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TECHNICAL MEMORANDUM

TO: Bob Kirkpatrick – Northern Region
Mary Beth Marks – On-Scene Coordinator

cc: M. Cormier

FROM: Allan Kirk

DATE: February 15, 2002

RE: Underground Mine Assessment
Delivery Order No. 7, Task 4
New World Mining District Response and Restoration Project

Introduction

Maxim Technologies, Inc. (Maxim) was tasked by the USDA Forest Service with verifying the extent and location of underground mine workings and exploration borings on District Property, and evaluating the need and feasibility of accessing adits and shafts that were significant contributors to water quality degradation. The extent of underground workings was verified by reviewing available literature, geophysical information, and mine maps. The potential impacts of underground workings were further evaluated by reviewing available mine waste data, compiling historic water quality data, and collecting water quality and flow data from adit discharges. To the extent possible, underground mine information was field-verified, and the data compiled into this technical memorandum.

A number of underground workings were developed in the New World Mining District between its discovery in the late 1880's and 1954, the end of historic mining operations. The location of the 16 principal underground workings within the New World Distinct is shown on Figure 1. This document summarizes mining history, geologic nature of the deposits, and available baseline information concerning these 16 underground mines and presents data on adit discharge and mine waste chemistry. Response options available for closure of the underground mines and contributions to loading from associated wastes and discharges will be further evaluated in future Engineering Evaluation/Cost Analyses (EE/CAs) using the information presented in the technical memorandum. The reader should note that there are other major underground workings in the Republic (lead-zinc-silver) District, south of Cooke City and a few short underground adits on Miller Mountain (west of Miller Creek) that are not discussed in this report, as these properties lie on non-District Property, as well as numerous prospect pits and short caved adits that are common throughout the District but rank relatively low in terms of water quality degradation.

The 16 principle underground workings discussed in this report are organized by the geographic area in which they occur. One or more set of workings may be identified from the same geographic area, often because these workings were developed while exploring for the same mineral deposit, by the same company, or both. Where available, maps of the underground workings are presented. The Abandoned

newworld\undergnd\allen\dumpsite.dwg

FCSI-96-7
Upper and Middle
Spaulding Dump

FCSI-99-1
Sheep Mtn
Dump One

Scotch Bonnet Mtn.

FCSI-96-8
Lower
Spaulding Dump

Como Basin
Deposit

FCSI-96-15-2
Upper Trendennic
Dump Two

FCSI-96-15-1
Upper Trendennic
Dump One

Lula/Contact
Dump

Stillwater

Daisy

Creek

Fisher Mtn.

FCSI-96-2A
Glengarry Dump

FCSI-96-6
Middle Trendennic
Dump One

FCSI-96-5
Lower Trendennic
Dump One

DCSI-96-1
McLaren
Multicolor Dump

River

FCSI-96-1A
Gold Dust
Mine and Dump

McLaren Open
Pit Mine

Fisher

FCSI-96-17
Homestake
Adit and Dump

Crown Butte Mtn.

Henderson Mtn.

FCSI-96-16
Homestake Pit

Creek

MCSI-96-6
Little Daisy
Adit and Dump

Custer National Forest
Gallatin National Forest

MCSI-96-2
Black Warrior
Miller Creek
Headwaters Dump One

Miller

Creek

SBSI-99-85
Alice E Mill Site

District Boundary
Fig 1
U.S. 212
Cooke City

N

0 Feet 2000
Scale 1:24,000

MAXIM 9902245.128

Source: Mine waste source areas from Gallatin National Forest
Interagency Spatial Analysis Center (October 27, 1999)
Topographic data from USGS 7.5 Cooke City Quad
Contour Interval = 40'

Mine Disturbance Area
District Boundary
Forest Boundary

Site Map
New World Mining District
Response and Restoration Project
Cooke City Area, Montana
FIGURE 1

and Inactive Mines Scoring System (AIMSS) ranking of the mines is shown on Table 1. Geochemical data on mine wastes associated with the underground workings is presented in Table 2. Water quality and flow data are presented in Table 3 for the 11 historic mine adits that discharge water, along with relevant water quality standards.

Also discussed in this memorandum is a summary of the number and density of drill holes used to evaluate several known mineral deposits where the 16 mines are located. A tally of drill holes drilled in outlying exploration area is also presented. The number of holes remaining open and the closure methods for other holes is discussed. Finally, the need for and feasibility of accessing underground workings to address impacts are evaluated.

Daisy, Homestake and Gold Dust Mines on Central Henderson Mountain

Western Smelting and Power (and its predecessors) operated the Daisy, Homestake and Gold Dust mines (Figure 1) from the late 1880's to the early 1920's. The three mines were driven in Henderson Mountain to explore, develop and mine copper-gold-silver mineralization in the vicinity of what was later to be identified as the Homestake Breccia Pipe (Figure 1). Western Smelting and Power developed these mining areas and established mine related facilities at other select sites along Fisher Creek as part of an overall mining property package. This package consisted of a flume and 250-megawatt hydroelectric generating plant located on lower Fisher Creek; and a copper/gold smelter (White Smelter) on the patented Chicago mill-sites near the junction of the Fisher Creek Road with Fisher Creek. The smelter was connected to the Gold Dust Adit portal area and the Homestake Mine and open pit near the summit of Henderson Mountain by a 2,500-foot long aerial tram designed to move ore from the mines to the smelter. With the possible exception of the open pit mining on Henderson Mountain near the Homestake Mine, none of the mines ever produced any significant amounts of ore. There is some speculation that this entire mining venture was a scam to bilk investor out of money, as legitimate mining companies rarely built power plants, smelters and aerial trams prior to having identified mineable reserves. These operators may have been well intentioned and must have been confident of discovering ore as most mining scams disappear before spending any investor money on actual mine-related facilities.

Subsequent drilling by Crown Butte Mines in the early 1990's (1990-1993) identified ore grade mineralization in the Homestake Breccia Pipe (a phreatic explosion vent to the surface) that indicated the developers of Western Smelting and Power were indeed exploring in the right area. The Daisy Adit penetrates Henderson Mountain about 60 feet above the elevation of ore of the Homestake Breccia Pipe and the Gold Dust Adit heading stops about 250 feet short of ore within the pipe on the same elevation as the adit drift.

Daisy Mine: The Daisy Mine is located on the northwestern slope of Henderson Mountain southeast of Daisy Pass at an elevation of about 9,840 feet (Figure 1). Western Smelting and Power operated the mine from 1888-1890. The ruins of a stamp mill (only the foundation remains, the stamp mill was moved to Cooke City), boarding house, stable, and two cabins are located at the mine site just below the portal between the adit and the Daisy Pass road. The Daisy Mine has approximately 2,385 feet of workings (Lovering, 1929) with portals on both the southwest and northeast flanks of Henderson Mountain (Figure 2). The longer of the two adits is collared just above the old stamp mill site. Its trend is ENE and the workings are approximately 1,400 feet in length, with only about 1,200 feet of which were accessible in the early 1920's (Lovering, 1929). This adit is connected by a raise (approximately 200 feet in height) that connects with a shorter adit that collars on the northeast flank of Henderson Mountain (elevation 9,960 feet). This adit was driven to the west-southwest, parallel to and slightly northwest of the main Daisy adit and is about 500 feet in length. The top of the raise is about 400 feet in from the portal of this

Table 1
Abandoned and Inactive Mines Scoring System (AIMSS)
Rating Scores for Waste Rock Dumps Associated with Underground Mines

New World Mining District – Response and Restoration Project

Site No.	Site Name	Other Name	Ownership	Material Type	Volume (cu yards)	Total Score	Rank
MCSI-96-2	Miller Creek Headwaters Dump One	Black Warrior	public	waste rock	800	9.9308	2
SBSI-99-85	Alice E Mill Site	Lower Alice E.	public	tailings	3360	1.0794	12
FCSI-96-2A	Glengarry Dump	Lower Glengarry	public	waste rock	13000	0.7592	15
DCSI-96-1	McLaren Multicolor Dump	McLaren Mine	public	waste rock	3100	0.5707	17
MCSI-96-6	Little Daisy Adit and Dump	Little Daisy	public	waste rock	900	0.3114	20
FCSI-99-1	Sheep Mountain Dump One		public	waste rock	185	0.3086	21
FCSI-96-8	Lower Spaulding Dump		public	waste rock	2630	0.2314	23
FCSI-96-1A	Gold Dust Mine and Dump	Gold Dust	public	waste rock	5700	0.2095	24
FCSI-96-5	Lower Trendennic Dump One		public	waste rock	3430	0.1385	26
FCSI-96-7	Upper and Middle Spaulding Dump	Upper Glengarry Mine	public	waste rock	740	0.0895	33
FCSI-96-15-2	Upper Trendennic Dump Two	Commonwealth #1	public	waste rock	310	0.0759	36
FCSI-96-6	Middle Trendennic Dump One	Manhattan	public	waste rock	820	0.0422	45
FCSI-96-15-1	Upper Trendennic Dump One	Commonwealth #1	public	waste rock	100	0.0091	70
FCSI-96-17	Homestake Adit and Dump	Homestake #2	public	waste rock	424	0.0085	73
FCSI-96-16	Homestake Pit		public	waste rock	100	0.0046	78
FCSI-96-15-5	Upper Trendennic Dump Five	Commonwealth #2	public	waste rock	10	0.0045	79

