Chapter 2

Description of Alternatives

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2.1 INTRODUCTION

GSM operates an open pit gold mine and mineral processing facility at the south end of Bull Mountain near Whitehall, Montana. Bull Mountain forms a north-south trending topographic divide ranging in elevation from approximately 5,000 to 6,500 feet in the mine area. The open pit lies just east of the topographic divide and currently occupies an area with 218 acres of total disturbance. This will not increase in size through Stage 5B.

As described in Section 1.4.3, the mine and facilities would normally be reclaimed under reclamation plans that have been approved by DEQ and BLM. However, portions of the statute relied on to select the method of pit closure in the 1998 ROD were ruled unconstitutional by the District Court. In its June 2002 judgment, the District Court ordered DEQ to begin implementation of a partial pit backfill reclamation plan in accordance with the procedures set forth in MMRA. To comply with the court order, and because pit designs have changed and new technical data are available to reevaluate potential environmental impacts of closure by partial pit backfilling, DEQ and BLM have determined that an SEIS is required.

What has changed in Chapter 2 since the DSEIS?

Chapter 2 describes the alternatives, their development and impact. The preferred alternative is also outlined. Based on additional data and public comments, the following changes have been made:

- GSM 2004 Annual Report was used to update all figures.
- GSM's 2006 Annual Report was used to update some acreages.
- Another soil borrow source was identified.
- The rationale for the less than 10 percent of pit water likely flowing south along Range Front Fault and other secondary flow paths was explained.
- The pit water balance was updated to reflect recent data (Telesto, 2006).
- Table 2-2 was changed to match Table 1 in the Summary.
- All text, figures and tables were revised from data provided by GSM and various consultants.
- Text was corrected based on references.

This chapter includes:

- A description of the mine plan and modifications that affect the ultimate configuration of the open pit;
- The process used to formulate the pit closure alternatives evaluated in this SEIS;
- Descriptions of the alternatives that have been considered;
- A summary of the reclamation impacts projected for each of the alternatives considered; and,
- The agencies' Preferred Alternative.

A range of alternatives was developed as a result of the scoping process. All reasonable alternatives were explored and objectively evaluated. Although some of the alternatives were eliminated from detailed study, descriptions of all alternatives are included in this chapter. The Partial Backfill Alternative described in the 1998 Final EIS and subsequently updated to reflect current conditions and modifications (GSM, 2002) is the Proposed Action. The No Pit Pond Alternative described in the 1998 Final EIS and the 1998 ROD serves as the No Action Alternative. Five additional alternatives or variations of these alternatives were studied in this SEIS. Two of the five alternatives were evaluated in detail.

GSM was permitted for 2,964 acres of disturbance (1997 Draft EIS, Table II-22)(GSM 2006 Annual Report). Based on minor revisions permitted since 1998, GSM's approved area for disturbance is 3,002.5 acres. GSM is currently bonded for 2,619.55 acres of disturbance. GSM's permit area is 6,125 acres.

Table 2-1 compares the permitted disturbance at GSM with the proposed disturbance at the end of Stage 5B mining (GSM 2006 Annual Report). GSM's current actual disturbance is 2,236 acres. A new disturbance map was developed and was used to prepare the figures in the SEIS. The numbers reported in Table 2-1 are based on the latest acreage determination and are considered the most accurate. Because these numbers were developed from new site maps and surveys, the numbers do not match the table in the GSM 2002 Annual Report or the 1997 Draft EIS, Table II-22. The disturbance categories were modified to better reflect actual disturbance. Some acreages were moved from one disturbance category to another.

GSM has completed 1,066 acres of reclamation within the disturbance boundary as of December 31, 2006. Table 2-1 details the completed reclamation. At the end of Stage 5B, a total of 560 acres of BLM land would have been disturbed.

Table 2 - 1. Summary of GSM's Permitted Disturbance and Reclaimed Areas

Disturbance Category	Disturbance at End of Stage 5B (Acres)	Reclaimed as of December 31, 2004 (Acres)	1997 Draft EIS Permitted Disturbance (Acres)
West and South Waste Rock Dump Complex	507	507	616
East Waste Rock Dump Complex	438	106	536
East Waste Rock Dumps Misc.	88	46	134
Buttress Waste Rock Dump & Road	66	51	266
Open Pit	218	7	254
Open Pit Area	68	0	82
Facilities	90	4	35
Tailings Impoundments	578	268	865
Stockpiles & Borrow Areas, Roads, and Miscellaneous	183	83	176
TOTAL	**2,236**	**1,072**	**2,964**

Source: GSM 2006 Annual Report Table AR-05-7.1 and 1997 Draft EIS Table II-22.

2.2 MINE PLANNING

2.2.1 Pit Development and Waste Rock Dump Complexes

Mining at GSM is accomplished with conventional open-pit methods that consist of drilling, blasting, loading, and hauling. Waste rock has been extracted and hauled to dump complexes located at the east, west, and south sides of the pit. All waste rock from current mining activities is placed in the East Waste Rock Dump Complex. The bottom of the pit is currently at an elevation of 4,650 feet, 700 feet below the lowest point on the eastern rim of the pit. Figure 1-2 shows the entire mine and facilities area.

Since mining began in 1982, pit development has occurred in stages, which have progressively deepened and expanded the pit. Pit Stages 1 through 5A have been completed. Development of the Stage 5B Pit to the 4,650-foot elevation has been approved by the agencies. In September 2003, GSM decided to begin mining Stage 5B and is now proposing an ultimate pit bottom elevation of 4,525 feet. The agencies will evaluate this change of pit depth in this SEIS. Figure 2-1 shows the ultimate pit configuration upon completion of the Stage 5B Pit. The mill was shut down in December 2003. Main prestripping of waste rock for Stage 5B was performed throughout 2004. The mill reopened December 31, 2004 (Shannon Dunlap, GSM, personal communication, 2006).

GSM has already reclaimed substantial portions of the waste rock dumps totaling 654 acres (Table 2-1). The West Waste Rock Dump Complex, which includes the South Dump, is totally reclaimed. In addition, 106 acres of the East Waste Rock Dump Complex and 41 acres of the Buttress Dump have been reclaimed (Table 2-1). Reclamation of the rest of the East Waste Rock Dump Complex began again in 2006 (GSM 2006 Annual Report)

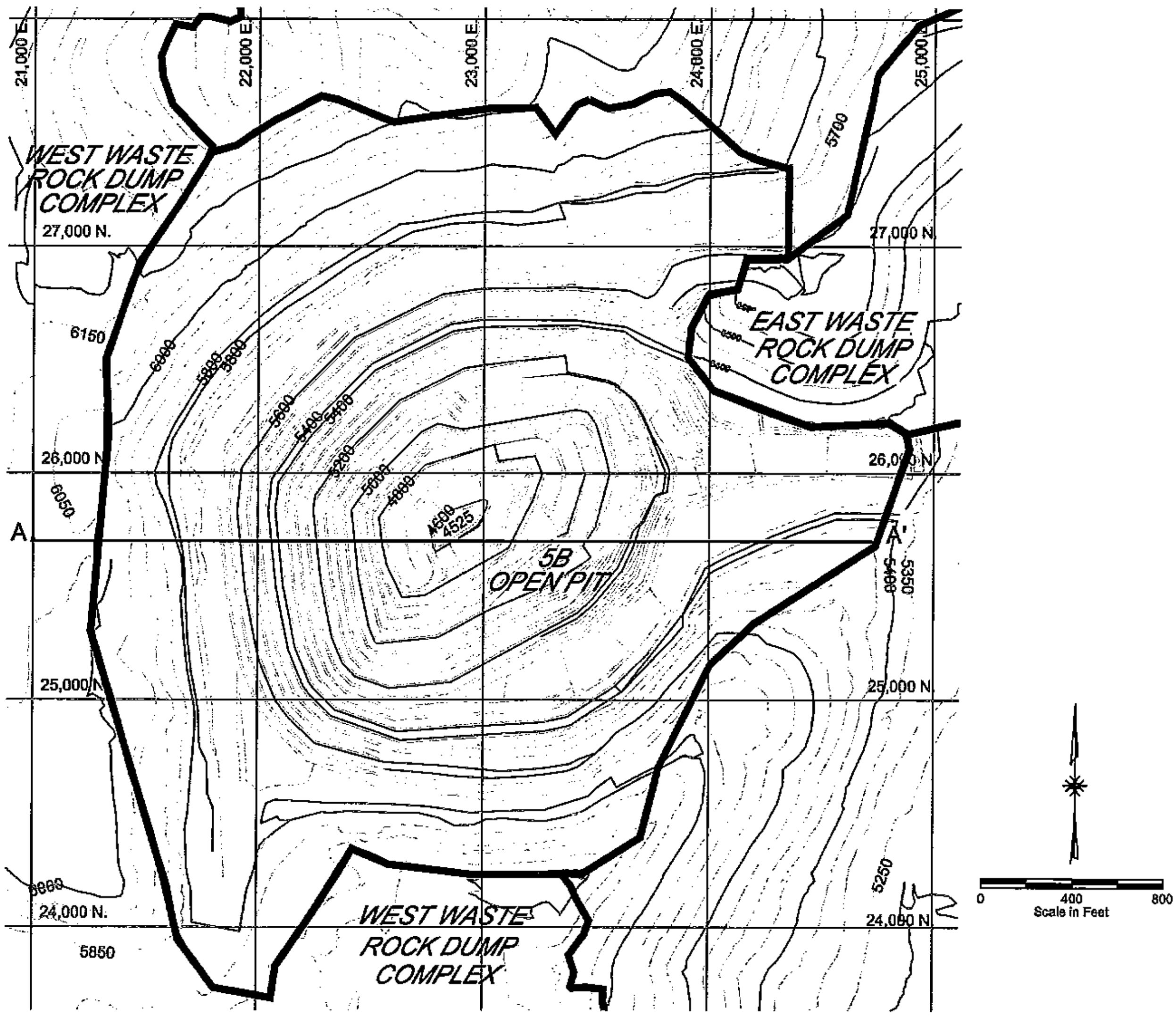
2.2.2 Underground Operation

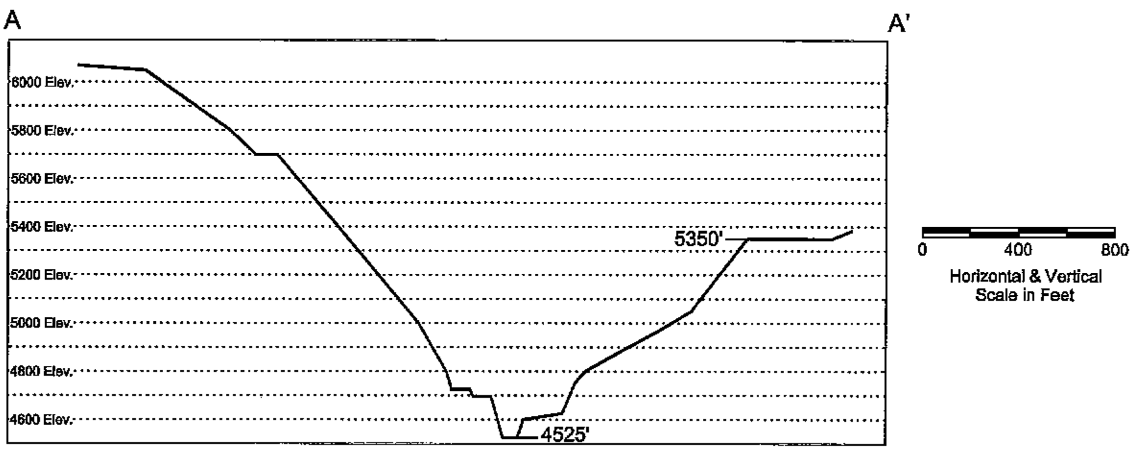
In addition to the open pit mining, GSM has operated a small underground mine with an average production of about 1,000 tons per day (see Figure 2-2). Small, high-grade ore pockets below and adjacent to the pit were mined in the underground workings. The mine portal is located within the open pit at an elevation of 4,857 feet. Portal construction began in July 2002. Development of the first stope, an excavation used in the mining of ore, began in August 2002. Three additional stopes were developed. Mining extracted ore between the elevations of 4,900 feet and 4,400 feet. The workings consist of 3,000 feet of development drifts and the stopes from which ore was extracted. This phase of underground mining was completed by the end of January 2004. The Agencies approved a phase II underground mining plan on August 28, 2006 to allow three new portals. This additional work includes development of 12,000 feet of drifting; additional sumps, raises, and drill stations; and, mining up to 800,000 tons of ore at a rate up to 1,500 tons per day.

2.2.3 Pit Dewatering

Controlling the accumulation of precipitation in the pit and the movement of groundwater through the pit highwall is an important aspect of the pit development plan. Mine dewatering is conducted at GSM to dewater the ore and waste rock actively being mined, to keep the pit floor and underground workings dry, and to release pore pressures in the open pit highwalls. Dewatering operations are monitored by recording pumping rates and collecting water samples for chemical analyses.

Prior to 2002, in-pit sumps were used for dewatering. In July 2002, GSM installed a dewatering well in the bottom of the pit. The well was constructed to a depth of approximately 118 feet (bottom elevation 4,748 feet). Until July 2003, when it was removed by mining, this well was pumped routinely to keep the water level below the pit floor. Based on data collected from a flowmeter installed on the dewatering line, water inflow to the pit during that period averaged 27 to 30 gpm.





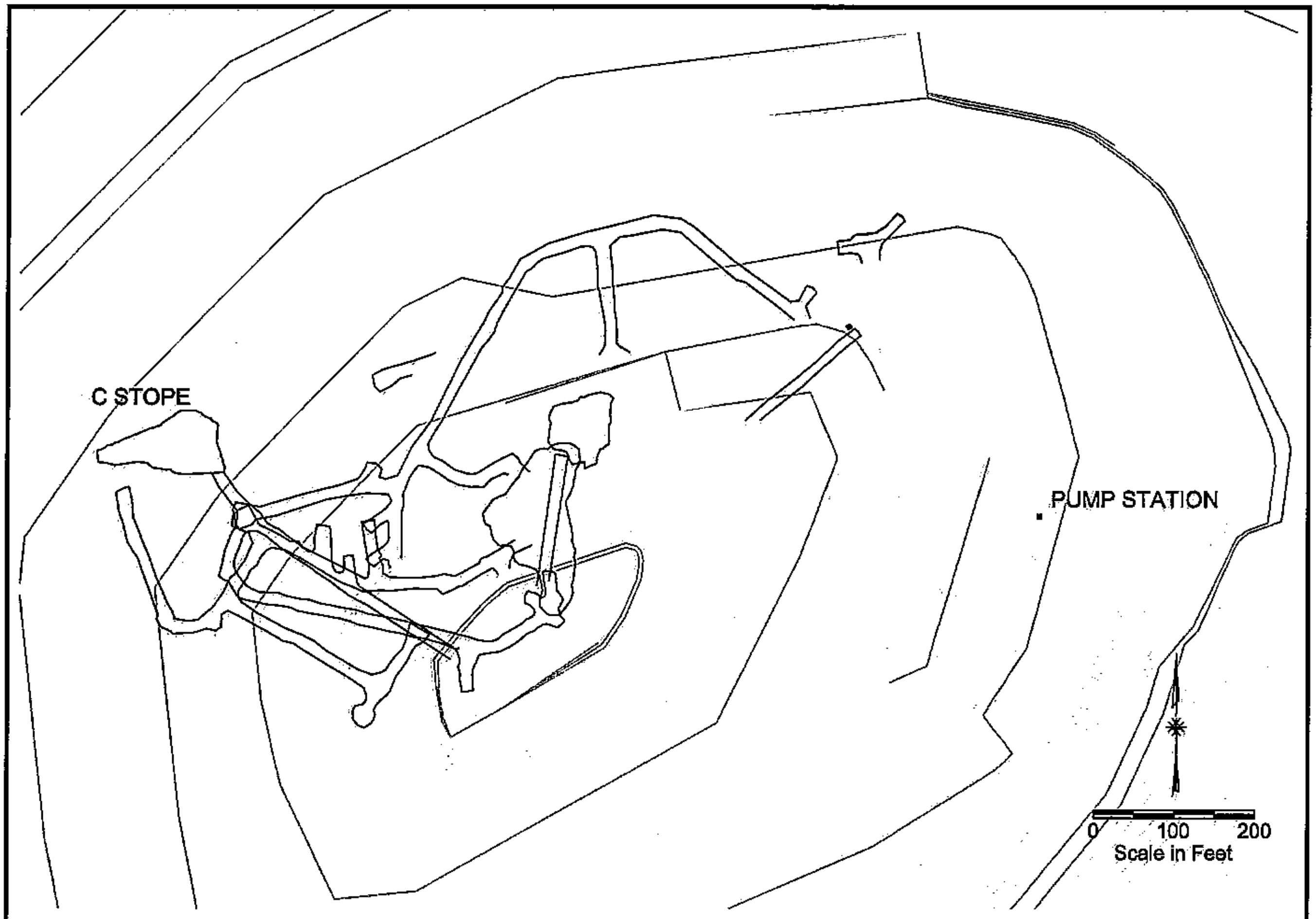
Ultimate Pit Floor Elevation = 4525 Feet

