

FINAL

NEW WORLD WASTE REPOSITORY LONG-TERM MONITORING PLAN

NEW WORLD MINING DISTRICT RESPONSE AND RESTORATION PROJECT



JULY 2006

United States Department of Agriculture
Forest Service
Gallatin National Forest

MAXIM
TECHNOLOGIES INC.

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LONG-TERM MONITORING PLAN**

**New World Mining District
Response And Restoration Project**

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**New World Mining District
Response And Restoration Project**

Prepared for:

**USDA Forest Service
Gallatin National Forest
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I.0 INTRODUCTION

This Long-Term New World Repository Monitoring Plan presents monitoring activities that will be conducted annually at the New World Repository over a 10-year period following completion of construction of the facility. Monitoring will be done in conjunction with response and restoration activities for the New World Mining District Response and Restoration Project that is being conducted by the USDA Forest Service under the guidance of the Overall Project Work Plan (Maxim, 1999a). Any additional monitoring that may be required following the initial 10-year monitoring period will be determined following analysis of the year 10 data.

I.1 PURPOSE

The purpose of this monitoring plan is to guide monitoring activities that will be performed at the repository site. The purpose of monitoring is to identify environmental or geotechnical conditions that could compromise the stability of the facility or that indicate the facility is operating outside of design criteria. Because the facility inters mine waste that is intended to be isolated from the environment, any release of waste from the facility would indicate a failure of systems put in place to prevent a release.

I.2 BACKGROUND

On August 12, 1996, the United States signed a Settlement Agreement (Agreement) with Crown Butte Mining, Inc. (CBMI) to purchase CBMI's interest in their New World Mining District (District) holdings. This transfer of property to the U.S. government effectively ended CBMI's proposed mine development plans and provided \$22.5 million to cleanup historic mining impacts in the District. In June 1998, all interested parties and CBMI signed a Consent Decree (Decree). The Decree, approved by the United States District Court, finalized the terms of the Agreement and made available the funds that are being used for mine cleanup. Monies available for cleanup will be spent first on District Property, which, as defined in the Decree, includes all property or interests in property that CBMI relinquished to the United States (**Figure I**). As funds are available after District Property is cleaned up to the satisfaction of the United States, other mining disturbances in the District may be addressed.

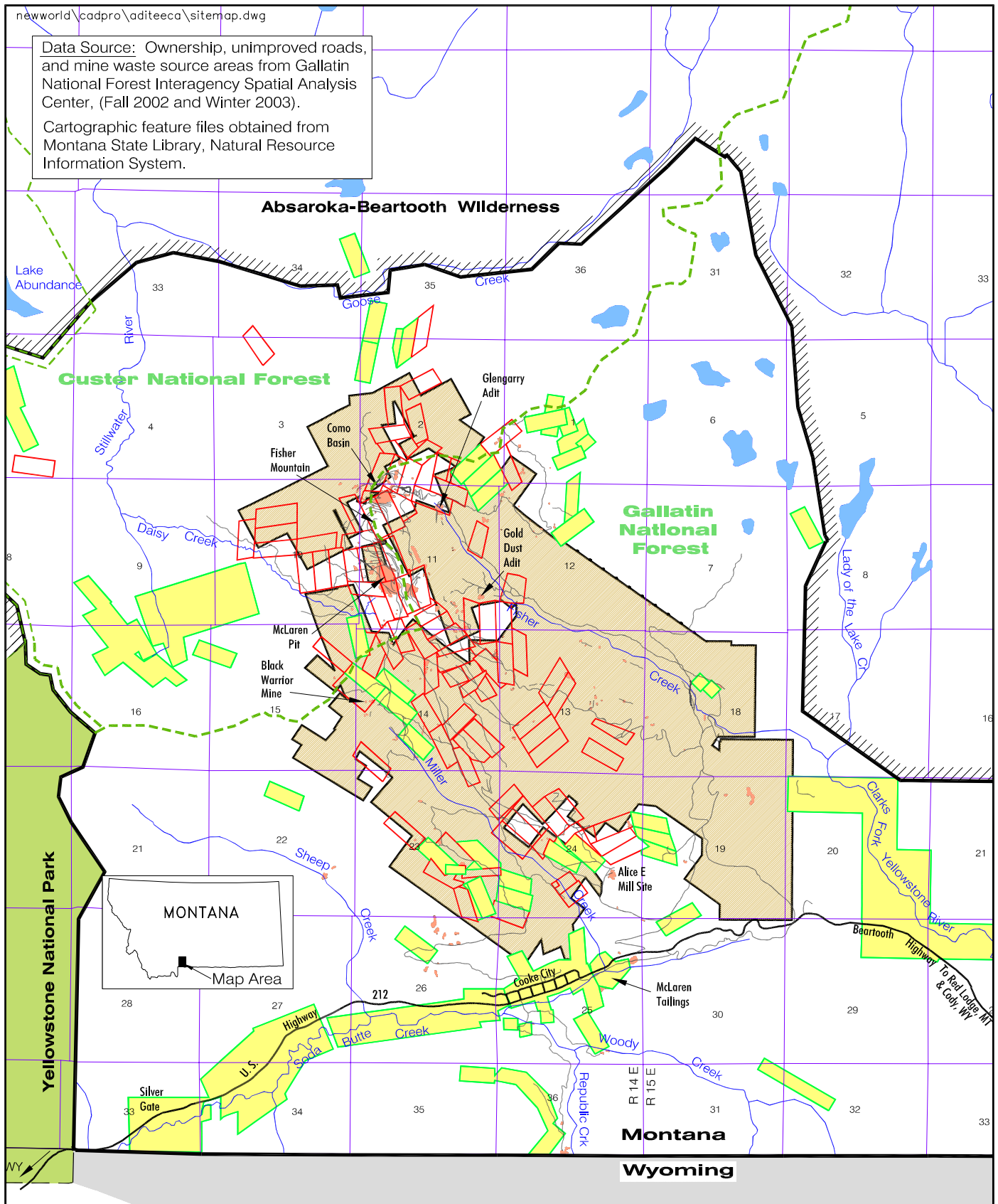
The USDA Forest Service is the lead agency responsible for implementing the cleanup of historic mining impacts in the District. The repository site is being managed by the USDA Forest Service under their Superfund authority for conducting non-time-critical removal actions (EPA, 1993). Non-time-critical removal actions are defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as actions that are implemented by the lead agency to respond to "the cleanup or removal of released hazardous substances from the environment ... as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment..." (EPA, 1993).

A general description of the site, project objectives, and project organization are provided in this introductory section. More detailed descriptions of the overall project are contained in numerous documents that have been produced for the project, including the Overall Project Work Plan (Maxim, 1999a), annual work plans, and annual project summary documents. These documents are available on the project website at:

<http://www.fs.fed.us/r1/gallatin>

and at three project information repositories located at the Gallatin National Forest Supervisor's Office in Bozeman, Montana; the Gardiner Ranger District Office in Gardiner, Montana; and at the Cooke City

Data Source: Ownership, unimproved roads, and mine waste source areas from Gallatin National Forest Interagency Spatial Analysis Center, (Fall 2002 and Winter 2003).
Cartographic feature files obtained from Montana State Library, Natural Resource Information System.



