DEQ
Montana Department
of Environmental Quality

June 15, 2021

RE: Notice of release and public comment period for the Draft Environmental Impact Statement for the Proposed Tailings Reprocessing Project at the Golden Sunlight Mine.

Dear Interested Party:

The Department of Environmental Quality (DEQ) has released a Draft Environmental Impact Statement (EIS) to analyze the potential environmental impacts from a proposed tailing reprocessing project at the Golden Sunlight Mine. The Golden Sunlight Mine is located approximately five miles northeast of Whitehall, Montana in Jefferson County.

The project, an amendment to their current operating permit under the Metal Mine Reclamation Act, would allow Golden Sunlight to excavate and reprocess tailings and extend the life of the mine by up to 12 years. Golden Sunlight would excavate tailings in Tailing Storage Facility 1 using conventional methods, move the material to a re-pulping plant, pump the slurried tailings to the flotation plant in the mill, and reprocess the tailings to extract a gold and sulfide concentrate. Approximately 26 million tons of tailings would be reprocessed, and the remaining product would be disposed in an onsite pit. After excavation, the tailings facility footprint would be reclaimed for land uses such as grazing, recreation and wildlife habitat. All proposed activities would occur within the existing permitted disturbance boundary and would not include any new disturbance areas.

The Draft EIS is available for public comment from June 15, 2021 – July 15, 2021. The Draft EIS describes the proposed action, no action, and DEQ's preferred alternative and permit stipulations. Impacts to resource areas from these actions are analyzed within the Draft EIS. The preferred alternative could change in response to public comment on the Draft EIS, new information, or new analysis that might be needed in preparing the Final EIS.

All comments become part of the public record for this project and are available for public review, along with the name(s) of the commenter(s). The Draft EIS has been posted on DEQ's website. To submit comments or view the Draft EIS, visit the DEQ website at:(http://deq.mt.gov/Public/publiccomment).

Greg Gianforte, Governor I Christopher Dorrington, Director I P.O. Box 200901 I Helena, MT 59620-0901 I (406) 444-2544 I www.deq.mt.gov

Written comments may be submitted at the public meeting, via electronic mail at mepa@mt.gov, or postal mail at:

Craig Jones
Department of Environmental Quality
P.O. Box 200901
Helena, MT 59601

DEQ will host a public meeting on Tuesday June 29, 2021, at 6:30 p.m. The meeting will be held in person at the Borden Building in Whitehall as well as hosted virtually on Zoom (accessible both online and by telephone).
The meeting will provide the public with information on the proposed project and an opportunity to submit comments.

What: A public hearing on the Golden Sunlight Mine Draft EIS

When: Tuesday, June 29, 2021, 6:30 p.m. MST

Where:
Participants can attend either in person or virtually through Zoom. The in-person meeting will be held at Borden Building, Whitehall, Mont. (103 W Legion Ave., Whitehall 59759).

Participants can also attend the meeting via Zoom and receive instructions about how to access the meeting by registering at:
http://deq.mt.gov/Public/publiccomment

The online meeting is accessible both online and by telephone. DEQ will make reasonable accommodations for those with disabilities who wish to participate in the meeting. If you require an accommodation or would like to register by phone, please contact Moira Davin, Public Relations Specialist at: 406-461-2503 or by email at: Moira.Davin@mt.gov. Participants joining online are asked to join the meeting ten minutes early to test their connection.

DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED AMENDMENT 017 TO PERMIT NO. 00065 FOR THE GOLDEN SUNLIGHT MINE

June 2021

BARRICK GOLDEN SUNLIGHT MINE
JEFFERSON COUNTY, MONTANA

DEQ Montana Department of Environmental Quality

EXECUTIVE SUMMARY

This Executive Summary provides an overview of the Environmental Impact Statement (EIS) for the proposed Amendment 017 to Hard Rock Mine Operating Permit No. 00065 submitted by Barrick Golden Sunlight Mines, Inc. (GSM) for the Tailings Reprocessing Project (the TRP or Project) in Whitehall, Montana. The EIS describes the resources that are potentially affected by the proposed Amendment activities. This summary does not provide all of the information contained in the EIS; for additional information, refer to the EIS and sources referenced within.

This EIS describes the Proposed Action and alternatives, including (1) the No Action Alternative and other alternatives described in Chapter 2.0, Description of Alternatives; and (2) a summary and comparison of the alternatives.

Purpose and Need

The Montana Department of Environmental Quality's (DEQ) purpose and need in conducting the environmental review is to act upon GSM's application to amend Operating Permit No. 00065. The Golden Sunlight Mine is an open-pit and underground gold mine. Mining and milling operations ceased in April 2019. The permit amendment (Proposed Action) would allow GSM to excavate and reprocess tailings from the previously reclaimed Tailings Storage Facility 1 (TSF-1), construct a new Re-Pulping Plant, reprocess the tailings to separate sulfur and gold, and dispose of the remaining tailings by partially backfilling the Mineral Hill Pit (Pit). Ground water from the Pit would continue to be pumped, treated, and monitored similar to current water-management operations.

The Proposed Action would not increase the size of the mine permit boundary or the currently approved disturbance boundary. The permit amendment would occur over approximately 12 years. GSM's purpose and need for the Project would include sulfur and gold production to help meet market demands and enhance or prolong employment and tax payments from the Golden Sunlight Mine.

DEQ's Record of Decision (ROD) will document the outcome on the permit amendment that is based on information provided in the Amendment Application, analysis in the EIS, and substantive provisions of the Montana Metal Mine Reclamation Act (MMRA) (Section 82-4-301, Montana Code Annotated [MCA]). DEQ's ROD would be published no sooner than 15 days after the Final EIS is published. The Final EIS will include comments received on the Draft EIS and the agency's responses to substantive comments.

The Montana Environmental Policy Act (MEPA) (Section 75-1-201, *et seq.*, MCA) requires an environmental review of actions taken by the state of Montana that may significantly affect the quality of the human environment. This EIS was prepared to satisfy these MEPA requirements. Before beginning its environmental review under MEPA, DEQ reviewed GSM's Amendment Application, determined that it was complete and compliant with the MMRA (Section 82-4-301, MCA), and issued a draft permit amendment on October 26, 2020. Issuance of the draft permit amendment as a final permit amendment is the proposed state action subject to this environmental review under Section 82-4-337(1)(f), MCA.

Project Location and History

The Golden Sunlight Mine is an open-pit and underground gold mine located in Jefferson County, Montana (**Figure ES-1**). The mine is within all or portions of Sections 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, and 33 of Township 2 North, Range 3 West; Sections 4, 5, and 6 in Township 1 North, Range 3 West; and Sections 13, 24, 25, and 36 in Township 2 North, Range 4 West, Montana Meridian. The site is located 5 miles northeast of Whitehall, Montana. The mine has a 3,399-acre permitted disturbance boundary in a total mine permit area of 6,205 acres.

GSM also has an approved Plan of Operations with the Bureau of Land Management (BLM) (No. MTM-82855). The proposed changes to the operating permit are largely on private land; a small area (1.4 acres) of BLM land would be covered by a portion of the tailings material in the Pit. The Operating Permit No. 00065 for the Golden Sunlight Mine was approved by the Montana Department of State Lands on June 27, 1975. Montana Department of State Lands preceded DEQ as the administrator of the MMRA. The Plan of Operations was approved by the BLM in 1982. GSM has obtained 16 amendments to Operating Permit No. 00065, which are provided in **Table ES-1** and in Section 1.3, Project Location and History.