Table 2
Geochemical Data on Waste Rock Dumps Associated with Underground Mines

New World Mining District – Response and Restoration Project

Site No.	Site Name	Material Type	Volume (cu yards)	AIMSS Total Score	AIMSS Rank	pH (su)	EC (mmhos/cm)	Ag (mg/Kg)	As (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Hg (mg/Kg)	Pb (mg/Kg)	Zn (mg/Kg)	NP (t/1000t)	Total S (%)	Lime Req (t/1000t) lab
MCSI-96-2	Miller Creek Headwaters Dump One	waste rock	800	9.93	2	5.8	3.14	100	460	69	<6	1990	0.85	43100	8950	73	3.75	118
SBSI-99-85-01	Alice E Mill Site	tailings	3360	1.08		4.5	0.42	64	55	16	<5	187	3.7	398	206	3	0.58	37
FCSI-96-2A	Glengarry Dump	waste rock	13000	0.76	15	3.2	3.31	<20	18	2	<5	280	0.59	65	39	<3	0.75	39
DCSI-96-1A	McLaren Multicolor Dump	waste rock	3100	0.57	17	2.4	9.46	<20	3	15	<5	808	0.68	73	7	<3	4.45	189
MCSI-96-6	Little Daisy Adit and Dump	waste rock	900	0.31	20	5.7	3.07	<20	55.7	20.4	<5	217	1	262	210	17	1.65	54
FCSI-99-1-01	Sheep Mountain Dump One	waste rock	185	0.31	21	2.8	1.27	119	167	21	<5	869	1.47	11000	1020	<1	1.72	80
FCSI-96-8	Lower Spaulding Dump	waste rock	2630	0.23	23	2.1	12.97	<20	240	34	<6	17600	<0.5	110	49	<3	7.17	293
FCSI-96-1A	Gold Dust Mine and Dump	waste rock	5700	0.21	24				34.9	<0.5	20.4	98.4	0.256	51.2	83.3	61.6	4.67	
FCSI-96-5	Lower Trendennic Dump One	waste rock	3430	0.14	26	5.6	4.06	<20	90	11	14	303	0.75	44	98	34	1.78	63
FCSI-96-7	Upper and Middle Spaulding Dump	waste rock	740	0.09	33	2.2	15.85	<20	310	75	<6	2120	<0.5	130	28	<3	23.99	1080
FCSI-96-15-2	Upper Trendennic Dump Two	waste rock	310	0.08	36													
FCSI-96-6	Middle Trendennic Dump One	waste rock	820	0.04	45	2.4	2.99	<20	70	11	<5	163	0.55	238	44	<3	0.95	30
FCSI-96-15-1	Upper Trendennic Dump One	waste rock	100	0.01	70	3.6	3.01	<20	90	28	<5	628	0.35	525	96	10	4.25	176
FCSI-96-17	Homestake Adit and Dump	waste rock	424	0.01	73	7	0.7	<20	50	11	<5	642	<0.5	54	58	17	0.31	12
FCSI-96-16	Homestake Pit	waste rock	100	0.00	78	6	2.7	<20	140	27	<5	2420	<0.5	218	233	38	1.1	43
FCSI-96-15-5	Upper Trendennic Dump Five	waste rock	10	0.00	79													

NOTES:

mmhos/cm	= millimhos/centimeter	NP	= neutralization potential
su	= standard units	S%	= percent sulfur
mg/kg	= milligrams per kilogram	t/1000t	= tons per 1000 tons
cu	= cubic yards	AIMSS	= Abandoned and Inactive Mines Scoring System

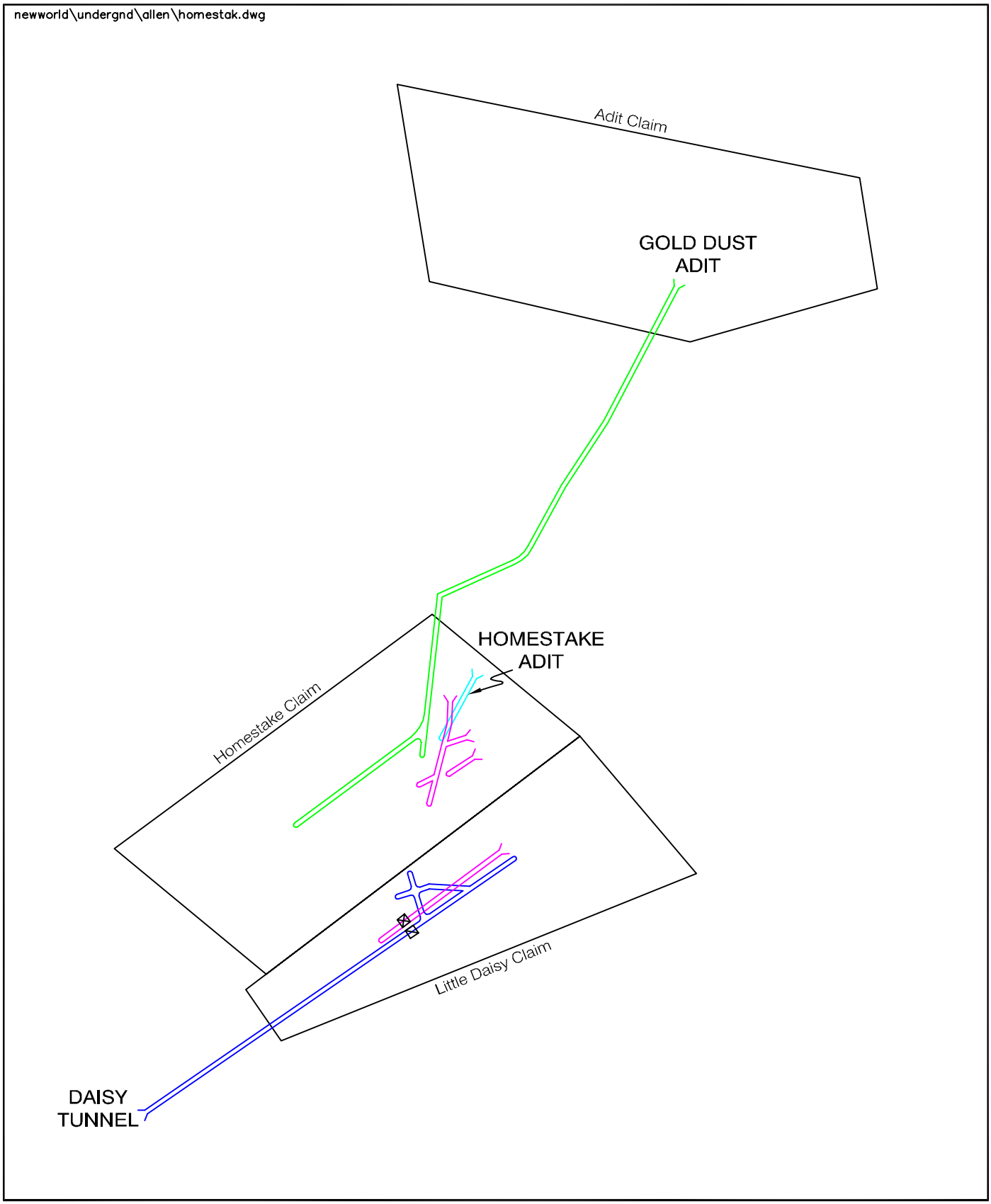
Table 3
Water Quality and Flow Data for Seepage from Underground Mines

Old Designation						F-2		M-1	M-8	AEC-1	F28		
Sample ID	**FCSI-96-5**	**FCSI-96-6**	**FCSI-96-15**	**F-8A**	**FCSI-99-1**	**FCSI-96-8**	**D-18**	**MCSI-96-6**	**MCSI-96-2**	**SBSI-99-85**	**FCSI-96-1A**		
Location	Low. Tredennick	Mid. Tredennick	Up. Tredennick	Glengarry*	Sheep Mnt#1	L Spalding	McLaren	Little Daisy	Black Warrior	Alice E Mill	Gold Dust	Standard	
METALS (mg/l)													
Al dissolved	<0.1	<0.1	***0.2***	**8.8**	<0.1	**3.2**	<0.1	<0.1	<0.1	<0.1	<0.1	0.087 Chronic	
Al total rec	<0.1	***0.2***	***0.3***	**9.5**	***0.4***	**3.3**	***0.2***	***0.1***	<0.1	**0.8**	<0.1	0.087 Chronic	
As dissolved	<0.003	<0.003	***<0.005***		<0.003	**0.004**	<0.003	<0.003	<0.003	<0.003	<0.003	0.018 HH SW	
As total rec	<0.003	***<0.003***	***<0.005***	**0.005**	***<0.003***	**0.007**	***<0.003***	***<0.003***	<0.003	**<0.003**	<0.003	0.018 HH SW	
Cd dissolved	<0.0001	0.0002	***0.0002***	**0.0016**	<0.0001	**0.0016**	0.0017	<0.0001	0.0011	<0.0001	<0.0001	0.0025 Chronic	H=100
Cd total rec	0.0002	***0.0001***	***0.0004***	**0.0016**	***0.0002***	**0.0013**	***0.0017***	***<0.0001***	0.002	**<0.0001**	<0.0001	0.0025 Chronic	H=100
Cu dissolved	0.001	0.082	***0.042***	**2.719**	0.002	**13.2**	0.017	0.002	0.004	0.009	0.002	0.0093 Chronic	H=100
Cu total rec	0.004	***0.082***	***0.051***	**3.357**	***0.035***	**13**	***0.028***	***0.013***	0.015	**0.013**	0.004	0.0093 Chronic	H=100
Fe dissolved	0.02	0.04	***0.1***	**47.7**	0.02	**160**	20.8	<0.01	0.07	0.08	0.11	0.3 HH SW	
Fe total rec	0.12	***0.97***	***0.22***	**531**	***1.01***	**165**	***20.8***	***1.05***	0.55	**1.59**	0.35	0.3 HH SW	
Pb dissolved	<0.001	0.001	***0.03***	**0.021**	<0.001	**0.01**	<0.001	0.001	0.008	<0.001	<0.001	0.0032 Chronic	H=100
Pb total rec	0.001	***0.003***	***0.038***	**0.021**	***0.015***	**0.012**	***<0.001***	***0.047***	0.066	**0.007**	<0.001	0.0032 Chronic	H=100
Mn dissolved	0.066	0.061	***0.069***		0.007	**4.69**	1.04	0.151	0.006	0.008	0.064	0.05 HH SW	
Mn total rec	0.074	***0.064***	***0.069***		***0.069***	**4.69**	***1.04***	***0.18***	0.023	**0.059**	0.073	0.05 HH SW	
Mo dissolved	<0.01	<0.01	***<0.01***		<0.01	**<0.01**	<0.01	<0.01	<0.01	<0.01	<0.01		
Mo total rec	<0.01	***<0.01***	***<0.01***		***<0.01***	**<0.01**	***<0.01***	***<0.01***	<0.01	**<0.01**	<0.01		
Zn dissolved	0.03	0.04	***0.07***	**0.402**	0.02	**0.46**	0.01	<0.01	0.22	0.02	<0.01	0.12 Chronic	H=100
Zn total rec	0.04	***0.04***	***0.06***	**0.428**	***0.05***	**0.42**	***0.01***	***<0.01***	0.42	**0.05**	0.01	0.12 Chronic	H=100
LAB SAMPLING (mg/l)													
Acidity as $CaCO_3$	<2	<2			<2	486	<2	<2	<2	<2	<2		
Alkalinity Bicarbonate as HCO_3	56	<1			16	<1	73	200	113	12	254		
Alkalinity Carbonate as CO_3	0	0			0	0	0	0		0	0		
Alkalinity Total as $CaCO_3$	46	<1			13	<1	60	164	93	10	208		
Chloride as Cl	2	<4			2	8	2	<4	<1	<1	<1		
Sulfate as SO_4	49	23			17	**769**	***264***	201	43	23	**451**	500	
Calcium as Ca	25	5			9	78	101	111	47	9	136		
Hardness as $CaCO_3$	99	21			31	302	314	417	142	31	595		
Magnesium as Mg	9	2			3	26	15	34	6	2	62		
Potassium as K	<1	<1			<1	<1	2	1	<1	<1	2		
Sodium as Na	2	<1			<1	2	4	3	<1	1	18		
Electrical Conductivity **	211	67	296	1042	76		587	710					
pH ***	7	4.9	5.4	2.9	7.21		6.4	7					
Total Dissolved Solids	163	82	83	544	85		492	527					
Total Suspended Solids	<10	<10	<4		21		32	<10					
FIELD SAMPLING													
Temp °C	5.6	3.7	5.6		5.3	4.8	5.1	3.4	4.5	9.1	4.6		
pH, su	**5.26**	**4.66**	**5.26**	**3.1**	6.92	**2.6**	6.59	6.97	7.49	***6.32***	7.54	6.5	
Sc, ms	72.7	55.08	72.7	929	66.13	1651	609.1	657	248.2	69.29	1005		
Turb, FTU	1	2	1		3	27	23	3	6	12	6		
TDS, mg/l	48.84	37.42			43.87	**1205**	421.2	457	169.7	46.45	***717.9***	500	
ORP, mv	296	268			274	544	192	264	270	276	286		
Cu, mg/l	0.02	0.05			<0.01	11.6	0.05	<0.01	0.01	0.03	<0.01		
Fe(t), mg/l	0.16	<0.01			<0.01	139.5	17.9	0.04	0.35	0.14	0.34		
Fe+2, mg/l	0.04	n/d			n/d	3.5	16.5	<0.01	0.02	0.05	0.01		
DO, mg/l	8.9	8.6	8.9		8.2	10.6	0.6	2.8	9.2	10.2	8.5		
Flow, gpm	0.6	3.14	0.6	10-38	0.6	<0.1-2	8.08	1.93	0.09	6.7	30		