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

Chamber of Commerce office in Cooke City, Montana. The reader is encouraged to review these documents to gain a better understanding of the overall project.

I.3 SITE LOCATION AND DESCRIPTION

The District falls within the Gallatin and Custer National Forests and abuts Yellowstone National Park's northeast corner. The Absaroka-Beartooth Wilderness Area bounds the District to the north and east, with the Montana-Wyoming state line forming the southern boundary of the District. The District lies entirely within Park County, Montana (**Figure 1**).

The communities of Cooke City and Silver Gate, Montana are the only population centers near the District. The neighboring communities of Mammoth, Wyoming, and Gardiner, Montana, are located about 80 kilometers (50 miles) to the west. Red Lodge, Montana is located about 105 kilometers (65 miles) to the northeast via the Beartooth Highway, and Cody, Wyoming, is located 95 kilometers (60 miles) to the southeast.

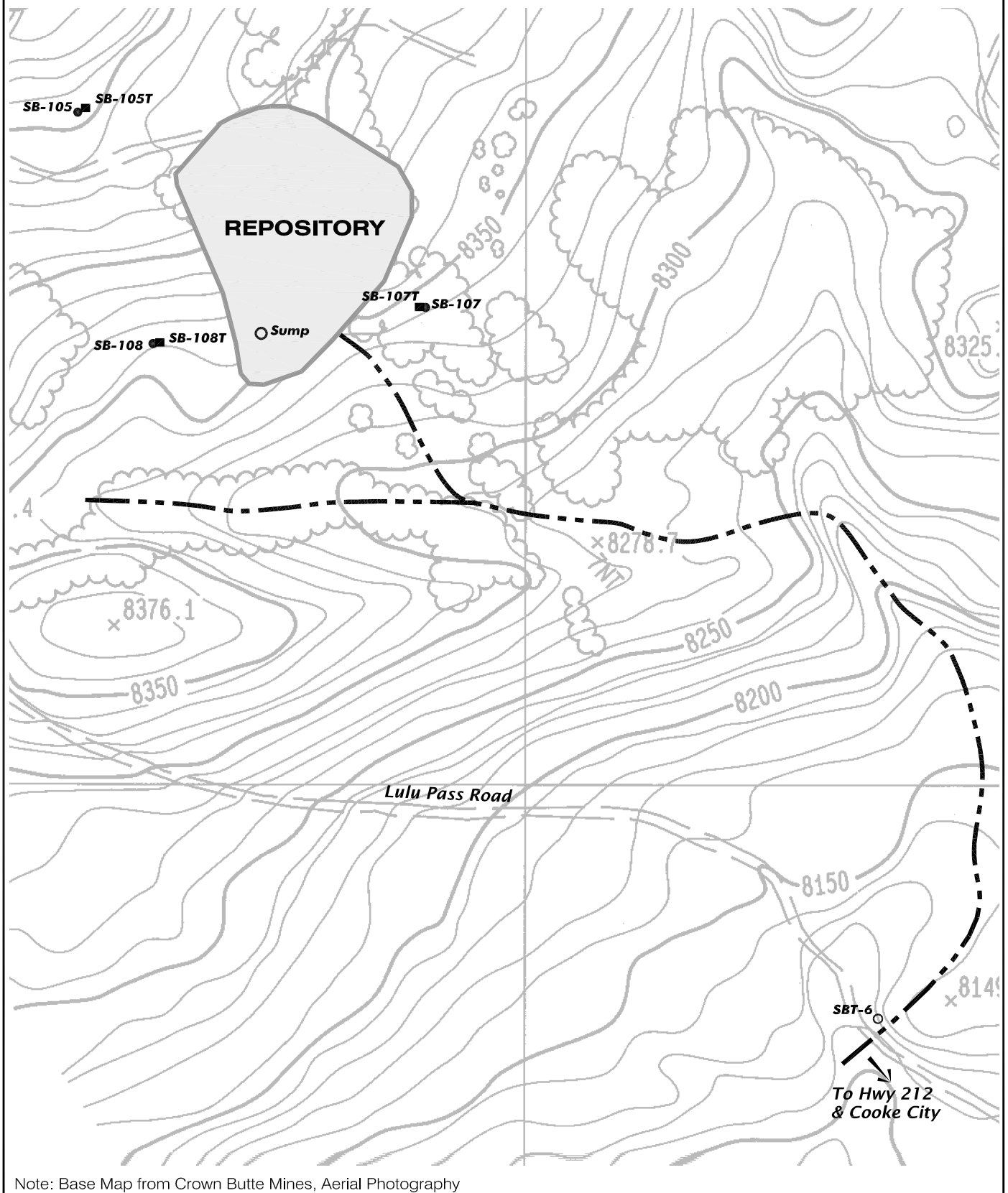
The District is located at an elevation that ranges from 2,400 meters (7,900 feet) to over 3,170 meters (10,400 feet) above sea level. The site is snow-covered for much of the year and only one route of travel is open on a year-round basis -- the highway between Mammoth and Cooke City. The Sunlight Basin road accesses the District from northwestern Wyoming during the spring, summer and fall but only allows access to within a few miles of the District in winter. The Beartooth Highway allows access to the District from the east but is closed during winter.

The District covers an area of about 10,360 hectares (25,600 acres). Historic mining disturbances affect both District and non-District property, with about 20 hectares (50 acres) located on District Property. Mining disturbances on non-District Property include the McLaren Tailings and McLaren Mill Site, which cover 6.9 hectares (17 acres), and the Great Republic Smelter, which is located in the town of Cooke City and covers 0.2 hectares (0.5 acres).

The topography of the District is mountainous with dominant glacial features, and is situated at the headwaters of three river systems that all flow into the Yellowstone River. The three tributaries are the Clark's Fork of the Yellowstone, the Stillwater, and the Lamar. The Lamar River flows through Yellowstone Park. The major tributary streams in the District include Daisy, Miller, Fisher, Goose, Sheep, Lady of the Lake, Republic, Woody, and Soda Butte creeks.

I.4 NEW WORLD REPOSITORY DESCRIPTION

The New World Repository is located about 2.4 kilometers (1.5 miles) north of Highway 212 on the Lulu Pass road (**Figure 2**). The repository was constructed in two phases, the first completed in 2002 and the second expected to be complete in 2005/06. The first phase of construction involved placing approximately 24,000 cubic meters (32,000 cubic yards) of mine waste rock and mill tailings from nine mine waste areas into the repository. The repository was designed for expansion and was placed under a temporary cover until 2005. In July 2005, the temporary cover was removed to allow placement of an additional 26,700 cubic meters (34,900 cubic yards) of waste from six sites. This work was substantially complete by mid-October 2005, with final reclamation of the repository cover scheduled to be finished in 2006. The major components of the repository include a rock toe buttress, a double-lined bottom liner system with toe drains and sump, and a double-lined cover system. The repository covers an area of about 1.8 hectares (4.5 acres).



