adit opening or mine bench representing the overall composition of the ore and host rock.
2) a composite sample across the mine waste pile, and
3) a background composite sample of the soils outside the influence of the mining activity.

Composite samples were collected using a stainless steel scoop and bowl, which was throughly mixed before filling a 250-ml HDPE jar or sealed bag. Samples were place in a cooler for storage and transport until turned over to MBMG's or contract laboratory for analyses. Site and sample locations were determined using a hand held Global Positioning System (GPS), and/or by plotting them on a topographic map.

In addition to mine sites, mining prospects were also investigated to determine if they pose a health risk. Selected sites that were representative of the disturbances found for a given area, determined by the visiting MBMG hydrogeologist were sampled.

Three soil samples were collected from each site:

1) a composite sample across the prospect pit.
2) a composite sample of the surrounding waste pile, and
3) a composite background sample of the undisturbed area bordering the prospect.

Locally, one composite background sample was collected for several prospects in a given area.

5.1 South Dakota

There are five discontinuous tracts of land administered by the Custer National Forest in South Dakota. Three of these have been explored and mined for uranium: North Cave Hills, South Cave Hills, and Slim Buttes. The East and West Short Pine Hills were explored for uranium but were never mined so they were not investigated for this report. The North Cave Hills area was previously investigated and sampled by Pioneer Technical Services (2002) and is currently under a CERCLA cleanup action. All the major sites in the North Cave Hills listed by Minobras (1977), and Christensen and Manchester (1964) were investigated by Pioneer and are currently being reclaimed (figure 11). No further sampling was done in the North Cave Hills.

Seventy-six sites were found and visited in the South Cave Hills and Slim Buttes areas (figures 11a, 11b). Twenty-four sites were sampled, making a total of 65 samples collected.

Mining began prior to 1920 for lignite coal resources, primarily for local consumption, and additional lignite mining on a local scale was done in the 1930's (Stevenson, 1956). In the Slim Buttes area the Mendenhall mine, located in sec. 1, T. 17 N., R. 7 E., and the Bar-H mine located in sec. 27, T. 19 N., R. 8 E., were located in private tracts of land inside land administered by the Custer National Forest. Other lignite coal mines were located near the border of the Custer National Forest but do not impact land administered by the CNF. These include the Ellis mine, shown by Petsch (1955) to be located in ADDA, sec. 2, T. 16 N., R. 7 E. This site was visited but no signs of past workings could be found. The Bonnewell, Mitchel, Hodge, and Wammen mines also bordered the CNF in the Slim Buttes area. Their locations are shown on figure 7. The Olserud Mine in DBCC, sec. 36, T. 18 N., R. 7 E., as mapped by Petsch (1955), and shown to be active at that time is inside the CNF border, but no workings or past mining disturbances where found when visiting the area in August 2002. The Ivers mine, was inactive by 1955 (Petsch, 1955), and is located in BACC, sec. 21, T . 19 N., R. 8 E. was also on CNF-administered land, but a local rancher at the G. Lermeny Ranch stated that the mine was reclaimed 5 or 6 years ago, along with other mines by a Mr. Carr from Prairie City, South Dakota. In the South Cave Hills, lignite coal has been mined from the Hilton Mine, that also borders the CNF but does not impact CNF-administered land.

Even though knowledge of uraniferous lignites date back to 1951 uranium mining activity did not begin until 1954, and by the spring of 1955 all of the Cave Hills and Slim Buttes area had been claimed covering approximately 65,000 acres (Christensen and Manchester, 1964). According to Christensen and Manchester (1964), thousands of discovery cuts and prospects were made in the area, and a high percentage of these cuts were in unconsolidated overburden and did not contain lignite-bearing uranium. Prospecting was conducted by bulldozer cuts, backhoe, rim cutting, and drilling.

Large scale mining operations for uraniferous lignites began in 1962. Many of the smaller sites listed by Minobras (1977) mined in the late 1950's were reworked and consumed by these larger operations. Most of these large operations were in the North Cave Hills, but there were two

Custer National Forest, Sioux Division, North Cave Hills, South Dakota

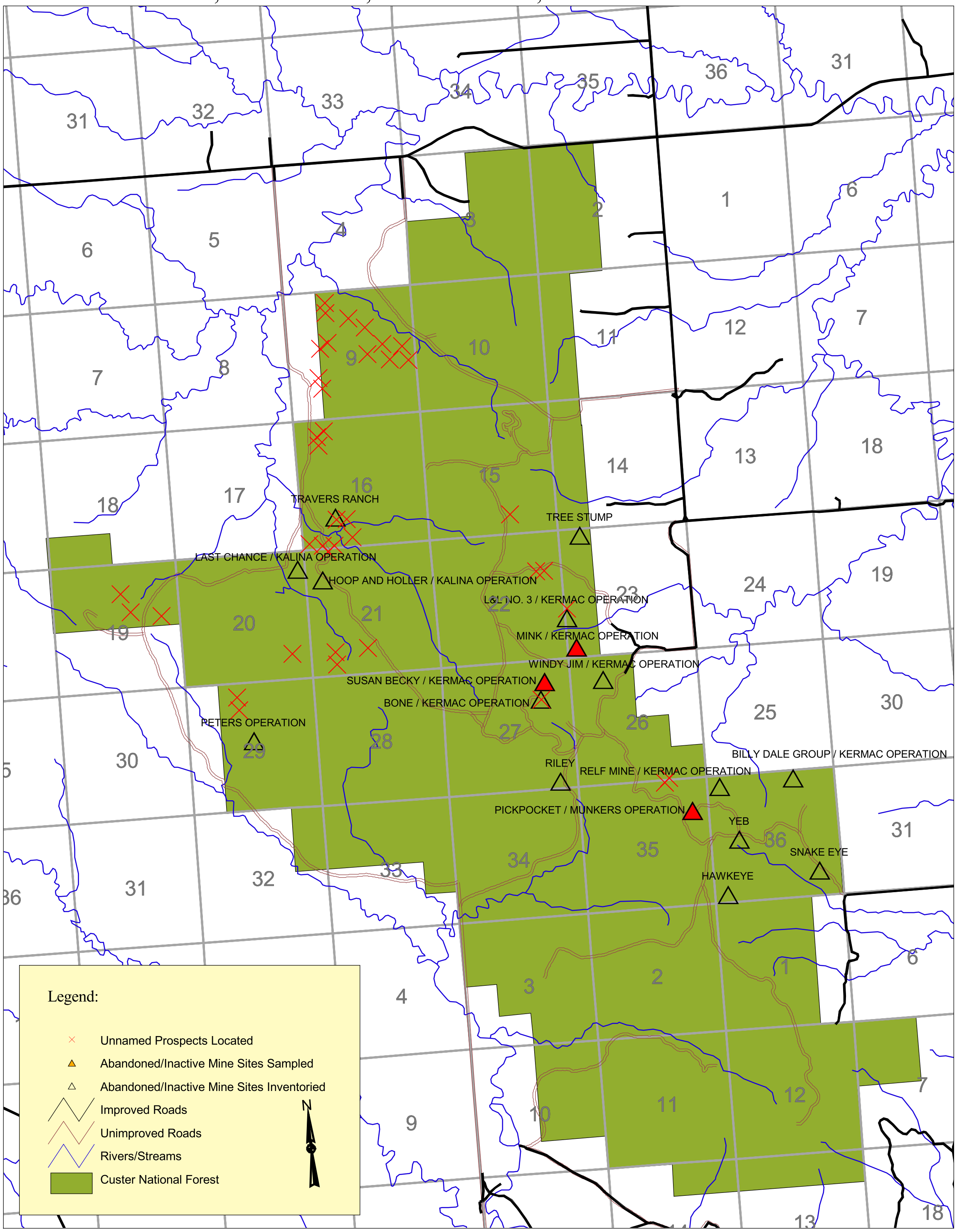


Figure 11. Sites inventoried in the North Cave Hills and are currently under a CERCLA cleanup action.

Custer National Forest, Sioux Division, South Cave Hills, South Dakota

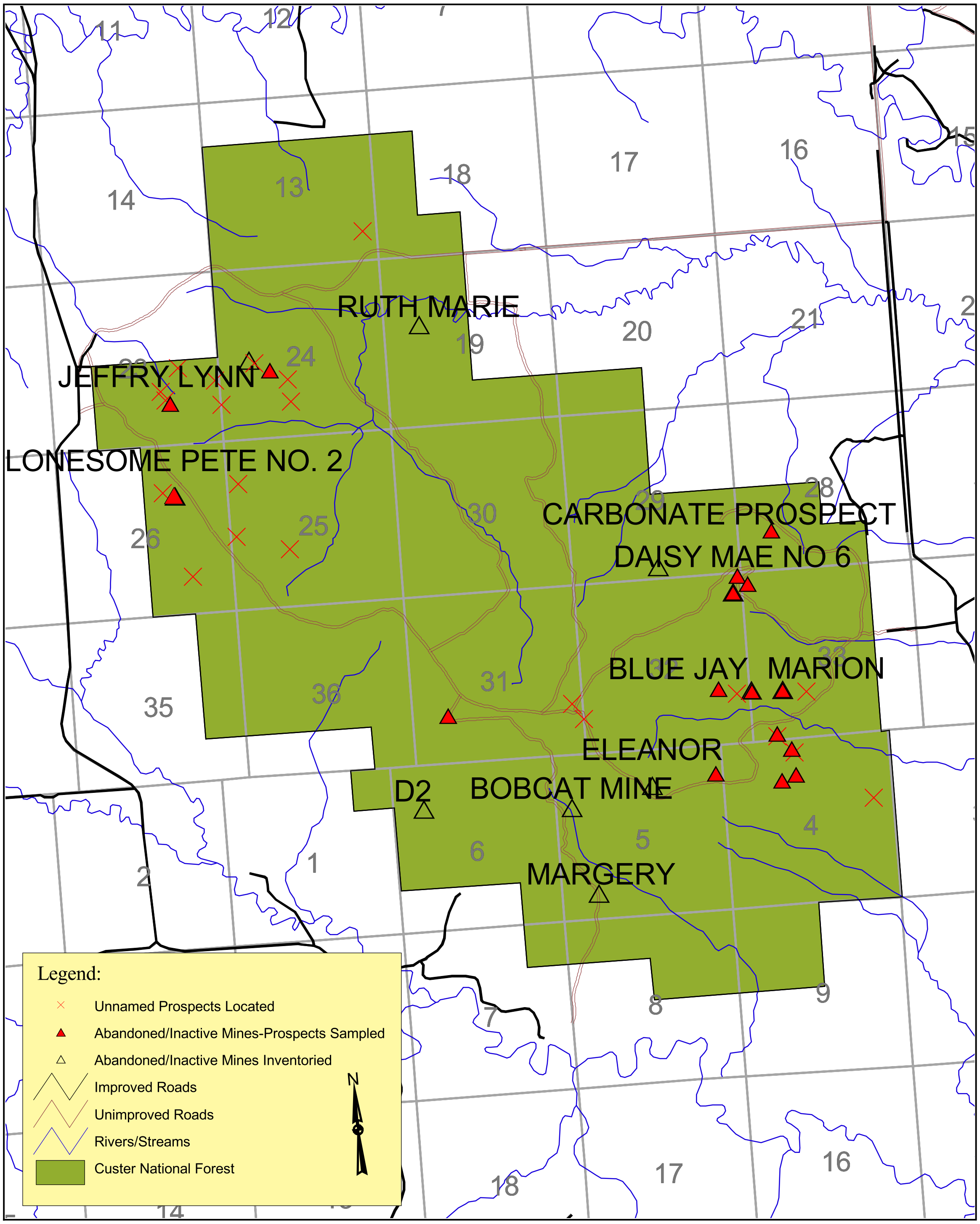


Figure 11a. Sixteen sites were sampled in the South Cave Hills.