All Alternatives

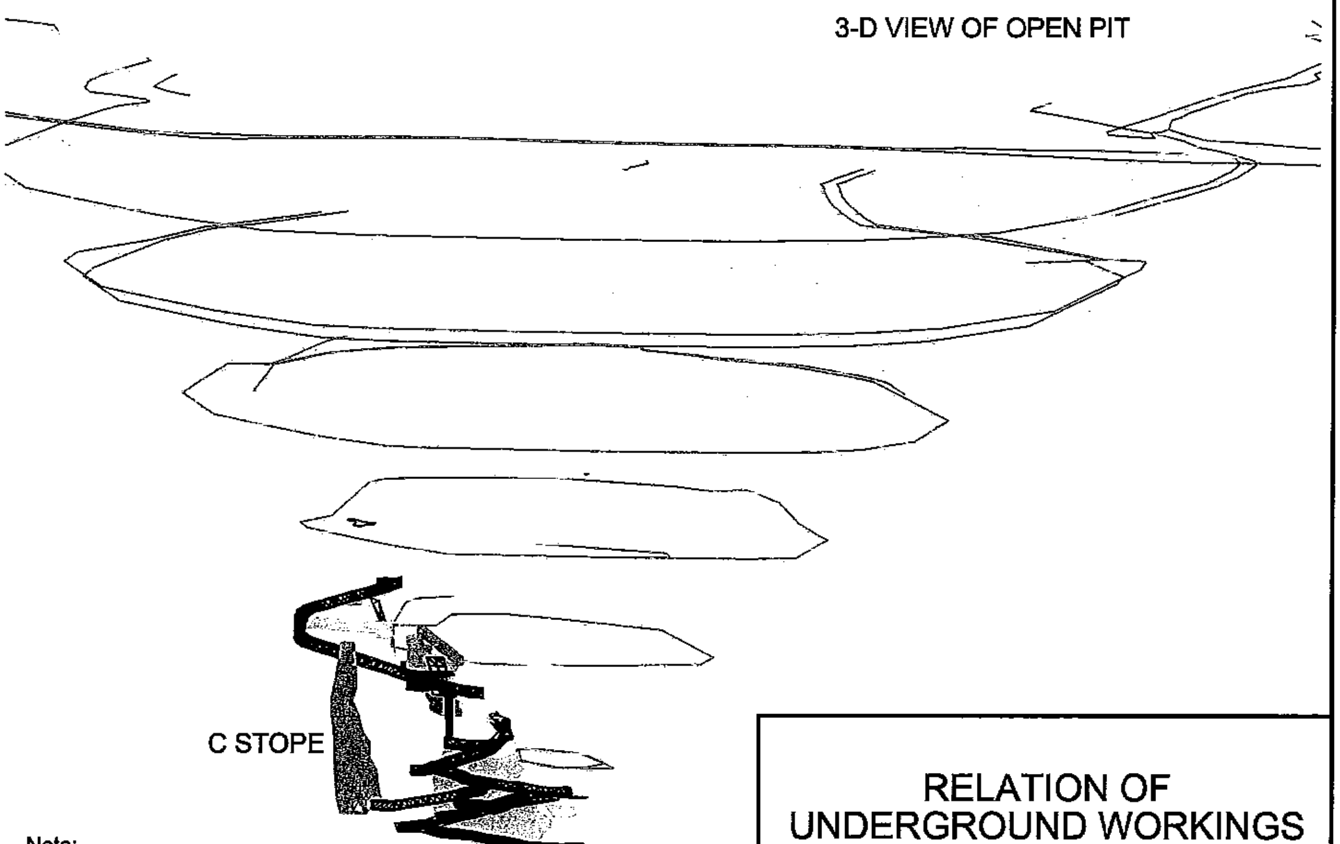
STAGE 5B
PIT EXPANSION
MINE PLAN

Figure 2-1 expand-5b.dwg

FIGURE 2-1



3-D VIEW OF OPEN PIT



Note:
Major portion of underground workings will be mined out during Stage 5B including the 4857 Portal.

RELATION OF UNDERGROUND WORKINGS TO FINAL STAGE 5B PIT

FIGURE 2-2

Figure 2-2-rev4-04-underground.dwg Rev. 1/2007

Two vertical highwall wells (PW-48 and PW-49) within the pit are regularly pumped to intercept groundwater from the Corridor Fault area before it enters the pit (see Figure 3-2 for location of the Corridor Fault and Figure 3-5 for locations of the wells). These highwall wells produce a combined flow of approximately 18.2 gpm (Telesto, 2006). Horizontal drains in the pit highwall are incorporated into the dewatering system as required to maintain safe operations. The workings inside the underground mine continue to produce less than 5 gpm (estimated at 1 to 2 gpm).

The pit dewatering system constructed during underground mining used a sump in the underground workings to drain and collect pit water. Water in the pit flowed into the underground workings through drill holes connecting the bottom of the pit with the underground workings. The underground mine has a sump with an approximate 500,000-gallon capacity at an elevation between about 4,450 and 4,500 feet. Any water that collected in other areas of the underground workings was pumped to this sump. Water was pumped from the underground sump through a 3-inch high-density polyethylene (HDPE) line to the 4,700-foot booster station. From the 4,700-foot booster station, water was pumped to the 4,850-foot booster station, and then to the 5,000-foot bench booster station through 4-inch HDPE lines. Finally, the water was pumped out of the pit from the 5,000-foot bench booster station to a lined holding pond below the mill. Up to 15,750,000 gallons of water were pumped out of the pit annually.

When Phase I underground mining ceased at the end of January 2004, water started collecting in the pit bottom and underground workings. This water flowed to the underground workings through drill holes connecting the pit bottom with the underground workings. A dewatering well was installed from a pit bench to the underground workings to accommodate dewatering activities during mining of the upper benches of the Stage 5B pit. The existing booster pumps and piping continue to be used for dewatering activities. As mining of the Stage 5B pit progresses, the dewatering well may need to be relocated to another area of the pit. The underground workings can contain a volume of 20 million gallons of water before the water table reaches the pit bottom at the 4,650-foot elevation. As of the end of 2006, there was no water in the bottom of the pit. GSM began pumping for Phase II underground mining again in July, 2006.

Water removed from the pit is either sprayed over blasted rock to control dust or is pumped to the lined holding pond below the mill and then to the water treatment facility in the mill. The water from the highwall dewatering wells is either: 1) mixed with treatment plant discharge and directed to the land application disposal (LAD) infiltration basin, 2) sent to the lined pond below the mill for treatment at the water treatment plant, or 3) pumped to Tailings Impoundment No. 2 for reuse as process water.

2.2.4 Plan Modifications

Since the 1997 Draft EIS, various modifications to GSM's mine plan have been made and approved. The following changes are considered important to the reevaluation of reclamation alternatives:

- The ultimate pit floor, which was projected to be at an elevation of 4,700 feet in the 1997 Draft EIS, is currently permitted to an elevation of 4,650 feet.
- An underground mine has been developed that accessed the ore zone through a portal in the pit highwall at the 4,857-foot elevation.
- The key cut on the pit rim where the haul road enters the pit will be left at an elevation of 5,350 feet rather than cutting the road down to an elevation of 5,200 feet as previously approved.

GSM has begun mining the Stage 5B Pit, which is currently permitted to be mined to an elevation of 4,650 feet. Up to 18 months of waste rock stripping was required to develop the Stage 5B ore zone for mining. A total of 25,000,000 cubic yards (37,500,000 tons) of waste rock and 6,267,000 cubic yards (9,400,000 tons) of ore would be removed during the life of the existing designated Stage 5B pit (GSM, 2003d). A total of 218 acres are inside the current open pit. This is 36 acres less than presented in the 1997 Draft EIS, Table II-22. The difference is due to a revised pit design, modified mining methods since the 1997 Draft EIS, and disturbance accounting changes in April 2004 (Table 2-1). The outline shown on Figure 2-1 is 218 acres. Waste rock from mining the Stage 5B Pit will be placed at various locations on the currently permitted East Waste Rock Dump Complex (Figure 2-5). The footprint of the East Waste Rock Dump Complex will remain 438 acres out of a permitted 670 acres (Table 2-1).

In the modified Partial Pit Backfill Alternative required by DEQ, GSM proposed to mine Stage 5B to the 4,525-foot elevation (GSM, 2002). The 5B pit expansion would add 4 to 5 years to the current mine life. Figure 2-1 shows the proposed topography for the pit at completion of the Stage 5B Pit development. Under this plan, the perimeter would not change from the existing pit configuration. The agencies will evaluate the change of pit depth in the SEIS. In Chapter 4, all reclamation alternatives, including the No Action Alternative, have been evaluated assuming the Stage 5B Pit would be fully developed to 4,525 feet. This allows the agency decision makers to evaluate whether to apply the proposed pit changes to any of the alternatives, including the No Action Alternative.

2.3 DEVELOPMENT OF ALTERNATIVES

The action under review is reclamation of the open pit. This section provides a brief description of how the various reclamation alternatives were developed for evaluation in this document. Because several of the alternatives have a long history of environmental review and litigation associated with them, historical background has been included in Section 1.4.3.

2.3.1 1998 EIS Record of Decision

The ROD for the 1998 Final EIS selected the No Pit Pond Alternative. This alternative required the bottom 100 feet of the pit (from an elevation of 4,700 feet to 4,800 feet) to be backfilled with unspecified waste rock from the East Waste Rock Dump Complex.

The backfill would be used as a sump to prevent a pond from forming in the pit. Two to three wells in the backfill would be used for pit dewatering coupled with water treatment. The top of the backfill would provide a working surface of 7.4 acres where personnel could install and maintain the dewatering system. Worker and dewatering system protection would be provided by building one or more berms around the perimeter of the working area to trap rocks that might ravel from the highwall.

The major focus of the No Pit Pond Alternative was the avoidance of groundwater degradation by pumping water out of the backfill to maintain the groundwater level near 4,700 feet. Another objective was to prevent exposure of wildlife to contaminated water after closure. Maintaining the pit as a hydrologic sink and capturing all pit water inflows would achieve these objectives. Slopes less than 2H:1V, major pit roads, and the pit bottom would have been covered with 2 feet of oxidized waste rock, 2 feet of soil, and revegetated. Twenty-six out of the 254 pit acres would have been revegetated. The rest of the pit was to be reclaimed as highwalls and talus slopes. In the 1998 Final EIS, DEQ and BLM concluded that the No Pit Pond Alternative would substantially achieve those objectives. It is the currently approved reclamation plan for the pit. This plan has been modified to reflect current conditions at the mine and constitutes the No Action Alternative that has been reevaluated in this SEIS.

2.3.2 1997 Draft EIS Partial Backfill Alternative

As described in Section 1.4.3, in a June 2002 judgment, the District Court ordered DEQ to begin implementation of the partial pit backfill reclamation plan, which had been evaluated in the 1997 Draft EIS, in accordance with MMRA. The 1997 Draft EIS Partial Backfill Alternative projected an ultimate pit floor elevation of 4,700 feet. As conceptually described, the Partial Backfill Alternative would require the GSM pit to be backfilled. The ultimate pit would be backfilled to the low point on the rim of 5,200 feet. The upper pit highwall would be reclaimed to 2H:1V slopes by hauling, end dumping, and dozing waste rock. Backfilling would have consisted of two activities:

- Hauling, end dumping, and dozing 34,700,000 to 36,700,000 cubic yards (52,000,000 to 55,000,000 tons) of waste rock material from the East Waste Rock Dump Complex to backfill the pit and cover the lower highwall; and,
- Hauling, end dumping, and dozing approximately 21,000,000 to 22,000,000 cubic yards (31,000,000 to 33,000,000 tons) of waste rock material from the West Waste Rock Dump Complex to complete covering of the highwall.

The backfilled area would be graded to a free-draining surface. All acid producing rock within the pit would be covered with two feet of oxidized waste rock. Then that surface would be covered with two feet of soil. The entire pit area of 254 acres would be revegetated.

Pit dewatering coupled with water treatment would be required. The wells would be installed through the backfill in order to maintain the pit as a hydrologic sink. However, the agencies believe technical feasibility and potential effectiveness of these measures were not evaluated adequately in the 1997 Draft EIS.

The Partial Pit Backfill With In-Pit Collection Alternative described in this SEIS is presented as the Proposed Action to comply with the District Court's 2002 order. Under this alternative, some changes to the 1997 Draft EIS Partial Backfill Alternative are being evaluated:

- The elevation of the floor of the pit would be changed from 4,700 feet to 4,525 feet;
- Waste rock would be hauled from the East Waste Rock Dump Complex. No backfill would be obtained from the reclaimed West Waste Rock Dump Complex;
- The pit would be backfilled to a minimum elevation of 5,350 feet, which is the low point elevation on the eastern pit rim;
- Portions of the upper pit highwall would be cast blasted and dozed to achieve the 2H:1V slopes, increasing the total pit disturbance area by 56 acres (8.9 acres south of pit, 42.2 acres north and west of pit, and 4.9 acres of roads around the top rim of the pit) from 218 acres to 274 acres (Figure 2-4); and,
- The reclamation cover would be a 3-foot-thick layer of soil with more than 45 percent rock fragments amended in the surface, instead of two feet of oxidized waste rock covered with two feet of soil. This is the currently approved reclamation cover plan for all waste rock dump complexes at GSM (DEQ/BLM, 2002 and 2003).

2.3.3 Determination of Range of Alternatives

DEQ and BLM used comments received during the scoping process described in Section 1.7.1 and previous environmental documents prepared on the mine to determine the range of alternatives. To assist the agencies in determining the range of alternatives to be evaluated in this SEIS, DEQ and BLM initiated an Multiple Accounts Analysis process in May 2003. BLM, DEQ, EPA, GSM, and the environmental groups that are plaintiffs in the District Court action each sent two technical personnel to form a technical working group (TWG) to produce and evaluate alternatives using the MAA process (Robertson GeoConsultants, 2003).

As the process evolved, the TWG modified alternatives based on technical discussions and evaluation of accepted practices. Between meetings, proposed modifications were evaluated by various experts and the TWG was supplied with these supplemental analyses. During this process, public comment from a scoping meeting conducted in Whitehall was incorporated into the process. A local rancher also attended the fourth MAA meeting.

During the evaluation, the TWG identified and evaluated the following seven alternatives:

1. No Pit Pond (No Action) (includes in-pit water collection);
2. Partial Pit Backfill With In-Pit Collection (Proposed Action);
3. Partial Pit Backfill Without Collection;
4. Partial Pit Backfill With Downgradient Collection;
5. Partial Pit Backfill With Amendment;
6. Underground Sump (with underground water collection sump); and,
7. Pit Pond (with pump and treatment).

The agencies have identified 13 technical issues, 7 environmental issues, 12 socioeconomic issues, and 1 project economics issue as having importance for pit reclamation (Table 1-4). These are defined in Section 1.7.2 with additional explanation found in the Technical Memorandum describing the MAA process (Robertson GeoConsultants, 2003).

DEQ and BLM reviewed the results of the MAA process during preparation of this SEIS. While the MAA was not formally completed, the agencies determined that the range of alternatives identified satisfies the requirements of MEPA and NEPA and the District Court's 2002 order. Selection of the Preferred Alternative was based on data, studies, and analyses pertaining to these alternatives, which are described in Chapter 4, and the mandates of the laws, rules, and regulations administered by the agencies.

2.4 ALTERNATIVES CONSIDERED FOR DETAILED STUDY

2.4.1 Introduction

Seven alternatives were developed and evaluated. Three of the alternatives were dismissed from detailed consideration in the SEIS due to environmental or technical concerns (see Section 2.5). Four alternatives were studied in detail. These include:

- The No Pit Pond (No Action) Alternative, presented in the 1997 Draft EIS and selected as the Preferred Alternative in the 1998 ROD, as modified per current mine conditions (GSM, 2002);
- The Partial Pit Backfill With In-Pit Collection Alternative (Proposed Action), presented in the 1997 Draft EIS as the Partial Backfill Alternative as modified by GSM (GSM, 2002);
- The Partial Pit Backfill With Downgradient Collection Alternative developed to address the concerns with in-pit pumping associated with the Partial Pit Backfill With In-Pit Collection Alternative; and,
- The Underground Sump Alternative developed to address concerns with in-pit pumping and the potential burial of mineral resources and reserves associated with the partial pit backfill alternatives.

2.4.2 No Pit Pond Alternative (No Action)

As described in the 1998 ROD, DEQ and BLM selected the No Pit Pond Alternative in order to maintain the pit as a hydrologic sink, thus preventing any contaminated water from leaving the pit and moving into the regional groundwater system. Because the agencies also wanted to prevent a pit pond from forming, the bottom 100 feet of the pit would be backfilled with unspecified waste rock from the East Waste Rock Dump Complex to create a backfill sump. The backfill would serve as a flat working surface on which to station two to three dewatering wells and other components of a collection system. The dewatering system would collect water in the sump and pump it to a permanent water treatment plant. By maintaining the groundwater level as low as possible in the backfill, no water would be allowed to pond in the pit bottom. Protection for the pumping facilities and workers would be provided by building one or more berms around the perimeter of the 7.4-acre working area to trap rocks that might fall from the pit highwall. A 4-foot reclamation cover system would be placed over the backfill.

Since the ROD was issued in June 1998, changes have been made to the planned pit configuration to enhance safety, improve the waste-to-ore ratio, and target ore zones. Modifications common to all alternatives are outlined in Section 2.2.4. Additional planning and investigation to implement this pit closure plan has also continued. The changes affecting the No Pit Pond Alternative are as follows:

- The pit would be backfilled from an ultimate pit bottom elevation of 4,525 feet to an elevation of 4,625 feet instead of 4,700 feet to 4,800 feet;
- The flat working surface on top of the pit backfill would decrease to 1.3 acres from the previously planned 7.4 acres;
- Crusher reject waste rock materials (see Section 2.4.2.2) would be used for the sump backfill;
- The reclamation cover system would consist of 3 feet of soil, instead of 2 feet of oxide rock covered with 2 feet of soil; and,
- During reclamation, accessible pit roads, benches, and other areas within the pit would be resoiled and revegetated (consisting of 1.3 acres of pit floor working surface, 7 acres already reclaimed, and 52 acres of miscellaneous and pit roads), leaving approximately 158 acres (218 acres less 60 acres) of pit area unrevegetated. The area inside the perimeter of the pit would be 218 acres instead of 254 acres (see previous discussion in Section 2.2.4) projected in the 1997 Draft EIS (Table II-22).

2.4.2.1 Underground Mine Closure

The underground sump in the underground mine would not be closed until the end of mining because it would be used as part of a dewatering system for Stage 5B. Portions of the pit that break through into the underground mine pose a hazard to workers and would be backfilled. The current mine plan for the 5B Pit includes mining a safe distance from the underground stopes, backfilling the stopes, and then mining through the stopes (Shannon Dunlap, GSM, personal communication, June 21, 2004). GSM started backfilling the stopes in 2006. Three stopes have been backfilled to date (Shannon Dunlap, GSM, personal communication, 2006). Because the underground workings have encountered less than 5 gpm of water, the water from the underground mine is not expected to alter the final water management system.