Note: Base Map from Crown Butte Mines, Aerial Photography



0 Feet 300
Contour Interval = 10 Feet

MAXIM
TECHNOLOGIES INC. 5561065A.100

- Bedrock Monitoring Well
- Surface Water Monitoring Location
- Glacial Till Monitoring Well

New World Repository Location Map
New World Mining District
Response and Restoration Project
Cooke City Area, Montana

FIGURE 2

When the first phase of the repository was constructed in 2001/2002, waste placed in the repository was exposed to precipitation that fell during construction and over the winter between construction seasons. This precipitation increased the moisture content of the waste and, after draining from the waste, accumulated in the repository sump. It was necessary to dispose of this accumulated fluid in the sump in the spring of 2002 to prevent overflow of the sump. In April 2002, about 41,640 liters (11,000 gallons) was pumped from the sump and disposed on-site using snowmaking equipment. Following repairs that were made to the temporary closure in 2002, the rate of water accumulating in the sump was monitored using continuous water level recorders, and it was noted that the rate of accumulation increased coincident with the melting of snow at the repository in the spring. This observation along with other evidence indicated that a tear in the temporary cover was allowing a seasonal incursion of water into the repository during snowmelt. During the peak period of water accumulation, the spring snowmelt period which lasts from four to six weeks at the repository site, the sump gained about 1,020 liters (270 gallons) of water per day (0.19 gallons per minute). Since October 2002, about 605,700 liters (160,000 gallons) of water have been removed from the repository sump and disposed in the Cody, Wyoming, sewage lagoon.

Water that had accumulated in the repository sump was routinely monitored for physical and chemical characteristics. These data show that the chemistry of the water reflects the chemistry of sulfides present in the interred waste. This water is neutral to slightly acidic, and contains elevated concentrations of total dissolved solids, sulfate, iron, and manganese, with trace amounts of arsenic, barium, copper, selenium, and zinc. **Table I** presents repository sump chemistry for the period of 2001 to 2004.

The repository has been designed and constructed to prevent surface water from entering the waste through the engineered cover and to prevent any solution generated in the waste from exiting the lined facility into surface water or groundwater. The design components that are integral to these functions are the bottom liner, the rock toe buttress, the sump, and the top liner and soil cover system. Environmental conditions that could compromise the cover or the bottom liner include, but are not limited to, the following: erosion of the soil cover to a depth that exposes the composite top liner system; damage to the composite cover liner system that allows water to infiltrate through the cover into the waste; slumping or mass wasting of the soil cover; conditions that cause the rock toe buttress to become unstable, exposing the interred waste to the environment; and leaks that develop in the bottom liner or top liner system. Environmental monitoring activities detailed in this long-term monitoring plan are intended to provide information that will identify any conditions that might compromise the ability of the repository to prevent a release of mine waste contaminants to the environment, and to allow for the implementation of corrective actions.

TABLE 1
REPOSITORY SUMP MONITORING - REPOSITORY SUMP CHEMISTRY
2001 to 2004 WATER QUALITY DATA
New World Mining District Response and Restoration Project

PARAMETER (metals are total recoverable)	REPOSITORY SUMP																			
	10/8/01	11/26/01	1/15/02	3/5/02	5/2/02	5/21/02	5/30/02	6/6/02	6/12/02	6/25/02	6/30/02	1/8/03	5/29/03	6/11/03	6/18/03	7/1/03	3/23/04	4/19/04	5/21/04	6/4/04
Inches water			48	45	38	69	68	42	40	36	36	36	61	55	55	73	34	45	56.5	58.5
pH - lab (field) (s.u.)	6.5	7.1	6.8	7.1	6.5	7.1	(6.75)	6.9	(6.9)	(7.15)	(7.1)	6.5	6.5	--	--	6.5 (6.2)	6.8	7.3	6.9 (6.7)	6.7 (6.5)
Conductivity (umhos/cm)	4310	3760	4050	3110	3020	1360	1229	1330	1371	1044	1346	2920	3400	2480	2230	3040	3110	3330	3050	3070
Conductivity - lab (field) (umhos/cm)	4310	3760	4050	3110	3020 (3170)	1360 (1377)	(1229)	1330 (1354)	(1371)	(1044)	(1346)	2920 (3160)	3400 (3280)	(2480)	(2230)	3040 (3260)	3110	3330	3050 (2820)	3070 (2920)
Chloride (mg/l)			12	13	8	<4		1				8	14			13	9	10	11	11
Sulfate (mg/l)	1900	1680	1720	1620	1030	425		377				1220	1230			1240	1260	1140	1250	1390
Alkalinity (mg/l)	1280	1060	839	778	1060	428		428				1010	1020			959	959	985	1000	950
TDS (mg/l)			3350	3250	2570	1010		1020				2870	2840			2920	2770	2830	2880	2910
TSS (mg/l)			16	<10	12	10		47				25	22			12	8	11	10	10
Hardness (mg/l)			1840	1735	1700	867		833				2020	2110			2140	2030	2030	2040	2030
Aluminum (mg/l)	2.7	<0.1	0.2	<0.1	<0.1	0.14		0.3				<0.1	<0.1			<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (mg/l)	<0.003	0.004	<0.003	0.003	<0.003	0.003		<0.003				0.005	0.003			0.003	0.005	0.005	0.004	0.004
Barium (mg/l)			0.03	0.03	0.03	0.02		0.04				0.04	0.02			0.03	0.024	0.027	0.025	0.025
Cadmium (mg/l)	0.0003	<0.0001	<0.0001	<0.0001	0.0008	<0.0001		<0.0001				<0.0001	<0.0001			<0.0001	<0.0001	0.0002	<0.0001	<0.0001
Chromium (mg/l)	0.003	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001				<0.001	0.001			<0.001	0.002	<0.001	<0.001	0.002
Copper (mg/l)	0.024	0.007	<0.001	0.002	0.002	0.002		0.004				0.006	0.004			<0.001	0.004	0.001	0.001	0.002
Iron (mg/l)	6.09	0.29	0.89	0.78	0.94	0.64		0.7				7.9	7.95			5.84	4.02	3.19	3.85	4.13
Lead (mg/l)	0.018	<0.003	<0.001	<0.001	<0.001	<0.001		0.003				<0.001	<0.002			<0.001	<0.003	<0.001	<0.001	<0.001
Manganese (mg/l)	2.35	2.1	1.99	1.71	3.55	1.79		1.66				4.61	6.09			5.33	4.79	4.04	4.17	4.72
Mercury (mg/l)			<0.0002	<0.0002	<0.0002	<0.0002		<0.0002				<0.0002	<0.0002			<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Selenium (mg/l)			0.003	0.002	0.001	<0.001		<0.001				0.002	0.002			0.003	0.001	0.005	0.005	0.004
Silver (mg/l)			0.0055	<0.0005	<0.0005	<0.0005		<0.0005				<0.0005	<0.0005			<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Zinc (mg/l)	0.07	0.03	<0.01	<0.01	<0.01	0.02		0.03				0.12	0.02			<0.01	<0.01	<0.01	0.01	0.07

Notes: Shaded cells indicate parameters of interest; blank cell indicates parameter not analyzed/not measured
cfs = cubic feet per second; s.u. = standard units; umhos/cm = micromhos per centimeter; mg/L = milligrams per liter;

2.0 MONITORING AND MAINTENANCE ACTIVITIES

Monitoring and maintenance activities include measuring surface water and groundwater parameters and making visual observations of soil and vegetation conditions on the cover. These activities are described in detail in the following sections. A checklist for collection of data associated with this monitoring plan is included in **Appendix A**.