Custer National Forest, Sioux Division, Slim Buttes, South Dakota

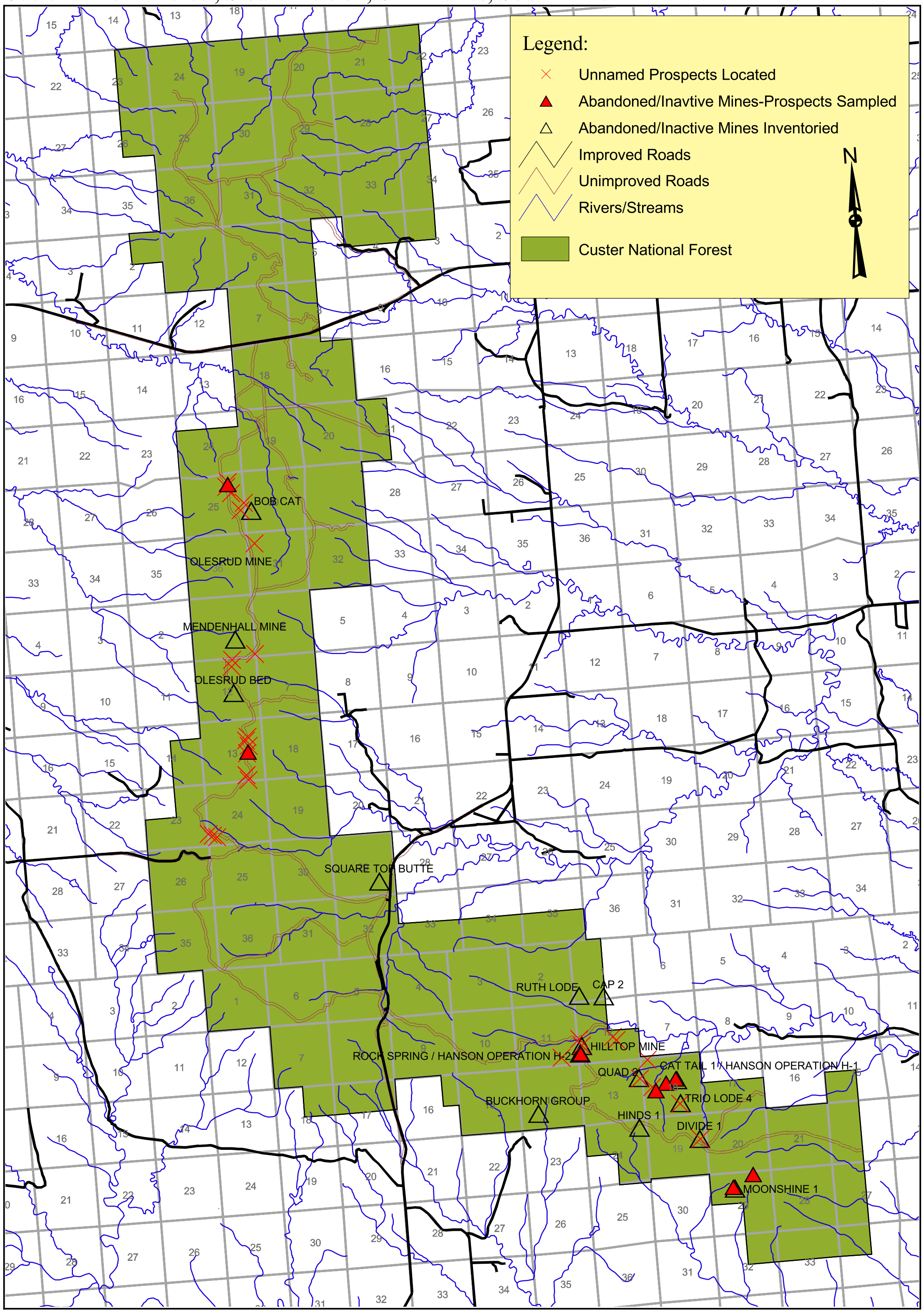


Figure 11b. Eight sites were sampled in the Slim Buttes area.

larger operations in the Slim Buttes known as Hanson Operations H-1 and H-2. Christensen and Manchester (1964) state there was no mining activity in the South Cave Hills at the time of their inspection in October 1963, but they did make note of a large pit in SW1/4, NE1/4, sec. 26, T. 21 N, R. 4 E. mined around 1956 covering about 2 acres. Minobras (1977) listed this site as Lonesome Pete No. 2. This site was visited and sampled for this report.

Of the thousands of discovery cuts and pits made in the Slim Buttes and Cave Hills area many were filled or partially filled in by local ranchers to protect livestock, according to Christensen and Manchester (1964). Today, the prospect pits remaining have the sides sloughed in and are predominantly re-vegetated by grasses and sage (figure 12). Most likely these cuts and pits were made because soil or overburden more than 1-2 feet thick stops gamma rays, so the overburden was removed to probe the bedrock while prospecting for uranium with a Geiger or scintillation counter.

During this investigation fifty-one prospects and 12 exploration cuts were investigated with a scintillation counter. The sites were located using a hand held GPS system and are listed in appendix V. Prospects are considered pits dug by a backhoe or bulldozer. Cuts were made by a bulldozer excavating into a hillside the width of the dozers blade, much like a road cut, looking for lignite beds (figure 13).

Scintillation readings for the prospects ranged from 60-120 counts per second (cps), and the exploratory cuts ranged from 80-1,200 cps. Soil samples were collected at 6 of the prospects and 9 exploration cuts were sampled. Currently there are no federal standards for uranium in soils, and the South Cave Hills and Slim Buttes area are not under a Comprehensive Environmental Response Compensation and Liability Act (CERCLA) action. However, the soil samples were compared to CERCLA limits (3 times above background levels) to assess whether there are possible environmental and health risks in the area (table 20). None of the prospects sampled exceeded 3 times local background levels. In fact, all were below the detection limit of 5 mg/kg uranium. This is not surprising because most of the prospects were on top of the bluffs capped by the sandstones of the Tongue River member in the Cave Hills area and sandstones of the Arikaree Formation in the Slim Buttes area. Uraniferous lignites are chiefly in the lower part of the Tongue River and Ludlow members of the Fort Union. Concentrations greater than three times background were found at 8 of the 9 bulldozer cut sites for at least one of the samples collected; a cut sample or waste sample. Most of the cuts exposed lignite beds and the lignite was sampled as part of the overall composite of the cut.

Uranium mine sites named in Minobras (1977) and Christensen and Manchester (1964) in the South Cave Hills and Slim Buttes area were investigated and sampled. Concentrations greater than three times background were found at 8 of the 9 mine sites for at least one of the samples collected; either a lignite, mine bench or waste sample. Table 21 list the sites and concentrations.

Bulldozer prospect naturally re-vegetated.

Bulldozer prospect on top of plateau, South Cave Hills.

Soil sample SCH2 collected from bulldozer prospect.

Figure 12. Typical bulldozer prospects in the Slim Buttes and South Cave Hills area.

Bulldozer cut into hillside exploring a lignite seam. Sloughing from the cut bank has mostly covered the lignite bed. Soil sample SCH3A was collected from this cut.

Lignite bed exposed from a bulldozer cut in the South Cave Hills near the Daisy Mae No. 6. Soil sample SCH12A was collected from this lignite bed.

Figure 13. Bulldozer cuts exploring lignite beds in the South Cave Hills.

5.2 South Cave Hills

Lonesome Pete No. 2 was one of the few mines that did not extract uranium from lignite; uranium was found in a carbonaceous siltstone, located about 150 feet below the rim of South Cave Hills. Curtiss (1955) states that the Lonesome Pete No. 2 was the largest mining operation at that time and 100,000 cubic yards of rock had been removed. This was considered exploratory work yielding ore-grade assays. Upon visiting the site, a 15-20 foot highwall composed of a light gray siltstone capped by a brown sandstone was found. The upper mine bench is approximately 500 feet long and 150 feet wide with 6 piles of gray silt (ore?), from 2 to 6 cubic yards each, scattered across the mine bench. These piles had higher scintillation readings than the mine bench itself. Readings ranged from 760 to 5,200 cps for the piles where the bench readings were 360-1,400 cps. Sample SCH1A was collected by traversing across the front of the mine bench and then traversing across the back of the bench near the highwall collecting a sample every 20 feet (not differentiating between mine bench or ore pile) to make a composite sample. Analysis of the sample reported 272 mg/kg uranium and 71.2 pCi/g radium-226. Sample SCH1PILE was collected from a pile of gray silt with the highest average scintillation readings at the base of the of an old ore chute. This pile is on a second lower mine bench before the waste pile. Uranium and radium concentrations from this pile are 1,830 mg/kg and 166 pCi/g, respectively. Gully erosion has entrenched the waste pile by a 6-8 foot deep trench. Figure 14 shows Lonesome Pete No. 2 mine bench, ore piles and waste pile.

There were no major workings found for the Blue Jay and Marion mines. Only exploratory cuts and prospects were found at the locations as mapped by Minobras (1977). A cut approximately 80 feet long at the base of a massive red sandstone was identified as the Marion. The waste sample from this site (SCH10W) has concentrations greater than three times background for uranium and radium 226. At the Blue Jay, a trench/bulldozer prospect was found. None of the soil samples exceeded three times background.

The Daisy Mae No. 6 is at the head of a small drainage below South Cave Hills rim and forms a small mine bench exploring a lignite layer at the base of a massive sandstone (figure 15). Minobras (1977) states that the uranium occurs in a thin claystone bed above the lignite layer at the Daisy Mae No. 6. This layer was not observed at the time of the visit. Sloughing of the highwall has buried the clay and lignite layer, but lignite clinkers coat the mine bench from burning the lignite to concentrate the ore and reduce shipping cost. Under the clinkers, the remaining 4-8 inches of the lignite bed was untouched. Soil sample SCH10A was of the clinker and lignite bed on the mine bench. Bulldozer cuts 22, 23, 24 explored the same lignite seam across the draw from the Daisy Mae No. 6.

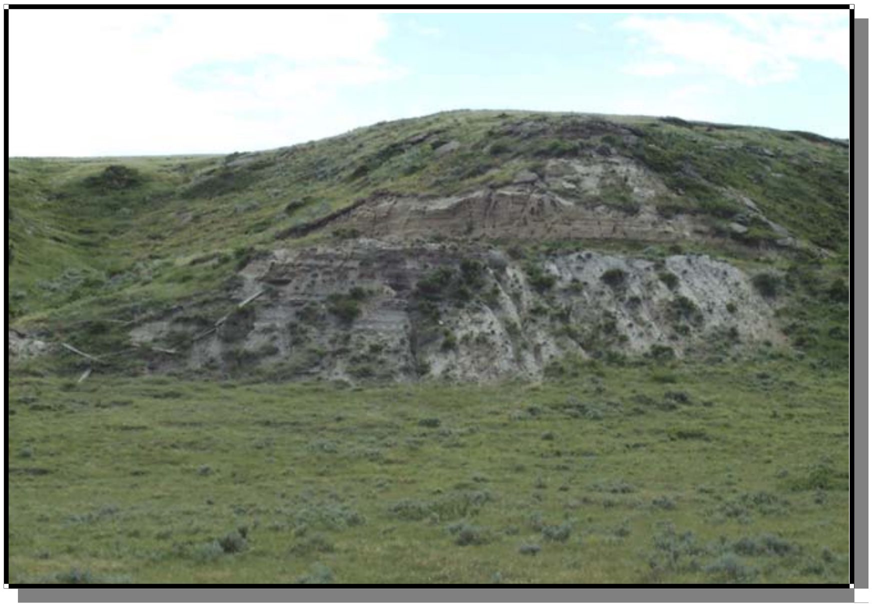
The Jeffery Lynn explores an area at the base of the rimrock sandstone of the Tongue River Formation in sec. 23, T. 21 N., R. 4 E. Petsch (1956) mapped this as an active uranium mine in 1956. A trench about 80 feet long and 20 feet wide was cut through the capping sandstone along a narrow ridge. Scintillation readings were 80-100 cps. This cut may have been made trying to find a lignite bed exposed at the base of the rim where a small area was worked. A composite soil

Radioactive ore pile on upper mine bench.

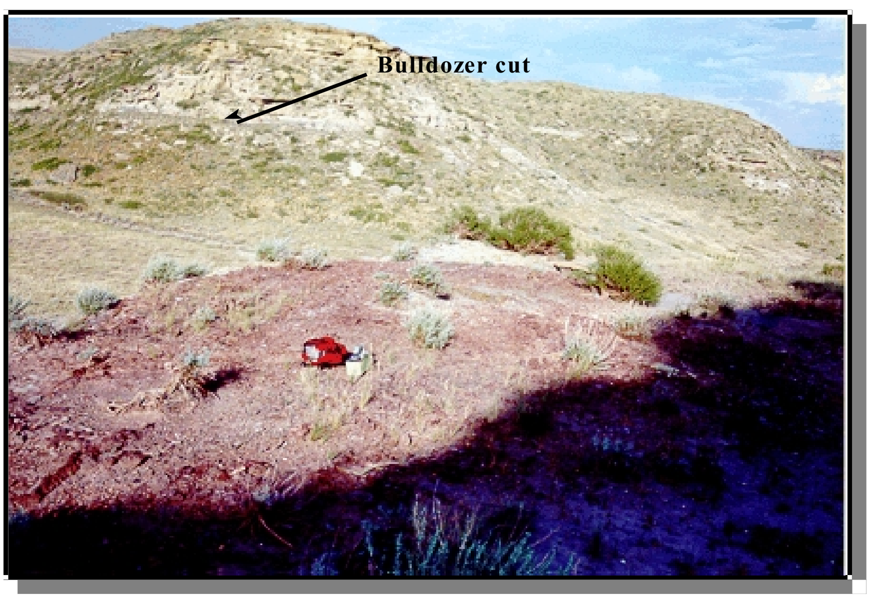
Collected sample SCH1PILE from ore pile at base of chute.

Gully eroding through waste pile.

Figure 14. Views of Lonesome Pete No. 2 upper and lower mine bench, and waste pile.



View of the Daisy Mae No. 6, South Cave Hills.



Clinkers on mine bench of the Daisy Mae from burning ore in place to reduce shipping cost. Soil sample SCH10A was collected from these clinkers. On the hillslope in the background is a bulldozer cut exploring the same lignite layer.

Figure 15. The Daisy Mae No. 6 mine site in the South Cave Hills.

sample (SCH14A2) collected from this mine bench has concentrations of 342 mg/kg uranium and 60.5 pCi/g radium-266. Further down the ridge workings or a disturbed area in a gray tan silt showed only background concentrations in sample SCH14A. Disturbances in this area were bulldozer cuts into the hillside and the one trench through the sandstone affecting 1 acre or less.

Table 19. Prospects and exploration cut concentrations.