Notes:
mg/l = milligrams per liter
gpm = gallons per minute
mv = millivolts

Bold-well out of compliance
*average all samples collected; data range 20-48 samples
** Sc = specific conductivity in millisiemens
*** pH in standard units

Italic- marginally out of compliance
HH = Human Health
SW = Surface Water
H = Hardness



(after Lovering, 1929)

N

0 Feet 400

Raise or Winze
Top
Bottom

MAXIM TECHNOLOGIES INC® 9902245.233

Map of Underground Workings in the Daisy Adit
Homestake Adit and Gold Dust Adit Mine Areas
New World Mining District
Response and Restoration Project
FIGURE 2

adit. The portal on the Daisy Creek side has been backfilled and access blocked with mine wastes (Figure 3), there is a small dump on the scree slope below the portal containing about 900 cubic yards of material (Figure 4; Table 1). Geochemical data from the waste rock is presented in Table 2. Water is ponded behind the wastes at the portal and seeps across the road and out onto the dump surface, where it infiltrates into the waste rock pile and underlying scree slope down hill (Figures 3 and 4 photos). The water does not obviously come to surface again below the point of infiltration into the waste rock. The portal on the east side of Henderson Mountain has been closed with a set of portal timbers and a locking metal gate. Geochemical data related to mine waste present at the mine is shown in Table 2. A summary of water quality data from the Daisy Mine is presented in Table 3.

Gold Dust Adit: The Gold Dust Adit is located on the southwest side of the Fisher Creek Valley, near the break in slope forming the flank of Henderson Mountain (elevation 9220 feet) (Figure 1). Western Smelting and Power Company also owned the Gold Dust Adit. Facilities associated with this mine include the Chicago (White) smelter, and aerial tram that connected the portal with the smelter (2500 feet long), blacksmiths shop, boarding house, electric compressor (still in building), and several cabins. The adit was driven between 1920 and 1925 and drifts to the southwest for about 2,300 feet (Figure 2). No production is recorded from the adit. A waste rock dump is present at the portal of the Gold Dust Adit that contains approximately 5,700 cubic yards of material. Geochemical data related to mine waste present at the mine is shown in Table 2. No production has been recorded from the Gold Dust Adit.

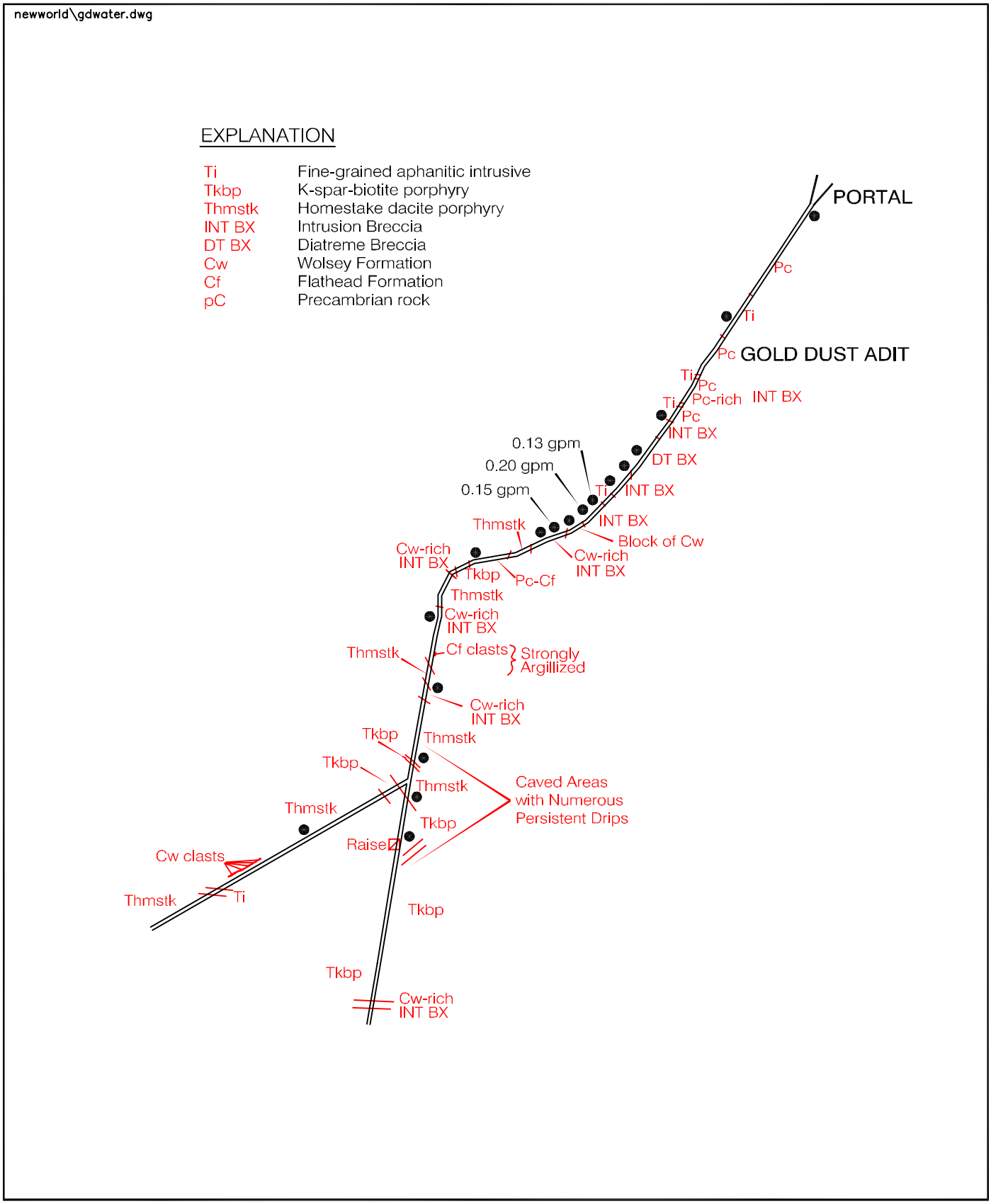
After discovery of the Homestake Breccia Pipe, in 1990 by surface drilling, Crown Butte Mines executed an underground drilling program from the Gold Dust Adit to delineate mineralization in the lower portion of the breccia pipe by drilling angle holes from four drill stations. The mine portal and underground workings were rehabilitated to gain access and to cut four new drill stations. The mine was mapped geologically during the rehabilitation work and water sources were identified and sampled (Figure 5). Approximately 23,331 feet of drilling were completed in 23 drill holes. Drill holes that were making water when drilled were closed with mechanical packers. The portal was closed with a series of timber sets and a locking steel gate that is need of repair (Figure 6). The mine discharged water prior to being rehabilitated by Crown Butte Mines, and continues to discharge water currently. Water presently flows from the portal of the Gold Dust Adit at a rate as large as 30 gallons per minute. Water quality is fairly good in that it meets all Montana Circular WQB-7 water quality criteria except for iron and manganese (Table 3).