2.1 SUMP MONITORING AND MAINTENANCE

The objective of sump monitoring is to determine the volume and chemistry of water present in the sump. If the capacity of the sump is approached, appropriate plans can be made to reduce the volume of water to a lower level. Knowledge of the chemistry of the water provides information useful in determining disposal options.

2.1.1 Repository Sump Characteristics

The repository sump has a capacity of about 121,130 liters (32,000 gallons) at a height of 178 centimeters (70 inches) above the bottom of the sump. If water rises above this level, it begins wetting the lowermost waste that was placed above the sump footprint. The sump is equipped with a six-inch diameter polyethylene pipe where water levels can be monitored and where excess water can be pumped from the sump. **Figure 3** shows details of the sump construction.

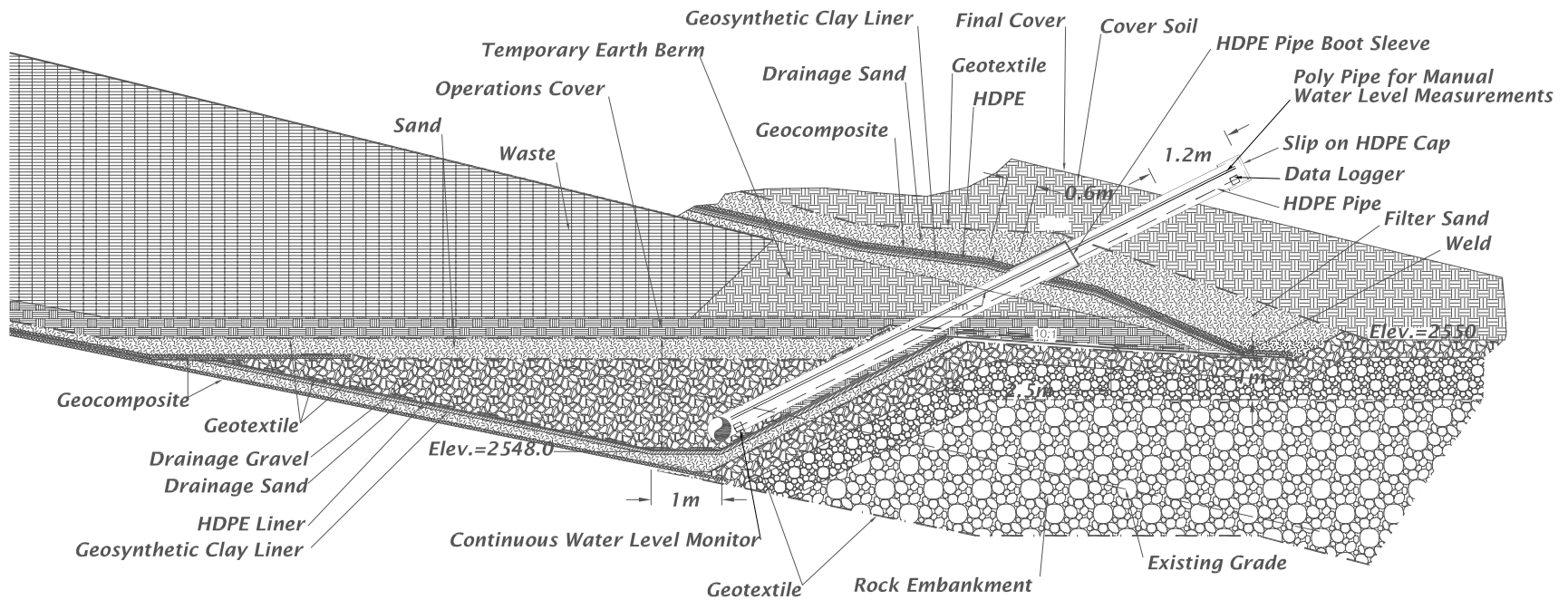
The repository sump is currently instrumented with a continuous water level measurement device that records the level of water in the sump and stores the data internally. This instrument is powered by replaceable batteries with a battery life of about six months. Water level in the sump can also be measured manually in the field using a pressure vacuum gauge attached to a small diameter poly pipe that is inserted into the bottom of the sump. This measurement converts pressure head to inches of water in the sump.

2.1.2 Annual Sump Monitoring Activities

For regular monitoring of the sump, water levels will be recorded on a daily basis by the continuous water level instrument. This data will be downloaded quarterly beginning in January of each year and permanently stored in the project database. Fresh batteries will be installed in the continuous water level monitor following each data download, and the instrument will be checked each time to ensure it is operating within normal parameters. A water level measurement will also be manually taken in the field using the vacuum gauge to verify water level readings collected by the continuous water level instrument. If the instrument is found to be malfunctioning, a replacement instrument will be obtained and installed in the sump, with continuous water level measurements reinitiated as soon as possible.

After water levels are collected and the continuously recorded data are downloaded, a water sample will be drawn from the sump using a dedicated polyethylene bailer. Field parameters will be measured in the water sample and recorded on a groundwater field form. Field parameters are used to track trends in sump chemistry; a list of field parameters that will be measured is shown in **Table 2**.

If water level information collected each quarter indicates that the sump capacity may be exceeded before the next quarterly monitoring event, a water sample will be collected and analyzed for laboratory parameters. **Table 3** lists sampling requirements for samples and **Table 4** lists laboratory analytical requirements. Water samples will be collected in accordance with methods and procedures described



Repository Sump Construction Detail

Scale: 1:100

TABLE 2
GROUNDWATER FIELD PARAMETERS

Parameter	SOP Number⁽¹⁾	SOP Title	Event
Specific Conductance	SOP-05	Field Measurement of Specific Conductance	All
pH	SOP-06	Field Measurement of pH	All
Water Temperature	SOP-07	Field Measurement of Water Temperature	All
Oxidation-Reduction	SOP-28	Field Measurement of Redox Potential (Eh)	All
Dissolved Oxygen	SOP-08	Field Measurement of Dissolved Oxygen	All
Depth to Water	SOP-20	Field Measurement of Groundwater Level	All

1 Maxim Standard Operating Procedures (Appendix A)

TABLE 3
GROUNDWATER SAMPLING REQUIREMENTS

Parameter	Preservation⁽¹⁾	Bottle Size/Type
Dissolved Metals	Filtered through 0.45 micron filter; HNO ₃ to pH < 2; Iced to 4°C	500 milliliter polyethylene
Common Ions/Physicochemical	Iced to 4°C	1 liter polyethylene