Public Involvement and Scoping

DEQ determined that GSM's Amendment Application was complete and compliant on October 26, 2020. On February 10, 2021, DEQ issued a press release seeking public comment on a Draft EIS that analyzed potential environmental impacts from a proposed mine tailings project at the Golden Sunlight Mine. The press release was submitted via email to national, state, and local news outlets and requested public comment on the Project until March 12, 2021. DEQ prepared a legal notice for the public scoping meeting that was published in the *Whitehall Ledger* (a weekly newspaper) on February 10, 17, 24, and March 3, 2021. The release described the purpose of the scoping meeting, provided a web link to access the permit application, and identified methods to submit EIS scoping comments. DEQ established a public comment scoping period from February 10, 2021, to March 12, 2021 (i.e., 31 calendar days). During this time, DEQ received comments from the public via email, mail, or public meetings. An online public meeting was held remotely via Zoom on March 4, 2021.

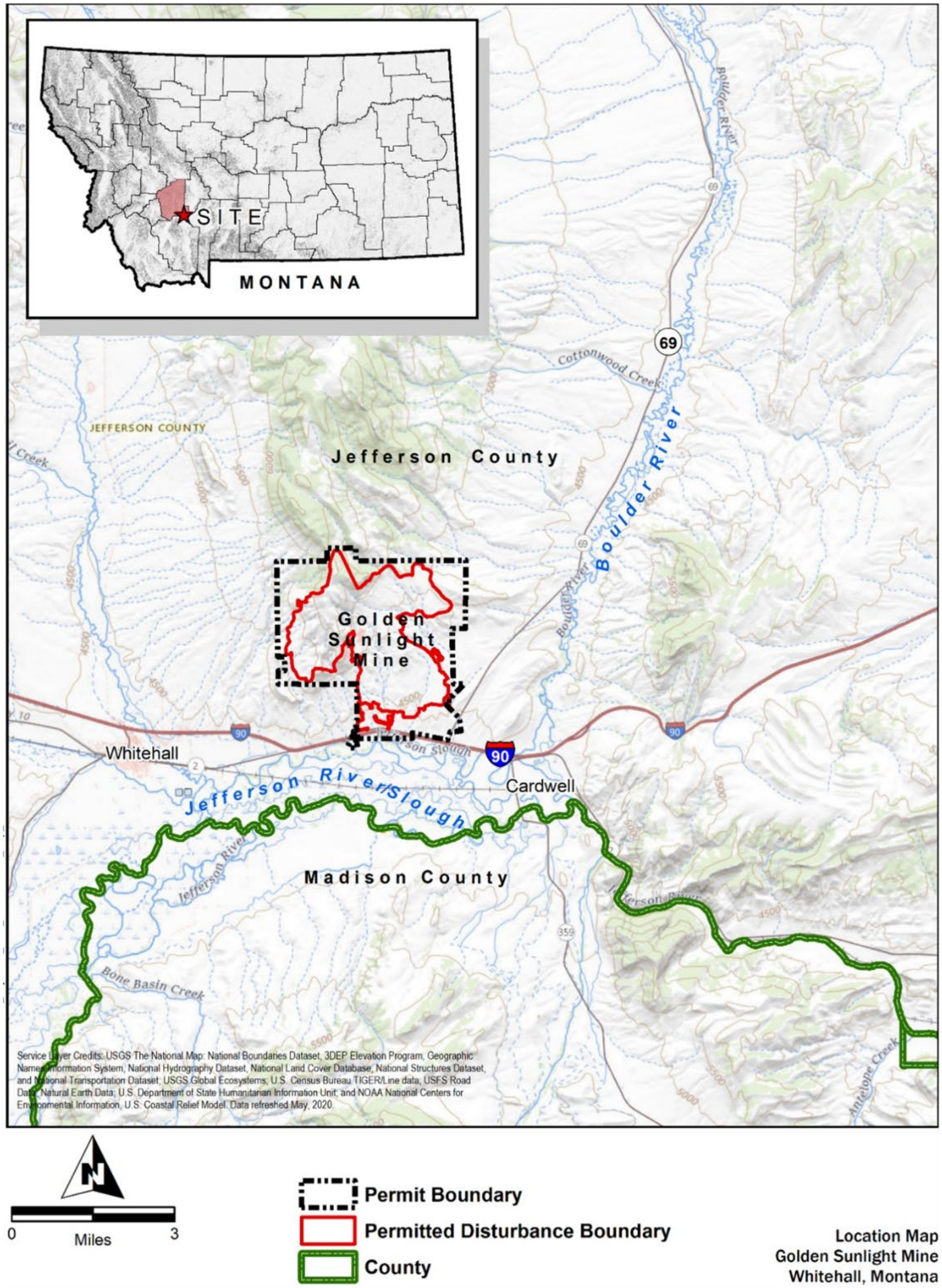

Figure ES-1
Location of Golden Sunlight Mine Showing the Permit Boundary and Permitted Disturbance Boundary

Table ES-1
Summary of Amendments and Revisions Golden Sunlight Mines, Inc. Operating Permit 00065

Permit Amendments	Change	Date Approved
Operating Permit 00065	Permit 00065 issued.	June 27, 1975
Amendment 001	10-year Operating Plan, new mill support facilities, TSF-1, and pit stages 1, 2, and 3. Increased allowed disturbance to 1,022 acres.	April 24, 1981
Amendment 002	Utility corridor added. Increased allowed disturbance to 1,028 acres.	October 7, 1981
Amendment 003	North Dump extension. Increased allowed disturbance to 1,098 acres.	April 15, 1983
Amendment 004	South Dump added. Increased allowed disturbance to 1,218 acres.	March 14, 1984
Amendment 004A	Pumpback wells added. Increased allowed disturbance to 1,241 acres.	July 31, 1984
Amendment 005	North Dump expansion. Increased allowed disturbance to 1,370 acres.	August 14, 1987
Amendment 006	Stage III mining and sump expansion. Increased allowed disturbance to 1,749 acres.	January 12, 1989
Amendment 007	Borrow pit added. Increased allowed disturbance to 1,764 acres.	August 4, 1989
Amendment 008	Stages 4 and 5 and Tailings Storage Facility 2 (TSF-2) added. Increased allowed disturbance to 2,264 acres.	July 1, 1990
Amendment 009	Interim Dump Plan.	April 1, 1997
Amendment 010	Extended active mining through Stage 5B Optimized and modified reclamation plans. Increased allowed disturbance to 2,967 acres.	July 9, 1998
Amendment 011	Supplemental EIS ROD – Underground Sump Pit Dewatering, 21 stipulations added.	August 17, 2007

Permit Amendments	Change	Date Approved
Amendment 012	Reconfigured East Buttress Dump and extended mining with 5B Optimization Pit. Realigned permitted disturbance boundary and increased allowed disturbance to 3,101 acres.	February 17, 2010
Amendment 013	Authorized construction of Sulfide Flotation Plant (not yet implemented). Increased allowed disturbance to 3,102 acres.	Draft approved June 4, 2010 Modification approved March 23, 2020
Amendment 014	Mining in East Area Pit.	November 22, 2010
Amendment 015	Mining North Area Pit South Area Extension. Increased allowed disturbance to 3,192 acres.	January 9, 2014
Amendment 016	Extended the mine permit boundary for the APEX underground mine.	October 25, 2018

Issues of Concern

DEQ collected comments on the Proposed Action and the issues to be considered through the public scoping meeting, letters, and emails. All comments were reviewed to identify specific issues or concerns. The following primary issues of concern are related to the Proposed Action:

- Tailings Storage Facilities;
- Appropriateness of Pit Backfill;
- Socioeconomics;
- Ground Water; and
- Surface Water.