Site	Sample ID	Uranium mg/kg	Radium 226 pCi/g	Times above background uranium	Scintillation readings average cps
Prospect 3	SCH15A SCH15W SCH15B	ND ND ND	0.4 0.5 0.5	--- ---	67 67 67
Prospect 5	SCH2A SCH2W SCH2B	ND ND ND	--- --- ---	--- ---	85 83 82
Prospect 34	SCH16A SCH16W SCH16B	ND ND ND	--- --- ---	--- ---	105 95 89
Cut 7	SCH3A SCH6B	75 5	--- ---	15	390 140
Cut 8	SCH4A SCH6B	27 5	--- ---	5.4	650 140
Cut 10	SCH5A SCH6B	8 5	---	1.6	300 140
Cut 12	SCH6A SCH6W SCH6B	6 42 5	--- --- ---	1.2 8.4	270 270 140
Cut 13	SCH7A SCH7B	241 7	--- ---	34.4	800 140
Cut 23	SCH11A SCH11W SCH10B	343 82 15	--- --- ---	22.9 5.5	1000 430 230
Cut 24	SCH12A SCH12W SCH10B	118 21 15	--- --- ---	7.9 1.4	535 255 230
Cut 29	SCH13A SCH13W SCH13B	116 131 ND	--- --- ---	23.2 26.2	325 160 160

Site	Sample ID	Uranium mg/kg	Radium 226 pCi/g	Times above background uranium	Scintillation readings average cps
Prospect 3	SB2A SB2W SB2B	ND ND ND	0.6 0.5 0.7	--- ---	100 100 100
Prospect 21	SB7A SB7W SB7B	ND ND ND	--- --- ---	--- ---	88 88 88
Prospect 33	SB8A SB8W SB8B	ND ND ND	0.4 0.5 0.3	--- ---	92 92 92
Cut 11	SB4A SB4W SB3B	152 ND ND	--- --- 1.7	30.4 ---	280 150 107

Notes: Sample ID; SCH=South Cave Hills or SB=Slim Buttes, sample number, A= trench workings, mine bench, lignite bed, W=waste pile, B=background,
ND= Not detected at the reporting level (RL) of 5 mg/kg for uranium, 0.1 pCi/g for radium 226.

5.3 Slim Buttes

Large scale mining operations began in the Slim Buttes area in 1962 with the Hanson Operation mined in two areas (Christensen and Manchester, 1964) :

Area H-1 T. 16 N., R. 9 E., section 18, SW1/4NE1/4; operator, Llewellen Hanson. An area 300 feet long by 155 feet wide. Overburden up to 30 to 60 feet has been stripped. A lignite seam 30 to 36 inches thick has been mined. It appears to be in the C or D horizon of the Ludlow...
...Approximately 2 to 3 acres have been disturbed at this site.

Area H-2 T. 16 N., R. 8 E., section 12, SW1/4SW1/4; operator, Llewellen Hanson. Stripping operations were in progress with about 4 acres of disturbed area involved. Approximately 45 feet of overburden is being removed. Mining appears to be in the C or D bed of the Ludlow.

The H-1 mined area is the same mining location listed by Minobras (1977) as the Cat Tail1 (figure 16). Overburden of a tan sandstone was removed forming highwalls 35-40 feet tall. The composite soil sample of the mine bench (SB3A) exceeded three times background levels. Remnants of an old lignite stockpile approximately 25 feet in diameter was found a few 100 yards west of the mine bench. Scintillation readings were as high as 196,000 cps. A soil sample of this lignite exceeded background levels by 1,670 times. Additional workings were found west across the unnamed draw of Antelope Creek; a mine bench approximately 100 feet long and 60 feet wide with a sandstone highwall 60-80 feet high (figure17). Soil samples from this mine bench labeled (mine bench H-1/cut 12) exceeded three times background levels. A small 4 foot diameter area of lignite on the mine bench had scintillation counts as high as 2,500 cps. This was sampled as part of the overall composite of the mine bench sample (SB5A). Four other smaller exploratory bulldozer cuts were seen in the drainage basin, but were not sampled.

The Hanson Operation area H-2 is the same mining location listed by Minobras (1977) as the Rock Springs and Hilltop mine. The center stake for the Hilltop Lode No. 4 claim was found approximately 800 feet northeast of the H-2 workings. The H-2 workings were not found on the first visit to the area in June 2000 because the highwall blends in with the natural surroundings. It's not until one is up close to the mine bench before disturbances can be seen in the area. This area consists of a mine bench approximately 100 feet wide by 300 feet long with a sandstone highwall 40-60 feet high exposing a lignite bed at the base (figure 18). The bench sample (SB6A) collected along the lignite seam exceeded three times background levels. The waste sample from the overburden was below detection limit for uranium.

Connecting benches following the contour of the hillslope below the rim of Slim Buttes make up the Moonshine Mine. The mine bench is 50-60 feet wide by 430 feet long. Removal of overburden has left a 60-80 foot highwall fractured with rock rubble at its base. A lignite bed is exposed at the base of the highwall. Weathering has formed large sink holes in the mine bench. The composite soil sample (SB1A) collected along the base of the highwall exceeded three times background levels for uranium and radium-226.

Ten sites listed by Minobras (1977) for Slim Buttes were never located. This may be because some of the sites may have been only a prospect or occurrence, being staked as a mining claim but never worked. The ten sites are: Square Top Butte, Calamity Jane Group, Potato Creek, 1 of P, Finger Buttes, Cap2, Ruth lode, Quad 2, Hinds 1, and Divide 1. A local rancher, Doug Jensen, said the Hinds 1 did exist, was a smaller operation than the Moonshine or H-2, and is below the rim about a 1/4-mile east of Hines spring. Petsch (1955) also mapped several abandoned mines that were not located. These are listed below:

Coal, BCBC, sec. 19, T. 16 N., R. 9 E., Hinds 1
Coal, DACB, sec. 13, T. 16 N., R. 8 E., Divide 1 ?
Uranium, CBDB, sec. 17, T. 16 N., R. 9 E.
Uranium, CCBD, sec. 2, T. 16 N., R. 8 E.
Uranium, AAAD, sec. 2, T. 16 N., R. 8 E., Finger Buttes ?

Table 20. Mine sites and background concentrations.

Site	Sample ID	Uranium mg/kg	Radium-226 pCi/g	Times above background uranium	Scintillation readings average cps
Lonesome Pete NO. 2	SCH1A SCN1W SCH1B SCH1PILE	272 25 ND 1830	71.2 9.1 1.6 166	54.5 5 --- 366	2830 600 135 5300
Blue Jay ? Cut 16	SCH8A SCH8W SCH8B	9 ND ND	--- --- ---	1.8 0 ---	135 133 140
Marion ? Cut 17	SCH9A SCH9W SCH9B	13 109 ND	5.5 16.6 2.4	2.6 21.8 ---	830 550 175
Daisy Mae No. 6	SCH10A SCH10W SCH10B	906 14 15	77.2 4.7 7.9	60.4 --- ---	1000 430 230
Jeffery Lynn	SCH14A SCH14A2 SCH14W SCH14B	6 342 45 6	2.5 60.5 --- 3.1	0 57 7.5 ---	105 945 105 100
Moonshine	SB1A SB1W SB1B	60 20 ND	72.1 3.2 0.9	12 4 ---	200 117 128
Cat Tail 1/H1	SB3A SB3A2 SB3W SB3B	34 8520 6 ND	12.4 1670 7.2 1.7	6.8 1704 1.2 ---	450 196000 260 107
Mine Bench H1	SB5A SB5W SB5B	68 40 ND	38.8 5.2 2.4	13.6 8 ---	425 175 100
Hanson Operation H2	SB6A SB6W SB6B	109 ND 5	32.2 4.6 2.4	21.8 0 ---	540 115 98

Notes: Sample ID; SCH=South Cave Hills or SB=Slim Buttes, sample number, A= trench workings, mine bench, lignite bed, W=waste pile, B=background,
ND= Not detected at the reporting level (RL) of 5 mg/kg for uranium, 0.1 pCi/g for radium 226.

5.3 Montana, Pryor Mountains

Reconnaissance work for uranium bearing lignite beds of the Ekalaka Hills was conducted by Gill (1959). The geology an lignite resources has been described by Bauer (1924). Average concentrations of uranium were found to be 0.005 percent by Gill, but no major uranium mining activity occurred in the area. The lignite beds have been mined for their coal content. The area was not investigated under this report because of the limited exploration and lack of uranium mining in the Ekalaka Hills.

View of the Hanson Operation area H-1. This is the same area that Minobras (1977) listed as the Cat Tail. Sample SB3A2, with the high concentration of uranium (8,520 mg/kg), was collected west of these workings just outside the view of this photograph.

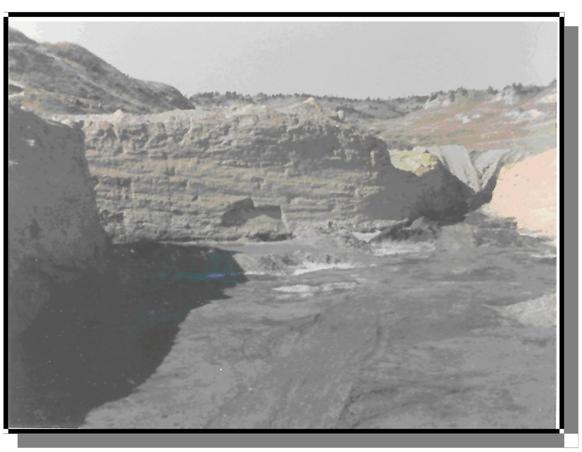


Image on the left is the Hanson Operation area H-1 as it looked in 1963 while still active, taken from Christensen and Manchester (1964). Image on the right is how the mine pit appeared in June, 2000.

Figure 16. Views of the Hanson Operation area H-1 in Slim Buttes, South Dakota.

Stock pile of lignite burned in place at area H-1 of the Hanson Operation in 1963; photo taken from Christensen and Manchester (1964).

More workings of the Hanson Operation in area H-1 west of the photos in figure 15 across the draw of the unnamed tributary of Antelope Creek.

Figure 17. Views of the Hanson Operation in area H-1, past and present.

Area H-2 of the Hanson Operation while still active in 1963; photo taken from Christensen and Manchester (1964).

Image is of the mine bench and highwall of the Hanson Operation area H-2 in August, 2000

Figure 18. Views of the workings of the Hanson Operation area H-2.

The first uranium mineralization in the Pryor Mountains was discovered in 1955 on the Old Glory Claim (Minobras, 1977). Jarrad (1957) states that the interval between initial discovery and general knowledge of the discovery most of the mountain crest of Big Pryor was claimed, and exploration work had begun. By 1956, all of Big Pryor and parts of East Pryor mountain were claimed. A total of 315 claims were staked in the Pryor Mountains (Patterson and others, 1988).

The Pryor Mountains encompass approximately 76,800 acres within the Custer National Forest. The Pryors were visited in the summer of 2001. Numerous prospects are scattered throughout the Pryor Mountains consisting of shallow surface disturbances from bulldozer trenching, backhoe digging and hand trenching (figure 19), 47 uranium prospects were inventoried and 10 of the 47 prospects were sampled. Prospects were located using a hand held GPS system and samples collected were based on scintillation readings that were representative of the disturbances found for a given area. Scintillation readings ranged from 15 to 60 cps. Only the waste sample for prospect 3 has concentrations greater than three times background levels. This prospect was not a pit but a shallow adit driven into a outcrop of Madison limestone for 25-30 feet near a naturally formed cave that had also been prospected. All the other prospects sampled were the pit type and were less than three times background levels. In fact, concentrations were near or below background levels. Table 21 list the prospect's uranium concentrations.

There were only 2 uranium mines inside the boundary of CNF-administered land for the Pryor Mountains: the Old Glory and Sandra mines. Workings of the Sandra consist of one large adit and waste pile and another smaller adit a few hundred yards northeast of the larger one (figure 20). The larger adit has a visible, bright yellow, powdery ore in the waste pile. Jarrard (1957) states the uranium ore is tyuyamunite. Analysis for uranium from the soil sample collected from the waste pile reported 412 mg/kg U^{238}, 213 times greater than background. The adit is collapsed at the opening, but has reopened above the collapse. The opening is about 8 feet in diameter allowing access into the mine workings. The second adit explored an outcrop of the Madison limestone, driven approximately 20 feet into the cliff face. Yellow ore is visible at the adit opening and in the waste pile. A composite soil sample of the adit and waste pile reported 712 mg/kg U^{238}. Table 23 lists the uranium concentrations for the 2 mine sites on CNF-administered land.

Six adits, a trench and an area explored with a bulldozer were found to make up the workings of the Old Glory Mine (figure 21). The lowest adit had the largest waste pile and was treated as a separate site; MBMG collected an adit, waste, and background sample. The waste sample from the lower adit (DOGW10) has uranium concentrations greater than three times background levels. The adit face is collapsed but has an opening roughly 4 feet by 6 feet wide, allowing access to the workings (figure 22). Because the upper adits are all in close proximity to one another soil sample DOGA20 is a composite sample of the upper adits. Four of the adits are open or partly open. One adit is collapsed with no access to the workings. The adit sample and waste sample for the upper workings are greater than three times background levels, and the uranium concentrations are shown in Table 22. The area south of the adit workings disturbed by a bulldozer was sampled (GP2A10) showed uranium concentrations greater than three times background levels and is also listed in Table 22.