1 HNO₃ = nitric acid

**TABLE 4
GROUNDWATER ANALYTICAL REQUIREMENTS**

Parameter	PQL (mg/l)⁽¹⁾	EPA Method No. ⁽²⁾	Max. Holding Time
Physicochemical			
Specific Conductivity	None	2310B	28 days
pH	None	150.1	Upon arrival at lab
Total Dissolved Solids	None	2340C	7 days
Hardness	None	2340B	6 months
Acidity	None	305.1	14 days
Metals⁽³⁾			
Aluminum	0.05	200.8/200.7	6 months
Arsenic	0.001	200.8/200.7	6 months
Cadmium	0.0001	200.8/200.7	6 months
Copper	0.001	200.8/200.7	6 months
Iron	0.01	200.8/200.7	6 months
Lead	0.001	200.8/200.7	6 months
Manganese	0.003	200.8/200.7	6 months
Zinc	0.01	200.8/200.7	6 months
Common Cations⁽³⁾			
Calcium	1.0	200.8/200.7	6 months
Magnesium	1.0	200.8/200.7	6 months
Potassium	1.0	200.8/200.7	6 months
Sodium	1.0	200.8/200.7	6 months
Common Anions⁽³⁾			
Sulfate	None	375.2	28 Days
Bicarbonate	None	2320B	14 Days
Carbonate	None	2320B	14 Days
Chloride	None	325.3	28 Days

1 PQL = Practical Quantitation Limit in milligrams per liter (mg/L)

2 Source: EPA, 1986, Test Methods for Evaluating Solid Waste – Physical/Chemical Methods, SW-846.

3 Groundwater parameters will be analyzed as dissolved constituents as filtered through a 0.45 micron filter

in the Site-Wide Sampling and Analysis Plan (Maxim, 1999b) and Maxim Standard Operating Procedures (SOPs), which are included in **Appendix A** of this plan.

2.2 GROUNDWATER MONITORING

The objective of groundwater monitoring is to measure physical and chemical parameters to determine whether the repository is negatively impacting groundwater resources. This objective will be accomplished by monitoring wells located both upgradient and downgradient of the repository. Wells installed in these positions at the repository site are shown in **Figure 4** and are listed in **Table 5**. At each of the three locations shown in the figure, two wells have been installed, with one of the wells completed in glacial till at a shallow depth and the other completed in bedrock. Groundwater flow direction in the shallow till generally parallels the slope (**Figure 4**).

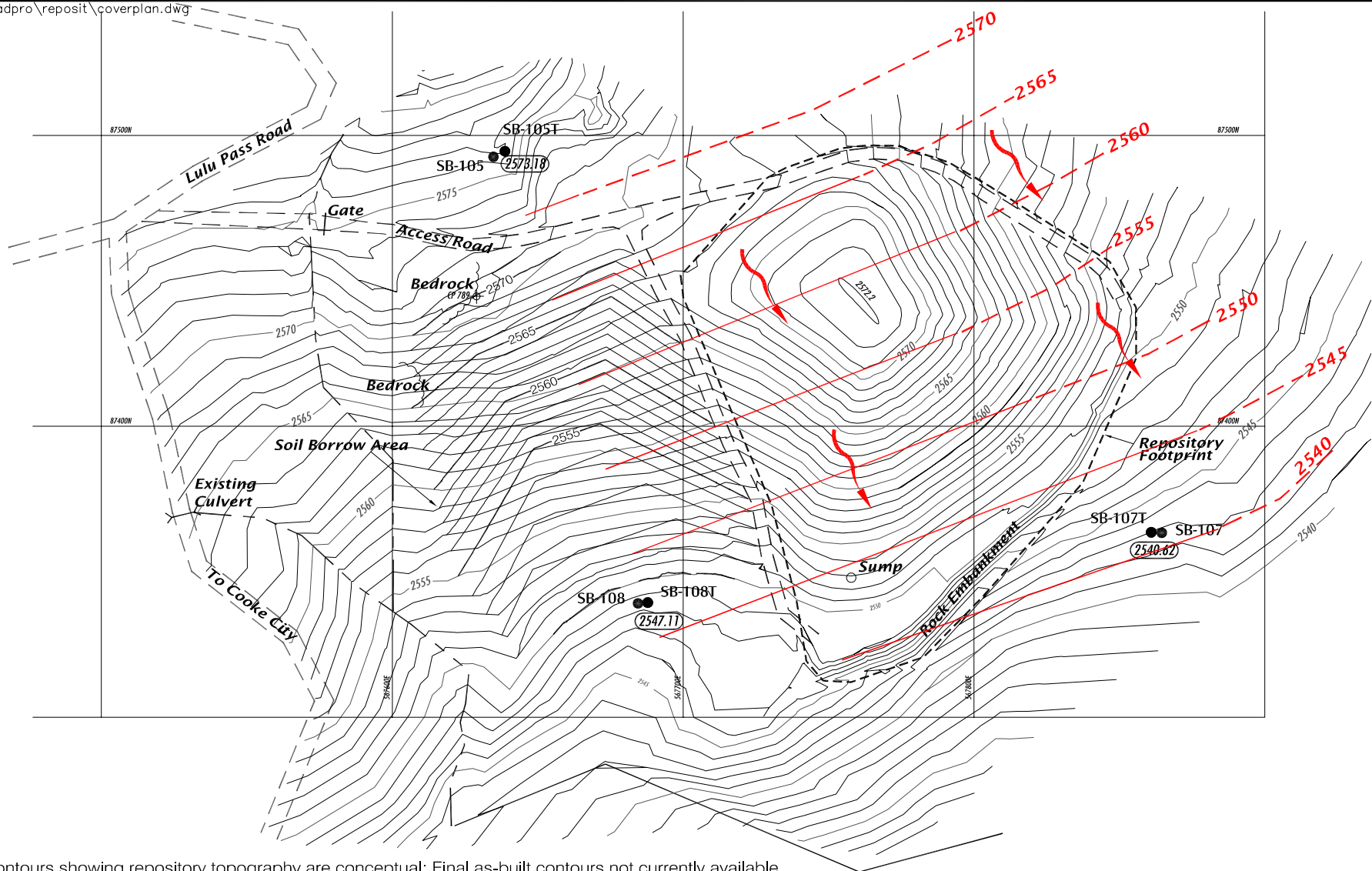
TABLE 5 LONG-TERM REPOSITORY MONITORING WELLS							
Well No.	Year Installed	Total Depth (feet)	Completion Formation	Depth to Bedrock (feet)	Annual Monitoring Event		
					May	July	Continuous
SBGW-105T	1999	17	Till	--	X	X	W
SBGW-105	1999	35	Granite	24	X	X	--
SBGW-107T	1999	10	Till	--	X	X	W
SBGW-107	1999	30	Granite	15	X	X	--
SBGW-108T	1999	14.75	Till	--	X	X	--
SBGW-108	1999	35	Granite	19	X	X	--

Note: X Samples collected and analyzed for full suite of laboratory parameters.
W Continuous water level monitoring.