Homestake Adit. The Homestake Adit and related workings were also owned and developed by Western Smelting and Power Co. There are a total of four adits and a small open pit in the vicinity of the Homestake Adit (Figure 2). A raise connects the longer of these two adits. The total length of all four adits and associated cross-cuts and drifts is less than 700 feet. The lower adit portal lies at about 10,000 feet in elevation and was driven about 225 feet to the southwest. The longer of the upper adits was driven almost due south for about 350 feet. The remaining two adits were driven at about the same elevation as the upper adit and are each about 50 feet in length. As can be seen on Figure 2, the Homestake Adit lies almost directly above the Gold Dust Adit, but the two sets of workings are separated by about 600 feet in elevation -- both were driven in vain searching for the Homestake breccia deposit. The main Homestake Adit, with the top of the winze exposed in the floor of the workings, has been closed with wooden timber portal sets and a locking steel gate that are in need of repair (Figure 7). The other adits are closed with backfill or rock fall material at the portals (Figure 8). Geochemical data related to mine waste present at the portal locations is shown in Table 2. None of the adits discharge water, although an ephemeral pool of water exists near the portal of the lower adit.

Figure 3. The portal of the Daisy Mine on the west side of Henderson Mountain has been backfilled and access blocked with mine wastes (note seepage).

Figure 4. A small waste rock dump occurs on the scree slope below the portal of the Daisy Mine containing about 900 cubic yards of material (mill site in the foreground).

newworld\gdwater.dwg



(after Crown Butte Mines, 1993)

N

0 Feet 300

0.13gpm ● Persistent Drips
Flow in Gallons per Minute

MAXIM 9902245.233

Geologic Map of the Gold Dust Adit
Showing Water Sources and Volumes (winter, low flow)
New World Mining District
Response and Restoration Project
FIGURE 5

Figure 6. Portal area of the Gold Dust Adit showing portal timber sets, concealed is a locking metal gate (both of which are in need of repair or alternate method of closure).

Figure 7. The main Homestake adit has been closed with wooden timber portal sets and a locking steel gate both of which are in need of repair (or alternate closure).

Figure 8. The other Homestake adit portals are closed with backfill or rock fall material at the collar.

McLaren Adits and Winter Tunnel

In 1933, The McLaren gold-copper-silver mining operation was developed on the west side of Fisher Mountain (Figures 1). Initial mining and exploration was conducted from a series of eight east-northeast trending adits of varying length. These adits are shown on McLaren Gold Mines maps of 1937 and 1947 (Figure 9). The ninth adit called the McLaren Adit or the Winter Tunnel does not appear on maps until 1952, one year prior to the cessation of open pit mining. On this map the "proposed" Winter Tunnel is shown to be about 400 feet long. The geometry of the ore exposed in the exploration adits indicated that the ore deposit in the McLaren Mine area was aerially extensive, tabular and dipped gently to the southwest. It was determined that the McLaren gold-copper deposits could be most efficiently mined by open pit methods. In the subsequent open pit mining operations, waste rock was stripped from the underlying massive sulfide ore, and stockpiled to the north side of the pit. The massive sulfide ore was stripped down to its lower contact with an interformational dacitic intrusive sill. Presumably these first eight adits were mined out during open-pit mining operations, however this cannot be confirmed as these former adit levels are buried by waste rock. What can be said is that no workings were exposed in the deranged topography of the pit post-mining, no workings were encountered during exploration drilling, and no buried working were discovered by Crown Butte Mines while recontouring the historical pit using heavy equipment. This does not preclude however, that some portions of the old workings could remain buried, especially in the vicinity of the highwall.

As mine development progressed, an adit (Winter Tunnel) was driven to the northeast from the northwest corner of the pit; the waste rock from this adit was deposited near the junction of the county road with the Lake Abundance road (Figure 1). Driving this tunnel documented the fact that the McLaren copper-gold deposit continued to the north in the subsurface. The waste rock stored to the north of the pit was removed and placed back into the "mined-out" main pit, with the intention of extending the mine workings to the north. However, at about that time in 1953, the mill burned to the ground, and was never rebuilt. The winter tunnel, used in exploring the McLaren deposit, therefore was not disturbed by historic open-pit mining activities and still remains at the north end of the pit (Figure 10). It collars at about 9,640 feet in elevation, near the junction of the main county road with the Lake Abundance road. The actual layout of the workings is unknown. A waste rock dump of approximately 3,100 tons, locally known as "Hot Hill", was placed near the portal of the adit (foreground of Figure 10). Based on the size of the waste rock dump and the dimensions of the adit (about 6 feet wide by 7 feet high), it is estimated that there is about 1.55 cubic yards of in-place rock per foot of adit driven, if one assumes a 1.1 swelling factor (1.75 yards on the dump per linear foot of drifting) then the estimated length of workings would be approximately 1,770 feet. One thousand seven hundred and seventy lineal feet of workings, along the same heading, would take the tunnel well past the main Fisher Mountain intrusive contact (and out of the ore) and it is, therefore, presumed that there must be cross-cuts and drifts and/or stopes developed in the mine to account for additional waste material present on the dump. Geochemistry of the McLaren mine wastes (Table 2) indicates the waste is chemically some of the poorest quality rock remaining on the surface in the District. Water flows from this adit at a rate of about 8-10 gallons per minute. Water quality data is presented in Table 3.

Ore present beneath an interformational, Tertiary-age, dacitic intrusive sill occurring in the upper third of the Meagher Limestone at the McLaren Mine was not mined, and significant additional reserves were discovered by CBMI to lie beneath this intrusive sill. In addition, by recent and current economic standards, most waste rock placed as backfill into the open-pit is of ore-grade. CBMI drilled in the McLaren Mine area proper from 1987 through 1990 to evaluate the ore remaining in the lower portion of the Meagher Limestone and in mine backfill materials within the McLaren Pit. A total of 69,979 feet of exploration drilling were completed in 303 drill holes.

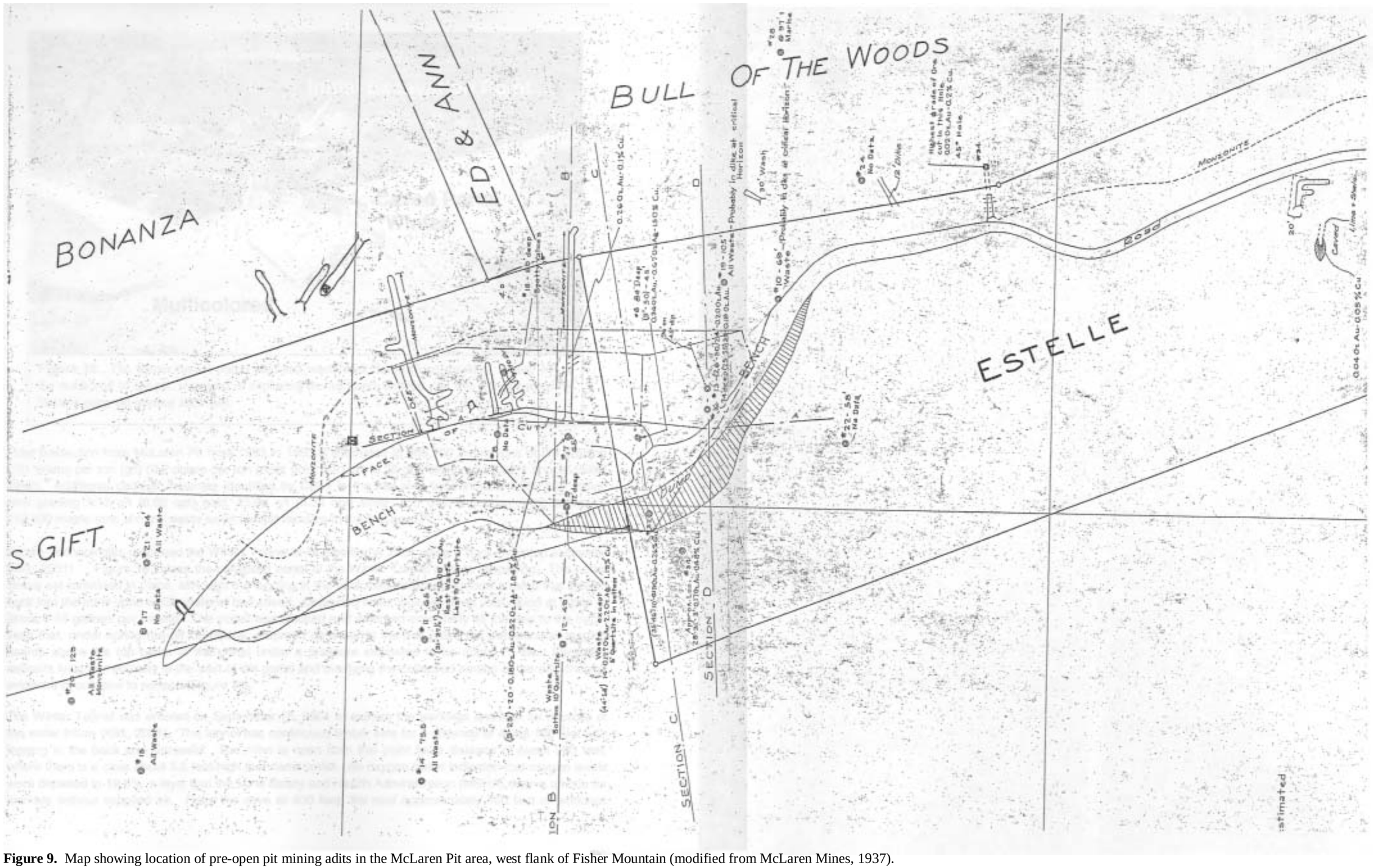


Figure 9. Map showing location of pre-open pit mining adits in the McLaren Pit area, west flank of Fisher Mountain (modified from McLaren Mines, 1937).