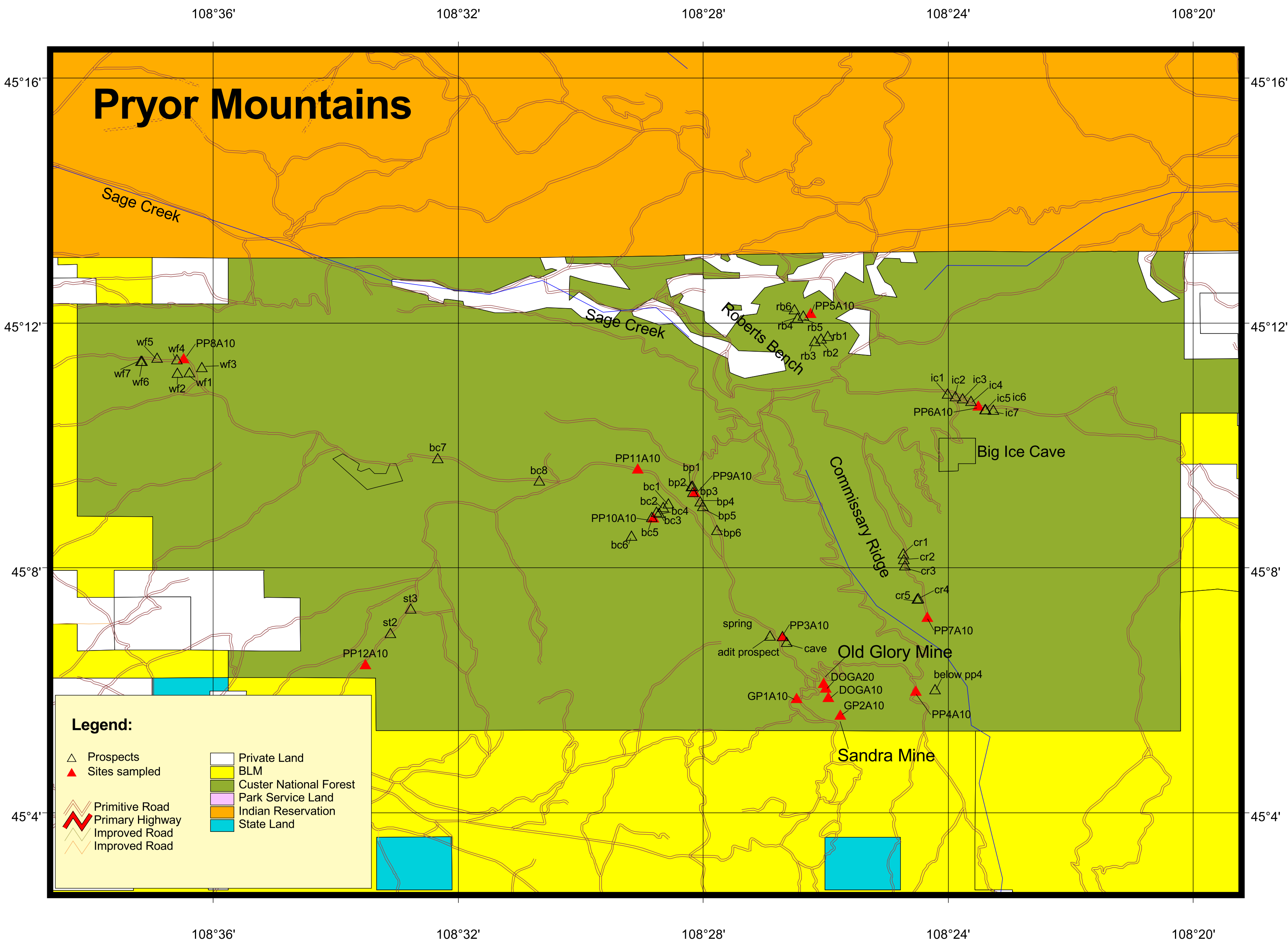


Figure 19. Prospects and mines located in the Pryor Mountains.

Table 21. Uranium concentrations for the Pryor Mountain prospects.

Site	Sample ID	Uranium mg/kg	Times above background	Scintillation readings average cps
Prospect 3	PP3A10 PP3AW10 PP3B10	2.16 5.92 0.91	2.4 6.5	
Prospect 4	PP4A10 PP4W10 PP4B10	0.63 0.69 0.64	0.9 1.1	28 28 28
Prospect 5	PP5A10 PP5W10 PP5B10	<0.50 <0.60 <0.61	0.8 0.98	50 50 50
Prospect 6	PP6A10 PP6W10 PP6B10	<0.64 <0.64 <0.61	1.05 1.05	33 39 38
Prospect 7	PP7A10 PP7W10 PP7B10	0.60 0.65 <0.57	1.05 1.14	45 48 55
Prospect 8	PP8A10 PP8W10 PP8B10	1.14 1.08 0.74	1.5 1.5	46 44 53
Prospect 9	PP9A10 PP9W10 PP9B10	<0.65 0.58 <0.6	1.08 0.95	29 39 42
Prospect 10	PP10A10 PP10W10 PP10B10	<0.60 <0.59 <0.62	0.97 0.95	45 48 61
Site	Sample ID	Uranium mg/kg	Times above background	Scintillation readings average cps
Prospect 11	PP11A10 PP11W10 PP11B10	<0.71 <0.59 <0.69	1.02 0.86	37 40 45
Prospect 12	PP12A10 PP12W10 PP12B10	0.65 0.71 0.62	1.04 1.1	28 28 28

Notes: Sample ID; PP= prospect, sample number, A= trench workings
W= waste pile, B= background, < = less than detection limit.

Table 22. Pryor Mountain uranium mine site concentrations.

Site	Sample ID	Uranium 238 mg/kg	Times above background	Scintillation readings average cps
Sandra Mine	GSAA10	3.46	1.8	50
	GSAA20	712	369	2800
	GSAW10	412	213	900
	GSAB10	1.93		10
Old Glory Mine	DOGA10	1.88	2.8	150
	DOGW10	3.86	5.8	50
	DOGB10	0.66		60
	DOGA20	95.4	145	300
	DOGW20	28.9	44	300
	GP2A10	3.89	4.2	60
	GP2B10	0.92		40

The public visiting the Custer National Forest are able to reach the mine sites by a four wheel drive road, and there was evidence of people exploring the mine dumps as well as some of the workings. A cabin between the Sandra and Old Glory mines is used by the general public for overnight stays and there are specimens of uranium ore in the cabin from people exploring the two mines. Due to the public visiting the mines and from occasional overnight stays at the mine sites by forest employees, a more complete analyses of the naturally occurring radionuclides was performed on the soil samples collected at the Old Glory mine sites. Results ranged from 12 pico curies per gram (pCi/g) and 0.8 pCi/g for gamma and radium-226 respectively for the background samples to 260 pCi/g and 39 pCi/g for gross gamma and radium-226 respectively for the upper adit samples of the Old Glory. The complete laboratory analytical results listing all the radionuclides tested for are listed in appendix II.

Roberts Bench

Commissary Ridge

Stockmans Trail

West Flank of Red Pryor Mountain

Figure 20. Typical bulldozer prospects in the Pryor Mountains.

Collapsed adit of the Sandra Mine

Waste dump and ore chute of the Sandra Mine

Opening above the collapsed adit allowing access into the mine workings.

Visible uranium ore in roof of a shallow adit in Madison limestone of the Sandra Mine.

Figure 21. Views of the workings at the Sandra Mine.

Area explored by a bulldozer. Sample GP2A10 was collected from this site.

Upper adits intersect underground drift at the Old Glory Mine.

Third open adit in the upper workings of the Old Glory.

Figure 22. Mine workings at the Old Glory Mine in the Pryor Mountains.

Lower adit and dump at the Old Glory Mine.

Adit partially blocked by collapse of hill slope.

Adit open behind collapse debris at the lower adit entrance.

Figure 23. Views of the Old Glory Mine in CNF-administered land.

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Appendix I
USFS - MBMG 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 and 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 all 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
List of Sites in the Custer National Forest

CODE	MINE NAME	T	R	SEC.	TRACT	QUADRANGLE
S	ACME	8S	14E	35		COOKE CITY
S	ANACONDA PGM DEPOSIT	5S	15E	21		MEYER MOUNTAIN
S	BEAVERTRAIL	8S	14E	28		COOKE CITY
V	BENBOW MINE	05S	16E	31		MOUNT WOOD
V	BILLY DALE GROUP / KERMAC OPERATION	22N	05E	36	ABAC	LUDLOW
V	BLUE JAY	21N	05E	32	DADC	MCKENZIE BUTTE
S	BLUEBIRD	05S	14E	23		
V	BLUEBIRD NO. 2 CLAIM	09S	18E	13		BLACK PYRAMID MTN
V	BOB CAT	18N	08E	30	CBDA	JB HILL
V	BOBCAT MINE	20N	05E	5		MCKENZIE BUTTE
V	BONE / KERMAC OPERATION	22N	05E	27	ACCAA	LUDLOW
V	BUCKHORN GROUP	16N	08E	14	CBDD	SHEEP MOUNTAIN
V	CAP 2	16N	08E	1		SHEEP MOUNTAIN
S	CARBONATE PROSPECT	21N	05E	29	CDDD	MCKENZIE BUTTE
V	CAT TAIL 1 / HANSON OPERATION H-1	16N	09E	18	ACCB	SHEEP MOUNTAIN
S	CHROMIUM OCCURRENCE	05S	14E	21		PICKET PIN MOUNTAIN
S	COLE CREEK QUARRY	07S	19E	22		RED LODGE WEST
V	COPPER GLANCE	08S	15E	19		LITTLE PARK MOUNTAIN
V	COPPER IDOL	8S	15E	19	CDDD	COOKE CITY
V	COPPER INDEX	08S	15E	19		LITTLE PARK MOUNTAIN
V	COPPER KING	08S	15E	19	ACBD	COOKE CITY
V	COPPER QUEEN	8S	15E	19	A	LITTLE PARK MOUNTAIN
V	COPPER SENTINEL	8S	15E	19	DBCD	COOKE CITY
S	D2	20N	05E	6	BCAB	MCKENZIE BUTTE
V	DAISY MAE NO 6	21N	05E	33	BBBD	MCKENZIE BUTTE
U	DIVIDE 1	16N	09E	19		SHEEP MOUNTAIN
V	DRILL CLAIM	09S	18E	13		BLACK PYRAMID MTN
S	DRINKARD PROPERTY	08S	27E	32		RED PRYOR MOUNTAIN
V	EDISON, JO DANDY, FEAR NOT	9S	14E	2	BDDA	COOKE CITY
V	EDSEL GROUP	08S	19E	33		BLACK PYRAMID MTN
V	ELEANOR	20N	05E	5	ABCC	MCKENZIE BUUTE
S	ELIZABETH	08S	14E	35		COOKE CITY
U	FISHTAIL CREEK MINE	05S	16E	25		EMERALD LAKE
V	FOUR CHROMES	08S	19E	28	BBB	BLACK PYRAMID MTN
V	GALLON JUG NO 4	09S	18E	23		BLACK PYRAMID MTN
V	GALLON JUG NOS 1 & 2	09S	18E	23		BLACK PYRAMID MTN
V	GIANT EXTENSION	8S	15E	18		LITTLE PARK MOUNTAIN
S	GOLDEN GRIZZLY	09S	14E	11		COOKE CITY
V	GOOSE LAKE AREA	08S	15E	18		LITTLE PARK MOUNTAIN
S	GREAT RIFT CLAIM	09S	14E	10		COOKE CITY
S	GREEN LEASE	08S	27E	32		RED PRYOR MOUNTAIN
S	GREENBACK	08S	14E	32		CUTOFF MOUNTAIN
S	GYPSUM CREEK DEPOSIT	09S	27E	32		RED PRYOR MOUNTAIN
V	HAWKEYE	22N	05E	36	CCCB	LUDLOW
S	HECELA-FLORA	08S	15E	18		LITTLE PARK MOUNTAIN
V	HERCULES	8S	15E	19	ACBD	COOKE CITY
V	HIGHLINE GROUP	09S	19E	20		BLACK PYRAMID MTN
V	HILLTOP MINE	16N	08E	12	CBCC	SHEEP MOUNTAIN
S	HILTON MINE	20N	05E	6	DBBD	MCKENZIE BUTTE
U	HINDS 1	16N	08E	24		SHEEP MOUNTAIN
V	HOOP AND HOLLER / KALINA OPERATION	22N	05E	21	BCBA	LADNER SE