Continuous water level monitors are currently installed in two of the three glacial till wells, the upgradient well (SBGW-105T) and the downgradient well (SBGW-107T). As with the repository sump water level instruments, water levels will be measured at these two wells on a daily basis and stored internally. Continuous water level data will be used to closely monitor water levels adjacent to the sump, especially during the spring snowmelt period when water levels rise to within a few inches of the surface in the shallow till wells. **Figures 5 and 6** show water level changes in the two wells since the water level monitors were installed.

Continuous water level data will be downloaded quarterly beginning in January of each year and permanently stored in the project database. At this same time, water levels will be manually measured in the field following Maxim SOP 20 in each of the six wells at the site (**Table 5**). Field measurements will be used to verify water level readings collected by the continuous water level instrument in the upgradient and downgradient wells, and water level readings taken from the bedrock wells and the SBGW-108 well pair to allow determination of groundwater flow direction and vertical gradient.

Fresh batteries will be installed in the continuous water level instruments following each data download, and the instrument will be checked each time to ensure it is operating within normal parameters. If an instrument is found to be malfunctioning, a replacement instrument will be obtained and installed as soon as possible.



Note: Contours showing repository topography are conceptual; Final as-built contours not currently available.



0 20 60
Metric: 1:2000
Contour Interval = 1 meter

SB-108T ● Monitoring Well

(2540.62) Groundwater Elevation (Meters) In
Glacial Till Wells on June 27, 2005

2540 — Groundwater Contour
Contour Interval = 5 meters
(Dashed where Inferred)