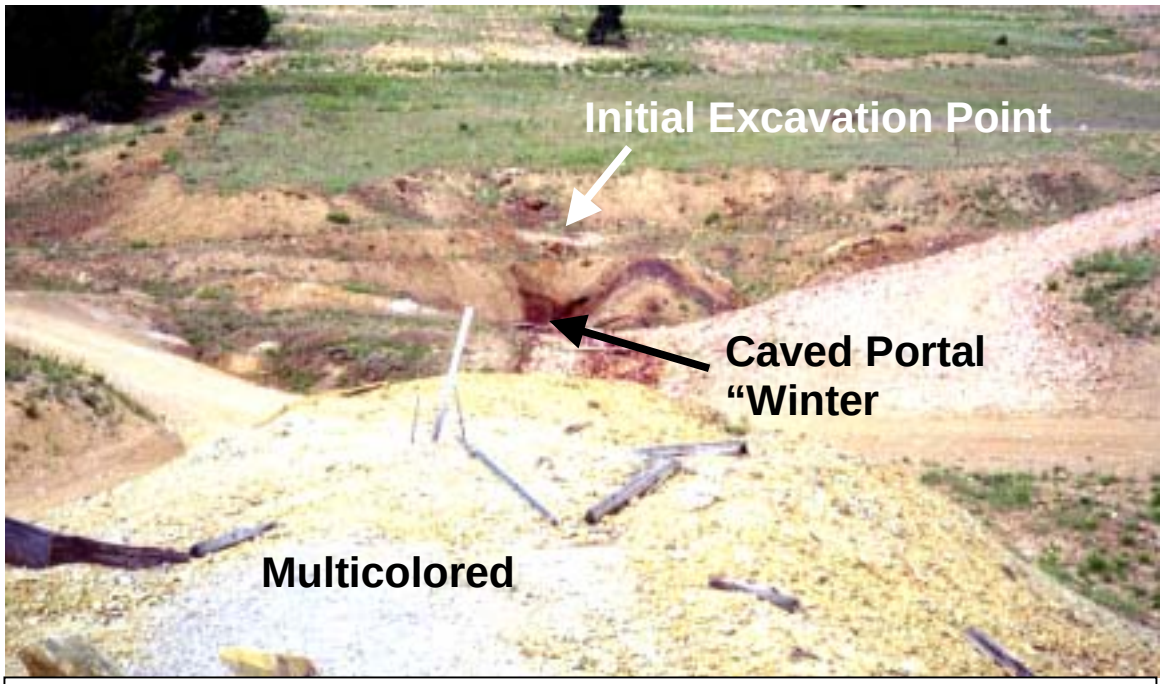


Figure 10. The winter tunnel portal area and waste rock dump (foreground of Figure 10) at the north end of the pit, was used in exploring the McLaren deposit and was not disturbed by historic open-pit mining activities.

Total production from McLaren Pit from 1933 to 1953 is estimated at 305,700 metric tons of ore grading 6.31 grams per ton (g/t) (0.2 ounce per ton (opt)) gold, 8.91 g/t (0.28 opt) silver, and 0.59% copper (Elliot 1992). Additional geologic reserves identified by CBMI in the McLaren area include 1,969,530 metric tons grading 3.12 g/t (0.09 opt) gold, 13.06 g/t (0.38 opt) silver, and 0.70% copper. Approximately 312,000 metric tons of mine waste as pit backfill remains in the McLaren Pit.

Maxim Technologies reopened the Winter Tunnel in September of 2001 using a track-mounted excavator (Kirk, 2001). Figure 10 shows the collapsed portal of the Winter Tunnel prior to reopening. The portal timber set remained in place, although the lagging in the back had collapsed to form a ramp that dipped back into the mine upon which material had caved. Degraded water typically flows year-round at a rate of about 8-10 gallons per minute. The portal was blocked and dammed essentially all the way to the back, such that, under spring run-off conditions, dammed up water in the adit jetted out between the lagging boards above the top beam at the portal under a pressure estimated to be about 15 lbs. Ferricrete deposits lying immediately to the east of the portal and overlying the collapsed portion of the adit showed evidence of collapse to surface (Figure 10).

The Winter Tunnel was entered on September 18, 2001 to explore the workings and look for sources of the water inflow (Kirk, 2001). The tunnel has continuous timber sets for a distance of about 100 feet with lagging in the back and sidewalls. The mine is open from this point for a distance of about 300 feet, where there is a cave about 3.5 feet high that dams water. An oxygen meter indicated that oxygen levels were depleted to 19.5%, a level that the Mine Safety and Health Administration (MSHA) deems unsafe for workers without supplied air. From the cave at 400 feet, the next approximately 100 feet of workings

were visible, at which point there was another small cave. Both of these caves could be crossed allowing access to the remaining workings if safe oxygen levels were present.
Altered and mineralized sedimentary rocks of the Meagher Limestone (pyrite, chalcopyrite and abundant iron oxides) are complexly intruded by the Fisher Mountain porphyry (as dikes, sills, and stocks?) over the accessible and visible portions of the mine (100-400 feet). No water sources other than an occasional drip were observed in the first 400 feet of working, and water was flowing over the dam at 400 feet. Based on the fact that the mine flows year-round it is assumed that a significant inflow must occur at some point further into the mine.

The area around the portal was cleaned up, and regraded once the mine was reopened and drained (Figure 11). A construction safety fence and a plywood portal closure were constructed for the winter. It is likely that the air will improve by natural convection over the winter, and access to the deeper portions of the mine could be attempted in early summer of 2002.

Figure 11. Portal area of the Winter Tunnel (McLaren Adit) after reopening in 2001.

Lula and Contact Mines

The Contact Mine lies on the Lulu and Boulder Patented mining claims and adjacent to the Contact patented claim located on the northwest flank of Fisher Mountain (Figure 1). Lovering (1929) reports that this adit extended some 400 feet to the south, but was completely caved during the time of his field-work (1918-1925). A small dump also exists near the portal of this adit, and is located just uphill of the cabin ruins at the south end of Lulu pass.

Glengarry Mine and Spaulding Tunnels on Scotch Bonnet Mountain

The Glengarry Mining Company initially had operations on the south-facing flank of Scotch Bonnet Mountain, immediately northeast of Lulu Pass (9,700 feet in elevation) (Figure 1). On old historic mine maps these workings are called the Spaulding Tunnels. The Spaulding Tunnels consist of three short adits at different elevations, the lower two of which are connected by a winze (Figure 12). Prior to 2001, the upper (310 feet) and lower adit (315) portals were closed with back-filled mine waste materials (Figure 13). The middle adit (200 feet) was accessible for about the first 50 feet, where a cave has blocked the workings.

In 1990, Crown Butte Mines, Inc. drilled five reverse circulation holes in the vicinity of the Spaulding tunnels. The mineralization in the vicinity of the workings was found to contain very large breccia fragments (> 50 feet in diameter) of sedimentary rocks that were caught up in this northern extension of the Crown Butte (?) Fault Zone. Although significant mineralization was drilled at shallow depths, the fault zone apparently contains no sedimentary limestone clasts at depth, and it is the replacement of the sedimentary limestone clasts that host the ore grade mineralization. It is probably for this reason that no ore was discovered at the level of the lower Glengarry Adit workings (discussed below).

The lower Spaulding Adit portal was scheduled for opening with a tracked-excavator in the summer of 2001 (Kirk, 2001). This adit consistently weeps water (0.1-2 gallons per minute) in the spring and early summer through a waste rock plug placed at an unknown time at the portal. This waste rock plug did not go all the way to the back (roof) of the portal and water could be sampled with a bailer from a pool behind the waste rock dam. The collapsed adit entry had produced a 40-foot long trough into the hillside, with a steep drop of more than 20 feet in height at the north end of the collapsed adit due to the fact that the adit was driven into the steep hillside.

Waste rock at the Middle and Lower Spaulding Adits was removed during August 2001 by IT (the US Forest Service contractor) for the Selective Source Response Action and hauled to the SB4 repository as part of reclamation activities. During the course of waste rock removal, the walls of the trough formed at the collapsed portal of the lower adit sloughed and the location of the lower portal was lost. Despite considerable effort using both a tracked excavator and a rubber-tired backhoe digging exploratory trenches on two occasions (August 23 and August 24, respectively) the portal could not be relocated, and the lower adit was not reopened (Kirk, 2001).

Reclamation of the upper and lower waste rock dump-sites and their respective portal areas was accomplished by regrading of the slope following the removal of waste rock, lime amendment of surficial materials, and mixing topsoil with the lime-amended surface (Figure 14). Erosion blankets were placed on the reclaimed slope. A percolation basin consisting of a lens of gravel surrounded by filter fabric was constructed just below the seep location at the lower portal site and a lined and armored drainage channel was constructed from the percolation basin down into the Como topographic basin. The middle tunnel portal was backfilled with rock. Waste rock geochemistry is presented in Table 2 and adit water quality data is presented in Table 3.

Subsequent to the development of the Spaulding workings, another adit, the Glengarry, was driven in the Fisher Creek drainage in 1925 (Lovering, 1929) at a lower elevation (9,320 feet) on a N. 70^{o} W. heading from about 0.5 miles east-southeast of the Spaulding workings (Figure 1). This adit was driven some 2,300 feet towards Lulu Pass in an attempt to intercept mineralization beneath the Spaulding Tunnels at depth (Figure 13). No mineralization was found at the level of the Glengarry Adit (Lovering, 1929).