2.4.2.2 Stage 5B Pit Backfill Plan

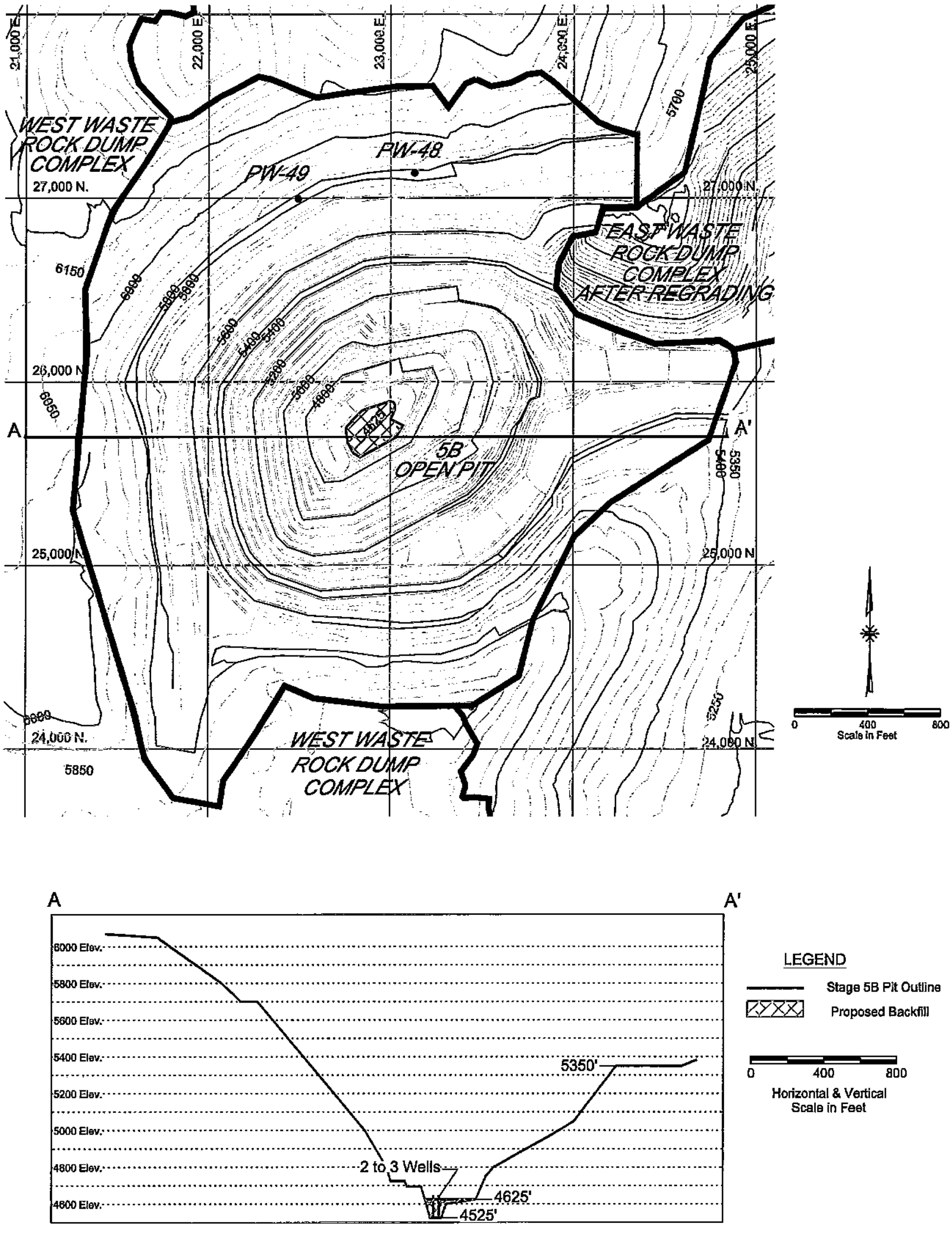
The lower portion of the Stage 5B Pit would be backfilled with 100 feet of crusher reject waste rock to provide a flat working area of 1.3 acres on which to station dewatering wells and other collection equipment. A 3-foot-thick layer of soil would be placed as a cover over the crusher reject. Approximately 111,000 cubic yards (167,000 tons) of crusher reject and 6,400 cubic yards of soil would be required. This limited amount of crusher reject would provide a sump to absorb precipitation and pit groundwater, thereby preventing a pond from forming in the bottom of the pit. Figure 2-3 shows the final topography (plan view) of the proposed backfilled Stage 5B Pit, as well as a cross-section of this pit configuration after backfilling and dewatering well locations.

Backfill material was identified as waste rock in the 1997 Draft EIS, Section II.B.6.b. There are two potential on-site sources of waste rock for the backfill (GSM, 2002). One source of material is stockpiled mixed oxidized and waste rock that is stored for reclaiming waste rock disposal areas. Another source is the crusher reject material. Due to the screening process, this material is fairly uniform in size and could provide a good material for sump construction. This is the material proposed for backfilling under this alternative.

The reclamation cover being considered in the various alternatives that use pit backfill is different than the approved cover that was described in the 1997 Draft EIS. The approved cover consists of 2 feet of oxide rock overlain by 2 feet of soil. The proposed modified cover consists of 3 feet soil. This cover has been previously approved by the agencies for use on 2H:1V slopes on the East Waste Rock Dump Complex (DEQ and BLM, 2003). No additional disturbance would be necessary to obtain the soil for the No Pit Pond Alternative cover requirements.

2.4.2.3 Dewatering and Water Treatment

Additional information on the conceptual design of the dewatering system is presented in Section 2.2.3. Based on the 1997 Draft EIS, Section IV.B.6.b analysis, pit dewatering for the No Pit Pond Alternative was expected to require removal of 102 gpm. Current analyses predict that between 25 and 27 gpm would require perpetual removal (Telesto, 2003a). The pit dewatering system would consist of two to three dewatering wells constructed through the crusher reject to the bedrock contact. The wells would not be over 100 feet deep. Well casings would be constructed of polyvinyl chloride (PVC). Stainless steel submersible pumps equipped with electronic sensors would be installed to maintain optimum drawdown of the water table.



No Pit Pond Alternative would have two to three dewatering wells through the 100 feet of backfill from the 4525 to 4625 elevation

No Pit Pond (No Action) Alternative

FINAL
NO PIT POND
CONFIGURATION

FIGURE 2-3

Figure 2-3 5b-backfill-xsec.dwg

Existing and newly constructed dewatering horizontal drains in the pit highwall would be used at closure. Based on additional hydrogeologic evaluations at the time of closure, horizontal drains drilled from the floor of the pit into target zones behind the pit highwall may also be utilized (GSM, 2002). The horizontal drains would be constructed by drilling 4-inch to 6-inch-diameter boreholes, into which 2-inch to 4-inch-diameter PVC pipes would be inserted. The PVC pipes would be perforated within the targeted dewatering zones and then sealed off from the remainder of the open boreholes to minimize the formation of acid. The horizontal drains would be used in combination with the two vertical pit highwall dewatering wells, PW-48 and PW-49 (Figure 2-3), but would not require individual pumps. Instead, the discharge lines would be manifolded into a common conveyance that would report to a collection/pumping station. The discharge would be routed by pipeline to the permanent water treatment plant with other pit water. The pit highwall wells would be utilized as necessary for dewatering and to maintain or improve highwall stability.

A dewatering monitoring program would be implemented to monitor progress of the dewatering, evaluate the effectiveness of the system, and document the volume and quality of water pumped from the pit.

2.4.2.4 Stability and Safety Concerns

The No Pit Pond Alternative was analyzed for stability and safety in the 1997 Draft EIS, Chapter IV, Section IV.A.6. A new pit design has been implemented since then with different pit highwall angles and blasting techniques. Previous pit slopes were mined at 45 degrees in sediments and 49 degrees in breccia. The steeper pit highwall has been mined at 53 degrees in sediments and 60 degrees in breccia. These steeper slopes have been made possible by using pre-split and controlled blasting techniques within 50 feet of the pit highwall and scaling of the pit highwall with an excavator or by hand. Controlled blasting results in a pit highwall where joints, fractures and the highwall rock are less disturbed, compared to the previous blasting methods used at GSM. As a result, not only is a steeper pit highwall possible, but the highwall is stronger and safer. There is considerably less broken and fractured rock left on the highwall as a result of controlled blasting and scaling. No major pit highwall failures were predicted in the 1998 Final EIS. Pit highwall dewatering wells and horizontal drains would continue to be operated as required to release pore pressures in the open pit highwall to minimize the potential for minor pit highwall failure. Additional information regarding pit highwall stability is included in Section 4.2.1.2.

Abrupt pit perimeters would be bermed and fenced. Public safety after mining would be ensured through fences, locked gates, warning signs, and on-site maintenance personnel.

Personnel that would monitor the site for safety and security would include persons on site for operating water treatment facilities and long-term monitoring activities, including the dewatering system, reclamation cover system, surface water diversions, and noxious weeds.

2.4.2.5 Surface Water Management

As part of the final reclamation of the site, GSM would construct berms and surface water diversions to minimize surface water entering the open pit. Storm water diversions would be constructed around the pit capable of handling a 100-year, 1-hour storm event. Most storm water would be diverted away from the pit; less than 1 percent would enter the pit (Telesto, 2003a). Surface water that enters the pit would evaporate or infiltrate into the crusher reject and be removed by the dewatering system.

2.4.2.6 Reclamation Requirements

Open pit reclamation activities that would be completed under this alternative (GSM, 2002) are:

- Portions of the underground mine would be closed during and at the completion of Stage 5B.
- The pit would be backfilled with 100 feet of crusher reject from the 4,525 to the 4,625-foot elevation.
- Berms would be constructed on the pit bottom to protect workers from rocks raveling and sloughing off the highwall.
- GSM has proposed using a 3-foot layer of soil, as currently approved for the waste rock dumps, for reclaiming the 1.3-acre flat working surface in the pit bottom.
- Major benches that have sufficient width to allow machinery access, which are not likely to become buried with rubble from the pit highwall over time, and pit haul roads would be capped with the 3-foot-thick soil cover and revegetated (53 acres, 7 acres already reclaimed, 60 acres total).
- In addition, 68 acres of miscellaneous associated disturbance (outside the pit) would be reclaimed under the existing reclamation plan. One hundred fifty-eight acres would be left unrevegetated in the pit.
- A two- to three-well dewatering system would be constructed.
- Abrupt pit perimeters would be bermed and fenced.
- Trees would be planted around the pit perimeter.
- Oxidized benches containing enough fine material to support plant life would be seeded and planted with trees where safety allows.
- Berms and storm water diversions would be constructed around the pit perimeter capable of handling a 100-year, 1-hour thunderstorm event.
- Warning signs would be placed around the pit perimeter.
- Dewatering wells and horizontal drains would be installed based on additional hydrologic evaluations at closure.

- Two horizontal excavations would be constructed for bats. A number of large and small raptor cavities would be constructed in the oxidized portion of the upper highwall. The exact location and configuration of the raptor cavities and bat excavations would be determined near the end of mine life when stable portions of the pit with suitable aspects can be most accurately identified.

The following table summarizes the pit backfill quantity requirements as well as cover soil, revegetation and dewatering needs of this alternative:

COMPONENT	Quantity	Units
Sump Material	111,000	cubic yards
Pit Backfill	0	cubic yards
Cover Soil [1]	290,400	cubic yards
Dewatering System	2-3	Wells
Backfill Depth (4,525-4,625)	100	Feet
Pit Area Revegetation [2]	60	Acres
Area Unrevegetated	158	Acres

[1]Cover soil is for 60 pit acres at 3-foot thickness on a flat surface.
[2]Includes 53 acres of pit roads and benches, 7 acres already reclaimed, and a 1.3-acre flat working surface in the pit bottom.

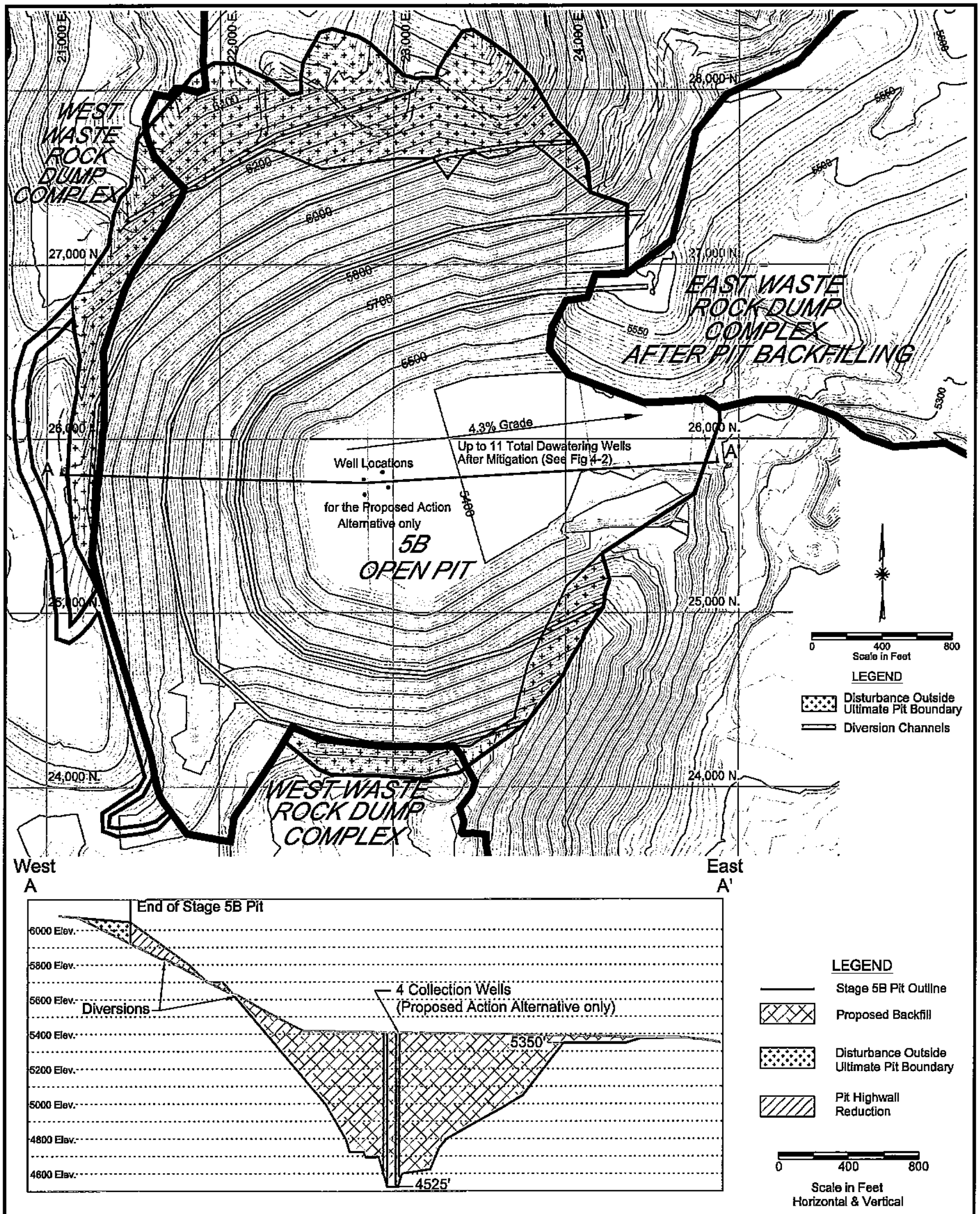
2.4.3 Partial Pit Backfill With In-Pit Collection Alternative (Proposed Action)

This updated version of the Partial Backfill Alternative analyzed in the 1997 Draft EIS incorporates current site conditions and several modifications submitted by GSM (GSM, 2002). As conceptually described in the 1997 Draft EIS, Chapter II, Section II.B.7, this alternative involves backfilling the GSM pit to a free-draining elevation on the east rim of the pit with previously excavated waste rock and recontouring the upper pit highwall to 2H:1V slopes. The entire area would be graded to a free-draining surface. A 4-foot reclamation cover system was to be placed over the graded area and revegetated. Four pit dewatering wells installed through the backfill coupled with water treatment would be required to maintain the pit as a hydrologic sink. Additional details of the 1997 Draft EIS Partial Backfill Alternative are presented in this SEIS Section 2.3.2.

The configuration of the Stage 5B pit design has changed to enhance safety, improve the waste-to-ore extraction ratio, and target ore zones. Modifications common to all alternatives are outlined in Section 2.2.4. In addition, the West Waste Rock Dump Complex has been reclaimed, and the reclamation cover system has been modified on the waste rock dump complexes to a 3-foot soil cover.

The original plan presented in the 1997 Draft EIS, Chapter II, Section II.B.7 has been modified. Changes include the following:

- The elevation of the floor of the pit would be lowered to an elevation of 4,525 feet to recover more ore from the Stage 5B Pit.
- Crusher reject would be used to backfill the lower 100 feet of the pit from 4,525 to 4,625 feet to act as a sump for the dewatering system.
- To allow surface water on the backfilled area to drain freely, the pit would be backfilled to a minimum elevation of 5,350 feet, which is the current low point elevation of the eastern pit rim.
- Waste rock would be hauled from the East Waste Rock Dump Complex. No backfill would be obtained from the reclaimed West Waste Rock Dump Complex.
- Cast blasting and dozing would be utilized to reduce the upper portion of the pit highwall to a 2H:1V slope rather than hauling all backfill material.
- Pit highwall reduction to 2H:1V slopes using cast blasting and dozing and the construction of soil haul roads would increase the pit disturbance area by 56 acres (Figure 2-4).
- Four dewatering wells would be used to maintain the pit as a hydrologic sink.
- The reclamation cover would be changed to a 3-foot-thick layer of soil with greater than 45 percent rock fragments amended into the surface instead of two feet of oxidized waste rock covered with two feet of soil as currently approved for all 2H:1V waste rock facilities at the mine.