These issues have been evaluated in detail in Section 1.7, Issues of Concern—Tailings Storage Facilities; Section 1.8, Issues of Concern— Appropriateness of the Mineral Hill Pit Backfill; and Section 1.9, Issues of Concern—Scoping. Impacts to resources were addressed to help determine reasonable alternatives for the permit amendment, including the Proposed Action.

Alternatives

No Action Alternative Overview

MEPA requires an analysis of the No Action Alternative for all environmental reviews that include an alternatives analysis. The No Action Alternative compares environmental conditions with the Proposed Action and establishes a baseline for evaluating the Proposed Action and other alternatives. MEPA requires that the No Action Alternative be considered even if it fails to meet the purpose and need or would not satisfy environmental permitting standards.

Under the No Action Alternative, GSM would continue to reclaim its mine facility under the existing operating permit. Open-pit mine operations ceased in 2015 and underground operations ceased in 2019. Mining could resume contingent on market prices, ore quality, and ore recovery efficiency and would be limited to the current permit (i.e., Operating Permit No. 00065) and the associated amendments, modifications, and revisions. The operating permit and amendments are summarized in **Table ES-1** and Section 1.3, Project Location and History.

The permit boundary encompasses 6,205 acres for the currently permitted Operating Permit No. 00065 shown on **Figure ES-1**. Under the No Action Alternative, no acreage would be disturbed outside of the current permitted disturbance area. The permitted disturbance area is 3,399 acres. As of May 2021, approximately 2,576 acres have been disturbed, including 1,256 acres that have been reclaimed with topsoil and seeded. A detailed description of the existing permit is provided in Section 2.2, No Action Alternative: Existing Permit.

Under the No Action Alternative, workforce levels would be expected to remain the same and reclamation activities would continue into approximately 2028. The current site water balance would not change under the No Action Alternative, and GSM would continue to use fresh water for dust suppression, fire control, and potable use as part of its Operations and Reclamation Plan. GSM would construct a Water Treatment Plant in the future to provide long-term treatment of flow from several sources, including TSF-1 pumpback well systems, TSF-2 underdrain, Pit dewatering, and water from waste rock dump capture systems (GSM 2014). Ongoing ground water quality monitoring and surface water monitoring would also continue under the No Action Alternative.

Proposed Action Overview

The Proposed Action would allow GSM to excavate and reprocess 26.2 million tons of tailings in TSF-1 to recover a fine gold and sulfide concentrate. The Proposed Action is intended to remove the tailings from the previously reclaimed facility and return the TSF-1 area to postclosure land uses for grazing, recreation, and wildlife habitat. The Proposed Action may also eventually reduce the need for long-term, on-site water treatment by eliminating discharge from TSF-1 and reducing the amount of water pumped from the Pit. However, the actual proposal to eliminate water capture or dewatering systems is not a component of the Proposed Action.

Tailings would be recovered from TSF-1 using conventional excavation and haulage, and removing the 26.2 million tons of tailings material is expected to take 12 years. The tailings would be excavated from northeast to southwest, and reclaiming the area underlying TSF-1 would be completed concurrently with the excavation. The excavated tailings would be transported to a Re-Pulping Plant where the tailings would be mixed with water to create a slurry that can be pumped uphill to the Flotation Plant within the mill. Water from the existing freshwater supply would be used in the Flotation Plant to recover gold and sulfide minerals. Reprocessed tailings would be pumped to a thickener plant to increase the pH (or alkalinity) of the solids as needed and create a slurry of 65 percent solids. The slurry would be pumped to the Pit for final disposal. Water accumulating on top of the tailings mass and ground water captured within the mine workings below the bottom of the Pit would be pumped back to the mill for reuse in the process or piped to TSF-2.

Tailings disposal in the Pit would result in a final surface level of 5,173 feet (ft) (mine datum), which is approximately 650 ft above the Pit bottom. The partial filling of the Pit would reduce highwall instability as well as reduce water acidity that accumulates at the base of the Pit. After reprocessed tailings placement is complete, the consolidated tailings would be covered with capping material, growth media, and revegetated. Pit ground water would continue to be pumped from the underground dewatering system and treated similar to currently approved water-management operations. Reclamation of the Pit roads, benches, and highwalls would remain as detailed in the Operations and Reclamation Plan (GSM 2014). At closure, the reclaimed tailings surface within the Pit would be approximately 50 acres with no permanent ponding.

The permit boundary for the currently permitted Operating Permit No. 00065 is shown on **Figure ES-1**. The current permitted boundary legal location is discussed in Section 2.2.2, Permit Boundary and Description of Disturbed Areas. Under the Proposed Action, all activities would occur on currently disturbed or previously disturbed and reclaimed land and would not result in new disturbance or changes to the permit boundary; no acreage would be disturbed outside of the current permitted disturbance area. The permitted disturbance area is 3,399 acres. As of May 2021, approximately 2,576 acres have been disturbed, including 1,256 acres that have been reclaimed with topsoil and seeded (GSM 2021a).

Site water management for the Proposed Action would include reprocessed tailings solutions, direct precipitation, fresh water, and ground water as described in detailed within Section 2.3.5, Water-Management System. The Proposed Action would not require a change in the Pit's approved water-management system.

Under the Proposed Action, vegetation, growth media, and capping material would be sequentially removed within the 190-acre reclaimed area of TSF-1. Before tailings are removed from the first cut, a northern portion of TSF-1 would be stripped of vegetation, growth media, and capping material, which would be placed in separate, temporary stockpiles and used for reclaiming the exposed native ground after the first cut is completed. Ongoing excavation would be limited to the areas directly above the tailings to be excavated to reduce dust and water runoff from exposed tailings. The growth media and capping material would be used to concurrently reclaim areas where tailings have been removed, and the original ground surface would receive the capping material followed by the growth media and seeding. The Proposed Action has a final reclaimed surface that would mimic the original topography of the TSF-1 area before tailings placement and disturbed areas would be reclaimed as specified in the Operations and Reclamation Plan. Final reclamation of TSF-1 would be completed within 2 years after tailings removal ceases.

The Proposed Action would place reprocessed tailings in the Pit to an elevation of 5,191 ft (mine datum) and the tailings would eventually settle to an elevation of 5,173 ft (mine datum) after consolidation. The Proposed Action reclamation would include placing 4 ft of capping material (comprising 2 ft of oxidized overburden and limestone and 2 ft of growth media) over the 50 acres of final tailings surface in accordance with the Operations and Reclamation Plan.

Department of Environmental Quality's Permit Stipulations

DEQ evaluated the addition of permit stipulations to address additional permit approvals, as well as reclamation timelines following temporary shutdowns and contingencies for operational monitoring. The following stipulations have been developed and are described in detail in Section 2.4, DEQ's Permit Stipulations:

- GSM is required to obtain approval from the DEQ Air Quality Bureau for any necessary modifications to the existing Montana Air Quality Permit (MAQP) #1689-08.
- GSM shall receive approval from BLM before disturbing the 1.4 acres of public land within the Pit.
- GSM shall update the Operations and Reclamation Plan to include the changes approved for Amendment 017. The updated Operations and Reclamation Plan shall be submitted to DEQ and BLM no later than 180 days after the amendment authorization. GSM shall provide as-built drawings for the new facilities that would be constructed as part of Amendment 017. The final facility locations and construction details shall be provided to the DEQ and BLM within the updated Operations and Reclamation Plan.
- GSM shall limit the volume of tailings stockpiles and duration of stockpiles located by the Re-Pulping Plant to ensure that stockpiled tailings or exposed TSF-1 tailings do not become a source of contamination during delays or shutdown. As soon as a shutdown

or delay longer than 1 year is anticipated, or 1 year has lapsed since active tailings excavation and reprocessing, the proposed reclamation activities should begin. Stockpiled tailings would be removed and placed in lined TSF-2; under such a condition and assuming the Re-Pulping Plant is still mechanically functional, stockpiled tailings would be slurried in the Re-Pulping Plant and moved via the pipeline from the Re-Pulping Plant to TSF-2.