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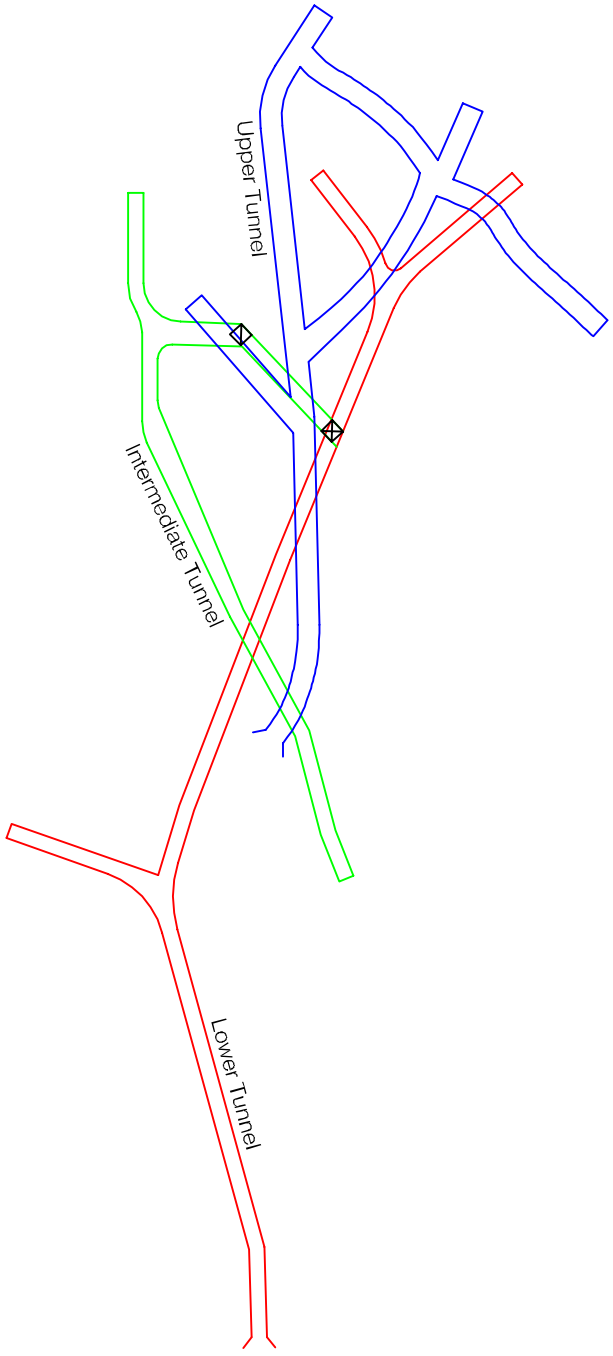

(after Lovering, 1929)

N

0 Feet 40

Raise or Winze between Lower and Intermediate Tunnels
☒ Top
☒ Bottom

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Map Showing the Location of Underground Workings in the Spaulding Tunnels Area
New World Mining District
Response and Restoration Project
FIGURE 12

Figure 13. Photograph showing the portal areas of the Spaulding Tunnels prior to reclamation and closure.

Figure 14. Photograph showing the portal areas of the Spaulding Tunnels after waste rock removal and re-grading.

In the early 1930's (workings appear on maps dating 1934), the southwest heading of the Glengarry Adit was driven some 600 feet to come in under mineralization identified at the surface in the Como Deposit (Figure 15). It is not known if the people that drove this heading (McLaren Mines?) were doing so to look for mineralization beneath stratabound replacement deposits of the Como Basin (extensions of ore grade mineralization to depth), or if they were looking for an underground access to mine the near surface ores of the Como deposit. In either case, they drove two sets of raises from this drift. The second set of raises came to surface in the base of the Como deposit (about 400 vertical feet). The first set of raises appears from old maps to have been abandoned after raising up about 50 feet. This raise makes a considerable amount of water (as much as 10 gpm).

The Glengarry Adit was partially re-opened by the Montana Bureau of Mines and Geology for the Montana Department of Natural Resources and Conservation (DNRC) in the mid-1970s to evaluate the mine for possible closure (DNRC, 1974).

In 2000, the Glengarry Adit was rehabilitated back to the Y-intersection (Figure 15) and access was gained to the most distal portions of the mine along both headings driven. Geology and structures were mapped and water sources identified and sampled (Bogert, 2001; Kirk, in prep.) In 2001, a portion of the second set of raises was rehabilitated from the surface in the Como Basin to a depth of about 250 feet, in order to assess water inflows and evaluate closure options (Figure 16). Bogert discusses this rehabilitation and subsequent engineering evaluation in a paper (Bogert, 2001).

The portal of the Glengarry adit is a source of mine drainage discharge that collects water from fractures and other geologic structures along approximately 2,500 lineal feet of underground workings and two sets of raises (Figure 15). Water flowing into the Glengarry Mine comes primarily from three well-defined sources and one diffuse source. The well-defined sources are a major roof leak located 1,050 feet in from the portal, bulkheads at top of the first raise about 40 feet above the tunnel level, and the upper portion and top of the second raise where it comes to surface (daylights) in the Como Basin. The diffuse source is the series of small roof leaks that occur between the portal and the major roof leak at 1050 ft.

The short raise (first raise encountered on way into the mine)) has a fairly constant flow in the range of 10 to 20 gallons per minute with the lowest flow occurring prior to snow-melt in the spring. The water is characterized by a pH of 3.2 to 3.3, 75 to 85 milligrams per liter (mg/l) iron, and 0.015 to 0.032-mg/l copper.

The second raise, which surfaces in the Como Basin, seasonally contributes 2 to 10 gallons per minute of inflow. During snow-melt, most of the flow is derived from water moving through colluvium in the Como Basin (which is weathered massive sulfide deposit), along the bedrock surface and into the raise. This water is characterized by a pH of 2.5, 100 to 400 mg/l iron, and 10 to 40 mg/l copper.

Flow from the major roof leak at 1,050 feet from the portal varies seasonally from 3 to 13 gallons per minute and is characterized by pH 4 to 5, 110 to 135 mg/l iron, and 0.004 to 0.05 mg/l copper. Diffuse roof leaks virtually dry-up in the winter and contribute a total flow between 1 and 15 gallons per minute during wetter seasons of the year. They are characterized by a pH of 5 to 6, 2 to 10 mg/l iron, and 0.001- to 0.006-mg/l copper.

As can be seen from these numbers, the Glengarry Adit receives several orders of magnitude more copper loading from the top of the Como raise than from all the other in-flows combined. The two raises and the 1,050-roof leak each contribute at least an order of magnitude more iron loading than do the diffuse roof leaks.

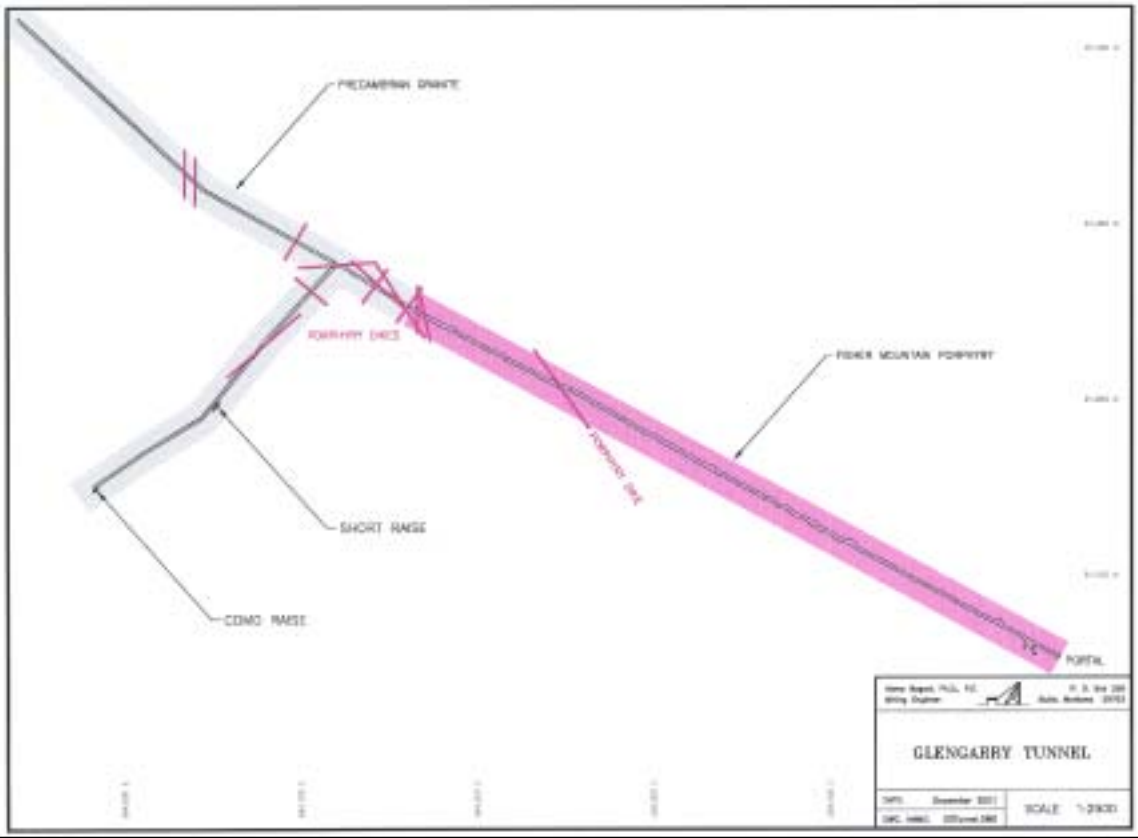


Figure 15. Map of the Glengarry Mine workings, showing simplified geology and structure.

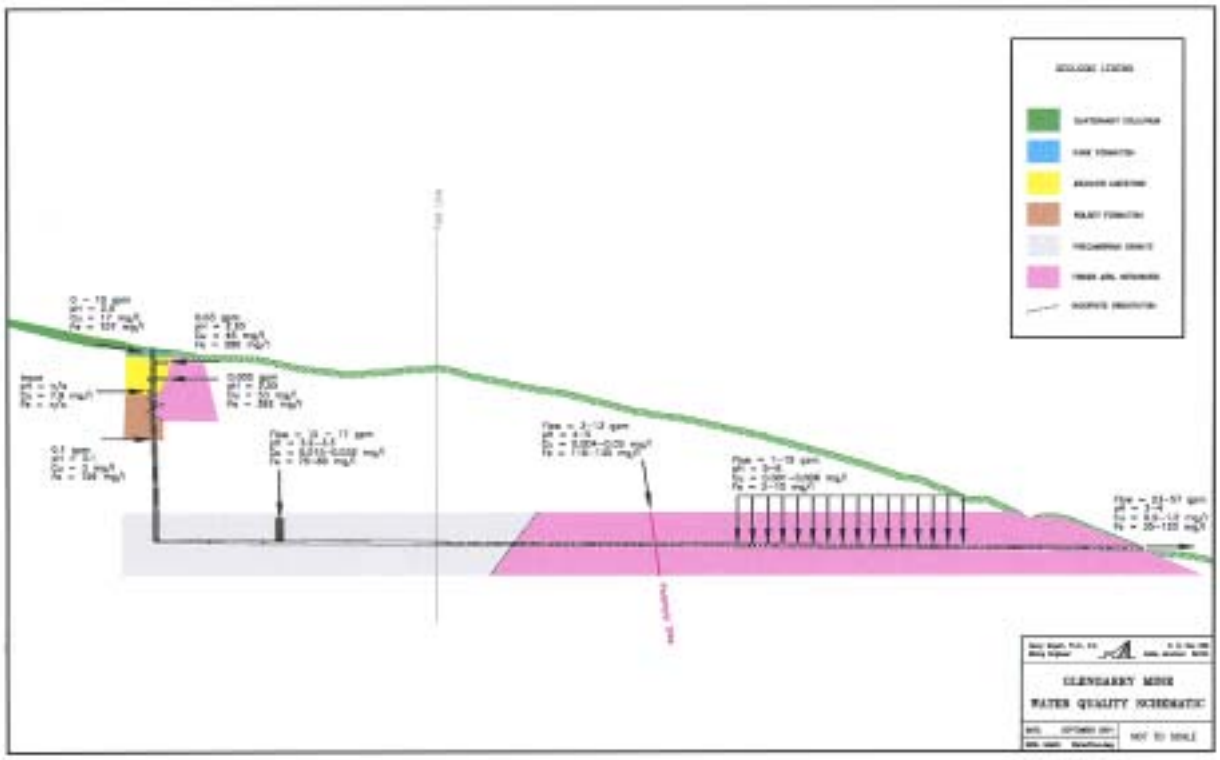


Figure 16. Cross-section through the Glengarry Mine, showing simplified geology, structure, water inflows and water chemistry (from Bogert, 2001).