CODE	MINE NAME	T	R	SEC.	TRACT	QUADRANGLE
V	HUDSON MINE	09S	14E	10		COOKE CITY
S	IRON MOUNTAIN CHROME GROUP	05S	14E	18		PICKET PIN MOUNTAIN
V	JEFFRY LYNN	21N	04E	24	CBAB	LADNER SE
V	L&L NO. 3 / KERMAC OPERATION	22N	05E	23	CBCB	LUDLOW
V	LAKE VIEW	8S	15E	18		LITTLE PARK MOUNTAIN
V	LAST CHANCE / KALINA OPERATION	22N	05E	20	AADB	LADNER SE
U	LITTLE NELL GROUP	08S	19E	31		BLACK PYRAMID MTN
V	LONESOME PETE NO. 2	21N	04E	26	ACAB	LADNER SE
V	LORRAINE	8S	15E	19	DDAB	COOKE CITY
S	LULU MINE / CONTACT / LULA	09S	14E	11		COOKE CITY
V	MARGERY	20N	05E	5	CCAC	MCKENZIE BUTTE
V	MARION	21N	05E	33	CBDC	MCKENZIE BUTTE
S	MCLAREN GOLD CO. / MCLAREN MINE	09S	14E	11		COOKE CITY
S	MENDENHALL MINE	17N	07E	1	DBDC	JB HILL
S	MERCER GROUP	8S	15E	19		COOKE CITY
V	MINK / KERMAC OPERATION	22N	05E	23	CCCA	LUDLOW
U	MOONSHINE 1	16N	09E	29		SHEEP MOUNTAIN
S	MOUAT IRON-TITANIUM GROUP	05S	15E	26		NYE
S	MOUAT NICKLE-COPPER	5S	15E	28		MEYER MOUNTAIN
S	MUTT LAKE	8S	14E	36		COOKE CITY
V	NORTH STAR CLAIM	09S	18E	24		BLACK PYRAMID MTN
S	NYE BASIN, ALICE	05S	15E	23		NYE
S	NYE BASIN, BIG SEVEN FAULT	05S	15E	25		NYE
S	NYE BASIN, LIP	05S	15E	22		NYE
U	OBW	8S	15E	30		COOKE CITY
V	OLD GLORY MINE	08S	27E	32		RED PRYOR MOUNTAIN
V	OLESRUD BED	17N	07E	12	DBBA	JB HILL
V	OLESRUD MINE	18N	07E	36	DBDB	JB HILL
V	PETERS OPERATION	22N	05E	29	BDDD	LADNER SE
V	PICK MINE	09S	18E	13		BLACK PYRAMID MTN
V	PICKPOCKET / MUNKERS OPERATION	22N	5E	35	AACD	LUDLOW
S	PSENDA ASBETOS PROSPECT	07S	17E	1		ALPINE MOUNTAIN
S	QUAD 2	16N	08E	13		SHEEP MOUNTAIN
V	RELF MINE / KERMAC OPERATION	22N	05E	36	BBBC	LUDLOW
V	RILEY	22N	05E	27	DDCD	LUDLOW
V	ROCK SPRING / HANSON OPERATION H-2	16N	08E	12	CCCD	SHEEP MOUNTAIN
V	ROSEBUD	06S	17E	32	ADAD	EMERALD LAKE
S	ROSEBUD ASBESTOS CLAIM	07S	17E	1		ALPINE MOUNTAIN
U	ROYSE CLAIM	08S	20E	34		TOLMAN FLAT
U	RUTH LODE	16N	08E	1		SHEEP MOUNTAIN
S	RUTH MARIE	21N	05E	19	BCDA	LADNER SE
V	SANDRA MINE	08S	27E	33		RED PRYOR MOUNTAIN
V	SHOVEL CLAIM	09S	18E	13	DAAB	BLACK PYRAMID MTN
V	SKYLINE CLAIM (HUDSON & BOULDER)	09S	14E	10		COOKE CITY
V	SNAKE EYE	22N	05E	36	DDBB	LUDLOW
V	SQUARE TOP BUTTE	17N	08E	29	DCAA	JB HILL
S	STILLWATER COMPLEX CHROMITE DEPOSIT	05S	15E	20		
S	STILLWATER MINE	05S	15E	21		MEYER MOUNTAIN/NYE
S	STILLWATER RIVER	09S	14E	4		COOKE CITY
V	SUSAN BECKY / KERMAC OPERATION	22N	05E	27	AACB	LUDLOW
S	TANDYS COAL MINE	04S	16E	29		NYE

CODE	MINE NAME	T	R	SEC.	TRACT	QUADRANGLE
V	TAYLOR-FRY-TUTTLE	05S	14E	17		PICKET PIN MOUNTAIN
U	THOM PROPERTY	07S	20E	31		RED LODGE WEST
V	TRAVERS RANCH	22N	05E	16	CCAA	LADNER SE
V	TREE STUMP	22N	05E	23	BBAC	LUDLOW
S	TRIO LODE 4	16N	09E	18	DCBA	SHEEP MOUNTAIN
S	U.S. TREASURY / U.S. MINT	09S	14E	2	BBDB	COOKE CITY
S	UNNAMED	8S	15E	19		LITTLE PARK MOUNTAIN
V	UNNAMED ADIT (OPEN)	8S	15E	19	DAAA	COOKE CITY
S	UNNAMED COAL MINE	04S	16E	33		NYE
S	UNNAMED COPPER MINE	04S	14E	13		MEYER MOUNTAIN
S	UNNAMED MINE	06S	23E	17		EMERALD LAKE
S	UNNAMED URANIUM	08S	20E	31		BARE MOUNTAIN
S	UNNAMED URANIUM	08S	20E	33		RED LODGE WEST
S	UNNAMED URANIUM	07S	19E	36		RED LODGE WEST
S	UNNAMED URANIUM (4)	09S	27E	16		RED PRYOR MOUNTAIN
S	UNUS	8S	15E	19		COOKE CITY
U	VIJAK QUARTZ LODE	08S	19E	10		RED LODGE WEST
U	WALLY JR.	8S	14E	35		COOKE CITY
V	WEAVER PROPERTY	07S	20E	31	BDCC	RED LODGE WEST
V	WEST OF COMO - AGNES M UNPATENTED ?	9S	14E	10	AAAA	COOKE CITY
V	WINDY JIM / KERMAC OPERATION	22N	05E	26	BBDD	LUDLOW
V	YEB	22N	05E	36	CBAA	LUDLOW

V: Visited S: Screened in office U: Location inaccurate

Locations of unnamed prospects inventoried in the Pryor Mountains.

Site	Longitude	Latitude	7.5 Quad.
adit prospect	-108.4451	45.1146	Red Pryor Mountain
cave	-108.4441	45.1131	Red Pryor Mountain
spring	-108.4486	45.1148	Red Pryor Mountain
below pp4	-108.4037	45.1001	Red Pryor Mountain
cr1	-108.4123	45.1372	Big Ice Cave
cr2	-108.4121	45.1356	Big Ice Cave
cr3	-108.4118	45.1339	Big Ice Cave
cr4	-108.4084	45.1249	Big Ice Cave
cr5	-108.4082	45.1250	Big Ice Cave
wf1	-108.6066	45.1865	Indian Spring
wf2	-108.6098	45.1863	Indian Spring
wf3	-108.6031	45.1879	Indian Spring
wf4	-108.6099	45.1901	Indian Spring
wf5	-108.6153	45.1904	Indian Spring
wf6	-108.6194	45.1896	Indian Spring
wf7	-108.6197	45.1896	Big Ice Cave
bp1	-108.4697	45.1555	Big Ice Cave
bp2	-108.4700	45.1555	Big Ice Cave
bp3	-108.4695	45.1539	Big Ice Cave
bp4	-108.4676	45.1514	Big Ice Cave
bp5	-108.4668	45.1501	Big Ice Cave
bp6	-108.4630	45.1435	Big Ice Cave
bc1	-108.4762	45.1508	Big Ice Cave
bc2	-108.4776	45.1498	Big Ice Cave
bc3	-108.4787	45.1482	Big Ice Cave
bc4	-108.4794	45.1486	Big Ice Cave
bc5	-108.4807	45.1471	Big Ice Cave
bc6	-108.4863	45.1419	Big Ice Cave
bc7	-108.5389	45.1631	Indian Spring
bc8	-108.5114	45.1570	Indian Spring
st1	-108.5586	45.1070	Bear Canyon
st2	-108.5519	45.1156	Bear Canyon
st3	-108.5464	45.1222	Bear Canyon
ic1	-108.4003	45.1807	Big Ice Cave
ic2	-108.3982	45.1800	Big Ice Cave
ic3	-108.3961	45.1794	Big Ice Cave
ic4	-108.3939	45.1786	Big Ice Cave
ic5	-108.3900	45.1764	Big Ice Cave
ic6	-108.3899	45.1764	Big Ice Cave
ic7	-108.3878	45.1763	Big Ice Cave
rb1	-108.4364	45.1950	Big Ice Cave
rb2	-108.4347	45.1957	Big Ice Cave
rb3	-108.4328	45.1964	Big Ice Cave
rb4	-108.4411	45.2014	Big Ice Cave
rb5	-108.4394	45.2019	Big Ice Cave
rb6	-108.4419	45.2036	Big Ice Cave

Locations of unnamed sites inventoried in South Dakota.

Site	Longitude	Latitude	7.5 Quad.
1	-103.1064	45.3590	Sheep Mountain
2	-103.0993	45.3614	Sheep Mountain
3	-103.1000	45.3629	Sheep Mountain
4	-103.0888	45.3628	Sheep Mountain
5	-103.0877	45.3620	Sheep Mountain
6	-103.0780	45.3568	Sheep Mountain
7	-103.0810	45.3526	Sheep Mountain
8	-103.0772	45.3503	Sheep Mountain
9	-103.0683	45.3459	Sheep Mountain
10	-103.0627	45.3373	Sheep Mountain
11	-103.2016	45.4997	JB Hill
12	-103.2021	45.4986	JB Hill
13	-103.2008	45.4969	JB Hill
14	-103.1968	45.4945	JB Hill
15	-103.1981	45.4928	JB Hill
16	-103.1943	45.4848	JB Hill
17	-103.1970	45.4590	JB Hill
18	-103.2048	45.4580	JB Hill
19	-103.2052	45.4564	JB Hill
20	-103.2017	45.4398	JB Hill
21	-103.2024	45.4389	JB Hill
22	-103.2016	45.4376	JB Hill
23	-103.2031	45.4309	JB Hill
24	-103.2032	45.4308	JB Hill
25	-103.2025	45.4297	JB Hill
26	-103.2173	45.4179	JB Hill
27	-103.2160	45.4174	JB Hill
28	-103.2146	45.4169	JB Hill
29	-103.2024	45.4360	JB Hill
30	-103.5178	45.8759	Lander SE
31	-103.5177	45.8749	Lander SE
32	-103.5157	45.8664	Lander SE
33	-103.5140	45.8664	Lander SE
34	-103.5133	45.8643	Lander SE
35	-103.5163	45.8635	Lander SE
36	-103.5174	45.8629	Lander SE
37	-103.5182	45.8636	Lander SE
38	-103.5203	45.8639	Lander SE
39	-103.5175	45.8515	Lander SE
40	-103.5174	45.8501	Lander SE
41	-103.5122	45.8517	Lander SE
42	-103.5244	45.8517	Lander SE
43	-103.5339	45.8473	Lander SE
44	-103.5337	45.8458	Lander SE
45	-103.5451	45.8571	Lander SE
46	-103.5500	45.8578	Lander SE
47	-103.5514	45.8599	Lander SE
48	-103.5644	45.7792	Lander SE
49	-103.5747	45.7651	Lander SE
50	-103.5749	45.7670	Lander SE

Site	Longitude	Latitude	7.5 Quad.
51	-103.5788	45.7686	Lander SE
52	-103.5832	45.7653	Lander SE
53	-103.5838	45.7674	Lander SE
54	-103.5882	45.7687	Lander SE
55	-103.5905	45.7668	Lander SE
56	-103.5900	45.7660	Lander SE
57	-103.5819	45.7584	Lander SE
58	-103.5826	45.7539	Lander SE
59	-103.5762	45.7525	Lander SE
60	-103.5883	45.7508	Lander SE
61	-103.5912	45.7581	Lander SE
62	-103.4876	45.8655	Lander SE
63	-103.4841	45.8589	Lander SE
64	-103.4828	45.8589	Lander SE
65	-103.4796	45.8544	Ludlow
66	-103.4849	45.8444	Ludlow
67	-103.4660	45.8340	Ludlow
68	-103.4653	45.8345	Ludlow
69	-103.5149	45.8909	Ludlow
70	-103.5149	45.8898	Ludlow
71	-103.5113	45.8890	Ludlow
72	-103.5087	45.8878	Lander NE
73	-103.5149	45.8864	Lander NE
74	-103.5162	45.8858	Lander NE
75	-103.5168	45.8825	Lander NE
76	-103.5164	45.8813	Lander NE
77	-103.5166	45.8765	Lander NE
78	-103.5061	45.8858	Lander NE
79	-103.5086	45.8848	Lander NE
80	-103.5021	45.8838	Lander NE
81	-103.5030	45.8854	Lander NE
82	-103.5051	45.8840	Lander NE
83	-103.5432	45.7375	Lander NE
84	-103.5419	45.7361	Lander NE
85	-103.5145	45.7370	Lander NE
86	-103.5230	45.7373	McKenzie Butte
87	-103.5185	45.7334	McKenzie Butte
88	-103.5165	45.7319	McKenzie Butte
89	-103.5073	45.7275	McKenzie Butte

Appendix III
Description of Mines and Mill Sites
Custer National Forest

ACME

PK008647

The Acme, a gold-silver-copper deposit, was screened out because it is a private patented claim on the north wall of Goose Creek Canyon, sec. 34, T. 8 S., R.14 E. It consists of 3 pits, 1 shaft, and 1 caved adit (Simons and others, 1979).

ANACONDA PGM DEPOSIT

SW001502

This site is private and has been screened out. It is part of the Stillwater mine and the active Stillwater mining area.

BEAVERTAIL

PK008646

This site was screened out because it is a shallow prospect with two adits, 10 feet long (Simons and others, 1979).

BENBOW MINE

SW006336

This site is private and was screened out. The Benbow property was first located in 1918. During 1941, 1942, and 1943, the Anaconda Copper Mining Company drove 25,260 feet of drifts, crosscuts, and laterals; 11,630 feet of intermediates; 9,502 feet of raises; and 395 feet of shafts. Approximately 224,700 tons of ore containing 18.4 percent chromic oxide were mined and /or broken during this development and by sublevel stoping (Wimmler, 1948).

BILLY DALE GROUP / KERMAC OPERATION

HA009039

Minobras (1977) reports that the Billy Dale Group was one of the larger producers of the North Cave Hills area. Two uraniferous lignite beds less than 1-foot thick were strip mined under 75 feet of sandstone-shale overburden. No discharging water, structures, or other environmental hazards were found at the site. Currently is under CERCLA action for radioactivity.

BLUEBIRD

SG001928

The Bluebird claims consist of a few pits dug by locators and 18 trenches dug by the U.S. Bureau of Mines in 1943 (Wimmler, 1948). Subsequently, the site was screened out.