- A tailings sampling and analysis program shall be implemented to ensure the quality of the concentrate product to verify that the residual sulfide content of the flotation tailings meets the proposed design criteria (0.5 percent total sulfide) and the thickened tailings receive adequate neutralization potential to meet the stated water quality objectives for the process solution pond. Within 180 days after the amendment authorization, GSM will provide DEQ and BLM with a description of this tailings sampling and analysis program for the composition of residual tailings that would be disposed within the Pit, including sampling frequency, parameters for analysis, and reporting schedule. Monitoring results will be used to optimize the flotation system and the adjustment of lime addition rates at the thickening plant while also demonstrating that the target concentration of 0.5 percent (or less) of total sulfur minus sulfate is being consistently achieved for the residual tailings before disposal. GSM should also develop a response protocol or automated lime injection mechanism that adjusts the pH of the flotation tailings so that excess neutralization potential is established (dependent on its sulfide content).

As recommended in the Amendment Application, GSM shall update the existing Ground Control Management Plan to address the following topics and submit the plan to DEQ and BLM within 180 days after the amendment authorization:

- At the Pit, GSM shall revise the Ground Control Management Plan to include measures for protecting in-pit infrastructure (specifically the South Well) from rockfall impacts during and after the TRP.
- GSM shall update its Ground Control Management Plan for the TRP to include specific monitoring at the Flotation Plant, the Rattlesnake Earth Block immediately upslope of TSF-1, and the Pit. If acceleration of the west wall failure is observed, tailings deposition in the Pit should be ceased until a root-cause analysis has been performance and mitigation plan has been developed.

Department of Environmental Quality Modified Alternative

The proposed alternative reclamation methods of TSF-1 and the Pit were evaluated to reduce environmental impacts. Information regarding these reclamation alternatives is discussed in Section 2.5, DEQ Modified Alternative—Enhanced TSF-1 and Pit Reclamation and in Technical Memorandum 3—Reclamation Alternatives Evaluation. Upon reviewing the Proposed Action and preliminary environmental impacts, the final reclamation design of TSF-1 could be improved to reduce visual impacts, diversify vegetation, and enhance wildlife habitat. This alternative includes recommendations for grading configuration, capping material, habitat, vegetation, and seed mixes. The final reclamation design of the Pit could be improved to enhance vegetation diversity, and seed mix alternatives were investigated to provide reclamation options for the Pit. The alternative components that are different from the Proposed Action include the following:

- Alternative Micro-Topography and Mosaic Vegetation of TSF-1;
- Suitability Testing of TSF-1 Capping Material;
- Modified Seed Mix of TSF-1; and
- Modified Seed Mix of the Pit.

Alternatives Considered and Dismissed

Under MEPA, a reasonable alternative is one that is practical, technically possible, and economically feasible. Any alternative under consideration must also meet the purpose and need of the Proposed Action. During scoping and development of the EIS, alternatives to the Proposed Action were suggested and discussed by agency representatives and GSM as required by MEPA Section 75-1-201(1)(b)(iv)(C)(II), MCA. Some alternatives considered were dismissed from further analysis. Each alternative and the reason for dismissal is described in Section 2.6, Alternatives Considered but Dismissed From Detailed Analysis. The following alternatives were dismissed:

- Alternative Tailings Excavation;
- Alternative Tailings Conveyance;
- Replace Re-Pulping Plant With High-Pressure Slurry Ablation Technology;
- Dispose Unprocessed Tailings in the Mineral Hill Pit;
- Dispose Reprocessed Tailings in an Alternate Location;
- Amend Tailings With Cement;
- Amend Tailings with EnviCore;
- Amend Tailings with Foam;
- No Growth Media Placement in the Mineral Hill Pit;
- Pit Perimeter Rockfall Catch Ditch;
- Improved Habitat Creation in the Mineral Hill Pit;
- Variable Water Management Near Tailings Storage Facility 1; and
- Alternate Water Source.

Each of these alternatives or alternative components was considered and eliminated from detailed study for a variety of reasons, including operational feasibility, an increase in environmental impacts, or failure to meet the purpose and need of the Project.

Summary of Impacts

This EIS discloses and analyzes the environmental consequences that may result from selecting and implementing the Proposed Action and alternatives described in Chapter 2.0, Description of Alternatives. Substantive consequences are presented in **Table ES-2**, which summarizes and compares in detail the impacts of the three alternatives considered. The Proposed Action would have similar impacts as the No Action Alternative on land use and noise. Detailed resource impacts analyses are provided in Chapter 3.0, Affected Environment and Environmental Consequences (primary impacts) and Chapter 4.0 Cumulative, Unavoidable, Irreversible and Irretrievable, and Secondary Impacts and Regulatory Restrictions (cumulative and secondary impacts).

Preferred Alternative

Administrative Rules of Montana 17.4.617(9) requires an agency to state a preferred alternative in the EIS, if one has been identified, and provide reasons for the preference. DEQ has identified the Micro-Topography of TSF-1 Alternative, the Suitability of TSF-1 Capping Material Alternative, and the developed permit stipulations as the Preferred Alternative.

The Proposed Action consists of returning the land to its predisturbance topography, but specific grading techniques are not detailed. Upon reviewing the Proposed Action, the final reclamation methods and design of TSF-1 could be improved to reduce visual and environmental impacts and increase vegetation diversity and wildlife habitat. Under the Preferred Alternative, TSF-1 reclamation would be modified to ensure that landform variation is created that would support an increase in vegetation type and thereby improve the quantity and quality of wildlife habitat. The density and location of small topographic changes of the native ground surface would be measured in the predisturbance imagery and topography, then used as criteria to confirm that the approximate original contour is restored as concurrent reclamation advances. The environmental benefits from varying landforms at TSF-1 would create a mosaic of grass, forb, and shrub vegetation patterns and microclimates that support multiple habitats for vegetation and wildlife.

The modified seed mixes for TSF-1 and Pit Alternatives which were analyzed are not included in the Preferred Alternative (see Section 2.5.2.3, Modified Seed Mix of TSF-1 and Section 2.5.2.4, Modified Seed Mix of the Pit). The Proposed Action includes a modified seed mix that was developed by GSM and a vegetation consultant in 2019 (Minor Revision 19-002) based on decades of past species performance on revegetation at the mine. Environmental benefits of further modifying the seed mixes for TSF-1 and the Pit through the Agency Modified Alternative are not clear.

Under the Suitability of TSF-1 Capping Material Alternative, the intermediate capping material would be evaluated to ensure its future capacity to support grasses, forbs, and shrubs on the reclaimed TSF-1 area. The tailings/capping material boundary would be tested during mining advancement to confirm or deny the toxicity of that material and identify potential effects of upward contaminant migration and reduce the likelihood of inadvertent mixing of the two. Adequate material characterization would also be performed on the stockpiled capping material before replacement for reclamation. Unsuitable and poor-quality material would hinder the successful establishment of vegetation on the TSF-1 reclamation area; as a result, the quality of wildlife habitat would be reduced. The visual impacts of inferior capping and/or growth media would be a noticeable reduction in vegetation cover and potentially areas devoid of vegetation. The suitability criteria for the capping material would align with the existing sampling guidance provided by GSM’s vegetation consultant.