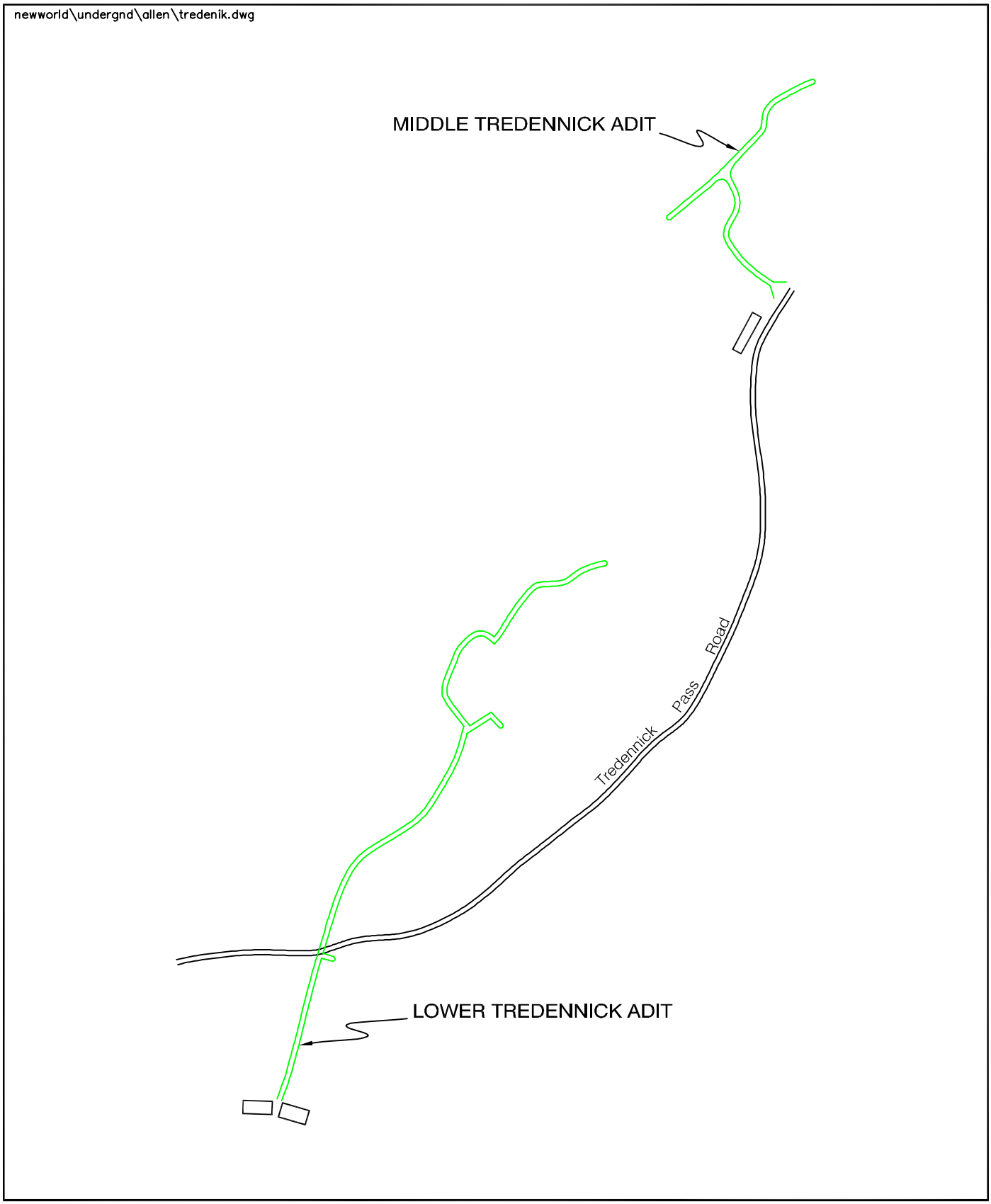
The Glengarry Mine closure options will be evaluated in an EE/CA that will be prepared on the Como Basin, Glengarry Mine, and erosional problems in the vicinity of these areas in 2002 (Maxim Technologies, in prep.).

Tredennic Mines on the southeast flank of Scotch Bonnet Mountain

The Tredennick Mines were operated by the Tredennick Development Company on claims located on the southeast flank of Scotch Bonnet Mountain (Figure 1). The workings consist of three principal adits (Figure 17) with about 1,375 feet of combined workings. The upper adit is short and only drives about 125 feet to the northeast along a narrow pyrite rich vein in Precambrian granite, beneath a topographic bench capped by Flathead Sandstone. The upper adit lies to the northeast of the lower two adits and was collared at about 9,800 feet in elevation. The middle adit (420 feet long), which is collared at about 9,600 feet, intercepted a narrow zone of copper-gold mineralization at the contact with Precambrian basement and the gabbro of the Scotch Bonnet intrusive complex. The lower adit (collared at 9,480 feet) with more extensive workings (810 feet) was attempting to drive to the north-northeast to intercept mineralization beneath the middle adit workings at depth. The adit was not completed to its targeted distance and therefore drives for all of its length in unmineralized or weakly mineralized rock, which explains why water quality (Table 3, only manganese exceeds WQB-7 standards) and waste rock geochemistry (Table 2, low pH with relatively low concentrations of copper, lead, and zinc) do not contain high concentrations of contaminants. A number of short adits lying at higher elevations on Scotch Bonnet Mountain were also affiliated with the Tredennick Mines. No significant production has occurred from any of the Tredennick workings. Adit seeps and mine wastes were present at all three adit portals (Figure 18). Waste rock deposits were excavated and removed to the SB4 waste rock storage repository in 2001. Infiltration basins were constructed at the site of historic adit seeps, and the waste rock areas were lime amended, top soiled and revegetated. These waste rock dumps were scheduled for early removal in the overall reclamation process because water from the creek flows through mine wastes at both the middle and lower the portal sites. Waste rock volume and geochemistry is presented in Table 2. Water quality of the three-adit seeps is reported in Table 3.

Black Warrior Mine in Upper Daisy Creek

The Black Warrior Mine lies near the headwaters of Miller Creek (Figure 1). It consists of an underground adit about 425 feet in length and an 80-foot raise to surface. The collar of the raise to surface occurs at an elevation of about 9,720 feet and lies just to the south of Bull-of–the-Woods Pass. The adit was driven to the north-northeast along fracture-controlled lead-zinc-silver mineralization in the Pilgrim Limestone along what is likely a splay of the Crown Butte Fault Zone. There is a small dump (800 cubic yards) at the mine portal, which has been closed with back-filled mine wastes (Figure 19). A small volume of water exits the portal. Crown Butte Mines closed the shaft for safety reasons by backfilling the shaft with waste rock and dolomite. A soil cover was placed over the disturbed portion of the shaft site and the site was seeded and fertilized. Another shallow (largely back-filled) shaft occurs to the northwest at Bull-of-the-Woods Pass. Analyses of the waste rock dump materials and the water seeping from the collapsed adit are reported in Tables 2 and 3 respectively. Water quality impacts to the uppermost reaches of Miller Creek were identified in an ionic tracer and synoptic sampling study conducted by Cannon of the US Geological Survey (Cannon, 2000). However, Cannon noted that water quality impacts during this low flow sampling event could not be detected at the next surface sampling site only 190 feet downstream. Total maximum daily load (TMDL) evaluations conducted by the MDEQ have identified impacts to surface water quality at high flow that can be detected further downstream.



(after Lovering, 1929)

N

0 Feet 150

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Plan Map Showing the Underground Workings
of the Middle and Lower Tredennick Mines
New World Mining District
Response and Restoration Project
FIGURE 17

Figure 18. Portal area of the Lower Tredennick Mine.

Figure 19. Photographs of the Black Warrior portal area and waste rock dump, upper Miller Creek (note seepage).

Alice E. Mine - Southern Flank of Henderson Mountain

The Alice E. Mine (Figure 1) is located on the southwestern flank of Henderson Mountain. The mine was operated in the mid-1890's as an open-pit operation that mined oxidized gold from fracture controlled mineralization in the Flathead Formation (sandstone/quartzite). Shallow underground mining in various adits and (grass root) stopes are also present in the mine area and have locally caved to surface. Some gold-bearing pyritic ore is exposed in these workings and contained in the waste rock (Table 2); however, because the Alice E. Mine recovered gold using cyanide it was not effective in treating sulfide-rich ores. The foundations of the old cyanide mill are about all that remain on the site from a cultural point of view. Some water emanates as a spring (?) from near the mill site (Figure 20). The water quality from this seep is reported in Table 3. Apparently, no attempt was ever made to process the sulfide ores. There are both mine waste rock and tailings at the Alice E. Mill site. Data on the chemistry of these materials are reported in Table 2.