Partial Pit Backfill with In-Pit Collection Alternative would have four 800-875 foot dewatering wells drilled to approximately the 4525-foot elevation. Up to eleven total dewatering wells are required after mitigation. (See Figure 4-2)

Partial Pit Backfill with Downgradient Collection Alternative would have no in-pit wells.

Partial Pit Backfill Alternatives

FINAL
PARTIAL PIT BACKFILL CONFIGURATION

FIGURE 2-4

Figure 2-4 PPB-backfill-xsec.dwg

2.4.3.1 Underground Mine Closure

Underground mine closure would be the same as for the No Pit Pond Alternative (Section 2.4.2.1).

2.4.3.2 Stage 5B Pit Backfill

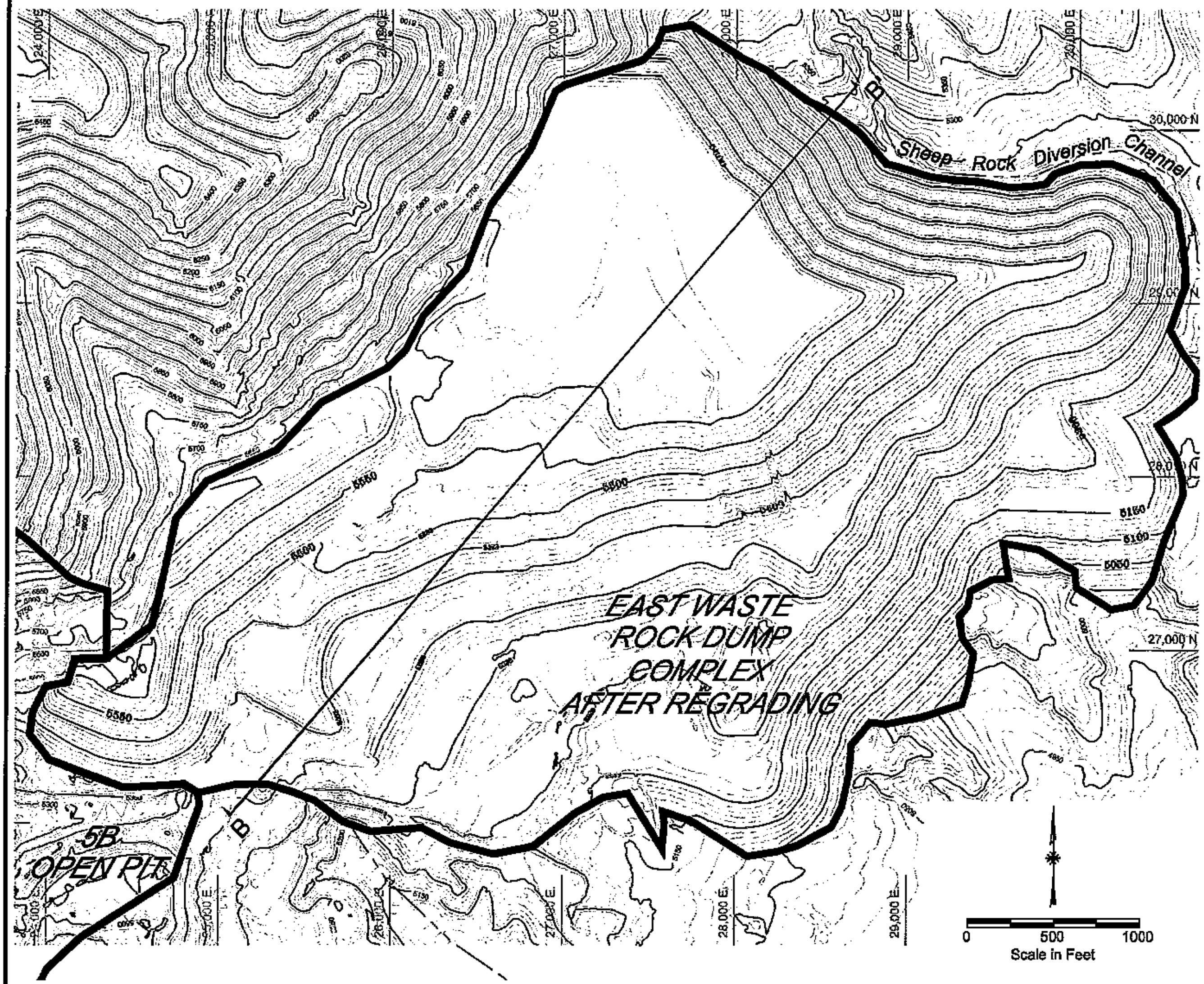
After the Stage 5B Pit is mined to a bottom elevation of 4,525 feet and portions of the underground mine are closed, the pit would be backfilled to establish a free-draining surface. About 111,000 cubic yards (167,000 tons) of crusher reject waste rock would be placed in the bottom of the pit to act as a sump for the dewatering system. This waste rock would need to be hauled by truck down into the pit.

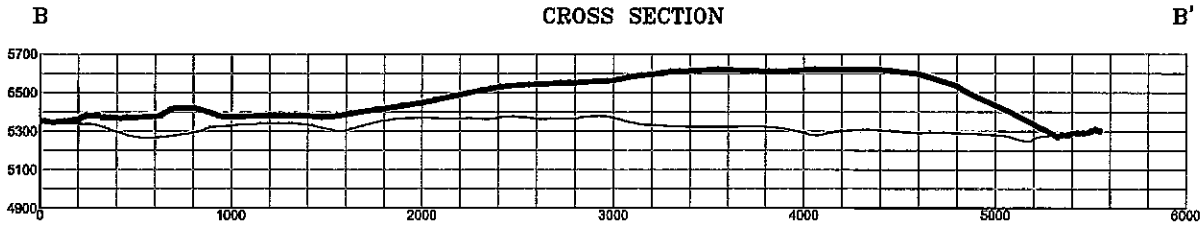
A total of approximately 33,200,000 cubic yards (50,000,000 tons) of additional waste rock would then be hauled from the East Waste Rock Dump Complex to backfill the pit to create a sloping surface with an average elevation of 5,400 feet (Figure 2-4). This waste rock would be dumped into the pit from the 5,400-foot elevation. After reclamation is completed, surface drainage would exit the pit backfill at an elevation of 5,350 feet.

Waste rock for backfilling the pit would not be hauled from the reclaimed West Waste Rock Dump Complex. GSM would reduce the pit highwall above the 5,400-foot elevation to 2H:1V slopes by employing cast blasting and dozing. Approximately 11,900,000 cubic yards (17,850,000 tons) of pit highwall material and 56 acres of additional disturbance in the pit area would be needed to recontour these slopes and develop roads for soil distribution (Figure 2-4). Storm water diversions would be installed every 200 vertical feet down the backfill slope to minimize erosion and to intercept runoff. The benches would be constructed similarly to those constructed for the waste rock dumps. Drainage diversions on the benches would be sloped to collect runoff and route it off the backfill material. The final pit configuration after backfilling the Stage 5B Pit is shown in Figure 2-4, which includes both plan and cross-sectional views.

The topography of the East Waste Rock Dump Complex after mining under the Stage 5B Pit plan is shown in both plan and cross-sectional views on Figure 2-5. Figure 2-6 shows the final configuration of the East Waste Rock Dump Complex after removing 33,200,000 cubic yards of material for backfilling from a 222-acre area. The East Waste Rock Dump Complex and Buttress Waste Rock Dump are permitted to hold up to 146,000,000 cubic yards (219,000,000 tons) based on the mine design at that time (1998 ROD) (Figure 1-2). In December 2003, the East Waste Rock Dump Complex contained approximately 76,700,000 cubic yards (114,750,000 tons), while the buttress dump contained approximately 2,000,000 cubic yards (3,000,000 tons). Between December 2003 and December 2005, 34,000,000 tons were placed in the East Waste Rock Dump Complex. Another 7,000,000 to 10,000,000 tons of waste rock would be added through the end of Stage 5B mining (Shannon Dunlap, GSM, personal communication, 2006). The East Waste Rock Dump Complex is permitted for 670 acres of disturbance. The ultimate East Waste Rock Dump Complex disturbance will be 438 acres. A total of 106 acres of the dump complex are already reclaimed. After Stage 5B mining is completed, GSM estimates that the East Waste Rock Dump Complex would contain 104,000,000 to 106,000,000 cubic yards (156,000,000 to 159,000,000 tons), depending on ore grade (GSM, 2002). The Partial Pit Backfill With In-Pit Collection Alternative would remove 33 percent of the total volume in the East Waste Rock Dump Complex into the pit. None of the backfilling operations would reduce the current footprint of the dump of 438 acres. This varies from the 1997 Draft EIS, Chapter II, Section II.B.7.b, which would have used 30 to 32 percent of the total permitted volume and would have completely removed 82 acres of the dump complex.

About 1,541,800 cubic yards of soil material would be required to cover the pit areas to be revegetated with a 3-foot-thick reclamation cover. The cover is described in Section 2.3.2. Two sources of cover material were considered. One source of cover material is an area northeast of the East Waste Rock Dump Complex that has been used as a soil borrow area (GSM, 2002). Another potential borrow area with more rock fragments has been identified by GSM north of Tailings Impoundment No. 2 (GSM, 2003c). The proposed source includes a 47-acre soil borrow source identified north of Tailings Impoundment No. 1. A portion of the area (about 16 acres) has been permitted for disturbance. The remaining 31 acres of this area would be permitted for a soil borrow source (Figure 1-2) (Shannon Dunlap, GSM, personal communication, 2006). After the earthwork and soil placement are complete, the surfaces would be revegetated using the approved seed mix.





LEGEND

- Pre-Mining Topography
- Regraded Topography

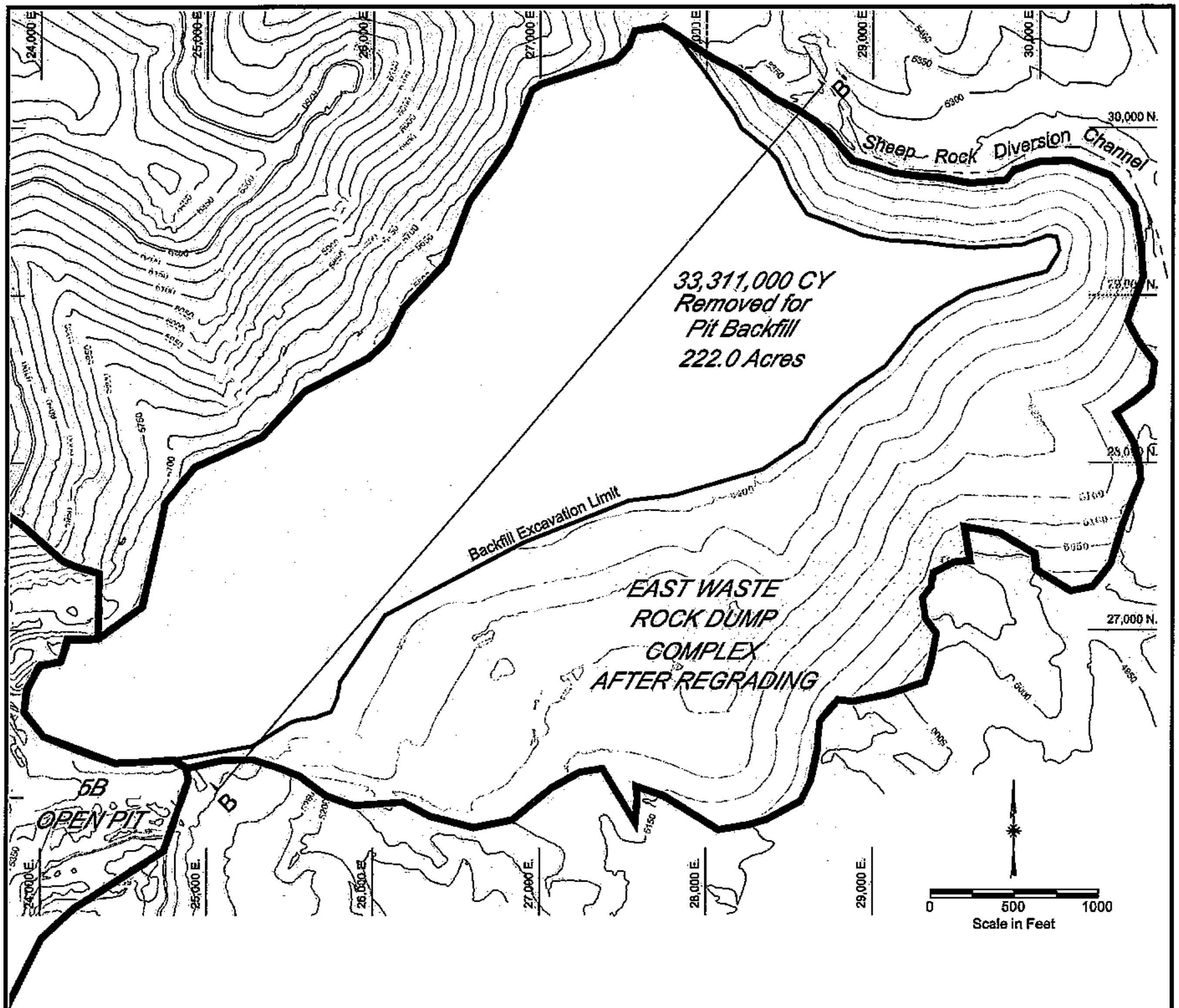
0 500 1000
Horizontal & Vertical
Scale in Feet

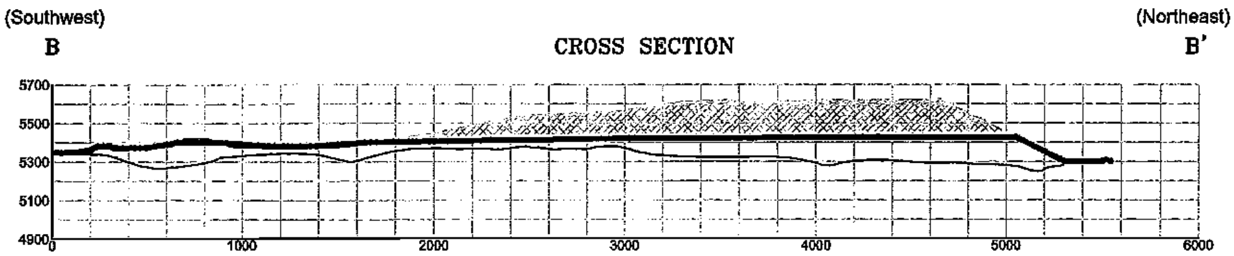
No Pit Pond & Underground Sump Alternatives

EAST WASTE ROCK DUMP COMPLEX TOPOGRAPHY AFTER REGRADING

FIGURE 2-5

Figure 2-5 Rockdump-xsec.dwg





LEGEND

Pre-Mining Topography

Regraded Topography

East Waste Rock Dump Complex Removed For Partial Pit Backfill Alternatives

0 500 1000
Horizontal & Vertical Scale in Feet

Partial Pit Backfill Alternatives

EAST WASTE ROCK DUMP COMPLEX TOPOGRAPHY AFTER PARTIAL PIT BACKFILL AND REGRADING

FIGURE 2-6

Figure 2-6 PPB rockdump-xsec.dwg

2.4.3.3 Dewatering and Water Treatment

For the Partial Pit Backfill With In-Pit Collection Alternative, the 10-year time-weighted average water balance indicated that the pumping rate would be on the order of 27 to 42 gpm (Telesto, 2006). The dewatering system would consist of four dewatering wells constructed through the pit backfill to the bedrock contact. This backfill would be non-homogeneous and the permeability would be variable. The wells would be drilled at an average surface elevation of 5,400 feet and would extend down into the sump backfill at the bottom of the pit. Consequently, wells up to 875 feet would be required.

Boreholes would be 10 to 12 inches in diameter and would be lined with 6-inch diameter stainless steel casing. The bottom of the casing would be slotted in the saturated zone between the 4,525- and 4,625-foot elevation. A stainless steel submersible pump equipped with electronic sensors to maintain optimum drawdown would be installed in each well. The pumps would be connected to 3-inch diameter PVC discharge lines. The discharge lines would be manifolded into a common conveyance and routed by pipeline to the permanent water treatment plant prior to being discharged back into the ground near the water treatment plant via percolation ponds, LAD, or other approved methods. Special corrosion resistant pumps and stainless steel casings would be required to extend the life of the wells and ancillary equipment.

2.4.3.4 Stability and Safety Concerns

The highwall would be stabilized with backfill up to the 5,400-foot elevation and with cast blasted highwall rock above that elevation in the Partial Pit Backfill With In-Pit Collection Alternative. No major pit highwall failures were predicted in the 1997 Draft EIS, Chapter IV, Section IV.A.7 for the Partial Backfill Alternative. Public access to the permit area would continue to be prohibited in selected areas due to concerns about the safety and security of maintenance personnel and equipment that would remain in the area. Public safety after mining would be ensured through fences, locked gates, and warning signs.

2.4.3.5 Surface Water Management

As part of the final reclamation of the site, GSM would construct berms and surface water diversions around the pit perimeter to prevent over 99 percent of surface water from entering the area of the backfilled pit (Telesto, 2003a). Limited surface water that infiltrates into the pit backfill would be removed by four dewatering wells. Surface water diversions would be installed on benches approximately every 200 vertical feet down the slope of the reduced highwall to minimize erosion and intercept runoff (Figure 2-4). The benches would be constructed similar to those constructed for the waste rock dump complexes. Diversions would be sloped to collect runoff and route it off the reclaimed pit area. The storm water diversions would be constructed following the existing approved plan for this type of structure.