Table ES-2
Summary of Primary Impacts of the No Action Alternative, Proposed Action, and Agency Modified Alternative Organized by Resource Area

Chapter	Resource Area/ Impact	No Action Alternative	Proposed Action	Agency Modified Alternative
3.2	Geology and Geotechnical	No change from the current permitted conditions.	Increased slope stability of the Pit highwalls. Failure of one open stope in underground workings beneath the Pit is expected but unlikely to impact dewatering systems or cause other adverse stability or environmental impacts. Potential for instability in the Earth Blocks caused by TSF-1 removal is unlikely and risk is manageable with geotechnical monitoring.	Same as the Proposed Action.
3.3	Ground Water Hydrology and Geochemistry	The Pit would continue to be dewatered. At TSF-1, ground water impacts from seepage would continue with very slow improvement, and the pumpback systems would continue to operate. The water treatment plant would be constructed after reclaiming the remaining facilities (before 2028).	Pit dewatering would peak near the end of reprocessed tailings deposition. Dewatering would continue but the rate would decrease over 100 years as tailings drain. Ground water quality around TSF-1 would improve more rapidly after removing the tailings, but pumpback systems would continue to operate. The reclamation of other facilities (such as TSF-2) and the construction of the water treatment plant would be delayed until after project completion (12 years).	Same as the Proposed Action.

Chapter	Resource Area/ Impact	No Action Alternative	Proposed Action	Agency Modified Alternative
3.4	Surface Water Resources	No change from the current condition.	The primary impacts to surface water resources are changes in storm water management that are internal to the existing mine site. Additional fresh water would also be needed for processing that would be diverted from the existing water right on the Jefferson River. The recirculation of process water may reduce, but not eliminate, the use of the fresh water source.	Same as the Proposed Action.
3.5	Soils and Reclamation	No change from the current condition. TSF-1 is currently reclaimed and vegetated. Safely accessible benches and roads in the Pit would be reclaimed as under the 2014 Operations and Reclamation Plan.	Soils, vegetation, and previous reclamation would be disturbed during tailings removal and processing at TSF-1. Previously disturbed areas would be reclaimed concurrently with active tailings recovery. TSF-1 footprint would be returned to approximate original contour and reclaimed. The Pit would be partially infilled with tailings and a 50-acre surface would be reclaimed.	Improved methods for reclamation of TSF-1 footprint and increased vegetation diversity at TSF-1 and Pit.
3.6	Vegetation	The Pit would be revegetated under the 2014 Operations and Reclamation Plan. Benches and access roads would be capped with soil as necessary and seeded	Vegetation would be removed from the entire 190-acre TSF-1 surface over 12 years. Areas readied for reclamation would be reseeded with a seed mix similar to the current species composition. Six acres of the previously reclaimed East Buttress Dump Extension would have all vegetation removed for	Final vegetation diversity within TSF-1 and the Pit would increase. Seed mixes would be modified to include more forbs and shrubs, relative to grasses. Bareroot and containerized

Chapter	Resource Area/ Impact	No Action Alternative	Proposed Action	Agency Modified Alternative
		and/or planted with trees as safety allows.	the life of the Project before final reclamation and revegetation at the end of the TRP. The final 50-acre Pit surface would be seeded with a seed mix similar to other reclaimed areas within the mine.	shrubs would be planted within TSF-1.
3.7	Wildlife	Successful revegetation of the Pit would result in increased wildlife habitat within the Pit.	Temporary habitat loss within TSF-1 would occur. Overall habitat diversity within TSF-1 should increase after reclamation. Approximately 630 vertical feet of Pit highwall habitat would be lost, but the final 50-acre Pit surface would provide habitat for a variety of species.	Increased wildlife habitat diversity as a result of modifications to reclamation methods and vegetation.
3.8	Land Use and Recreation	No change from the current condition.	Only currently or previously disturbed land would be impacted. Postclosure land use (i.e., wildlife habitat and public use) for the Proposed Action is the same as the No Action Alternative.	Same as the Proposed Action.
3.9	Visual Resources	No change from the current condition.	Removing vegetation, capping material, and all tailings would return topography to a natural landscape similar to predisturbance topography.	The post-reclamation landscape would include a more natural appearance and vegetation of TSF-1 that better blends with the landscape.
3.10	Socioeconomics	GSM employment, financial and community contributions, taxes paid	The number of employees would increase, taxes paid by GSM and employees to Jefferson County and the	Same as the Proposed Action.

Chapter	Resource Area/ Impact	No Action Alternative	Proposed Action	Agency Modified Alternative
		by GSM and employees to counties and State of Montana would decline sooner. By 2028, minimal workforce would be required for long-term site and water management.	state of Montana would increase, and contributions to the community (e.g., financial, participation, and technological supplies) would increase for the project duration (12 years). The workforce reduction associated with closure and long-term management would be delayed.	
3.11	Noise	No change from the current condition.	Noise impacts would be isolated to the mine for excavation, processing, and backfilling. Minor noise impacts at nearby receptors from increased highway transportation.	Same as the Proposed Action.

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1.0 PURPOSE AND NEED

1.1 INTRODUCTION

This Environmental Impact Statement (EIS) was prepared on an application for Amendment 017 to Hard Rock Mine Operating Permit No. 00065 submitted by Barrick Golden Sunlight Mines, Inc. (GSM) for the Tailings Reprocessing Project (the Project) in Whitehall, Montana. GSM submitted the Amendment Application to the Montana Department of Environmental Quality (DEQ) on March 30, 2020. On October 26, 2020, DEQ determined that the Amendment Application and associated deficiency comment responses were complete and compliant with the substantive requirements of the Metal Mine Reclamation Act (MMRA), Section 82, chapter 4, part 3, Montana Code Annotated (MCA). DEQ simultaneously issued a draft permit amendment approval along with the Compliance Determination, as required in 82-4-337(d)(iv), MCA.

GSM submitted a modification to the Amendment Application on February 5, 2021, for the purpose of relocating the Re-Pulping Plant from where it was initially proposed. On February 10, 2021, DEQ determined that the modification did not substantially change the application nor the previous Compliance Determination. GSM submitted a second modification to the Amendment Application on April 28, 2021, for the purpose of clarifying the potential location of a covered concentrate stockpile and relocating the thickener facilities from the initially proposed location. On May 19, 2021, DEQ determined that the modification did not substantially change the application or the previous Compliance Determination.

The Montana Environmental Policy Act (MEPA) requires state agencies to prepare an EIS before taking a state action that significantly affects the quality of the human environment (Section 75-1-201(1)(b)(iv), MCA). DEQ prepared this EIS before taking state action. The permit amendment would allow GSM to excavate and reprocess tailings and dispose of them in the Mineral Hill Pit (Pit). DEQ prepared this EIS to present the analysis of possible environmental consequences of three alternatives: No Action Alternative, Proposed Action, and Agency Modified Alternative (AMA). The alternatives are described in detail in Chapter 2.0, Description of Alternatives.

1.2 PURPOSE AND NEED

DEQ's purpose and need in conducting the environmental review are to act upon GSM's application to amend Operating Permit No. 00065.

The Golden Sunlight Mine is an open-pit and underground gold mine. Mining and milling operations ceased in April 2019. The permit amendment (or Proposed Action) would allow GSM to excavate and reprocess tailings from the previously reclaimed Tailings Storage Facility 1 (TSF-1), construct a new Re-Pulping Plant, reprocess the tailings to separate sulfur and gold, and dispose of the remaining tailings by partially backfilling the Pit. Ground water from the Pit would continue to be pumped and treated similar to current water-management operations. The Proposed Action would not increase the size of the mine permit boundary or the currently approved disturbance boundary. The permit amendment would occur over approximately 12 years. GSM's purpose and need for the Project would include sulfur and gold production to help meet market demands and enhance or prolong employment and tax payments from the Golden Sunlight Mine in the area.