BLUEBIRD NO 2 CLAIM
CB000081

The Bluebird No 2 Claim has no workings and borders the south side of the Pick claim on the eastern slope of the Hellroaring Plateau (James 1946, plate 61). Herdlick (1948) reported hand trenching and bulldozer exploration had been conducted on the Bluebird No. 2 claim, but no disturbances were found when visiting the area.

BOB CAT
HA009027

Four small bulldozer prospects were found in section 25, T.18 N., R.7 E. All are mostly re-vegetated, a few small trees have begun growing in some of the diggings.

BOBCAT MINE
HA009055

The general area of the Bobcat was visited but no workings were found. This was a site on the list of uranium mines, prospects and occurrences by Minobras (1977).

BONE / KERMAC OPERATION
HA009042

A bulldozer-cut, road next to the Susan Becky mine is all that was found for the Bone. Mining of the Susan Becky may have consumed the Bone, as it is now one large disturbed area. Currently it is under CERCLA action for radioactivity.

BUCKHORN GROUP
HA009030

No major workings were found for this site. Remnants of a bulldozer road can be seen in the badlands drainage and grassy knolls of the area.

CAP 2
HA009034

The general area of the Cap 2 was visited but no workings were found. This was a site in the list of mines, prospects and occurrences by Minobras (1977).

CARBONATE PROSPECT
HA009053

This site was screened out because it is listed as a prospect on a dry ridge top by Minobras (1977).

CAT TAIL NO. 1 / HANSON OPERATION H-1
HA009029

Three uranium strip-mined areas were found at this site. One cuts through a tan sandstone ridge for approximately 250 feet with highwalls 40 to 80 feet high on both sides of the cut. The other two areas are cuts into the hillside forming a flat mine bench that are now revegetated. There are no structures or water. Radioactive hazards may be present at the site.

COLE CREEK QUARRY
CB000099

This site was screened out because it has an accuracy of +/-1 km in the MILS database, and is a non-metallic limestone quarry.

COPPER GLANCE
PK002460

Two collapsed adits and a trench were found at the Copper Glance claim on the southwest shore of Goose Lake. Lovering (1929) stated two adits were driven close together in granite, exposing a quartz-sulphide vein about 10 feet thick where the lower adit crosses the vein. He also stated that the ore was of low grade and that no ore was shipped.

COPPER IDOL
PK008656

The Copper Idol also known as the Copper Index is on the southeast end of Goose Lake. The hiking trail for access into the Absaroka-Beartooth Wilderness crosses the mine waste dump of the lower of two collapsed adits. There was a slight adit discharge from the lower collapsed adit, but was insignificant, dampening the ground for only a few feet.

COPPER INDEX
PKOO2424

This site is shown to be on the southeast end of Goose Lake (Reed 1950, figure 11). Reed describes the deposit as chalcopyrite associated with feldspar gangue in syenite. Hartman's (1916) survey map of mining claims shows this to be the Copper Idol. Two collapsed adits were found, one above the other when the area was visited. The Goose Lake hiking trail crosses the waste pile of the lower working, and there was a slight adit discharge from the lower adit. The flow was so slight that an adit discharge sample could not be collected. The discharge was just enough to make the ground damp for a few feet.

COPPER QUEEN
PK009018

This patented claim lies north of the Copper King claim north of Goose Lake. It had evidence of discharge but was not discharging in August 1999. The adit had caved and daylighted but was not considered hazardous.

D2
HA009054

This site was screened out because it is on private land. No workings were seen by viewing the area from public land. This was a site in the list of former mines, prospects and occurrences by Minobras (1977).

DAISY MAE NO. 6
HA009052

The Daisy Mae No. 6 is a strip mine at the head of an unnamed drainage. The cut is approximately 150 feet long and 40 feet wide. Red clinkers on the mine bench suggest the lignite was burned in place. Minobras (1977) describes how many of the uraniferous lignites were burned in place, then uranium-bearing ash was shipped to Edgemont, South Dakota or to out of state mills. There are smaller bulldozer cuts along the same contact on the opposite side of the drainage. There are no structures or water at the site.

DRILL CLAIM
CB000753

The Drill claim is a small open pit mine on the north rim of the Hellroaring Plateau marked on the topographic map with a quarry symbol. This chromite deposit as described by James (1946) and Herlick (1948) extended about 160 feet horizontally and 100 feet vertically, with an average width of 5 to 10 feet. Mining and core-drilling indicated the deposit was shallow and followed the slope of the hillside. No structures, ground-water discharge, or hazardous materials were observed at the Drill.

DRINKARD PROPERTY
CB000111

This site was screened out because there are no references in the MILS database, and it had an accuracy of +/-1 km. It was listed as an uranium occurrence.

EDISON, JO DANDY, FEAR NOT
PK009020

These three unpatented claims were visited on 08/25/99. One dry open adit, a partially caved flooded shaft, and numerous prospects and trenches were found. From the size of the waste dump at the adit, the workings are estimated to extend less than a 100 feet into the hillside. All of the workings are in a highly altered, orange stained granite, and all are within the New World mining district.

EDSEL GROUP
CB000819

James (1946) describes the Edsel as two pits exposing the ore, but upon visiting the site no pits were seen but an open adit was discovered. The adit is at an elevation of 7,940 feet, is dry, and is several hundred feet west of the hiking trail out of Rock Creek that leads to the top of Silver Run Plateau. The adit, driven north into the hillside, is in a granite porphyry with the dump composed entirely of this granite. There is abundant serpentine float in and around the dump from above suggesting the adit was driven in hopes of intercepting the serpentine. A well-used path to the mine site and footprints leading into the portal indicate that it is frequently visited.

ELEANOR
HA009049

Two small revegetated, bulldozer prospects, were found for this site in tract ABCC, sec. 5, T.20 N., R.5 E., of the McKenzie Butte 7.5-min. quadrangle. This was a site in the list of former mines, prospects and occurrences by Minobras (1977).

ELIZABETH
PK002436

This site was screened out because it has an accuracy of +/-1 km in the MILS database, and nothing was found in the literature on workings or production. Lovering (1929) describes the claim as in the valley of Goose Creek almost due north of Red Mountain, at an altitude of about 8,700 feet with no road to the site.

FISHTAIL CREEK MINE
SW001550

The Fishtail mine is on the eastern edge of the Custer National Forest, and access to the site is through private property. In talking with local ranchers, there are no accessible roads into the area, and they have never come across any workings while hunting or moving cows between grazing pastures.

FOUR CHROMES
CB000825

No workings existed on these claims except for a few small discovery pits until 1942 when a series of 23 trenches and pits were dug by the U.S. Bureau of Mines in a narrow band of serpentine 100 feet wide (Herlick, 1948). Herlick noted that all of the work was done by hand. The sides of the trenches have sluffed in and are dry shallow depressions less than 3 feet deep as noted when visited 9/15/2000.

GALLON JUG NO. 1 & 2
CB000831

This site can be reached by taking Forest Route 2004 up the Hellroaring Plateau where it dead ends at the Absaroka-Beartooth wilderness boundary. From here, it is roughly a 1 mile hike along the trail to the workings. As reported by James (1946), a chromite-bearing serpentine is cut by a 30 feet wide diabase dike. The workings were abandoned in 1942 because of the difficulties in mining caused by the diabase dike. Two small shallow exploration trenches were seen about 200 feet north of the open pit workings of the Gallon Jug No. 1 & 2. No hazards were observed at the site.

GALLON JUG NO. 4
CB000837

This site is described in James (1946) as a complex landslip on the southern rim of Hellroaring Plateau near the headwaters of Lost Picket Creek. An open pit chromite mine marked on the topographic map with a quarry symbol was visited by MBMG geologists. It was found to consist of upper and lower cuts or benches on the plateau rim in serpentine, with the upper bench being part of the landslip described by James. There are no hazards or structures at the site except for a small wooden ore chute on the lower bench.

GIANT EXTENSION
PK008631

Simons and others (1979) list the Giant Extension as having 2 caved adits and 4 trenches. Two partially caved adits were found north of the Lorraine claim fitting Simons description and location for the Giant Extension’s workings. The openings are small, 3 feet by 1.5 feet, and extend only a short distance into the hillside. The workings are dry and no other environmental hazards were found.

GOLDEN GRIZZLY
PK006622

This site was screened out because it has an accuracy of only +/-10 km in the MILS database.

GREAT RIFT CLAIM
PK006602

This site was screened out because it is part of the New World Mining District Response and Restoration Project, and there are no references in the MILS database.

GREENBACK
PK002076

This site was screened out because it consist of only one L-shaped pit high on the ridge between the Stillwater River and Lake Abundance Creek. The prospect is in a pegmatite dike, which cuts foliated gneiss. The dike showed a trace of gold and 0.1-0.4 oz silver/ton (Helmuth, 1975).

GREEN LEASE
CB000117

This site was screened out because there are no references to it in the MILS database, and it had a location accuracy of +/-1 km. It was listed as a uranium occurrence.

HAWKEYE
HA009036

The general area of the Hawkeye was visited but no workings were found. This was a site in the list of mines, prospects and occurrences by Minobras (1977).

HECELA-FLORA
PK002442

This site was screened out because it has an inaccurate location of +/-1 km in the MILS database, and the only other reference is Reed’s (1950) appendix stating surficial exploration only.

HERCULES
PK008651

The Hercules was not found with certainity. Goose Lake basin contains many caved or sloughed workings making it difficult to pick out individual sites. Simons and others (1979) show the workings consisting of 2 trenches and 1 caved adit.

HIGHLAND GROUP
CB000843

Three large open pits make up the workings of the Highland group located at a latitude 45˚ 02' 02" and longitude 109˚ 42' 34". James (1946) reported an inclined shaft driven in the main ore body from the bottom of one of these pits, but when visited it was collapsed. The chromite deposits as described by James (1946) are in steeply dipping serpentine 1,000 feet long and as wide as 250 feet surrounded by a country rock of granite, granite gneiss, and amphibolitic gneiss. No structures, ground-water discharge, or hazardous-waste material was observed at the site. The highwalls from the open pits are more than 60 feet high and may be a safety concern.

HILLTOP MINE
HA009033

No workings were found for this site. The center post of the claim was found and it read "Center Post, Hill Top, Lode # 4." Minobras (1977) states that 300 tons of ore was shipped at an average grade 0.33% U_3O_8 and 0.04% vanadium. This site was most likely reworked in the early 1960's as part of the Hanson Operation known as area H-2.

HILTON MINE
HA009057

Winchester and others (1916) state that the Hilton mine was a drift mine originally mining lignite for fuel, It was in operation for about 1 year driving a drift 120 feet into the hillside. This site was screened out because it is on private land and is probably not impacting land administered by the Custer National Forest.

HOOP AND HOLLER / KALINA OPERATION
HA009043

Three small strip mined areas, were found for the Hoop and Holler. The largest area was 60 to 80 feet wide by 200 feet long with a highwall of 10 to 15 feet. The disturbed areas are mostly revegetated. There are no structures, or water. Currently it is under CERCLA action for radioactive environmental hazards. Minobras (1977) listed this site as 1 of 8 mines that were the principal producers of the North Cave Hills area.

HUDSON MINE
PK006614

The Hudson was screened out because it is part of the New World Mining District Response and Restoration Project. The site appeared reclaimed as part of this project when the site was visited 8/25/99.

IRON MOUNTAIN CHROME GROUP
SW001754

This site was screened out because it contains only a number of scattered shallow pits and trenches high on the eastern flank of Iron Mountain, ranging in altitude from 9,300 feet to about 10,000 feet (Wimmler, 1948).

JEFFRY LYNN
HA008586

Minobras (1977) shows this site in sec. 24, T.21 N., R.4 E., of the Ladner SE 7.5-min. quadrangle. A single bulldozer prospect was found at this location. West of here, in section 23, bulldozer cuts were found on a narrow ridge just below the plateau rim. The workings are mostly revegetated. Radioactivity maybe an environmental hazard.

JOSEPHINE MINE
PK006606

Workings are shallow and badly caved, and haven't been worked for many years as described by Lovering (1929). He did state that some high grade silver ore was packed to the Republic smelter in 1886. This site was screened out because it was described as shallow workings and because the location is vague.

LAKE VIEW
PK008632

This is a private patented claim west of Little Goose Lake bordering the Copper Queen claim. Viewing the site from public land, only a few shallow prospects could be seen. This fits with Simons and others (1979) who reports one 29 foot long collapsed adit, and 4 trenches.

LAST CHANCE / KALINA OPERATION
HA009044

A strip mine at the base of North Cave Hills in section 20, T. 22 N., R. 5 E., The mine bench is revegetated in native grasses and sagebrush with a few trees growing on the bench. The former working face is predominately in a light gray sandstone, claystone and shale with highwalls approximately 60 feet high. There are no structures or water, but it is currently under CERCLA cleanup action for radioactive hazards at the site.

LITTLE NELL GROUP
CB000849

James (1946) states the only chrome deposits of the Little Nell group are in section 31 adjacent to Chrome Creek. There is no Chrome Creek in the area, but from his description and map (plate 58) what James was calling Chrome Creek now is called Plateau Creek. Two attempts were made to reach the workings. Once from climbing up from the valley bottom of Lake Fork Creek, but this proved to be quite difficult with many high cliffs. The second attempt was from hiking up onto Silver Run Plateau and walking down to the workings. This proved to be too long of a distance to reach in one day, with a vague location.

L&L #3 / KERMAC OPERATION

HA009047

The L&L #3 is a strip mine that spans both sides of a point along the rim of the North Cave Hills area. A drainage separates the workings of the L&L #3 from the Mink, Windy Jim, and Susan Becky. All were mined under Kermac Operation along with the L&L #3. The mine bench has revegetated itself and there is no water. The site is currently under a CERCLA action in the Riley Pass area.