2.4.3.6 Reclamation Requirements

Of the 274 acres of disturbance (218 acres of the pit area plus 56 acres of highwall layback), 272 acres in the pit backfill, pit highwall reduction areas, and haul roads would be covered with 3 feet of soil and revegetated. The same 3-foot soil cover approved for waste rock dump complex reclamation would be used. Outside the pit area, reclamation requirements would be the same as the No Pit Pond Alternative, except at the East Waste Rock Dump Complex. The footprint of the East Waste Rock Dump Complex would remain the same as approved in the 1998 ROD. About 33 percent of the dump's volume would be removed for backfill. No acreage would be completely off-loaded. After placement of reclamation covers, the regraded areas would be fertilized and seeded with an approved seed mix.

The following table summarizes the pit backfill quantity requirements as well as cover soil, revegetation and dewatering needs of this alternative:

COMPONENT	Quantity	Units
Sump Material	111,000	cubic yards
Pit Backfill	33,200,000	cubic yards
Cast Blasting & Dozer Rehandle @ 20%	11,900,000	cubic yards
Cover Soil [1]	1,541,800	cubic yards
Diversion Structures	18,600	linear feet
Roadwork	5,550	linear feet
Dewatering System	4	Wells
Backfill Depth (4,525-5,400)	875	Feet
Pit Area Revegetation [2]	290	Acres
Area Unrevegetated	0	Acres

[1]Cover soil is for 53 acres of flat surface at 3 feet of cover soil and 239 slope acres (plan view adjusted for 2H:1V slope) at 40 inches of cover soil.
[2]This includes 218 plan view acres of the pit plus 56 acres of highwall layback plus 18 acres to adjust plan view acres to 2H:1V slope acres minus 2 acres of access roads.

2.4.4 Partial Pit Backfill With Downgradient Collection Alternative

This alternative is a variation of the Partial Pit Backfill With In-Pit Collection Alternative. These alternatives backfill the pit to a free-draining surface at approximately the 5,350-foot elevation and reduce the pit highwall above that elevation to 2H:1V slopes. The main difference is that instead of attempting to maintain the backfilled pit as a hydrologic sink by installing wells inside the backfilled area and pumping to remove contaminated groundwater, a system of wells would be operated outside and down gradient from the pit to intercept contaminated groundwater from the pit. The conceptual system would include an estimated 26 or more new capture wells, existing wells in the Tailings Impoundment No. 1 capture and monitoring system, and at least 10 new monitoring wells (Figure 2-7).

2.4.4.1 Underground Mine Closure

Underground mine closure would be the same as described for the Partial Pit Backfill With In-Pit Collection Alternative (see Section 2.4.3.1 above).

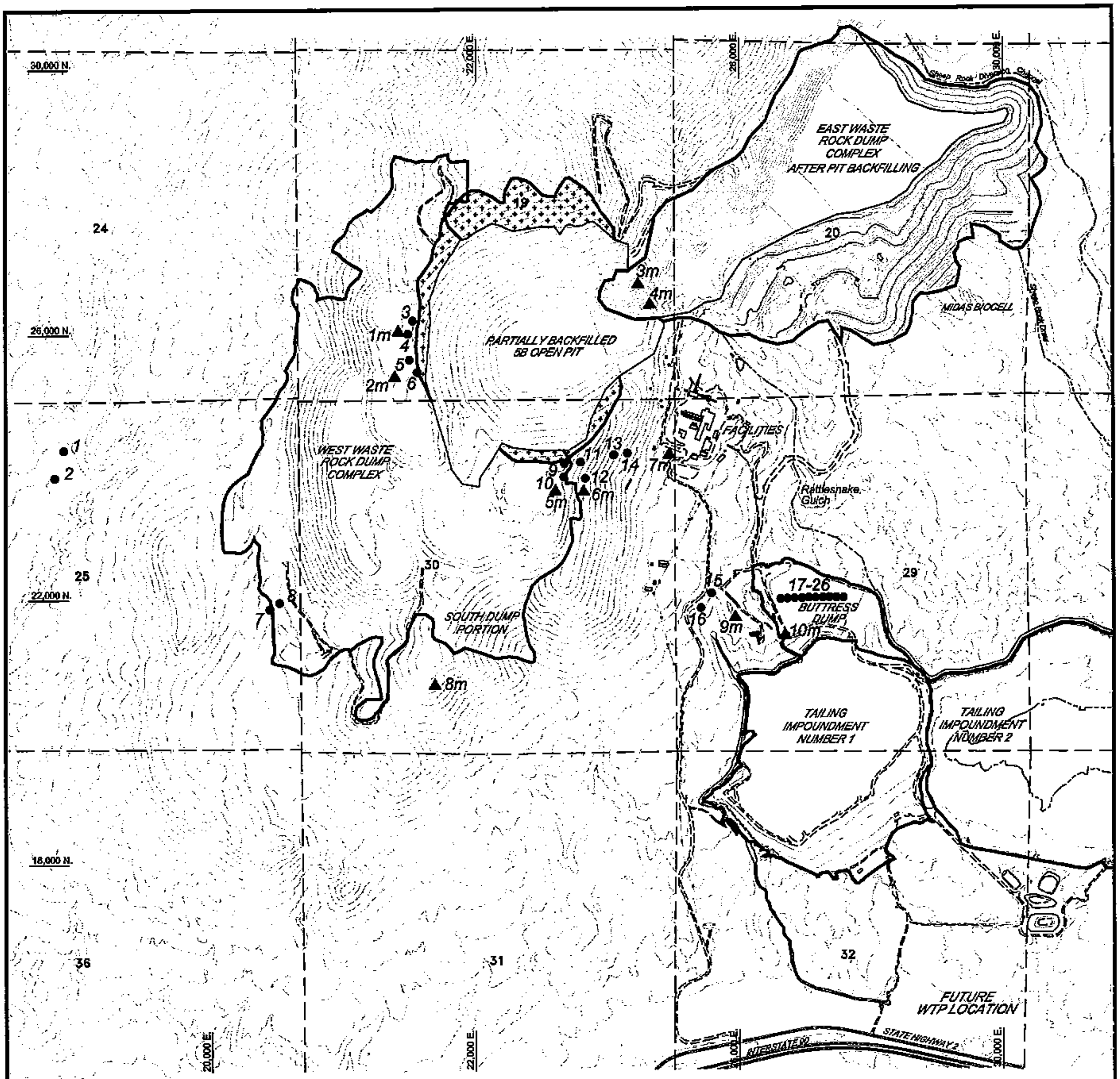
2.4.4.2 Stage 5B Pit Backfill

The backfill plan would be the same as under the Partial Pit Backfill With In-Pit Collection Alternative (see Section 2.4.3.2 above) except that the crusher reject sump would not be constructed in the bottom of the pit.

2.4.4.3 Dewatering and Water Treatment

The Partial Pit Backfill With Downgradient Collection Alternative would rely on a combination of natural attenuation, mixing with ambient groundwater, and collection and treatment to prevent contaminated pit groundwater from impacting groundwater outside of a permitted mixing zone. This alternative would not collect any water inside the perimeter of the pit. The groundwater level in the pit backfill would be allowed to rise and would discharge along natural flowpaths leading to the regional groundwater system down gradient from the pit. Contaminated groundwater from the pit, estimated at 27 to 42 gpm, would mix with ambient groundwater, estimated to range from 52 to 103 gpm, and the resulting combined flow would be collected in a series of 26 or more new capture wells plus the existing wells in the Tailings Impoundment No. 1 south pump back system (Telesto, 2006). These wells would be located down gradient from the pit. Up to 145 gpm of captured water would be pumped to the water treatment plant for treatment prior to release (HSI, 2003; Telesto, 2006).

Conceptual new well locations are shown on Figure 2-7. A hydrogeologic study would be conducted to locate the wells, and GSM would have to submit an application to modify the approved mixing zone.



LEGEND

- ● New Dewatering Well (1-26)
- ▲ New Monitoring Well (1m-10m)
- Highwall Reduction Area

0 1200 2400
Scale in Feet

Partial Pit Backfill With Downgradient Collection Alternative

POTENTIAL DOWNGRADIENT DEWATERING WELL LOCATIONS

FIGURE 2-7

Figure 2-7 Downgradient_wells.dwg

2.4.4.4 Stability and Safety Concerns

The only difference between this alternative and the Partial Pit Backfill With In-Pit Collection Alternative is that the elevation of the saturated zone in the pit would not be controlled. Highwall stability and safety concerns, as described in Section 2.4.3.4, under both partial pit backfill alternatives would be the same.

2.4.4.5 Surface Water Management

The surface water management plan under this alternative is the same as under the Partial Pit Backfill With In-Pit Collection Alternative (see Section 2.4.3.5 above). Surface water that infiltrates into the pit backfill would be allowed to escape the pit area as groundwater and would be collected down gradient in capture wells.

2.4.4.6 Reclamation Requirements

Reclamation requirements under this alternative are the same as for the Partial Pit Backfill With In-Pit Collection Alternative (see Section 2.4.3.6).

The following table summarizes the pit backfill quantity requirements as well as cover soil, revegetation and dewatering needs of this alternative:

COMPONENT	Quantity	Units
Sump Material	0	cubic yards
Pit Backfill	33,311,000	cubic yards
Cast Blasting & Dozer Rehandle @ 20%	11,900,000	cubic yards
Cover Soil [1]	1,541,800	cubic yards
Diversion Structures	18,600	linear feet
Roadwork	5,550	linear feet
Dewatering System	26+	Wells
Backfill Depth (5,400-4,525)	875	Feet
Pit Area Revegetation [2]	290	Acres
Area Unrevegetated	0	Acres

[1]Cover soil is for 53 acres of flat surface at 3 feet of cover soil and 239 acres of 2H:1V slope at 40 inches of cover soil (slope adjusted).
[2]This includes 218 plan view acres of the pit plus 56 acres of highwall layback plus 18 acres to adjust plan view acres to 2H:1V slope acres minus 2 acres of access roads.

2.4.5 Underground Sump Alternative

The Underground Sump Alternative is similar to the No Pit Pond Alternative described in Section 2.4.2, except no backfill would be placed in the pit and the underground workings would be improved and maintained for continual pit dewatering.

2.4.5.1 Underground Mine Closure

An underground sump pit dewatering system has been employed at GSM during two phases of underground mining beginning in July 2003. During Stage 5B mining, if water collects in the pit bottom, it would be drained into the underground workings through drill holes that intercept the underground workings from the bottom of the pit. Water collected in the underground sump would then be pumped out of the pit to the water treatment plant. Under the Underground Sump Alternative, after the Stage 5B Pit is finished, modifications would be made to the underground workings to improve their function as a continuing underground sump. At closure, water collected in the underground sump would continue to be pumped to the water treatment plant.

The portal enters the pit highwall at an elevation of 4,857 feet. The first phase of underground mining ended in January 2004. The second phase of underground mining was approved in August 2006. The underground mine consists of approximately 3,000 feet of development drifts and various stopes from which ore was removed. GSM started backfilling the stopes from the first phase of underground mining in 2006. Three stopes have been backfilled to date (Shannon Dunlap, GSM, personal communication, 2006). The current mine plan for the 5B Pit includes mining a safe distance from the underground stopes, backfilling the stopes where practicable, and then mining through the stopes (Shannon Dunlap, GSM, personal communication, June 21, 2004). Major portions of the underground workings, including the phase one portal, would be mined out during Stage 5B mining. The second phase of underground will add 12,000 feet of underground development and additional portal sites at elevations of 4875 feet, 4840 feet, and 4,620 feet. About 320 feet of additional underground development and a new portal at the 4,550-foot elevation would be required to prepare the underground mine for permanent use in the dewatering system (Section 2.4.5.3).

2.4.5.2 Stage 5B Pit Backfill

Under the Underground Sump Alternative, no backfill would be placed in the bottom of the pit.

2.4.5.3 Dewatering and Water Treatment

After closure of the pit, precipitation could collect in the pit by falling directly into the pit and by infiltrating into the fractured highwall and flowing to the pit bottom as is occurring during active mining. A groundwater dewatering system would be designed and constructed to maintain the groundwater level below the final 4,525-foot pit bottom elevation. At least initially, the two vertical highwall wells (PW-48 and PW-49) would also be operated (Figure 2-7).

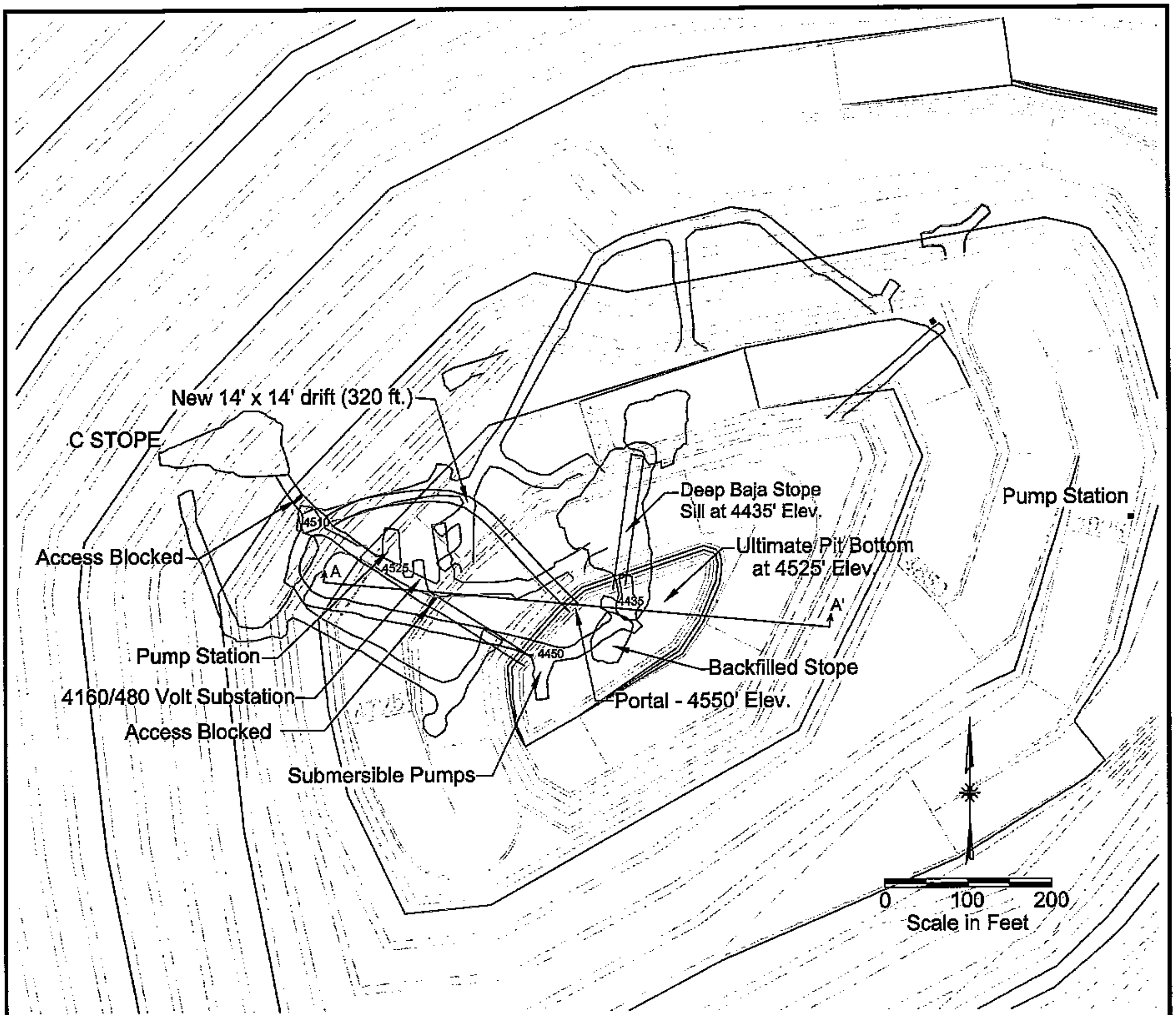
Access to the underground workings would be through the new 4,550-foot-elevation portal. The dewatering system would use the existing 14-foot-wide by 14-foot-high underground access tunnel between the 4,450-foot elevation and the 4,500-foot elevation as a sump, which has a total of 500,000 gallons of surge capacity. Submersible pumps at the 4,450-foot elevation would feed station pumps located in a cross-cut at the 4,525-foot elevation. At least one booster pump station at approximately the 5,000-foot bench would be required to provide the necessary lift to carry water out of the pit. Pumps and fittings would be stainless steel, and pipe would be HDPE pipe with sufficient wall thickness to contain the pressure developed within the dewatering system.

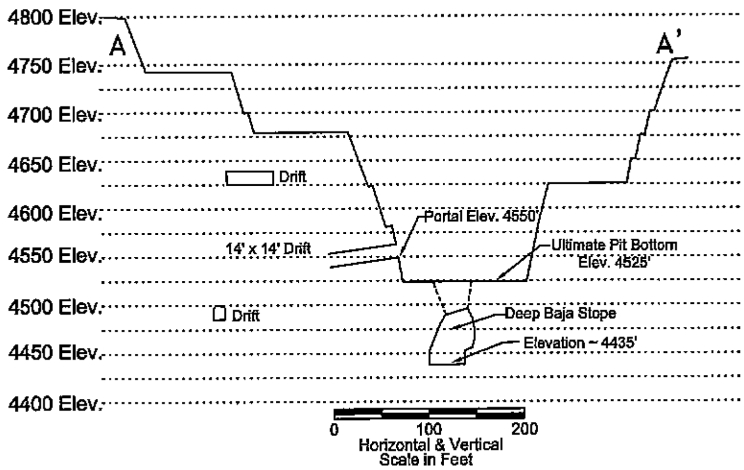
In order to dewater the GSM pit using the underground workings as a permanent sump, the following development and construction work would be required (GSM, personal communication, 2003):

- Installation of a 4,160-volt power line into the pit bottom at the 4,550-foot elevation;
- Construction of a portal at the 4,550-foot elevation in the Stage 5B Pit;
- Construction of 320 feet of 14-foot-wide by 14-foot-high access tunnel to meet the existing underground workings;
- Installation and upgrade of ground support in 1,000 feet of underground workings;
- Installation of an auxiliary fan and 900 feet of fiberglass ventilation duct;
- Blockage of the existing underground road in two locations;
- Installation of a substation to drop voltage from 4,160 to 480 volts;
- Installation of submersible pumps at the 4,450-foot elevation;
- Installation of centrifugal station pumps at the 4,525-foot elevation; and,
- Distribution of 480-volt power to pumps and fan.