MEPA (Section 75-1-201, *et seq.*, MCA) requires an environmental review of actions taken by the state of Montana that may significantly affect the quality of the human environment. The EIS was prepared to satisfy these MEPA requirements. Before beginning its environmental review under MEPA, DEQ reviewed GSM's Amendment Application and determined that it was complete and compliant with the MMRA (Section 82-4-301, *et seq.,* MCA) and issued a draft permit amendment on October 26, 2020. Issuance of the draft permit amendment as a final permit amendment is the proposed state action subject to this environmental review under Section 82-4-337(1)(f), MCA.

DEQ will decide which alternative should be approved in DEQ's Record of Decision (ROD) based on information provided in the Amendment Application, the analysis in the EIS, and the substantive provisions of the MMRA. DEQ's ROD would be published no sooner than 15 days after publication of the Final EIS. The Final EIS will include comments received on the Draft EIS and the agency's responses to substantive comments.

1.3 Project Location and History

The Golden Sunlight Mine is an open-pit and underground gold mine located in southern Jefferson County, Montana (**Figure 1.3-1**). The mine is within all or portions of Sections 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, and 33 of Township 2 North, Range 3 West; Sections 4, 5, and 6 in Township 1 North, Range 3 West; and Sections 13, 24, 25, and 36 in Township 2 North, Range 4 West, Montana Meridian. The site is 5 miles northeast of Whitehall, Montana. The mine has a 3,399-acre permitted disturbance boundary in a total mine permit area of 6,205 acres. GSM also has an approved Plan of Operations with the Bureau of Land Management (BLM) (No. MTM-82855). The proposed changes to the operating permit are largely on private land; a small area (1.4 acres) of BLM land would be covered by a portion of the tailings material in the Pit.

Operating Permit No. 00065 for the Golden Sunlight Mine was approved by the Montana Department of State Lands on June 27, 1975. Montana Department of State Lands preceded DEQ as the administrator of the MMRA. The Plan of Operations (No. MTM-82855) was approved by the BLM in 1982. GSM has subsequently obtained 16 amendments to Operating Permit No. 00065, which are provided in **Table 1.3-1**. Several other minor revisions have been approved.

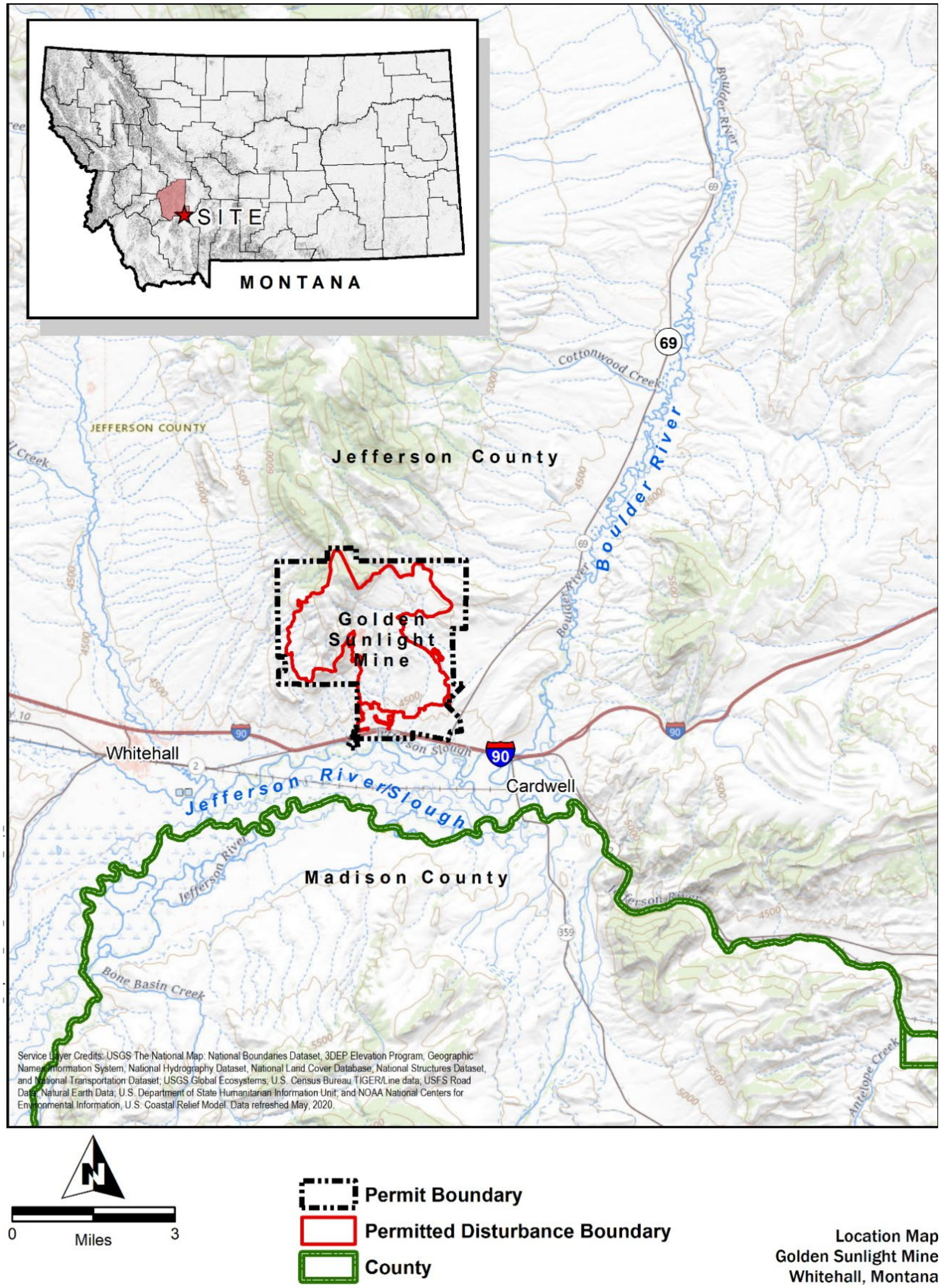


Figure 1.3-1
Project Location

Table 1.3-1
Summary of Amendments and Revisions GSM Operating Permit 00065

Permit Amendments	Change	Date Approved
Operating Permit 00065	Permit 00065 issued.	June 27, 1975
Amendment 001	10-year Operating Plan, new mill support facilities, TSF-1, and pit stages 1, 2, and 3. Increased allowed disturbance to 1,022 acres.	April 24, 1981
Amendment 002	Utility corridor added. Increased allowed disturbance to 1,028 acres.	October 7, 1981
Amendment 003	North Dump extension. Increased allowed disturbance to 1,098 acres.	April 15, 1983
Amendment 004	South Dump added. Increased allowed disturbance to 1,218 acres.	March 14, 1984
Amendment 004A	Pumpback wells added. Increased allowed disturbance to 1,241 acres.	July 31, 1984
Amendment 005	North Dump expansion. Increased allowed disturbance to 1,370 acres.	August 14, 1987
Amendment 006	Stage III mining and sump expansion. Increased allowed disturbance to 1,749 acres.	January 12, 1989
Amendment 007	Borrow pit added. Increased allowed disturbance to 1,764 acres.	August 4, 1989
Amendment 008	Stages 4 and 5 and Tailings Storage Facility 2 (TSF-2) added. Increased allowed disturbance to 2,264 acres.	July 1, 1990
Amendment 009	Interim Dump Plan.	April 1, 1997
Amendment 010	Extended active mining through Stage 5B Optimized and modified reclamation plans. Increased allowed disturbance to 2,967 acres.	July 9, 1998
Amendment 011	Supplemental EIS ROD – Underground Sump Pit Dewatering, 21 stipulations added.	August 17, 2007