LONESOME PETE NO. 2

HA008628

The Lonesome Pete is a uranium strip mine below the rim of South Cave Hills plateau. The mine bench and waste dump is completely revegetated. The bench area is approximately 150 feet wide by 500 feet long with a 40 to 60 foot high wall. The workings cut into a light gray sandy claystone with a shale lignite layer above. There are no structures at the site except for a small metal hopper and wooden ore chute. The site is dry, but may pose radioactive hazards at the site.

LORRAINE

PK008655

This prospect or short adit is located on a talus of granite but was driven into a gabbro (?) dike. Mineralization includes magnetite, chalcopyrite, and malachite. There are a few rotten timbers on the dump and the adit has a slight overhang but no safety hazards were noted. The start of the adit trends S. 38°E. (but the compass direction may be skewed because of the magnetite on the dump).

LULA MINE

PK006778

This is a private claim, and is part of the New World Mining District Response and Restoration project so it was screened out. Lovering (1929) reported 400 to 500 feet of development work had been done, but the workings had been allowed to cave.

MARGERY

HA009056

This site consist of one small bulldozer cut 60 feet long. The cut and waste pile have revegetated themselves. This was a site in a list of mines, prospects and occurrences by Minobras (1977).

MARION

HA009051

Three bulldozer cuts were found at the end of ridge lines in sections 33 and 4, T. 21 N., R. 5 E., McKenzie Butte 7.5-min. quadrangle. This was a site in a list of former mines, prospects and occurrences by Minobras (1977).

McLAREN GOLD CO.
PK002118

This site is part of the New World Mining District Response and Restoration project and was screened out. Reed (1950) listed the workings as an open cut.

MENDENHALL MINE
HA009025

This site was screened out because it is on private land. No workings could be seen when the general area was visited. Winchester and others (1916) describe the site as a small strip mine, and that the lignite beds are discontinuous.

MERCER GROUP
PK008645

This site was screened out because it is high on a dry ridge top overlooking Goose Lake. The workings are described by Simons and others (1979) as two adits, 67 feet and 14 feet long, and four pits.

MOUAT IRON TITANIUM GROUP
SW001718

This occurrence is on private land and does not impact land administered by the Custer National Forest. As a result, it was screened out.

MOUAT NICKEL-COPPER
SW008567

This site was screened out because it is private and part of the active Stillwater mining area. Workings makeup at least seven adits and over 8,000 feet of underground drifts (Page and others, 1985).

MUTT LAKE
PK008662

Mutt Lake was screened out because it is made up of only shallow surface workings. It was described by Simons and others (1979) as consisting of six pits and one 10 foot deep shaft.

NORTH STAR
CB000085

This site is on the eastern lip of Hellroaring Plateau and is marked on the topographic map with a quarry symbol. This open pit chromite mine, according to James (1946), was the largest known deposit in the district, and was nearly mined out in 1946. It produced some 35,000 tons of ore. The mine comprises several benches forming a large open pit on the plateau's rim. The only structure at the site is an ore chute just south of the pit made up of locally harvested timbers. No hazards were observed except for the highwall to the open pit that was estimated to be over 80 feet high.

NYE BASIN - ALICE
SW006344

The Alice is within the active Stillwater mining area so was screened out. Wimmler (1948) reported the only workings as one short adit on the Alice Claim. The U.S. Bureau of Mines dug 20 trenches at the site to sample for chromite in 1941.

NYE BASIN - LIP
SW006348

This site was screened out because it is part of the active Stillwater mining area and may be on private land. Wimmler (1948) states there are no underground workings at the claim and the U.S. Bureau of Mines did not conduct any trenching at the site.

NYE BASIN - BIG SEVEN FAULT
SW006340

This site was screened out because it is part of the active Stillwater mining area and may be on private land. Wimmler (1948) states there are no underground workings at the claim, but the U.S. Bureau of Mines conducted trenching and diamond drilling in 1941.

OBW
PK008657

The general area was visited but no workings were located. Simons and others (1979) list the OBW as one caved adit and one sloughed trench just south of the Copper Idol. A trench was found approximately 1,500 feet southeast of the Copper Idol, but was considered just one of many of the unnamed prospects in the Goose Lake area.

OLD GLORY MINE
CB000153

The Old Glory claim was the initial discovery of uranium deposits in the Pryor Mountains in

1955 (Minobras, 1977). Upon visiting the site, two open adits and three partly caved adits were found. All are in a light gray massive, partly siliceous and iron stained dolomite or a dolomite breccia,. No structures were found. Radioactivity maybe a hazard at the site.

OLESRUD BED
HA009024

Only one small approximately 40-foot long bulldozer prospect was found. The dig and waste pile are revegetated with native grasses and shrubs.

OLESRUD MINE
HA009026

No workings were found. Most likely, this site was a small strip mine that has since become revegetated blending with the natural surroundings. Minobras (1977) shows the mine being in tract DBDB, sec. 36, T.18 N., R.7 E. This is along the margin of Slim Buttes in the rolling grass hills.

PETERS OPERATION
HA009045

Marked by a mine symbol in section 29, T.22 N., R.5 E., Ladner SE 7.5 min. quadrangle, this site consists of two small strip mined areas below the rim of North Cave Hills plateau. The area has revegetated itself with native grasses and shrubs, making it barely discernable from the original surroundings. There are no structures or water at the site. The site is currently under a CERCLA cleanup action for radioactivity.

PICK MINE
CB000861

The Pick Mine is 3.2 miles from the Limberpine Campground south of Red Lodge on Forest Route 2004. The mine is an open cut into the hillside next to the road. According to James (1946), the chromite ore body that has been mined out was a single lens of ore approximately 80 feet long and 15 feet wide at its greatest width. Schafer (1937) stated that the Pick claim was originally developed by two adits. The lower adit was driven approximately 375 feet and an upper adit was around 120 feet. These adits were mined out or caved by the open cut. No hazards were observed at the site.

PSENDA ASBESTOS PROSPECT
CB000297

This site was screened out. There are no references in the MILS database and the location is inaccurate. The general area was visited but no workings were found.

QUAD 2

HA009031

This site was screened out because it is on a dry ridge top. The only reference is Minobras' (1977) list of mines, prospects, and occurrences.

RELF MINE / KERMAC OPERATION

HA009040

The top of a small butte capped by a 2- to 3-foot thick shale-lignite layer was strip mined. The top of the butte, less than an acre, was mined to the top of a tan sandstone bed. There are no structures or water at the site. The site is currently under a CERCLA cleanup action for radioactivity.

RILEY

HA009041

The area of the Riley was visited but no workings were found. Minobras (1977) includes the Riley in his list of former mines, prospects and occurrences.

ROCK SPRING / HANSON OPERATION H-2

HA009032

One bulldozer prospect and a flat vegetated bench, that may have been a former mine bench, was all that was seen at this site. This site is in the same area as the Hanson Operation, area H-2 and may have been consumed by these workings.

ROSEBUD

CB000201

One collapsed adit was found about 3,500 feet above Pine Grove Campground. No structures, adit discharge, metal leaching, or other environmental hazards were found.

ROSEBUD ASBESTOS CLAIM

CB000303

This site was screened out. There are no references in the MILS database and the location is inaccurate. The general area was visited but no workings were found.

ROYSE CLAIM

CB000387

The general area of the Royse claim was visited, but the site was not located. Minobras (1977) gives a location of sec. 34, T. 8 S., R. 20 E., and describes the site as an uranium occurrence of tyuyamunite in quartzite. No other references were found. There are two other unnamed prospects south of this occurrence marked on the Tolman Flat 7.5-min. quandrangle in sec. 3, T. 9 S., R. 20 E. The first prospect was located comprised of a shallow collapsed adit bearing N. 87˚ W. driven into a sandstone outcrop. The lower prospect to the south was not found.

RUTH LODE
HA009035

The general area of the Ruth Lode was visited, but no workings were found. This was a site in the list of mines, prospects and occurrences by Minobras (1977).

RUTH MARIE
HA008573

The Ruth Marie was screened out. The site is on private property and consisted of several bulldozer cuts into the hillside. The area is revegetated and does not impact land administered by the Custer National Forest.

SANDRA MINE
CB000165

This site has one collapsed adit, but a hole has daylighted above the cave portal. There is an associated waste-rock dump and timbered framed ore chute. The dump is composed of light gray limestone, and siliceous, iron stained, brown to purple dolomite breccia. Several hundred feet east of this adit are workings that have mined out the cliff face for eight to ten feet. An earthy yellow uranium mineral can be seen filling the fractures and vugs, and in the waste-rock dump. The site was dry. Radioactivity maybe a hazard at the site.

SHOVEL
CB000867

An adit is caved at the opening but partially open at the surface behind the cave-in for at least 20 feet. The adit is uphill from the Pick mine on the east slope of the Hellroaring Plateau. A side road leads to the chromite workings a half-mile above the Pick mine off of Forest Route 2004. As described by James (1946), the adit was driven about 75 feet before the ore was lost. The waste dump is predominantly amphibolite.

SKYLINE MINE
PK008649

The Skyline was screened out because it is part of the New World Mining District Response and Restoration Project. Visiting the area 8/25/99, the site looked reclaimed as part of this project.

SNAKE EYE
HA009037

The general area of the Snake Eye was visited but no workings were found. This was a site in the list of mines, prospects and occurrences by Minobras (1977).

SQUARE TOP BUTTE
HA009023

No workings or hazards were found for this site. This site may have been staked and claimed but never worked, or revegetation may have hidden any past signs of mining.

STILLWATER COMPLEX CHROMITE DEPOSIT
SW001496

This site is private and has been screened out. It is part of the Stillwater mine and the active Stillwater mining area.

STILLWATER RIVER
PK002316

This site was screened out because it is a placer deposit. Placer mining is not extensive in the New World mining district. Some evidence of placer mining was noted by Lyden (1948), but he also stated the deposits of gold-bearing gravels were neither rich nor abundant.

TANDY'S COAL MINE
SW001484

This site was screened out. It is a coal mine on private property not impacting land administered by the Custer National Forest.

TAYLOR-FRY-TUTTLE CLAIMS
SG001796

This group of claims, as explained by Wimmler (1948), is on the west side of West Fork of the Stillwater River and extends up the west side of the canyon following the main chromite band for about four miles to an altitude of about 9,500 feet. There are no underground workings but only a few pits and trenching dug in 1942 by the U.S. Bureau of Mines. The site was screened out and not visited.

THOM PROPERTY
CB000399

This site was screened out because its location is uncertain, +/-1 km in the MILS database, and there are no references listed.

TRAVERS RANCH

HA008544

This site consist of seven prospects, bulldozer cuts in surrounding hillsides of a small valley where Sawmill Canyon and Devils Canyon merge. The digs are mostly revegetated by natural grasses and shrubs of the area, and is part of the CERCLA action in the North Cave Hills area.

TREE STUMP

HA009048

The general area of the Tree Stump was visited, but no workings were found. This was a site in the list of former mines, prospects and occurrences by Minobras (1977).

TRIO Lode 4

HA009028

This site was screened out because it is on top of a dry ridge top. There are no other references other than Minobras' (1977) list of mines, prospects and occurrences.

UNNAMED

PK008629

This site was screened out because it is high on a ridge, is most likely dry, and was described by Simons and others (1979) as a single prospect pit.

UNNAMED COAL MINE

SW001622

This site was screened out. It is a coal mine on private property not impacting land administered by the Custer National Forest.

UNNAMED COPPER MINE

SG001604

This site was screened out. It only has an accuracy of +/-1 km in the MILS database with no references listed.

UNNAMED URANIUM

CB000039

This site was screened out because it is on state land, and has an accuracy of +/-1 km in the MILS database with no references listed.

UNNAMED URANIUM
CB000069

This site was screened out because the location is uncertain, a +/-1 km in the MILS database, and no references were listed.

UNNAMED URANIUM
CB000075

This site was screened out because the location is uncertain having a +/-1 km accuracy in the MILS database, and no references were listed.

UNNAMED URANIUM
CB000381

This site was screened out. There are no references to the site in the MILS database, and the location is inaccurate.

UNNAMED URANIUM
CB000441

This occurrence was screened out because it had no references in the MILS database, and had an inaccurate location.

UNNAMED VANADIUM
CB000417

This site was screened out. There are no references to the site in the MILS database, and the location is inaccurate.

UNUS
PK008652

The Unus is just east of the Copper King shaft, but was screened out. It consists of only shallow workings, 3 pits, 1 trench and 1 caved adit (Simons and others, 1979).

U.S. TREASURY
PK002256

This site was screened out because it is a private patented claim located near Goose Creek Canyon, about a mile north of Lulu Pass. Small quantities of ore packed out in the 1880's averaged over 300 ounces per ton silver (Lovering, 1929).

VIJAK QUARTZ LODE
CB000315

This site was screened out because its location is uncertain having an accuracy of +/-1 km in the MILS database, and there are no references listed.

WALLY JR.
PK008648

This site was screened out because the location is vague. The only reference found is Simons and others (1979) listing the Wally Jr. as a single adit 80 feet long.

WEAVER PROPERTY
CB000406

Two adits and several surface trenches were found on what is believed to be the Weaver property, a uranium dig along Willow Creek upstream of the Palisade Campground. The adit farthest upstream, approximately 0.5 miles from the campground, was collapsed. The lower adit, next to the creek, was open and did not have a waste dump. The lower workings are in a granite altered to clay varying between a brownish-red and gray clay in two to six inch bands. A well-used trail leads from the campground to the lower workings. No other environmental hazards were found.