Figure 2-8 shows the conceptual dewatering system for the Underground Sump Alternative after completion of Stage 5B.

Submersible pumps equipped with electronic sensors would be installed to maintain optimum drawdown of the water table. The discharge lines would be manifolded into a common conveyance pipe that would carry the water to the water treatment plant. Based on the proposed pit bottom at the 4,525-foot elevation, the submersible pumps would be placed approximately 75 feet below the pit bottom to provide an emergency underground storage capacity of approximately 4,000,000 gallons. Once the system is tested and on line, water would be pumped regularly to maintain the water level below the pit bottom.





EXAGGERATED VIEW OF BOTTOM 300 FEET OF PIT

Note:

The 4857 Portal will be mined out during Stage 5B.

See Figure 2.4 for Complete Pit Cross Section.

Figure 2-8 Pumpstation.dwg

Underground Sump Alternative

UNDERGROUND SUMP DEWATERING PLAN AFTER STAGE 5B

FIGURE 2-8

Data collection from the active pit dewatering program indicates that 25 to 27 gpm of water would have to be removed from the underground workings on an annual basis (GSM, personal communication, 2003; Telesto, 2006).

The quality of water extracted from the underground workings is expected to be similar to that observed for the current seeps. Based on the corrosion calculations conducted in support of the SEIS, pump system components made from plastic and stainless steel would be required (Gallagher, 2003b; Telesto, 2003e).

2.4.5.4 Surface Water Management

Surface water would be managed the same under this alternative as under the No Pit Pond Alternative described in Section 2.4.2.5.

2.4.5.5 Stability and Safety Concerns

Pit highwall stability and safety concerns for workers needing access to the 4,550-foot-elevation portal under the Underground Sump Alternative would be nearly the same as under the No Pit Pond Alternative described in Section 2.4.2.4. In addition, the underground workings and dewatering system would have to be maintained.

2.4.5.6 Reclamation Requirements

The reclamation requirements under the Underground Sump Alternative would be nearly the same as under the No Pit Pond Alternative, except no backfill would be placed in the pit bottom as a sump.

The following table summarizes the pit backfill quantity requirements as well as cover soil, revegetation and dewatering needs of this alternative:

COMPONENT	Quantity	Units
Sump Material	0	cubic yards
Pit Backfill	0	cubic yards
Cover Soil [1]	285,600	cubic yards
Diversion Structures	0	linear feet
Wells	0	Wells
Underground Entry	320	Feet
Backfill Depth (4,525)	0	Feet
Pit Area Revegetation [2]	59	Acres
Area Unrevegetated [3]	159	Acres

[1]Cover soil is for 59 pit acres at 3-foot thickness on flat surfaces.
[2]This includes 52 acres of pit roads, floor and benches and 7 acres already reclaimed.
[3]This includes 218 pit acres disturbed less 59 acres revegetated.

2.5 ALTERNATIVES CONSIDERED AND DISMISSED FROM DETAILED ANALYSIS

2.5.1 Introduction

Seven alternatives were developed and evaluated. Three of the alternatives were dismissed from detailed consideration in the SEIS due to environmental or technical concerns. Although the alternatives were dismissed, many technical analyses were completed for these alternatives and can be found in the Technical Memoranda prepared in support of the SEIS (Telesto, 2003a, 2003b, 2003c, 2003d, 2003e, 2003f, 2004; HSI, 2003; Robertson GeoConsultants, 2003; Gallagher, 2003c). The three dismissed alternatives are described below.

2.5.2 Partial Pit Backfill Without Collection Alternative

Like the Partial Pit Backfill With In-Pit Collection Alternative and the Partial Pit Backfill With Downgradient Collection Alternative, this alternative would backfill the pit to a free-draining surface at approximately the 5,350-foot elevation and reduce the pit highwall above that elevation to 2H:1V slopes. However, the Partial Pit Backfill Without Collection Alternative was developed to evaluate the possibility of avoiding long-term pit water collection and treatment. Under the Partial Pit Backfill Without Collection Alternative, wells would not be installed through the backfill and water would not be collected and treated. Natural attenuation and mixing of contaminated pit groundwater with ambient groundwater would be relied on to meet groundwater quality standards at the mixing zone boundary. This alternative would rely on the concept that over time waste rock used to backfill the pit would become less permeable than the surrounding rock. As a result, less water would flow through the pit. Consequently, maintaining the backfilled pit as a hydrologic sink might not be necessary and pit water treatment may not be necessary.

Currently, GSM has a site-wide mixing zone extending to the southern permit boundary for contaminated water from the waste rock dump complexes, Tailings Impoundment No. 1, and the water treatment plant's percolation pond (1998 Final EIS, Appendix 1, Figure 1). Pit discharge is not included in the mixing zone, so GSM would have to apply for a mixing zone modification to accommodate discharge from the pit. The current mixing zone boundary was used for the evaluation of this alternative.

After backfilling, the groundwater level in the pit would slowly rise, saturating the backfill. The pit would no longer be maintained as a hydrologic sink, and eventually the groundwater within the backfill would establish a hydrologic equilibrium with the natural groundwater system around the pit. Based on the water balance performed for the SEIS, seepage of groundwater from the pit backfill would begin approximately 21 years after mining ceases (Telesto, 2006). An equilibrium pit groundwater elevation of 5,260 feet was predicted to be reached approximately 61 years following the cessation of mining (Telesto, 2003a and 2006). The discharge rate from the pit was predicted to be from 27 to 42 gpm.

As the groundwater level rose in the pit backfill, it would migrate into fractures, faults and other geologic structures in the bedrock forming the pit highwall. When the groundwater rose, it would seep east along and across the structures, beneath the low point on the eastern rim of the pit, into the Tertiary debris flow (Tdf)/colluvial aquifer (URS, 2001). This is identified in Section 3.3.1.4 as the primary pit flowpath (HSI, 2003). The Tdf/colluvial aquifer is a buried gravel deposit forming a continuous pathway from the east side of the Range Front Fault, through Rattlesnake Gulch, where it blends with alluvial gravel deposits beneath Tailings Impoundment No. 1, reaching to the Jefferson River alluvial aquifer (Chapter 3, Section 3.3.1.5; and HSI, 2003). The existence and extent of the Tdf/colluvial aquifer flow path was mapped from geologic data in a number of detailed studies conducted by GSM and its consultants for a variety of purposes since 1985 (SHB, 1985 and Golder, 1995a) (see Figure 3-8). The pit flow path connecting to the Tdf/colluvial aquifer was evaluated for this SEIS (HSI, 2003).

Analysis of the geology and hydrogeology of the pit and surrounding bedrock indicated that secondary flow paths consisting of faults, fractures and other geologic structures could also provide pathways for seepage from a backfilled pit (HSI, 2003). These structures exit the pit in all directions. These same structures provide the pathways for the seeps and springs discharging into the pit during mining (Gallagher, 2003b). They are called secondary because:

- Their extent and continuity outside the pit may be limited or not completely mapped;
- Their hydrologic connection to existing surface water or groundwater features may be indirect; or,
- Their importance is inferred primarily by association with ferricrete deposits or high yield wells, which provide indirect evidence of a pathway.

The agencies assumed that less than 10 percent of the pit water would likely flow south along the Range Front Fault and other secondary flow paths. The 10 percent estimate is an assumption based on the consensus of several scientists working on this SEIS. The rationale for the less than 10 percent estimate is as follows:

The Sunlight Vein, Sunlight and Range Front faults, and the Corridor Fault create complex fault zones located on the eastern side of the pit. As water exits the pit, it would flow both along and out of these structures. Water that reaches Tertiary debris flow sediments will migrate into the primary flow path. The tendency for groundwater to flow preferentially either through any structures or into the Tertiary sediments is controlled by the relative ability of the materials to transmit water.

Studies have produced potentiometric maps that have included the Range Front Fault (Golder, 1995a; HSI, 2003; URS, 2001). All maps indicate that groundwater flows in a southeasterly direction. Water that crosses the fault zones will migrate into the Tertiary sediments. Water that stays in the fault zones would likely migrate southward. The hydraulic gradient between monitoring well PW-12, which is located on the east side of the fault near the east entrance to the pit, and PW-4, which likely intersects the Range Front Fault to the south, is approximately 0.013 foot/foot (*i.e.*, a vertical drop of 13 feet for every 1,000 feet of movement along the flow path) (Figure 3-8). The hydraulic gradient between PW-12 and PW-8 is approximately 0.037 ft/ft.

Considering these gradients, the transmissivity of the Sunlight and Range Front faults would have to be substantially greater than that of the surrounding rocks, or the faults would have to have relatively continuous impermeable zones acting as hydraulic barriers, in order for preferential flow to occur along the fault. Evidence of both is present in the pit area. There is a permeability contrast across the Sunlight and Range Front faults, evidenced by an abrupt change in groundwater level of 130 feet from the bedrock aquifer to the Tdf/colluvial aquifer (URS, 2001). This permeability contrast suggests either that the fault is acting as a hydraulic barrier or that there is a permeability contrast between rock types (URS, 2001). Geologic evidence in PW-64 indicates the permeability contrast in the Range Front Fault in this vicinity results from differences in rock types rather than structures. This conclusion supports contrasting permeability measurements in the bedrock and Tdf/colluvial aquifers (GSM, 1995; Hydrometrics, 1995). Hydraulic barriers are also present in the pit area as indicated by the change in oxidation state across the Wegner Fault, an early stage of range front faulting. The complex nature of the faulting along the range front strongly suggests that the presence of both permeability contrasts and impermeable zones have and will continue to influence the direction of groundwater flow.

Pit seep monitoring indicates that, between 1995 and 2001, GSM identified two seeps on the south pit highwall (Gallagher, 2003). The maximum measurable flow observed from these seeps was 0.75 gpm, with the majority of measurements recorded as "wet." The flow from seeps on the south highwall is expected to be 1 to 3 gpm. The observed flows occurred under the influence of a large hydraulic gradient created by the dewatered pit. If the hydraulic gradient is reversed in a backfilled pit such that groundwater moves out of the pit along structural pathways, the magnitude of the gradient away from the pit would likely be less than the gradient toward the pit. Potential outflows from the pit along the south highwall would likely be substantially less than 4.2 gpm.

Flow in fractured bedrock is complex and predicting where groundwater will flow is difficult. The majority of water would flow out of the pit via the Tdf/colluvial aquifer. It is estimated that a maximum of 4.2 gpm would flow out of a saturated pit via secondary flow paths in a variety of structures and locations. This is 10 percent of the total pit outflow under the Partial Pit Backfill With Downgradient Collection Alternative.

A groundwater mixing model was developed for the primary pit flow path from the pit to the Jefferson River alluvial aquifer (Telesto, 2003e). The model included mixing with ambient groundwater in the Tdf/colluvial aquifer and from precipitation. Due to the naturally acidic groundwater and coarse texture of the Tdf/colluvial aquifer beneath Rattlesnake Gulch, attenuation is probably minimal, and thus was not included in the model. This analysis indicated that primary groundwater quality standards for cadmium, copper, nickel and zinc, and secondary standards for sulfate and manganese would be exceeded at the current mixing zone boundary at the Jefferson River alluvial aquifer (Telesto, 2003e). Thus, compliance with groundwater quality standards could not be achieved without capture and treatment.

Analysis found that groundwater in a backfilled pit would also migrate along secondary pathways such as faults, fractures, and other geologic structures in the bedrock (HSI, 2003). There is no natural attenuation capacity, or ability to reduce the metals concentrations, available in the bedrock (Schafer and Associates, 1996). If collection and treatment are added to remedy this deficiency, this alternative becomes the same as the Partial Pit Backfill With Downgradient Collection Alternative. Consequently, this alternative was dismissed because compliance with groundwater quality standards could not be reliably assured without downgradient or in-pit collection of contaminated groundwater.

The reclamation requirements for the Partial Pit Backfill Without Collection Alternative would be the same as the Partial Pit Backfill With Downgradient Collection Alternative.

2.5.3 Partial Pit Backfill With Amendment Alternative

The Partial Pit Backfill With Amendment Alternative was developed to try to avoid the need for long-term pit water collection and treatment. Like the Partial Pit Backfill With In-Pit Collection and Partial Pit Backfill With Downgradient Collection alternatives, this alternative would backfill the pit to a free draining surface at approximately the 5,350-foot elevation and would reduce the pit highwall above that elevation to 2H:1V slopes. In this alternative, the chemical and the physical properties of the backfill would be conditioned to minimize groundwater flow and to prevent the generation of ARD through in-situ neutralization. The addition and mixing of sufficient lime to the acidic waste rock could increase the pH of the pore water, providing a less favorable environment for pyrite oxidation and/or minimizing metals mobility. Lime would be a mixture of calcium carbonate and calcium oxide mixed to DEQ specifications for lime amendment for waste rock (DSL, 1990). The goal would be to minimize the contaminant load that would be generated and transported in seepage from the pit, allowing compliance with applicable groundwater quality standards at the mixing zone boundary.

In this case, all material used to backfill the pit to a free-draining surface (33,300,000 cubic yards) would be hauled into the pit, placed in 2-foot lifts, and amended with lime at the rate of 200 tons of lime per 1,000 tons of waste rock backfill. This amendment rate would have about twice the neutralization potential needed for the waste rock backfill. Cast blasted and other backfill placed above the daylight level would not be amended.

The amended backfill would be constructed in lifts in the following sequence:

- Waste rock would be hauled from the East Waste Rock Dump Complex down into the pit;
- Waste rock would be dumped and spread in 2-foot-thick lifts;
- Lime would be hauled into the pit;
- Lime would be spread evenly over the top of the active backfill lift;
- Lime would be ripped into the backfill; and,
- The amended backfill would be compacted.

Backfill above the daylight level would be placed as described in the Partial Pit Backfill With In-Pit Collection Alternative. Compaction of the backfill placed below the free-draining grade would reduce the permeability of the backfill, which would restrict groundwater movement into and through the amended waste rock. A relatively low permeability plug of amended waste rock would be constructed within the pit.

Evaluation of this alternative revealed potential problems. Evidence was not found of cases where lime amendment of strongly ARD-generating rock or waste material was completely successful in controlling ARD production over a long period of time (Gallagher, 2003c). Some of the problems with lime amendment of ARD material could include:

- Lime amendment of ARD-impacted soils has been shown to be effective in surface reclamation, but not in a mass of waste rock as large as the GSM pit backfill.
- The chemical benefits of lime amendment may be short-lived, since some of the potentially reactive lime tends to become encapsulated by secondary mineral deposits of gypsum and hydroxides, rendering it ineffective in maintaining a non-acidic pH.
- The precipitation of secondary minerals from neutralization reactions would occur, but could not be counted on to form a complete low-permeability plug throughout the waste rock backfill.
- Locally, the formation of low permeability layers in the amended material due to plugging of pore spaces by iron hydroxide precipitates could lead to perching of groundwater recharge and ineffectual in-situ treatment by the amendment (Sonderegger and Donovan, 1984).
- Even if lime amendment would effectively maintain a nearly neutral pH, some contaminants, such as arsenic, selenium, sulfate and zinc, would remain mobile or could become more mobile under these conditions and would be available for groundwater transport out of the pit.
- The incorporation of the lime with the waste rock by ripping is not a perfect mixing process, resulting in many localized spots of ARD generation, which may be mobilized by groundwater (Dollhopf, 1990; Spectrum Engineering, 1996).

A pit backfill analog study did not find any cases, successful or unsuccessful, of mine reclamation programs using amended pit backfill (Kuzel, 2003; Gallagher, 2003c). Most mines do not have enough backfill history to draw any conclusions. Since the evidence did not support the premise that ARD production and migration from amended backfill could be controlled, seepage of ARD from the backfilled pit could occur. The process through which ARD from a backfilled pit migrates down the primary and secondary groundwater flow paths is described in Section 3.3.7.2. Analysis indicated that, without downgradient groundwater capture, compliance with groundwater quality standards for arsenic, selenium, sulfide, and zinc could not be reliably assured (Telesto, 2003e).

A safety risk was identified for construction workers attempting to implement this alternative because all backfill material below the daylight level would have to be hauled down into the pit via a steep road rather than being end dumped at the 5,400-foot elevation. While the addition of lime would neutralize the acidic quality of the mine waters for some period of time, it would also increase the mobility of other problem metals such as arsenic and zinc, potentially resulting in other environmental consequences (Gräfe et al., 2004). Due to the groundwater quality risk associated with this alternative and the high level of uncertainty, it was dismissed from further consideration.

The reclamation requirements for the Partial Pit Backfill With Amendment Alternative would be the same as the Partial Pit Backfill With Downgradient Collection Alternative, except that about 10,000,000 tons of lime would be needed. This lime would have to be mined or purchased from regional suppliers and hauled to the site.

2.5.4 Pit Pond Alternative

The possibility of creating a pit pond with biologic treatment was analyzed. The objective would be to design a pond that could sustain aquatic life and provide beneficial uses once it was developed. In the Pit Pond Alternative, the pit would passively fill with precipitation, groundwater, and runon water flowing into the pit. The design objectives would be to construct a pit pond that would remain as stable as possible year-round and to treat the water in the pit with microbes, nutrients, etc. As presently understood, a steady-state pit pond 110 feet deep would have a pool elevation of approximately 4,635 feet and would have roughly 30,000,000 gallons of storage (Telesto, 2003a).

The physical and chemical evolution of the pit pond would be monitored as the filling occurred. Depth profiles for temperature and electrical conductivity would be determined from sampling stations in the pit pond. The sample locations would be chosen to determine the effect of acid water on the electrical conductivity profile. During winter months, the freezing and thawing of the pond surface would be monitored. Samples would also be collected for various chemical analyses. Climate data would be collected with an on-site weather station. These data would be used to assist in modeling efforts and planning.