Permit Amendments	Change	Date Approved
Amendment 012	Reconfigured East Buttress Dump and extended mining with 5B Optimization Pit. Realigned permitted disturbance boundary and increased allowed disturbance to 3,101 acres.	February 17, 2010
Amendment 013	Authorized construction of Sulfide Flotation Plant (not yet implemented). Increased allowed disturbance to 3,102 acres.	Draft approved June 4, 2010 Modification approved March 23, 2020
Amendment 014	Mining in East Area Pit.	November 22, 2010
Amendment 015	Mining North Area Pit South Area Extension. Increased allowed disturbance to 3,192 acres.	January 9, 2014
Amendment 016	Extended the mine permit boundary for the APEX underground mine.	October 25, 2018

In December 2002, GSM submitted a revised partial pit backfill plan to DEQ and BLM to comply with the District Court judgment, the MMRA, and other applicable state and federal regulations. DEQ and BLM initiated a Supplemental EIS in April 2003 to evaluate pit reclamation alternatives at GSM. The final Supplemental EIS was completed in July 2007 and identified the "Underground Sump Alternative With Visual Mitigations" as the preferred alternative, which included underground workings and not backfilling the pit. The alternative instead required that a sump be used to collect ground water for pit dewatering to preclude the formation of a pit lake. DEQ and BLM issued the ROD for Amendment 011 in August 2007. The backfill options evaluated under the Supplement EIS included backfill with acid-generating waste rock, not backfill with reprocessed tailings as is being evaluated in this EIS. The differences between these scenarios are discussed further in Section 1.8, Issues of Concern—Appropriateness of the Mineral Hill Pit Backfill.

On March 11, 2020, GSM applied for a modification to Amendment 013 to DEQ for retrofitting a portion of the existing mill building to house a flotation plant rather than constructing a new sulfide flotation plant between TSF-1 and TSF-2, as approved in the original Amendment 013 in 2010. However, the final permit amendment was not issued by DEQ in 2010 because the reclamation bond was not posted and the project was never implemented at the mine. DEQ approved the modification to Amendment 013 on March 23, 2020, and determined that the modification was not a substantial change to the original amendment that was analyzed and approved in 2010. DEQ stated that the modification eliminated the potential impacts of new facility construction, and reprocessing the tailings could extend site activity beyond the life of mine. Employment could also be extended to support reprocessing and transporting fine ore concentrate.

GSM applied for Amendment 017 to DEQ on March 30, 2020; responded to deficiency comments from DEQ and BLM on July 13, 2020, and September 4, 2020; and submitted application modifications on February 5, 2021 and April 28, 2021. As noted in Chapter 1.1, Introduction, DEQ determined that the modifications did not substantially change the original application nor Compliance Determination; therefore, the modified application is the current version of the Proposed Action that is the subject of this environmental review.

1.4 Scope of the Document

DEQ prepared this EIS in compliance with MEPA. This EIS describes the potential direct, secondary, and cumulative environmental impacts that could result from the No Action Alternative, Proposed Action, and AMA considered in detail. The geographic scope of this EIS includes lands within the existing permit and disturbance boundaries.

This document is organized into the following nine chapters:

- Chapter 1. Purpose and Need: Chapter 1 includes information about the Project and the purpose of and need for the Project. This chapter also summarizes how DEQ informed the public of the Project and how the public responded.
- Chapter 2. Description of Alternatives: Chapter 2 provides a detailed description of the No Action Alternative, Proposed Action, and AMA considered in detail. These alternatives were developed based on key issues raised by the public and, as required by MEPA, in consultation with GSM.
- Chapter 3. Affected Environment and Environmental Consequences: Chapter 3 describes in detail the current environment and the potential direct and secondary impacts that result from the No Action Alternative, the Proposed Action, and AMA considered. This analysis is organized by resource.
- Chapter 4. Cumulative Impacts, Unavoidable Adverse Impacts, Irreversible and Irretrievable Commitments of Resources: Chapter 4 describes the cumulative impacts of present and future actions in the area as well as summarizes unavoidable, irreversible, irretrievable, and secondary impacts.
- Chapter 5. Consultation and Coordination: Chapter 5 provides a listing of agencies, groups, or individuals who were contacted or who contributed information.
- Chapter 6. List of Preparers: Chapter 6 provides a list of preparers for the EIS.

- Chapter 7. Response to Public Comments: Chapter 7 provides a response to comments obtained on the Draft EIS.
- Chapter 8. Glossary, List of Acronyms, Index: Chapter 8 provides the glossary, acronyms, and index.
- Chapter 9. References: Chapter 8 provides a list of the source materials that were used in preparing the EIS.

Appendices: The following appendices provide detailed information to support the analyses presented in the EIS:

- Appendix A. Technical Memorandum 1: Golden Sunlight Mine Project – Hydrologic and Geochemical Model Assessment.
- Appendix B. Technical Memorandum 2: Golden Sunlight Mine Project – Ground-Movement Model Assessment.
- Appendix C. Technical Memorandum 3: Golden Sunlight Mine Project – Reclamation Alternatives Evaluation.

1.5 AGENCY ROLES AND RESPONSIBILITIES

DEQ is responsible for administrating the MMRA and the administrative rules adopted to implement the MMRA. DEQ is also responsible for issuing and amending mine operating permits under the MMRA. This EIS is being prepared to provide a comprehensive analysis of potential environmental impacts of the Project. Before the Project could begin, other permits, licenses, or approvals may be required from federal, state, and local agencies.

1.5.1 State Agencies

The state agencies listed in **Table 1.5-1** administer relevant permits or conduct reviews that may potentially be required for the Project.

Table 1.5-1
Regulatory Authority and Responsibilities of State Agencies Related to the Golden Sunlight Mine Permit Amendment

Potential Permits or Reviews Required (Statutory Reference)	Purpose
DEQ	
MEPA, Analysis of Impacts (Title 75, chapter 1, parts 1 through 3, MCA)	MEPA requires that DEQ prepare an EIS before taking state action for any projects that may significantly affect the quality of the human environment.

Potential Permits or Reviews Required (Statutory Reference)	Purpose
MMRA, Operating and Reclamation Plans (Title 82, chapter 4, part 3, *et seq.,* MCA)	Mining must comply with state environmental laws and administrative rules. The MMRA established reclamation standards for lands that are disturbed by mining and generally requires that the lands be reclaimed to comparable stability and utility as that of adjacent areas. Reclamation must provide sufficient measures to ensure public safety and prevent air or water pollution and adjacent land degradation.
Montana Water Quality Act, Montana Pollutant Discharge Elimination System (MPDES) (Title 75, chapter 5, *et seq.,* MCA)	MPDES establishes effluent limits and treatment standards and regulates point-source discharges of pollutants into state surface waters or to ground water that is hydrologically connected to state surface waters through MPDES permits. State water quality standards, including nondegradation standards, specify the allowable changes in surface water or ground water quality. An MPDES permit may also authorize discharges of construction storm water and would require developing a Storm Water Pollution Prevention Plan. GSM operates under Multi-Sector General Permit Number MTR00498. The Project would not alter current outfalls or discharges although GSM would need to submit an updated Notice of Intent to update Section F – Facility or Operation Description of the site's Storm Water Pollution Prevent Plan.
Montana Clean Water Act, Section 401 Title 75, chapter 5, part 4*, et seq.,* MCA)	Federal permits related to discharges to state waters must obtain certification from the state that discharges (including groundwater) comply with state water quality standards.
Clean Air Act of Montana, Air Quality Permit (Title 75, chapter 2, parts 1 through 4, *et seq.,* MCA)	An Air Quality permit is required for constructing, installing, and operating facilities and equipment that may cause or contribute to air pollution. Air Quality Permit #1689-08 for the Golden Sunlight Mine was approved on August 11, 2014. GSM will need to modify its existing permit before reprocessing tailings because the Project may exceed the de minimus thresholds under ARM 17.8.745(1).