→ Groundwater Flow Direction

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

FIGURE 4

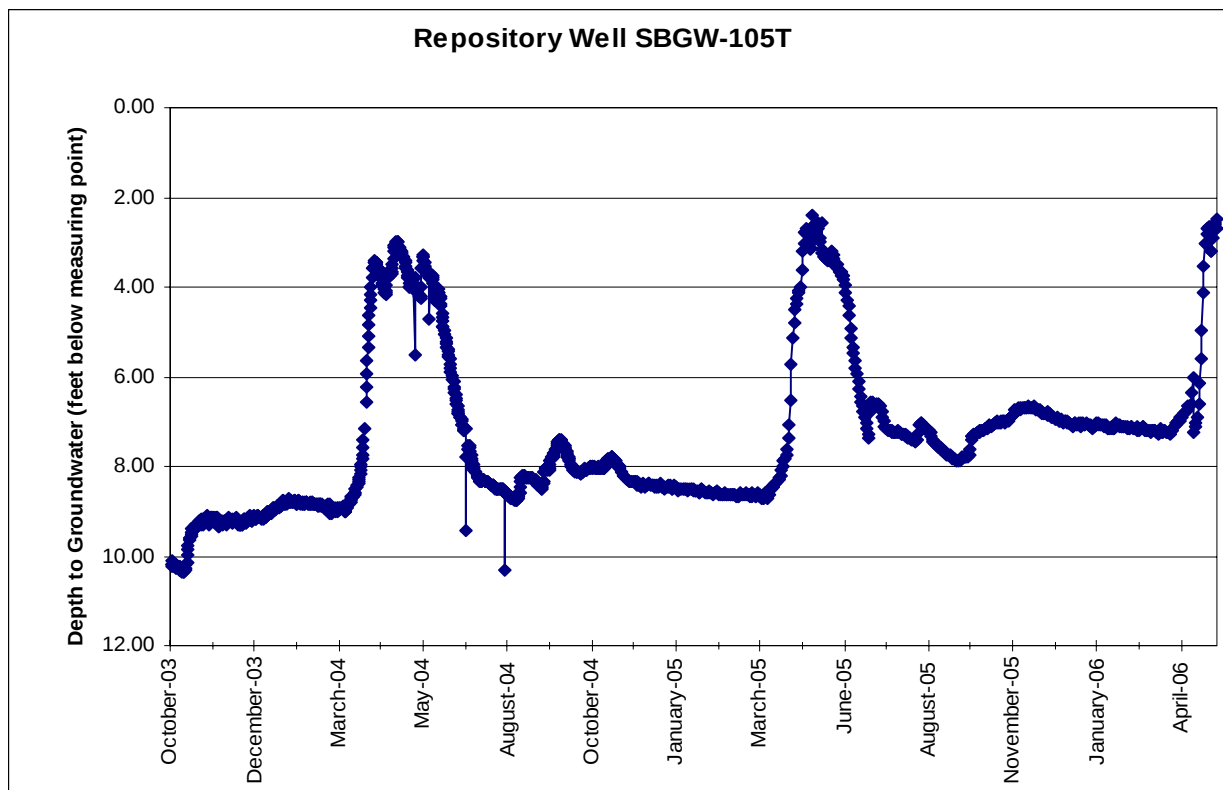


Figure 5. Depth to Groundwater in Repository Well SBGW-105T

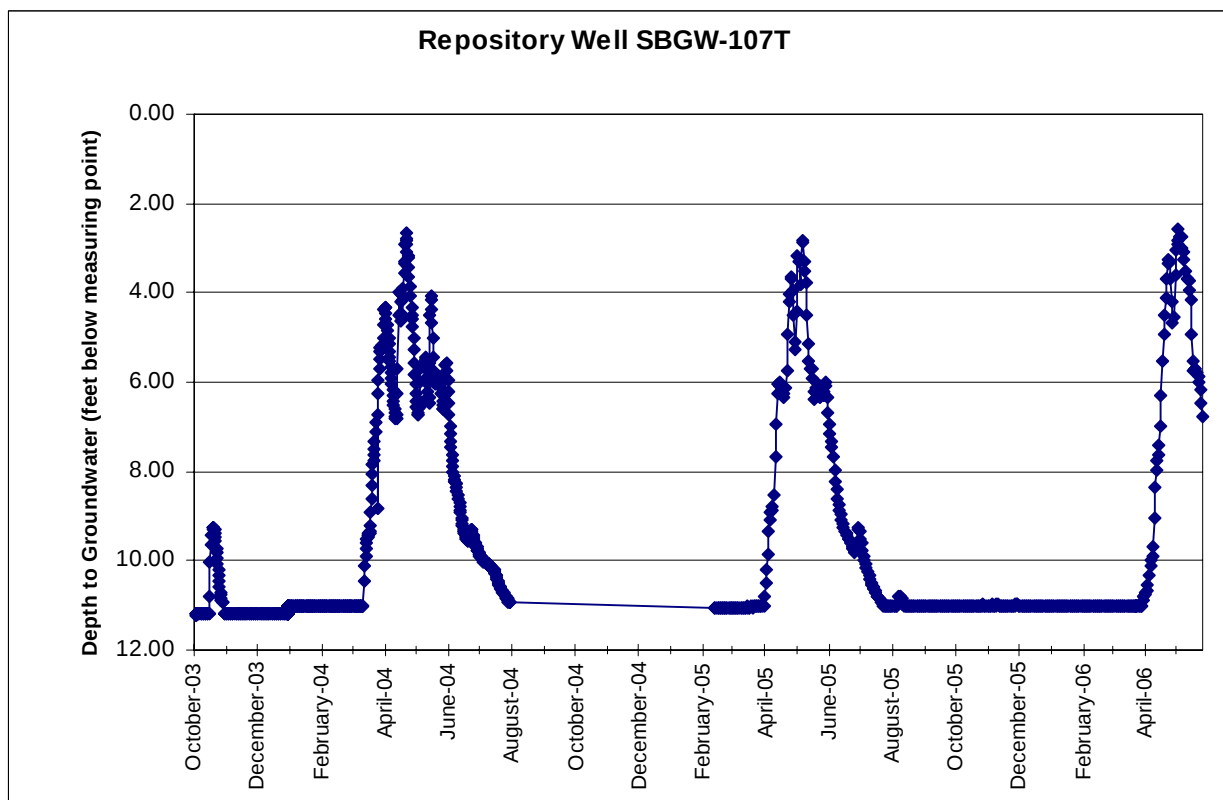


Figure 6. Depth to Groundwater in Repository Well SBGW-107T

Repository wells will be sampled twice annually: in late May when water levels are typically at the highest level reached during the year; and in mid-summer after water levels have fallen to seasonal lows (see **Figures 5 and 6**). Past experience has shown that water quality is generally more mineralized and contains higher concentrations of contaminants when water levels are high. Till well SBGW-107T is generally dry between August and April, although water levels in till well SBGW-105T remain about a foot or two above the total depth of the well during this same period. Water levels in both wells quickly respond to some rain events in the early fall (see **Figures 5 and 6**).

The two sampling events will involve measuring water levels, measuring field parameters, and collecting samples for laboratory analysis. **Tables 2, 3, and 4** list field parameters, sampling requirements, and analytical parameters.

2.3 SURFACE WATER QUALITY MONITORING

The objective of surface water monitoring is to measure physical and chemical parameters in the tributary that drains the repository area to determine whether the repository is negatively impacting surface water resources. Surface water sites that will be monitored are shown on **Figure 2**. Surface water sites SBT-6 and SBT-3 will be monitored before the onset of snowmelt (April), during higher flow conditions (May) in conjunction with the spring repository monitoring event, and during low flow in conjunction with the fall quarterly repository monitoring event. The toe seep will be monitored one time each year during high flow.

Surface water samples will be collected and analyzed in accordance with procedures and methods described in the Site-Wide Sampling and Analysis Plan (Maxim, 1999b). In addition to the analytical methods described in the Site-Wide SAP, analysis of dissolved metals will be added to the parameter list. Analysis of dissolved metals allows the determination of suspended metals in the total fraction by difference between the two results.

Table 6 lists surface water field parameters and standard operating procedures (SOPs) from the Site-Wide SAP. **Table 7** lists preservation and bottle requirements and **Table 8** lists surface water analytical requirements and practical quantitation limits (PQLs).

TABLE 6 SURFACE WATER FIELD PARAMETERS			
Parameter	SOP Number ⁽¹⁾	SOP Title	Event
Specific Conductance	SOP-05	Field Measurement of Specific Conductance	All
pH	SOP-06	Field Measurement of pH	All
Water Temperature	SOP-07	Field Measurement of Water Temperature	All
Flow	SOP-01	Streamflow Measurement; Wading Technique	All

1 Maxim Standard Operating Procedures (Appendix A, Site-Wide SAP)

TABLE 7
SURFACE WATER SAMPLING REQUIREMENTS

Parameter	Preservation ⁽¹⁾	Bottle Size/Type
Total Recoverable Metals	HNO ₃ to pH < 2; Iced to 4°C	500 milliliter polyethylene
Dissolved Metals	Filtered through 0.45 micron filter; HNO ₃ to pH < 2; Iced to 4°C	500 milliliter polyethylene
Common Ions/Physicochemical	Iced to 4°C	1 liter polyethylene

1 HNO₃ = nitric acid

TABLE 8
SURFACE WATER ANALYTICAL REQUIREMENTS

Parameter	PQL (mg/L) ⁽¹⁾	EPA Method No. ⁽²⁾	Max. Holding Time
Physicochemical			
Specific Conductivity	None	2310B	28 days
pH	None	150.1	Upon arrival at lab
Total Dissolved Solids	None	2340C	7 days
Total Suspended Solids	None	160.2	7 days
Hardness	None	2340B	6 months
Acidity	None	305.1	14 days
Metals⁽³⁾			
Aluminum	0.05	200.8/200.7	6 months
Cadmium	0.0001	200.8/200.7	6 months
Copper	0.001	200.8/200.7	6 months
Iron	0.01	200.8/200.7	6 months
Lead	0.001	200.8/200.7	6 months
Manganese	0.003	200.8/200.7	6 months
Zinc	0.01	200.8/200.7	6 months
Common Cations⁽³⁾			
Calcium	1.0	200.8/200.7	6 months
Magnesium	1.0	200.8/200.7	6 months
Potassium	1.0	200.8/200.7	6 months
Sodium	1.0	200.8/200.7	6 months
Common Anions⁽³⁾			
Sulfate	None	375.2	28 Days
Bicarbonate	None	2320B	14 Days
Carbonate	None	2320B	14 Days
Chloride	None	325.3	28 Days

1 PQL = Practical Quantitation Limit in milligrams per liter (mg/L)

2 Source: EPA, 1986, Test Methods for Evaluating Solid Waste – Physical/Chemical Methods, SW-846.

3 Surface water parameters will be analyzed as both total and dissolved (filtered through 0.45 micron filter) metals.

2.4 QUALITY CONTROL SAMPLES

Quality control (QC) samples will be collected during each sampling event and for each media sampled (i.e. surface water, groundwater, and repository sump) according to Maxim SOP-13 (QC Samples). The following QC samples will be collected:

- Blanks (DI water) - 1 per sampling event.
- Equipment rinsate blanks - 1 per day for each procedure requiring equipment decontamination (disposable equipment will be used where possible).
- Field duplicates - 1 per sampling event.

Quality control samples will be analyzed for the same constituents as field samples. Rinsate blanks will only be collected when pre-cleaned, disposable equipment is not available and reusable equipment requires decontamination.

2.5 REVEGETATION MONITORING AND MAINTENANCE

The objectives for revegetation monitoring of the repository are to determine if revegetation cover is adequately protecting the cover from erosion or soil stability problems and to identify areas that require maintenance. A percent cover criterion of 20% was developed for removal sites at higher elevations in the project area, and this criterion was derived from the average natural cover measured by Dr. Ray Brown at the McLaren area revegetation trial plots (Brown, et. al., 1996). However, due to the lower elevation of the repository site, a cover criterion of 40% will be used to determine if revegetation is adequate.

Quantitative revegetation monitoring will be performed annually to document general vegetation condition, presence of erosion features, and approximate percent coverage. Revegetation monitoring will be conducted in accordance with area-wide monitoring procedures described in the Long-Term Revegetation Monitoring Plan (Maxim, 1999c). Monitoring will be completed in one annual event timed to coincide with the period of maximum plant growth.