WEST OF COMO
PK009019

Prospects shown west of where the Lulu Pass road splits were examined on 08/25/99. The workings consisted of small prospects and a trench that parallels the drainage. No problems were noted although the drainage did have a small (less than 1 gpm) flow and some waste was in contact with the drainage. The area is defined as "west of Como" trench on the New World Mining District Response and Restoration Project map.

WINDY JIM / KERMAC OPERATION
HA009046

The Windy Jim is part of a large uranium strip mined area along the rim of the North Cave Hills area made up of the Windy Jim, Susan Becky, Mink, and L & L # 3. All were mined under Kermac Operation beginning in the late 50's, early 1960's, and is currently under a CERCLA cleanup order. There are no structures or water at the Windy Jim, but runoff from rainfall drained across the mine bench towards the Mink into two small ponds. One of the ponds was sampled for potential environmental hazards and the results are listed under the Mink of this report.

YEB

HA009038

This is a single revegetated bulldozer prospect. No other workings were found.

Appendix IV
Soil and Water

Analytical Results
Custer National Forest

Analytical results and exceedences of soil samples

Units: (mg/kg dry weight)

Site	Sample	Lab. ID	Ag	As	Ba	Cd	Cr	Cu	Ni	Pb	Zn	Hg
Benbow Mill	LBED10H	2000S012	<1.0	<1.0	6.21	<2.1	809	15.7	1070	<2.1	25.4	<1.0
Mink / Kermac Operation	PCMKW10H	2001S0015	<2.1	48.9	137	<4.1	7.6	17	12.7	13.3	30.1	NR
Pickpocket / Munkers Operation	PCPPW10H	2001S0014	<2.0	56.5	42.6	<4.1	4.36	9.89	15.6	14.1	37.1	NR
Susan Becky / Kermac Operation	SDSBW10H	2001S0013	<2.0	20.0	67.9	0.41	<4.1	9.95	6.69	7.28	18.1	NR

Note: NR = Not reported

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LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-001
Client Sample ID: 2002S0032, Old Glory Mine Upper ~~Adit~~ Waste (D06W20)

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	11	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	1.3	±				E901.1	08/12/02 13:38 / db
Cesium 137	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Cesium 137 precision	0.060	±				E901.1	08/12/02 13:38 / db
Gross Alpha	32	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.40	±				E900.0	08/19/02 16:39 / rs
Gross Beta	85	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.49	±				E900.0	08/19/02 16:39 / rs
Gross gamma	83	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	15	±				E901.1	08/12/02 13:38 / db
Lead 210	15	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 210 precision	2.6	±				E901.1	08/12/02 13:38 / db
Lead 212	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 212 precision	0.10	±				E901.1	08/12/02 13:38 / db
Lead 214	12	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	1.4	±				E901.1	08/12/02 13:38 / db
Potassium 40	8.3	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Potassium 40 precision	1.3	±				E901.1	08/12/02 13:38 / db
Radium 226	19.1	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.5	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.5	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc
Thorium 228	12	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Thorium 228 precision	3.3	±				E901.1	08/12/02 13:38 / db
Thorium 234	16	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Thorium 234 precision	2.2	±				E901.1	08/12/02 13:38 / db
Uranium 238	8.9	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Uranium 238 precision	2.6	±				E901.1	08/12/02 13:38 / db

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-002
Client Sample ID: 2002S0033, Old Glory Mine Upper Adit (DOGA20)

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	30	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	0.74	±				E901.1	08/12/02 13:38 / db
Gross Alpha	83	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.63	±				E900.0	08/19/02 16:39 / rs
Gross Beta	250	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.80	±				E900.0	08/19/02 16:39 / rs
Gross gamma	260	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	12	±				E901.1	08/12/02 13:38 / db
Lead 210	27	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 210 precision	2.1	±				E901.1	08/12/02 13:38 / db
Lead 214	28	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	0.66	±				E901.1	08/12/02 13:38 / db
Radium 226	39.8	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.8	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.8	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc
Thorium 228	75	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Thorium 228 precision	4.1	±				E901.1	08/12/02 13:38 / db
Thorium 234	59	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Thorium 234 precision	2.1	±				E901.1	08/12/02 13:38 / db
Uranium 238	45	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Uranium 238 precision	2.3	±				E901.1	08/12/02 13:38 / db

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LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-006
Client Sample ID: 2002S0044, Old Glory Prospect GP2A10)

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	0.10	±				E901.1	08/12/02 13:38 / db
Gross Alpha	4.0	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.16	±				E900.0	08/19/02 16:39 / rs
Gross Beta	21	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.27	±				E900.0	08/19/02 16:39 / rs
Gross gamma	8.7	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	0.91	±				E901.1	08/12/02 13:38 / db
Lead 210	2.2	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 210 precision	0.39	±				E901.1	08/12/02 13:38 / db
Lead 212	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 212 precision	0.020	±				E901.1	08/12/02 13:38 / db
Lead 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	0.090	±				E901.1	08/12/02 13:38 / db
Potassium 40	3.2	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Potassium 40 precision	0.31	±				E901.1	08/12/02 13:38 / db
Radium 226	2.0	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.2	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.8	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc

Report Definitions:
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MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-004
Client Sample ID: 2002S0035, Old Glory Mine Lower Adit (DOGW10)

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	0.070	±				E901.1	08/12/02 13:38 / db
Gross Alpha	2.5	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.14	±				E900.0	08/19/02 16:39 / rs
Gross Beta	12	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.23	±				E900.0	08/19/02 16:39 / rs
Gross gamma	2.7	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	0.014	±				E901.1	08/12/02 13:38 / db
Lead 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	0.070	±				E901.1	08/12/02 13:38 / db
Radium 226	0.8	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.1	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.5	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc

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QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-005
Client Sample ID: 2002S0036, Old Glory Mine Lower Adit (DOGA10)

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	0.090	±				E901.1	08/12/02 13:38 / db
Gross Alpha	2.6	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.14	±				E900.0	08/19/02 16:39 / rs
Gross Beta	20	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.27	±				E900.0	08/19/02 16:39 / rs
Gross gamma	2.1	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	0.19	±				E901.1	08/12/02 13:38 / db
Lead 212	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 212 precision	0.030	±				E901.1	08/12/02 13:38 / db
Lead 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	0.070	±				E901.1	08/12/02 13:38 / db
Radium 226	1.3	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.2	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.4	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc

Report Definitions:
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QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-003
Client Sample ID: 2002S0034, Old Glory Mine Lower Adit (DOGB10)

Background.

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	0.14	±				E901.1	08/12/02 13:38 / db
Cesium 137	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Cesium 137 precision	0.090	±				E901.1	08/12/02 13:38 / db
Gross Alpha	2.8	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.15	±				E900.0	08/19/02 16:39 / rs
Gross Beta	27	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.30	±				E900.0	08/19/02 16:39 / rs
Gross gamma	13	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	1.1	±				E901.1	08/12/02 13:38 / db
Lead 212	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 212 precision	0.040	±				E901.1	08/12/02 13:38 / db
Lead 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	0.070	±				E901.1	08/12/02 13:38 / db
Potassium 40	9.8	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Potassium 40 precision	0.75	±				E901.1	08/12/02 13:38 / db
Radium 226	0.8	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.1	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.4	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit

LABORATORY ANALYTICAL REPORT

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory
Lab ID: B02080465-007
Client Sample ID: 2002S0045, Old Glory Prospect P2B10

Report Date: 09/04/02
Collection Date: 08/06/02
Date Received: 08/08/02
Matrix: SOIL

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES (CONTRACT LAB WY00002)							
Bismuth 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Bismuth 214 precision	0.10	±				E901.1	08/12/02 13:38 / db
Cesium 137	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Cesium 137 precision	0.040	±				E901.1	08/12/02 13:38 / db
Gross Alpha	2.8	pCi/g		1.0		E900.0	08/19/02 16:39 / rs
Gross Alpha Precision	0.15	±				E900.0	08/19/02 16:39 / rs
Gross Beta	22	pCi/g		2.0		E900.0	08/19/02 16:39 / rs
Gross Beta Precision	0.28	±				E900.0	08/19/02 16:39 / rs
Gross gamma	12	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Gross Gamma precision	1.3	±				E901.1	08/12/02 13:38 / db
Lead 210	2.9	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 210 precision	0.53	±				E901.1	08/12/02 13:38 / db
Lead 212	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 212 precision	0.030	±				E901.1	08/12/02 13:38 / db
Lead 214	ND	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Lead 214 precision	0.080	±				E901.1	08/12/02 13:38 / db
Potassium 40	7.2	pCi/g		2.0		E901.1	08/12/02 13:38 / db
Potassium 40 precision	0.56	pCi/g				E901.1	08/12/02 13:38 / db
Radium 226	1.1	pCi/g-dry		0.1		E903.0	08/21/02 10:28 / sc
Radium 226 precision	0.1	±				E903.0	08/21/02 10:28 / sc
Radium 228	0.4	pCi/g-dry		0.1		E904.0	08/26/02 12:45 / sc
Radium 228 precision	0.2	±				E904.0	08/26/02 12:45 / sc

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: MT Bureau of Mines & Geology-Butte
Project: Old Glory

Report Date: 08/28/02
Work Order: B02080465

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E900.0									Batch: C_R12740
Sample ID: B02080465-001A	Sample Duplicate								08/19/02 16:39
Gross Alpha	34	pCi/g	1.0		70	130			
Gross Beta	84	pCi/g	2.0		70	130			
Sample ID: B02080465-007A	Sample Duplicate								08/19/02 16:39
Gross Alpha	3.5	pCi/g	1.0		70	130			
Gross Beta	17	pCi/g	2.0		70	130			
Sample ID: MB-R12740	Method Blank								08/19/02 16:39
Gross Alpha	ND	pCi/g							
Gross Beta	ND	pCi/g	2.0						
Sample ID: LCS-R12740	Laboratory Control Spike								08/19/02 16:39
Gross Alpha	68	pCi/g	1.0	136	70	130			S
Gross Beta	230	pCi/g	2.0	91.6	70	130			
Method: E901.1									Batch: C_R12590
Sample ID: B02080465-001A	Sample Duplicate								08/12/02 13:38
Gross gamma	81	pCi/g	2.0						
Sample ID: MB-R12590	Method Blank								08/12/02 13:38
Gross gamma	ND	pCi/g	2.0						
Sample ID: LCS-R12590	Laboratory Control Spike								08/12/02 13:38
Gross gamma	770000	pCi/g	2.0	98	70	130			
Method: E903.0									Batch: C_02RA-259
Sample ID: B02080465-007A	Sample Duplicate								08/21/02 10:28
Radium 226	0.990	pCi/g-dry							
Sample ID: B02080465-004A	Sample Duplicate								08/21/02 10:29
Radium 226	0.980	pCi/g-dry	0.100						
Sample ID: 226	Laboratory Control Spike								08/21/02 10:29
Radium 226	130	pCi/L	0.200	107	70	130			
Method: E904.0									Batch: C_02228324
Sample ID: 228	Laboratory Control Spike								08/26/02 12:45
Radium 228	7.70	pCi/L	1.00	93.9	70	130			
Sample ID: B02080465-006A	Sample Matrix Spike								08/26/02 12:45
Radium 228	40.2	pCi/L	0.100	121	70	130			

Qualifiers: ND - Not Detected at the Reporting Limit
S - Spike Recovery outside of recommended recovery limits
R - RPD outside of recommended recovery limits

Appendix IV. Water-quality chemistry.

Bottle Number		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	field_sc umhos/cm	lab_sc	lab_ph	redox	Disch. gpm
Benbow Mill - sample date 10/26/99																									
LBES20M	upstream	<30	<1	27	<2	2.5	<2	<.01	<2	<.002	<1	<2	<1	5.6	0.4	<.05	<.05	10.9	14	7.82	168	176	7.68		40
LBES10H	downstream	<30	<1	34	<2	2.1	<2	0.03	<2	<.002	<1	2.49	<1	<2	0.5	0.1	<.05	10.9	15	7.98	240	239	7.96		35
Copper King - sample date 07/24/99																									
GHES10L	upstream	<30	<1	17	<2	<2	<2	<.01	<2	0.004	-	<2	<1	3.56	0.3	<.05	<.05	8.86	4.5	8.29	30	31	6.48	187	45
GHES20L	downstream	<30	<1	8.2	<2	<2	<2	<.01	<2	<.002	-	<2	<1	<2	0.2	<.05	<.05	8.64	4.6	7.06	11.9	31	6.36	191	45
Copper Sentinel - sample date 07/24/99																									
GCSS10L	adit discharge	<30	<1	32	<2	<2	<2	<.01	<2	<.002	-	<2	<1	6.82	0.3	0.1	<.05	9.35	7.4	7.23	39	43	6.16	182	2
Mink / Kermac Operation - sample date 06/26/00																									
PCMKS10H	pond	633	637	137	<20	<20	42	2.45	28	0.022	<1	25.7	<10	30.3	<5.0	0.5	<.5	221	12	8.35	1174	962	7.58		0
Pickpocket No. 1 / Munkers Operation - sample date 06/26/00																									
PCPPS10H	pond	<300	220	291	<20	<20	34	2.15	31	<.01	<1	49	<10	37.8	<5.0	0.6	1.5	144	95	8.59	938	769	7.91		0
Susan Becky / Kermac Operation - sample date 06/26/00																									
SDSBS10H	pond	<300	313	336	<20	135	69	0.17	38	<.01	<1	71.1	<10	178	<5.0	0.6	<.5	72.5	10	8.7	1345	1130	7.71		0

[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