Adit Seepage Flow Rate and Geochemistry

Eleven of the 16 underground mines examined have a water discharge. Water chemistry of these discharges along with their flow rates is presented in Table 3. Table 3 shows the following:

- Chemical analyses are broken into three categories metals, laboratory parameters, and field parameters.
- Constituent concentrations that are much higher than Montana Circular WQB-7 water quality standards are shown in **bold** in a slight larger font size.
- Constituent concentrations that are only marginally out of compliance are shown in ***bold italics***.
- Montana Circular WQB-7 standards for each constituent are reported for the most restrictive category of constituent concentration (either human health, acute, or chronic aquatic life standards).

Table 3 shows that all of the adit discharges are out of compliance with Montana water quality standards for at least one constituent. However, several of the discharges are only marginally out of compliance with respect to some constituents, usually iron and manganese. These include the Lower Tredennick, McLaren (Winter Tunnel), Alice E. Mill site, and Gold Dust discharges. At the other end of the spectrum, more than half of the discharges are out of compliance with respect to numerous constituents. These include the Upper Tredennick, Glengarry, Sheep Mountain #1, Lower Spaulding, Daisy, and Black Warrior discharges. Although some of the discharges are well out of compliance with standards, flow from the adit discharges is very low, and resulting loads of metals from the mines may not represent a significant source to surface or groundwater. (e.g. Lower and Upper Tredennick, Sheep Mountain #1, and the Lower Spaulding discharges).

Need and Feasibility of Accessing Underground Workings, and Closures

Table 4 presents a summary of the characteristics of the sixteen underground mines, including the size and components of the underground workings, the size and relative quality of waste dumps, discharge water quality and quantity, the potential need to access the underground workings for further evaluation, and the likelihood of being able to access the workings.

Figure 20. Alice E. Mill-site showing seep originating from cut bank above the stone foundation of the mill.

Table 4
Summary of Underground Mine Characteristics and Preliminary Evaluation of Closure Options

SITE Name/No.	WORKINGS (Feet)		WASTE ROCK			WATER OUTFLOW			ACCESSIBILITY		CLOSURE	
	Horizontal	Vertical	Volume (cubic yards)	Quality	Move	Volume (gpm)	Quality	Closure	Likelihood	Need	Portal Dump	Safety
Little Daisy MSCI-96-6	1400	200	900	Poor	(No ?)	1.9	Poor	Yes	Poor	No	Yes	Yes
Daisy East	500	--	Unk	Unk	No	--	--	No	Poor	No	No	(?)
Gold Dust FCSI-96-1A	2300	50	5700	Fair	No	30	Fair	Yes	Good	Yes	Yes	Yes
Homestake FSCI-96-17	350	200	424	Fair	No	--	--	No	Good	No	No	Yes
	250	--	100	Fair	No	--	--	No	Good	No	No	No
	50	--	Incl.	Fair	No	--	--	No	Poor	No	No	No
	50	--	Incl.	Fair	No	--	--	No	Poor	No	No	No
McLaren DCSI-96-1A	1700 (?)	(?)	1300	Poor	Yes In prog	8.1	Fair	Yes	Good-Done	Yes	Yes In prog	Yes In prog
Lula & Contact	400	(?)	Unk	Unk	(No?)	--	--	No	Poor	No	No	No
Upper Spaulding FCSI-96-7	310	--	740	Poor	Done	--	--	Done	Poor-Done	Done	Done	Done
Middle Spaulding FCSI-96-7	200	--	Incl.	Poor	Done	--	--	Done	Poor-Done	Done	Done	Done
Lower Spaulding FCSI-96-8	315	75	2360	Poor	Done	0.1-2	Very Poor	Done	Poor-Done	Done	Done	Done
Glengarry FCSI-96-2A	2900	400 40	13000	Poor	Yes In prog	10-38	Very Poor	Yes In prog	Good	Yes In prog	Yes	Yes
Upper Tredennick FCSI-96-15	150	--	410	--	Done	0.8	Poor	Done	Good-Done	Done	Done	Done
Middle Tredennick FCSI-96-6	420	--	820	--	Done	3.1	Fair	Done	Poor-Done	Done	Done	Done
Lower Tredennick FCSI-96-5	810	--	3430	--	Done	1.9	Fair	Done	Poor-Done	Done	Done	Done
Black Warrior MCSI-96-2	425	100 (?)	800	Poor	Yes (?)	0.1	Poor	Yes	Fair	No (?)	Yes	No
Alice E. Mill Site SBSI-99-85	0	0	--	--	In-situ	6.7	Fair	Yes	-	-	No	--
Tailings	--	--	3360	Poor	Yes (?)	--	--	-	-	-	-	-
Waste	--	--	330	Poor (?)	No (?)	--	--	-	-	-	-	-

In addition, Table 4 qualitatively evaluates the need for potential closure of the adit openings, discharge controls, or waste dumps removal and/or reclamation. The quality of the waste materials is rated as either "Fair" or "Poor" based primarily on the AIMSS ranking and whether the waste materials directly impact groundwater or surface water. Mines with a ranking lower than No. 54 are qualitatively rated as fair because of relatively low groundwater and surface water pathway scores (not shown) and relatively small volume. The only exception to this is waste present at the Gold Dust Adit. These wastes are rated as fair because total metals concentrations are relatively low in the waste even though the AIMSS rank for the Gold Dust is 24. the "Move" column indicates whether removal of the dump is recommended (Yes), whether the dump has been removed (Done), whether in-situ reclamation of the dump is a viable option (In-Situ) or whether removal is probably not required (No). A question mark indicates uncertainty on the recommendation. As previously mentioned, potential Removal Actions associated with the waste materials will be further evaluated in future EE/CAs.

Exploration Borings in the New World District

Numerous companies throughout the history of the New World District conducted exploration drilling for a variety of targets. Most recently (1938 to present) these include McLaren Mines, Bear Creek Exploration (a subsidiary of Kennecott Minerals), Ranchers Exploration, Mine Finders, Kerr-McGee, Gulf Mineral Resources, Crown Butte Resources, Noranda Exploration, Noranda Minerals, and Crown Butte Mines, Inc. During the years 1987-1993 when Crown Butte Mines, Inc. was conducting exploration and definition drilling in the New World District a total of 327,031 feet of drilling was executed in 856 drill holes.

Como Deposit

There have been at least three rounds of exploration drilling in the Como deposit area (Table 5). The first two rounds of exploration core drilling were completed by Bear Creek Exploration (Kennecott Minerals, 69 holes) and then by Ranchers Exploration (48 holes). Both companies grid drilled the Como deposit on 25-foot centers. Bear Creek core holes were completed with a surface casing (just into bedrock) left in place with or without a welded cap. Ranchers Exploration core holes were left open upon completion and any surface casing present was removed. Re-contouring of the Como deposit area obliterated the location of almost all of these drill holes. Crown Butte Mines completed about 8376 feet of drilling in 48 holes (both core and reverse circulation drilling). Only about 12 of the Crown Butte drill holes were located and abandoned by backfilling the drill holes with enviroplug chips prior to re-contouring of the deposit area. The remaining holes were left open.

McLaren Deposit

Several companies between 1938 and 1987 drilled both core and rotary holes (about 40 holes) in the McLaren deposit area. Closure status of these earlier drilled holes is unknown. Crown Butte Mines completed about 69,979 feet of drilling in 303 holes (both core and reverse circulation drilling) (Table 5). Approximately 72 drill holes were located and abandoned by backfilling the drill holes with enviroplug chips and a cement plug at the surface prior to re-contouring of the McLaren. The remaining holes were left open.

Miller Creek Deposit

Crown Butte Mines, Inc. discovered the Miller Creek deposit in 1988. Exploration drilling early in 1989 confirmed the discovery. Following the drilling of these holes Crown Butte Mines. Inc. began an aggressive delineation drilling and definition-drilling program. A total of 115,046 feet of drilling were

completed in 224 core and reverse circulation drill holes in the Miller Creek deposit area (Table 5. Holes drilled during this program were abandoned by grouting the holes with cement from the bottom of the hole to a point thirty feet above the mineralized portion of the Meagher Limestone, then backfilling the drill holes with enviroplug chips to within 10 feet of the surface and a cement plug at the surface. Approximately 10 of the 17 earlier drilled holes were located and abandoned by in the manner described above. Some holes around the perimeter of the deposit were backfilled with enviroplug chips only, and some holes were lost prior to backfilling during exploration road construction (perhaps as many as 20).

Homestake Breccia Pipe Deposit

Crown Butte Mines, Inc discovered the Homestake Breccia deposit. A total of 91,510 feet of drilling was completed in 103 core and reverse circulation drill holes in the Homestake deposit area (Table 5). Almost all drill holes were abandoned by grouting the holes with cement from the bottom of the hole to a point thirty feet above the mineralized portion of the breccia, then backfilling the drill holes with enviroplug chips to within 10 feet of the surface and a cement plug at the surface. Probably less than 15 of these holes remain open. Crown Butte Mines also drilled 23,331 feet of core in 33 holes from underground locations in the Gold Dust adit. Underground drill holes that were making water were closed with a mechanical packer, but were not grouted. Mechanical packers placed in the holes should be considered a temporary rather than a permanent solution to water draining from drill holes. Underground holes that were not making water were left open (approximately 28 holes).

Outlying Exploration Drill Holes

Outlying exploration drill holes drilled by Crown Butte Mines (105 holes) were usually completed with enviroplug chips from top to bottom in the drill holes. Outlying exploration drill holes drilled previously by Bear Creek were core holes that were completed with a surface casing with a welded cap; most of these holes were not disturbed.

Table 5
Number of Drill Holes in the New World Deposit Areas with Closure Estimates

Deposit Area	# of holes	Footage	Qualitative Closure of Holes	Estimate of # of Open Holes
Como	158	>>8,376	Almost all open	146
Fisher Mountain	40	6,209	Almost all open	40
McLaren	343	> 69,979	Almost all open	271
Miller Creek	224	115,046	Almost all closed	27
Homestake	103	91,510	Almost all closed	15
Gold Dust Adit	33	23,331	Almost all open	28
Exploration	105	12,580	Mostly Closed	30
Total	**1006**	**327,031**		**557**

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