Area-wide observational monitoring will be conducted on the cover to record the number, size, and location of areas bare of vegetation and, the presence, size, and extent of erosional features such as rills and gullies. Criteria used to determine if an area is barren will be areas that are larger than 100 square feet, areas where reclamation treatment has clearly failed, or areas where significant erosion or slope stability concerns are associated with lack of vegetation.

Observations of barren reclaimed areas will include an assessment of the cause for the lack of vegetation and will be recorded on field sheets. Factors to note may be the appearance of salts, steepness of slope, seeding failure, or other soil inhibiting factors. Field observations will be recorded in a field book and photographs will be taken showing the general vegetation cover and any problem areas. Erosion sites or bare areas will be plotted on the site map shown on **Figure 4**.

If bare or eroded areas are observed during cover monitoring, soil samples will be collected for laboratory analysis. Samples will be collected from a depth of about 15 cm and placed in one-gallon polyethylene bags. Samples will be labeled by location and returned to a qualified laboratory for selected analyses in accordance with the parameters and methods in the Site-Wide SAP for native soil collection. Laboratory parameters may include USDA soil texture, coarse fragment content, pH,

electrical conductivity, organic matter, and nutrients. Sample collection and parameter selection will be performed at the discretion of the field observer to ensure site-specific conditions are being addressed. Following receipt of the laboratory analysis, recommendations will be made to amend soils or reseed barren areas.

2.6 REPORTING

An annual repository monitoring report will be prepared following the fall quarterly monitoring event. The report will include results of all monitoring activities conducted during the year at the repository. The annual monitoring report will describe the methods and procedures followed, will evaluate and summarize monitoring results, and will present recommendations for corrective action, if needed. Other information provided in the annual report will include visual observations, field notes, photographs, laboratory analytical reports, and a summary of monitoring costs expended.

2.7 ANNUAL MONITORING AND MAINTENANCE COST ESTIMATE

Estimated costs to perform annual monitoring tasks are presented in **Table 9**. These costs are based on mobilizing to the site from Bozeman, Montana, for four quarterly monitoring events. **Costs are based on current unit prices for hourly labor, mileage, and laboratory analysis of surface water and groundwater samples, and do not include replacing existing equipment or instrumentation.**

The cost estimate does not include sampling and analyzing soil samples in bare areas or costs for required maintenance. Any costs incurred for these activities would be dependent on the nature and extent of any revegetation failures. These conditions may never occur, or if present, would be highly variable from year to year.

TABLE 9 ESTIMATED ANNUAL REPOSITORY MONITORING COSTS				
Event	Labor	Laboratory	Other Direct Costs	Total Cost
January	\$1,225.50	\$0.00	\$482.00	\$1,707.50
April	\$1,457.50	\$1,043.75	\$785.00	\$3,286.25
May	\$4,315.00	\$2,736.80	\$954.20	\$8,006.00
Late July	\$2,233.50	\$1,324.40	\$577.00	\$4,134.90
Revegetation Monitoring	\$2,632.50	\$0.00	\$514.5	\$3,147.00
October	\$2,233.50	\$775.50	\$634.50	\$3,385.00
ANNUAL TOTAL COST	\$14,097.50	\$5,880.45	\$3,947.20	\$23,925.15
NET PRESENT VALUE - 10-YEAR MAINTENANCE COST (discount rate = 4%)				\$194,054

Note: Other direct costs include travel expenses, field equipment charges, and consumables; these costs do not include replacement of water level recording instruments if replacement is needed.

3.0 REFERENCES

- Brown, R.W, M.C. Amacher, B.D. Williams, W.F. Mueggler, and J. Kotuby-Amacher, 1996. Reclamation Research in the New World: 1995 Report of Research. USDA Forest Service, Intermountain Research Station, Forestry Sciences Laboratory, Logan, UT. Prepared for: Crown Butte Mines, Inc. May.
- EPA, 1993. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. EPA/540-R-93-057. Publication 9360.0-32. Office of Emergency and Remedial Response. Washington D.C. August.
- EPA, 1986. Test Methods for Evaluating Solid Waste – Physical/Chemical Methods, SW-846.
- Maxim Technologies, 1999a. Overall Project Work Plan. New World Mining District Response and Restoration Project. Final. Prepared for the USDA Forest Service, November 10.
- Maxim Technologies, 1999b. Site-Wide Sampling and Analysis Plan. New World Mining District Response and Restoration Project. Appendix B of the Overall Project Work Plan. Final. Prepared for the USDA Forest Service, November 10.
- Maxim Technologies, 1999c. Long-Term Revegetation Monitoring Plan. New World Mining District Response and Restoration Project. Appendix E of the Overall Project Work Plan. Final. Prepared for the USDA Forest Service, November 10.

APPENDIX A

MAXIM STANDARD OPERATING PROCEDURES LONG-TERM REPOSITORY MONITORING PLAN *New World Mining District Response and Restoration Project*

TABLE OF CONTENTS
STANDARD OPERATING PROCEDURES
MAXIM TECHNOLOGIES

NUMBER	TITLE
Checklist	Environmental Monitoring Checklist
SOP-01	Streamflow Measurement; Wading Technique
SOP-03	Surface Water Sampling
SOP-04	Field Sampling Filtration
SOP-05	Field Measurement of Electric or Specific Conductance
SOP-06	Field Measurement of pH
SOP-07	Field Measurement of Water Temperature
SOP-08	Field Measurement of Dissolved Oxygen
SOP-09	Sample Packaging and Shipping
SOP-10	Field Forms
SOP-11	Equipment Decontamination
SOP-12	Sample Documentation
SOP-13	QC Samples
SOP-18	Groundwater Sampling
SOP-19	Preparation and Preservation of Acid Soluble Samples
SOP-20	Field Measurement of Groundwater Level
SOP-22	Mine Waste, Soil, and Sediment Sample Collection
SOP-24	Soil Sample Preparation and Preservation
SOP-28	Field Measurement of Redox Potential

ENVIRONMENTAL MONITORING CHECKLIST

New World Waste Repository

Personnel	Date:	
Weather		
General Comments		
Activity (check box if completed)		
☐	General condition of entire site (attach detailed notes if more space required; attach photographs):	
☐	General description of vegetation condition (attach area-wide monitoring form):	
☐	Note any erosion or drainage problems observed (attach detailed notes if more space required):	
☐	Note condition of rock toe buttress including any evidence of surface cracks or slumps:	
☐	Are seeps present at the toe of the rock toe buttress? If so, note seep distribution and approximate flow:	
☐	Sump Characteristics: Sump water level: _____ feet Download data logger? _____ (yes or no) file name: _____ Sample collected? _____ (yes or no)	
☐	Monitoring Well Data: I05T depth to water: _____ feet I05 DTW: _____ feet I07T depth to water: _____ feet I07 DTW: _____ feet I08T depth to water: _____ feet I08 DTW: _____ feet Download data loggers? _____ file names: _____ Samples collected? _____	
☐	Surface water samples collected (attach field form):	
☐	Groundwater samples collected (attach field form):	
☐	Field recommendations or corrective actions taken (attach detailed notes if more space required):	