Design of the pit pond would involve applying scientific knowledge and engineering concepts to develop a final closure plan. Design work would consist of reducing uncertainties involved with the pit pond and gaining an understanding of the mechanisms that would operate in the pit pond. Some test work has been completed on this concept. But, the necessary work required to propose an in-situ treated pit pond is not complete at this time. As a result, a contingency to pump and treat water would be needed to drain the pond as in the Underground Sump Alternative.

Due to the lack of detailed studies to support such an action and the current uncertainties of success associated with a pit pond, the in-situ treatment concept could not be fully developed. Consequently, the pit pond concept was modified to incorporate a minimal pit pond with pumping and external water treatment.

2.5.4.1 Pit Pond With Pump and Treatment Alternative

The Pit Pond With Pump and Treatment Alternative is a no pit backfill option that has the objective of creating a pond of water inside the pit. The quality and level of the water allowed to accumulate in the pit would be managed by pumping from the pond in the pit as it forms, treating this water in the water treatment plant, and then recirculating treated water back into the pond to keep the water quality at an acceptable level. Because this concept would need to be tested in practice, a fully functional contingent underground sump collection and removal system would have to be made available to empty the pond and treat the water in case this alternative failed to provide adequate groundwater protection, as in the Underground Sump Alternative.

The pumping capacity would be designed to accommodate 65 gpm of water from the pit. Pumps could be stationed on a floating barge or inside the underground workings. If it became necessary to dewater all of the underground workings, a portable submersible pump could be advanced down the underground workings. In any case, some modification of the underground mine would be necessary to accommodate the pit pond. This might include constructing a new portal at an alternative elevation. Also, portable substations, fans, and pumping equipment would need to be removed from the sections of underground workings that would be below the pond elevation. HDPE pipes would be left in place.

Under the pump and treat concept, the water level in the pit would be kept as low as possible. Although a design water level was not determined for this concept, it would be well below the elevation of 4,635 feet, the point where evaporation would keep the pond at a steady state. If treated water from all sources was returned to the pit, it would take approximately five to six years for the water level to reach the steady-state elevation of approximately 4,635 feet (Telesto, 2003e).

The water quality of the pond would initially be similar to that observed for the current seeps. If water were left in the pond for long periods of time, evaporation would concentrate constituents. Thus, a pumping rate that balances inflows and evapoconcentration effects would be desired, but this would depend on the chosen treatment option. This pumping rate could be adjusted to meet a certain water quality desired for the treatment plant. Based on the corrosion calculations completed, pump system components made from plastic and stainless steel would be required.

Under the Pit Pond Alternative, the pit would remain a hydrologic sink above the pond elevation without the potential problems associated with constructing and operating a pumping system in acid producing backfill. However, even under this alternative, wells and drains in the highwall might still be used to target dewatering zones.

A water balance calculated for the pond was similar to that calculated for the No Pit Pond Alternative (Telesto, 2003a). Based on the water balance, the pond elevation would be well below the 5,050-foot elevation, which is the lowest contact with the Sunlight Fault and the point where water would be expected to begin escaping from the pit. No seepage out of the pit would be expected if the pond elevation were at the 4,635-foot level (Telesto, 2003a and 2003e).

There were concerns with this alternative which could not be addressed without actual field experimentation, data collection and additional technical analysis, including:

- The treated water returned to the pit could re-acidify.
- The equilibrium pit water level could fluctuate seasonally and annually and with cycles in weather.
- The continuing influx of acid salts from highwall runoff and the concentration effect from evaporation could affect the ability to maintain a treated pool.
- Given the uncertainties with the water chemistry and treatment capacity, applicable water quality standards might not be met.
- A contingency plan to improve the underground workings to dewater the pit would be needed.

Precipitation and groundwater that come into contact with the pit rock quickly acidify and become ARD. However, no studies have been performed on the interaction between treated water and the pit rock. The filling of a pit by groundwater would be a dynamic process involving the specific geometry of the pit, uncertain water chemistry, and rates of change in several other parameters.

Slope stability analyses show that the highwall would not be susceptible to mass failures under the conditions imposed by this alternative. Highwall stability would be the same as for the Underground Sump Alternative or No Pit Pond Alternative.

Reclamation requirements would be the same as for the Underground Sump Alternative.

The Pit Pond With Pump and Treatment Alternative has no clear advantage over the Underground Sump Alternative. At this point, without further technical review, any pond concept could only be considered by the agencies on a trial basis. Consequently, this alternative was dismissed.

2.6 RELATED FUTURE ACTIONS

Related future actions and impacts are discussed in Cumulative Impacts Section 4.7.

2.7 WATER TREATMENT AND CONTROL APPLICABLE TO ALL ALTERNATIVES

2.7.1 Collection and Treatment of Contaminated Groundwater

A water treatment system design was analyzed in the 1997 Draft EIS, Appendix A and approved in the 1998 ROD. Although quantities of water and the degree of contamination may vary between alternatives, all options require long-term measures to collect and treat contaminated groundwater, which either flows through or originates in the area of the mined-out pit. All alternatives carried forward in this SEIS have provisions for a capture system with pumps and pipes to collect water and convey it to the treatment plant. The projected reliability and effectiveness of the groundwater capture systems vary among the alternatives.

The 1997 Draft EIS, Chapter IV, Sections IV.B.7.b and IV.B.6.b estimated that 50 to 102 gpm of pit water would need to be captured and treated. In the SEIS, projected collection and treatment rates range from 25 to 42 gpm for alternatives involving capture within the pit (Telesto, 2006). Capture rate requirements for the Partial Pit Backfill With Downgradient Collection Alternative would be higher, due to the collection of an additional 52 to 103 gpm of ambient groundwater. The collection rate for the Partial Pit Backfill With Downgradient Collection Alternative would be in the range of 79 to 145 gpm (Telesto, 2006).

2.7.2 Water Treatment Plant

In all alternatives, water treatment would be required. The water treatment facility has already been permitted. In addition, GSM has posted a bond with the agencies for long-term water treatment. Although water treatment facilities with capacity to treat approximately 100 gpm currently exist in the mill building, GSM intends to replace this facility with a new water treatment plant after the mine closes. As reported in the 1997 Draft EIS, Map I-2, the new treatment plant would be located south of Tailings Impoundment No. 2 and would be designed to treat 102 gpm from the pit area (Figure 2-7).

2.7.3 Surface Water Management

GSM manages storm water runoff on site with lined and unlined diversions that route water around mine facilities, and with berms and swales that promote infiltration of runoff into the ground. All alternatives would employ provisions to divert surface water around the pit area, whether it is backfilled to a free-draining configuration or left open. Diversions constructed on acid-producing materials would be lined.

As part of the final reclamation of the site, GSM would construct permanent storm water controls. Erosion and sedimentation controls would be designed and implemented where necessary. The erosion and sedimentation control plan would consist of settling ponds and a network of associated collection and diversion channels (GSM, 1995b).

2.7.4 Monitoring

The water resources monitoring program currently in place (GSM 2006 Annual Report) would be modified at the end of mining, in coordination with DEQ and BLM. Facility-specific monitoring includes:

- Tailings Impoundment No. 1 seepage containment systems;
- Tailings Impoundment No. 1 and No. 2 area wells;
- Pit and waste rock dump complex area wells and seeps;
- Springs and surface water;
- Private residence wells; and,
- Diversion inspections.

Reclamation monitoring includes:

- Cover thickness evaluation;
- Revegetation success monitoring, including noxious weeds;
- Erosion monitoring; and,
- Steam vent monitoring.

2.7.5 Permanent Remediation Staff

All of the alternatives that have been evaluated require perpetual site staffing to monitor, operate, and maintain the water capture and treatment facilities, diversions and other erosion controls, revegetation success, weed control, etc. The permanent staff would range from 2 to 5 employees, depending on the alternative selected.

2.7.6 Return Diversion

The 1998 ROD approved the No Pit Pond Alternative in combination with the Return Diversion Alternative for the East Waste Rock Dump Complex. The diversion has already been constructed. Hence, the Return Diversion Alternative will be common to any of the pit closure alternatives.

Under the Return Diversion Alternative, Sheep Rock Creek is being diverted around the east end of the East Waste Rock Dump Complex and then reconnected with the unnamed tributary to the north on the east side of the dump (Figures 1-2 and 2-5).

2.8 SUMMARY OF IMPACTS FOR ALTERNATIVES

A detailed evaluation of impacts resulting from the Proposed Action and alternatives is provided in Chapter 4. Table 2-2 summarizes and compares the impacts of each alternative considered.

Table 2 - 2. Summary Comparison of Impacts Under the Proposed Action and Alternatives

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
Technical Issues				
Design & constructability of the alternative				
Proven design	Backfilling with 111,000 cubic yards of crusher reject to a depth of 100 feet is a proven design.	Backfilling with 33 million cubic yards of acidic waste rock and cast blasting and dozing the highwall to a 2H:1V slope is technically feasible.	Similar to Partial Pit Backfill With In-Pit Collection Alternative.	Not applicable.
	Dewatering this volume of material to a depth of 100 feet is a proven design.	Dewatering waste rock backfill from a depth of up to 875 feet has not been proven.	Pumping out of downgradient drainages in natural geologic formations up to 200 feet deep is done regularly, but the objective of overall 96 percent capture may not be achievable Based on their experience, the agencies believe a maximum capture efficiency of 80% per system is potentially achievable.	Maintaining hydrologic connection between the pit bottom and an underground sump 25 to 75 feet below the pit and pumping from the sump have been done successfully at GSM and other mines.
Design & constructability of the alternative				
Ability to construct the alternative at GSM	Problems with constructing this alternative would be minimal.	There would be more problems developing and implementing this alternative than the No Pit Pond Alternative because of the larger volume and depth of backfill needed, the amount	There would be more problems developing and implementing this alternative than the No Pit Pond Alternative because of the larger volume and depth of acidic backfill needed and the amount of cast blasted material	GSM has developed and maintained an underground mine, including an underground sump connected to the open pit.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
		of cast blasted material, and the problems drilling dewatering wells in up to 875 feet of unconsolidated waste rock in order to maintain the pit as a hydrologic sink.	required. Installing dewatering wells in downgradient drainages in natural geologic formations up to 200 feet deep has been done successfully at GSM.	
Pit highwall				
Pit highwall stability	Some portions of the pit highwall would be subject to raveling, talus formation, erosion, and limited sloughing. The overall stability of the pit highwall would be expected to increase over the long term as the rock materials achieve a more stable configuration.	No pit highwall would remain exposed. Backfilling the pit would eliminate pit highwall raveling and sloughing. Cast blasting would enhance the inherent stability of the pit highwall by reducing the slope to 2H:1V. The long-term stability of the pit highwall would be greater than the No Pit Pond Alternative.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Similar to the No Pit Pond Alternative.
Pit highwall maintenance requirements	Raveling and sloughing of the highwall would require periodic maintenance to re-establish the 5,700-foot-elevation safety bench, clear the access road, haul more backfill to create a new working surface in the pit bottom, and move rock to re-establish safety berms. This could occur more than once over the long term.	No highwall maintenance would be needed.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Similar to the No Pit Pond Alternative. Depending on the location of highwall raveling and sloughing, access to the 4,550-foot portal and the underground dewatering system could be lost. The 5,700-foot safety bench and access to the 4,550-foot portal would have to be re-established.
Backfill				
Backfill maintenance requirements	Settling in 100 feet of crusher reject would be	Up to 150 feet of settling could occur in the 875 feet of	Up to 200 feet of settling could occur in the 875 feet of backfill	Not applicable.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
	limited to 10 feet. Repairs would be needed to bring the crusher reject back to grade.	backfill, with 60 to 75 percent of the settling occurring during the backfilling operation. Repairs would be needed to bring the acidic backfill back to grade. Settling in the acidic backfill would affect storm water diversions on the 2H:1V slopes.	after it is inundated with groundwater. Sixty to seventy-five percent of settling would occur during the backfilling operation. The remaining settling would occur over about 61 years during saturation to the 5,260-foot elevation. Repairs would be needed to bring the backfill back to grade. Settling in the backfill would affect storm water diversions on the 2H:1V slopes.	
	Raveling and sloughing of the highwall would require periodic maintenance to re-establish the working surface and drill new wells.	The highwall would not ravel or slough.	The highwall would not ravel or slough.	Not applicable.
Underground workings				
Impacts to pit facilities due to subsidence related to underground mining	Localized failures of the walls and ceiling over time could result in subsidence, especially in seep and fault areas where chemical weathering would be increased. Subsidence could cause settling in the 100 feet of crusher reject, affecting the dewatering wells in the crusher reject.	Same as the No Pit Pond Alternative. Subsidence could cause settling in up to 875 feet of backfill, affecting the dewatering wells in the backfill.	Similar to the Partial Pit Backfill With In-Pit Collection Alternative, except the dewatering wells down gradient of the pit would not be affected.	Same as the No Pit Pond Alternative, except localized failures of ceiling and walls in seep and fault areas could occur over time, affecting access to the dewatering system in the underground workings.
Groundwater/ effluent management system				
Operation	Two to three wells would	Four wells would be	An additional 26 capture wells	No wells would be

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
requirements (number of wells)	be constructed through the acidic pit crusher reject about 100 feet deep to the bedrock contact.	constructed through the acidic pit backfill up to 875 feet deep to the bedrock contact. Wells would need to be replaced frequently due to corrosion.	and 10 monitoring wells would be constructed down gradient from the pit. This number of wells may not be enough to ensure compliance with groundwater quality standards at the mixing zone boundary.	constructed. Drill holes would be used to direct pit water to the underground sump.
Maintenance of capture points	Settlement of the 100 feet of crusher reject could cause separation, buckling, or shearing of well casings. About 60 to 75 percent of settlement would occur during the backfill operation and 25 to 40 percent over a longer period after backfilling is complete.	Settlement effects on well casings would be more severe than under the No Pit Pond Alternative.	Wells would be constructed outside of the pit and would not be subject to acidic backfill settling.	There would be no backfill to settle and no wells to damage. Rock fall from ceiling and walls of the underground workings could damage the dewatering system.
	Corrosion of the well casings, pumps, electrical components, monitoring equipment and pipelines from the acidic water in the backfill would cause periodic need for repair and replacement of dewatering system components.	Same as the No Pit Pond Alternative.	Short-term buffering by the aquifer and mixing with ambient groundwater would limit corrosion of pumps and screens, providing for longer pump life. After the buffering capacity of the aquifer is used up in a few tens of years, water quality would be similar to the No Pit Pond and Partial Pit Backfill With In-Pit Collection alternatives.	Corrosion would be similar to the No Pit Pond Alternative.
	Highwall raveling and sloughing could damage dewatering wells, monitoring equipment, power lines, and pipelines.	Not applicable.	Not applicable.	Similar to the No Pit Pond Alternative, except the collection system would not be damaged.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
	Pumping rates of 25 to 27 gpm at a lift of up to 200 feet would not be a problem. Pumping stations would be used to finish getting the water out of the pit. Not applicable.	Pumping rates of 27 to 42 gpm and the 875-foot lift compared to the No Pit Pond Alternative would cause more pump failure and may cause the need to allow the water table to rebound for pumping efficiency. No pumping stations would be needed. Not applicable.	Similar to the No Pit Pond Alternative. Multiple wells up to 200 feet deep would pump a total of 79 to 145 gpm. Not applicable.	Similar to the No Pit Pond Alternative, except the lift would increase by 75 feet. Access to the underground would be needed. Sloughing could bury the 4,550-foot elevation portal blocking access to the dewatering system needed for maintenance.
Storm water runon/runoff management				
Maintenance requirements (drainage channels off 2H:1V slopes)	Diversions on the upper pit highwall would route water away from the pit. Settling of diversions constructed on unconsolidated materials and accumulations of sediment and material sloughed from above would impair diversions' function. Periodic cleaning and repairs would be needed. Eventually, portions of the diversions would need to be reconstructed	Same as the No Pit Pond Alternative, except there would be diversions on the pit backfill.	Same as the No Pit Pond Alternative.	Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
	completely. Not applicable.	Diversions would be constructed on the 2H:1V slopes created by highwall reduction. Settling in the backfill could cause depressions where surface water could accumulate, infiltrate, and saturate the soil cover resulting in localized erosion on the face of the reclaimed slopes. Maintenance requirements for diversions would be the same as for the No Pit Pond Alternative, except there would be more diversions to maintain.	Maintenance requirements would be similar to the Partial Pit Backfill With In-Pit Collection Alternative. More settlement would occur due to saturation of the backfill.	Not applicable.
Soil cover				
Soil cover maintenance requirements (erosion, revegetation)	A 3-foot soil cover would be placed and revegetated on the pit floor, pit benches, and roads, totaling 53 acres. A total of 290,400 cubic yards of soil cover material, from existing sources, would be necessary. Eroded areas would need to be repaired, resoiled, and reseeded. Noxious weeds would have to be controlled.	A 3-foot soil cover would be placed and revegetated on the backfilled pit and reduced highwall, totaling 272 acres. A total of 1,541,800 cubic yards of soil cover material, resulting in an additional disturbance of 31 acres, would be necessary Same as the No Pit Pond Alternative.	Similar to the Partial Pit Backfill With In-Pit Collection Alternative. Same as the No Pit Pond Alternative.	Similar to the No Pit Pond Alternative, except there would be 1.3 fewer acres to maintain in the pit. A total of 285,600 cubic yards of soil cover material, from existing sources, would be necessary. Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
	The backfill surface would need to be regraded as the crusher reject settles. Rocks that ravel or slough from the highwall onto revegetated areas would need to be removed. Depending on the volume of rock, regrading, resoiling, and reseeding of reclaimed surfaces may be needed.	Backfill would settle up to 150 feet. More acidic backfill would have to be placed, graded, resoiled, and revegetated.	Backfill would settle up to 200 feet.	There would be no backfill needing cover maintenance.
	No highwalls would be covered with soil.	In localized areas, highwall seeps could saturate the soil cover with acidic water, contaminating soils and impairing revegetation success. The seep would have to be located and dewatered, contaminated soil would have to be replaced with clean soil, and the area would have to be revegetated	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.
Water treatment				
Additional sludge management requirements	Between 25 and 27 gpm of pit water would need treatment.	Between 27 and 42 gpm of pit water would need treatment.	Between 79 and 145 gpm of groundwater would be collected and treated trying to capture 96 percent of the 27 to 42 gpm of pit discharge to meet water quality standards.	Same as the No Pit Pond Alternative.
	The sludge management requirements would be	Weathering would continue to produce oxidation byproducts	Weathering would continue to produce oxidation byproducts	The water produced in the underground workings would

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
	similar to or less than estimated in the 1997 Draft EIS.	in the unsaturated backfill. Pumping would limit saturation of the backfill and impacts from jarosite dissolution. More sludge would be produced per gallon of treated water than under the No Pit Pond Alternative, so the sludge management requirements would be similar.	in the unsaturated backfill. Jarosite in the saturated portion of the backfill would, for a time, prevent reducing conditions from developing and allow further production of acid. Jarosite is stable under oxidizing conditions and unstable under reducing conditions. The presence of jarosite in the pit backfill would only influence the oxidation-reduction conditions until it all dissolves. Jarosite would likely dissolve and release metals in the saturated portion of the backfill. Once jarosite completely dissolves, reducing conditions would likely develop in the saturated portion of the backfill. The flow from the unsaturated portion of the backfill above the water table would contribute low pH water with high metals concentrations to the pit discharge for hundreds of years. There is limited natural attenuation capacity along the primary and secondary flow paths from the pit. The sludge management requirements would be about the same as the Partial Pit Backfill With In-Pit Collection Alternative because the chemical mass would be about	be comparable to the water quality in the No Pit Pond Alternative. Because there would be no backfill, jarosite, adsorbed metals, and other oxidation byproducts would remain relatively immobile in the waste rock dump complex. There would be minimal additional sludge.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
			the same.	
Additional operating requirements	There would be no additional water treatment operating requirements. The water treatment system in the SEIS is the same as that evaluated in the 1997 Draft EIS, and there would be less pit water to treat.	Same as the No Pit Pond Alternative.	The water treatment plant could require additional operating cost due to the increased water quantity treated under this alternative. The total amount of water would be less than the permitted treatment plant capacity.	Same as the No Pit Pond Alternative.
Flexibility for future improvements				
Potential for utilization of new technologies	New technology, such as *in-situ* water treatment, would be easier to apply in the less than 600,000 cubic yards of crusher reject and raveled and sloughed highwall rock under the No Pit Pond Alternative than it would be in the larger volumes of backfill under the partial pit backfill alternatives.	New technology, such as *in-situ* water treatment, would be harder to apply in 47 million cubic yards of pit backfill than under the No Pit Pond Alternative. Because of the problems with maintaining wells in acidic waste rock in the deeper backfill, this alternative offers less potential for utilization of new technologies. It would be harder to redesign the dewatering system in up to 875 feet of backfill.	Similar to the Partial Pit Backfill With In-Pit Collection Alternative, except that *in-situ* water treatment would be more difficult because of the lack of wells in the backfill. If treatment were attempted outside of the pit, a dispersed plume may be more challenging to track, contain, and treat *in-situ*.	New technology, such as in-situ water treatment, would be easier to apply in the open water of an underground sump than in backfill.
Environmental Issues				
Impacts to groundwater quality and quantity				
Risk of impacts to groundwater quality	The pit would be maintained as a hydrologic	Same as the No Pit Pond Alternative, except 27 to 42	The pit would not be a hydrologic sink. Two	Same as the No Pit Pond Alternative, except that water

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
and quantity in permit area	sink and between 25 and 27 gpm of pit water would be collected and treated before being discharged. No impacts to groundwater quality from pit outflows are expected. The groundwater level around the pit would be permanently drawn down. This would result in minor reductions in the flows of springs that are hydrologically connected to the pit.	gpm would be collected and treated. Same as the No Pit Pond Alternative.	groundwater capture systems in Rattlesnake Gulch, each operating at an efficiency of 87.5 percent or greater would be required to meet DEQ-7 water quality standards at the mixing zone boundary for the toxic and carcinogenic parameters modeled. The standard for iron would be exceeded. This level of capture efficiency may not be achievable. Based on their experience, the agencies believe a maximum capture efficiency of 80% per system is potentially achievable. The groundwater level around the pit would rebound so that the flows of springs that are hydrologically connected to the pit could be increased. Because of the higher pit groundwater elevation, ARD water from the pit could move along secondary flow paths in the bedrock and Bozeman Group aquifers where it is more difficult to detect and collect. Groundwater quality would likely be degraded up gradient of the collection wells where groundwater is already affected	would be pumped from the underground sump and treated. Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
			by ARD from natural mineralization and may eventually be impacted from 1-3 gpm of the East Waste Rock Dump Complex seepage in Rattlesnake Gulch. The potential for creating new springs or affecting water quality of existing springs is higher than under the other alternatives.	
Risk of violation of groundwater standards at permit boundary and impacts to beneficial uses of the Jefferson River alluvial aquifer	Groundwater quality standards would be met at the mixing zone boundary. Beneficial uses of the Jefferson River alluvial aquifer would not be affected.	Compliance with water quality standards at the mixing zone boundary may not be achievable long-term.	Two groundwater capture systems in Rattlesnake Gulch, each operating at an efficiency of 87.5 percent or greater would be required to meet DEQ-7 human health standards at the mixing zone boundary for the toxic and carcinogenic parameters modeled. The DEQ-7 standard for iron would be exceeded. The required capture efficiency may not be achievable. Based on their experience, the agencies believe a maximum capture efficiency of 80% per system is potentially achievable. With two systems each operating at 80 percent capture efficiency, DEQ-7 human health water quality standards for nickel, and copper would be exceeded at the permit boundary and within the Jefferson River alluvial	Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
			aquifer. Nondegradation criteria for groundwater quality in the JRA aquifer fail for arsenic, cadmium, copper, iron and nickel at all levels of groundwater capture efficiencies modeled, up to and including 96% combined capture efficiency.	
Impacts to surface water quality and quantity				
Impacts to springs, wetlands	The groundwater level around the pit would be permanently drawn down resulting in minor reductions in the flows of springs that are hydrologically connected to the pit.	Same as the No Pit Pond Alternative.	The groundwater level around the pit would rebound so that the flows of springs that are hydrologically connected to the pit would remain the same or increase. New springs or seeps could be created that would be impacted by ARD from the pit. Discharges of ARD at existing springs around the pit area could increase.	Same as the No Pit Pond Alternative.
Risk of violation of surface water standards and impacts to beneficial uses of the Jefferson River and Slough	There would be minimal pit discharge. There would be no risk of violation of surface water standards and impacts to beneficial uses in the Jefferson River and Slough.	Same as the No Pit Pond Alternative.	The risk of contaminants reaching the Jefferson River or Slough and affecting surface water quality and beneficial uses is greater than for alternatives that maintain the pit as a hydrologic sink. Two groundwater capture systems in Rattlesnake Gulch, each operating at an efficiency of 87.5 percent or greater would be required to meet DEQ-7	Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
			surface water quality standards At this capture efficiency, the chronic aquatic life standards were met in the Jefferson River Slough for the parameters modeled. Based on their experience, the agencies believe a maximum capture efficiency of 80% per system is potentially achievable. At this efficiency, the chronic aquatic life standard for aluminum would be exceeded in the Jefferson River Slough over the entire predicted range. Nondegradation criteria for surface water quality in the Slough fail for aluminum, copper and iron at all levels of groundwater capture efficiencies modeled, up to and including 96% combined capture efficiency. Control of pit seepage along secondary pathways may be difficult. There is little attenuation capacity in the Tertiary debris flow/colluvial aquifer.	
Reclamation plan changes				
Surface disturbance	No new pit disturbance.	56 acres of new pit disturbance and 31 acres of	Same as the Partial Pit Backfill With In-Pit Collection	Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
		new soil salvage disturbance.	Alternative, except 2 additional acres would be disturbed for downgradient wells.	
Hazards to wildlife	There would be no additional hazards to wildlife.	There would be fewer hazards to wildlife than under the No Pit Pond Alternative because the highwall would be eliminated.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.
Total remaining unrevegetated acres	158 acres	2 acres of access roads	2 acres of access roads	159 acres
<u>Socioeconomic Issues</u>				
Safety				
Risk to workers (reclamation and construction)	The safety risk to reclamation workers would be increased while crusher reject is being hauled down the steep roads into the pit, because of the potential for truck accidents.	The safety risk to reclamation workers would be the same as under the No Pit Pond Alternative while 100 feet of crusher reject is being hauled down the steep roads into the pit. The rest of the backfilling would be by end dumping acidic waste rock from the pit rim, a standard method used during mining that has less risk than hauling loaded trucks to the bottom of the pit. Cast blasting and dozing to reduce the pit highwall would present risks to workers.	Similar to the Partial Pit Backfill With In-Pit Collection, except separate placement of crusher reject in the bottom of the pit would not be required.	Less than the No Pit Pond Alternative. Backfill would not be hauled into the pit.
	Workers would be below a highwall of up to 1,875 feet high with the risk of injury from rock falls.	Workers installing, operating, and maintaining the dewatering system would not be working below a highwall	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Workers would be exposed to rock falls from the walls and ceiling of the underground workings as well as from the

	No Pit Pond (No Action)	**Partial Pit Backfill With In-Pit Collection (Proposed Action)**	**Partial Pit Backfill With Downgradient Collection**	**Underground Sump**
		and would not be at risk of injury from rock falls.		1,875-foot highwall. Overall risk would be less than the No Pit Pond Alternative.
Risk to workers (long-term maintenance)	Workers in the pit would be exposed to the 1,775-foot pit highwall raveling and sloughing. Long-term access would be needed to the pit bottom for monitoring and maintenance of the pit haul road, the 5,700-foot elevation pit safety bench, and the dewatering system.	Workers would not be exposed to pit highwall raveling and sloughing. Long-term access to the pit bottom would not be required. The risk to worker safety in this alternative would be less than the No Pit Pond Alternative and would be similar to the risk of work currently conducted on the waste rock dump complexes.	Similar to the Partial Pit Backfill With In-Pit Collection Alternative.	Similar to the No Pit Pond Alternative, except workers would be exposed to rock falls from the walls and ceiling of the underground workings as well as from the highwall. Overall risk would be less than the No Pit Pond Alternative.
Risk to public safety	Access restrictions on general public use would be maintained and would consist of signs, berms, and fencing around the pit area, but there would still be a risk to public safety from the pit highwall.	Same as the No Pit Pond Alternative, except there would be no risk to public safety from the pit highwall.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.
Mining employment				
Potential employment from mining Stage 5B	750 person years	750 person years. Premature closure would reduce this by 150 person years per year.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.
Reclamation employment				
Reclamation employment opportunities	123 person years	308 person years	308 person years	124 person years
Revenue from taxes				
Potential tax	$8,087,000	Same as the No Pit Pond	Same as the No Pit Pond	$8,087,000

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
revenues from mining Stage 5B		Alternative, except that premature closure would reduce this tax revenue.	Alternative, except that premature closure would reduce this tax revenue.	
Potential tax revenues from pit backfill	$319,500	$806,000	$911,000	$322,000
Mineral reserves and resources				
Access to future mineral reserves/ Resources	If the pit were to be enlarged for additional mining in the future, it would take 1.5 months to remove the 600,000 cubic yards of crusher reject, soil, and highwall rock. Time is based on the 2002 mining rate of 405,000 cubic yards per month. The pit would have to be dewatered before it could be enlarged. The additional time required to dewater the pit would be minimal.	If the pit were to be enlarged for additional mining in the future, it could take 116 months to remove the 47 million cubic yards of backfill and soil. The pit would have to be dewatered. The additional time required to dewater the pit would be the same as the No Pit Pond Alternative.	Same as the Partial Pit Backfill With In-Pit Collection Alternative. Because the water table would rebound, more of the acidic backfill would have to be dewatered as mining proceeded. The time required to dewater the pit would be longer than the Partial Pit Backfill With In-Pit Collection Alternative.	If the pit were to be enlarged for additional mining in the future, it would take 0.5 month to remove the 200,000 cubic yards of raveled and sloughed highwall rock and soil. Similar to the No Pit Pond Alternative.
Land use after mining				
Suitability of land use after mining	The land use after mining would be wildlife habitat. About 60 acres would be revegetated. About 158 acres of mule deer habitat would be lost. Limited	The land use after mining would be wildlife habitat. About 272 acres would be revegetated. Up to 2 acres of habitat would be lost for access roads. Raptor and	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	**Partial Pit Backfill With In-Pit Collection (Proposed Action)**	**Partial Pit Backfill With Downgradient Collection**	**Underground Sump**
	raptor and bat habitat would be developed in the upper highwall.	bat habitat would not be developed.		
Aesthetics				
Visual contrast with adjacent lands	Portions of the highwalls and benches would remain visible. Overall visual contrasts would be reduced to a level where they are noticeable, but not dominant in the landscape, following successful reclamation and revegetation. Landscape modifications would be consistent with the suggested VRM Class III rating for the area.	The reclaimed 2H:1V slopes covering the pit highwall and the reclaimed slopes of the waste rock dump complexes would still be visible, but the overall contrasts would be reduced under this alternative.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.
Potential future burden				
Potential future burden on society	The consequence of failure of this alternative would be the creation of a pit pond below the 5,050-foot elevation. No impacts to groundwater and minimal impacts to springs would occur.	The consequence of failure of this alternative would be uncontrolled discharges of ARD-impacted groundwater from the backfilled pit, which could adversely impact springs and beneficial uses of the Jefferson River alluvial aquifer.	Same as the Partial Pit Backfill With In-Pit Collection Alternative.	Same as the No Pit Pond Alternative.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
Potential for future liabilities for GSM	No water would leave the pit. If the dewatering system failed, it could be re-established on the regraded pit bottom through 200 feet of crusher reject and sloughed highwall rock more easily than through up to 875 feet of acidic backfill. Continued safe access to the dewatering system for operation and maintenance would be more difficult than the partial pit backfill alternatives because of highwall rock raveling and sloughing onto safety benches and access roads.	No water would leave the pit. If the dewatering system failed, it could be re-established by drilling new wells. Drilling and maintaining wells in up to 875 feet of acidic backfill would be problematic. Safe access to the dewatering system for operation and maintenance would not be a problem because there would be no highwall.	The potential for water quality degradation outside of the pit would be increased. From 27 to 42 gpm of untreated water would escape the pit. If either of the two groundwater capture systems failed to achieve at least 87.5 percent efficiency, groundwater standards for nickel and copper would be exceeded at the edge of the mixing zone.	No water would leave the pit. Removing water from the underground sump would be easier than pumping out of waste rock backfill or crusher reject. If the dewatering system failed, it could be re-established more easily than under the partial pit backfill alternatives. Continued safe access to the dewatering system for operation and maintenance, because of wall and ceiling rock sloughing in the underground workings, would be less risky than the No Pit Pond Alternative.
	Removing water from 100 feet of crusher reject would not be a problem. Dewatering system components would fail regularly from crusher reject settling and corrosion.	Removing water from up to 875 feet of acidic backfill would be difficult. Dewatering system components would fail more often than under the No Pit Pond Alternative.	The quality of the water collected down gradient of the pit would be partially attenuated and mixed with regional groundwater, but consistently achieving 87.5 percent capture for two pumping systems may not be achievable. Based on their experience, the agencies believe a maximum capture efficiency of 80% per system is potentially achievable. Dewatering system components would not fail as regularly due to settling and corrosion.	Dewatering system components would not fail as regularly due to corrosion.

	No Pit Pond (No Action)	Partial Pit Backfill With In-Pit Collection (Proposed Action)	Partial Pit Backfill With Downgradient Collection	Underground Sump
Project Economics Issues				
Costs				
Reclamation costs	$1,168,000	$55,355,000	$55,357,000	$1,260,000

2.9 PREFERRED ALTERNATIVE

The rules and regulations implementing MEPA and NEPA (ARM 17.4.617 and 40 CFR 1502.14, respectively) require that the agencies indicate a preferred alternative in the Draft SEIS, if one has been identified, and in the Final SEIS prepared for the project. The preferred alternative is not a final agency decision; it is an indication of the agencies' preference at this time. The agencies' preference considers all information that has been received and reviewed relevant to the proposed project, and all comments received on the Draft SEIS. The preferred alternative at this time is the Underground Sump Alternative with visual and other mitigations described in Section 4.8.3.2.

2.9.1 Rationale for the Preferred Alternative

Under all alternatives, no highwall failure that would be a threat to public safety or the environment outside the pit would occur and some wildlife habitat would be provided. However, only the Underground Sump and No Pit Pond alternatives provide adequate assurance that pollution of the Jefferson River alluvial aquifer in violation of water quality laws will not occur. These alternatives would provide almost complete control of pit seepage through evaporation and collection. Sufficient control of pit seepage to protect groundwater and surface water quality cannot be reliably assured under the partial pit backfill alternatives, because of the problems associated with drilling and operating wells in the 875 feet of reactive backfill and with effectively capturing seepage in or down gradient of the pit.

With the imposition of the visual mitigations described in Section 4.8.3.2, the Underground Sump and No Pit Pond alternatives also mitigate post-reclamation visual contrasts between the pit and adjacent lands.

The Underground Sump Alternative would pose less risk to workers monitoring and operating the water capture system from rock raveling from the highwall than would the No Pit Pond Alternative. Under the No Pit Pond Alternative, the workers would perform these functions while exposed to highwall raveling and sloughing. Under the Underground Sump Alternative, much of the work would be performed underground. In addition, the Underground Sump Alternative collection system would require less maintenance than the No Pit Pond Alternative because it would not be susceptible to damage from rock raveling from the highwall.

BLM is mandated by the Federal Land Policy and Management Act (PL 94-579) and subsequent 43 CFR 3809 surface management regulations to manage federal lands so as to prevent unnecessary or undue degradation of the public lands. The preferred alternative avoids unnecessary or undue degradation of the land by maximizing the amount of mine impacted water collected and treated, limiting the potential for mine impacted water to escape collection, and limiting the potential for water quality violations at the mine's mixing zone boundary.