Potential Permits or Reviews Required (Statutory Reference)	Purpose
Montana Hazardous Waste Act Title 75, chapter 10, part 4, *et seq.,* MCA) and the Solid Waste Management Act (Title 75, chapter 10, part 2*, et seq.,* MCA)	The acts regulate hazardous and solid wastes storage and disposal. Waste disposal permitting is not required for this project.

1.5.2 Other Agency Roles

Other agencies listed in **Table 1.5-2** require permits for the Project. County permits or approvals are not required for the Project.

Table 1.5-2
Federal Agencies–Potential Requirements

Potential Permits or Reviews Required (Statutory Reference)	Purpose
BLM	
Plan of Operations (43 Code of Federal Regulations Subpart 3809) Permit No. MTM-82855	The BLM has responsibilities and authority to prevent unnecessary and undue degradation of public lands by authorized mining operations. The BLM will require that the Plan of Operations be updated. GSM submitted the Project application to BLM in a request to update the Plan of Operations. A small area (1.4 acres) of BLM land would be affected by the Project, specifically within the Pit during the final years of tailings placement. The BLM is not a lead agency in conducting this Draft EIS but has been informed about the process and reviewed this Draft EIS. BLM may require supplemental National Environment Policy Act analysis before approving the Plan of Operations for the final placement of tailings within the Pit.

1.6 PUBLIC INVOLVEMENT AND SCOPING

On February 10, 2021, DEQ issued a press release stating that GSM's Amendment Application was complete and the environmental review was to begin (DEQ 2021). The press release disclosed the time and location of the public scoping meeting as well as information regarding the EIS and permit application. The press release was submitted via email to national, state, and local news outlets and requested public comment on the Project until March 12, 2021.

DEQ prepared a legal notice for the public scoping meeting. In addition to providing information about the public meeting, the notice described the purpose of the scoping meeting, provided a web link to access the permit application, and identified methods to submit EIS scoping comments. The notice was published in the *Whitehall Ledger* (a weekly newspaper) on February 10, 17, 24, and March 3, 2021. The Butte *Montana Standard* also printed an article about the Project and how to submit comments on February 12, 2021.

DEQ established a public comment scoping period from February 10, 2021, to March 12, 2021 (i.e., 31 calendar days). During this time, DEQ received comments from the public that were submitted via email, mail, or public meetings. On March 4, 2021, an online public meeting was held remotely via Zoom.

1.7 Issues of Concern—Tailings Storage Facilities

Section 82-4-337(c)(iii), MCA requires that when an application submitted after October 1, 2015, includes a tailings storage facility, DEQ shall verify the receipt of the certified design document (Section 82-4-376, MCA); the panel report (Section 82-4-377, MCA); and the tailings operation, maintenance, and surveillance manual (Section 82-4-379, MCA). Further, Section 82-4-336(13), MCA, requires that the reclamation plan must include, if applicable, the requirements for postclosure monitoring of a tailings storage facility agreed to by an independent review panel pursuant to Section 82-4-377, MCA.

DEQ evaluated these requirements and the conditions in the Amendment Application, as described in the Complete and Compliant Determination (October 26, 2020) and a DEQ memorandum from February 5, 2021 (Smith and Hayes 2021). DEQ determined that only a portion of the statutory requirements regarding tailings storage facilities are applicable to this proposed Amendment, as outlined in the following sections.

1.7.1 Tailings Storage Facility 1

As described elsewhere in this EIS, TSF-1 has been reclaimed and revegetated for decades. Although potentially misleading, the term “TSF-1” is used when discussing this reclaimed facility for consistency with the historical site nomenclature, before the enactment of TSF legislation and updated definitions in 2015. A better representation may be to consider the facility as “Impoundment 1” or “former TSF-1.”

The facility does not retain any free water or process solution, which means that TSF-1 does not meet the definition of a TSF as provided by Section 82-4-303(34)(b), MCA. The Proposed Action does not involve constructing a new TSF nor expanding the facility as defined by Section 82-4-303(11), MCA. Therefore, a design document and Tailings Operation Maintenance and Surveillance manual are not required for TSF-1 for this amendment.

GSM's reclamation plan does not contain requirements for postclosure monitoring of TSF-1 agreed to by an independent review panel under Section 82-4-377, MCA, because an independent review panel has not reviewed a design document for TSF-1. TSF-1 was constructed before enactment of Section 82-4-377, MCA and GSM is not proposing to expand the facility. Therefore, a design document is not required for Amendment 017 under Section 82-4-376, MCA, and Section 82-4-336(13), MCA is not applicable to this proposed Amendment.

1.7.2 Tailings Storage Facility 2

The east flank of TSF-1 is a shared embankment with the adjacent "TSF-2" facility (also known as the West Wing Dike for TSF-2). Unlike TSF-1, TSF-2 meets the definition of a TSF provided in Section 82-4-303(34)(a), MCA, and an Engineer of Record has been designated in accordance with Section 82-4-375(1), MCA for TSF-2. The proposed tailings reprocessing project (TRP) amendment would involve excavating and removing the tailings and embankments of TSF-1, although the shared embankment with TSF-2 would remain in place.

The actions associated with the TRP do not constitute constructing a new TSF nor expanding the TSF-2 facility, as defined by Section 82-4-303(11), MCA. Therefore, a design document is not required for TSF-2 for Amendment 017 under Section 82-4-376, MCA. However, the Engineer of Record is required to review, certify, and seal designs or other documents pertaining to tailings storage facilities submitted to DEQ and to annually inspect TSF-2 under Section 82-4-375(3)(b) and (c), MCA.

For the Amendment Application, a stability analysis was completed regarding the removal of tailings along the shared embankment, and the analysis report was certified by the Engineer of Record (GSM 2021a, Appendix D). The stability evaluation included a deformation analysis that estimated minor deformations of the slope from the design seismic event. The analyses ultimately determined that the deformations would not result in containment loss or compromise the overall stability of TSF-2. The results of the engineering analysis indicate that options for tailings excavation and buttressing the shared embankment would achieve acceptable static and pseudo-static factors of safety. The Complete and Compliant Determination and the stability analysis report (NewFields 2020) provide further details.

1.7.3 Mineral Hill Pit

The proposed configuration to dispose of tailings within the Pit means that the Pit would also not be defined as a tailings storage facility because the tailings and process solution would be contained completely below surrounding grade with no man-made retaining structures (Section 82-4-303(34)(b), MCA). Therefore, a design document and Tailings Operation Maintenance and Surveillance manual are not required for the Pit for this amendment.

1.8 Issues of Concern—Appropriateness of the Mineral Hill Pit Backfill

As described in the Complete and Compliant Determination, tailings placement (or backfill) within the Pit as proposed by this amendment would achieve the standards described in Section 82-4-336(9)(b), MCA. The tailings mass would improve geologic stability by limiting movement of the west highwall and the reclamation and revegetation of the consolidated tailings surface would provide additional wildlife habitat within the Pit. The tailings reprocessing methods in the Flotation Plant would reduce the sulfide mineral content of the residual tailings to be placed in the Pit (0.5 percent sulfur). The tailings-disposal methods would also incorporate lime into the tailings slurry and the temporary process solution stored within the Pit. These alkaline conditions would rinse previously weathered (oxidized) portions of the Pit and partially neutralize acidic solutions created by rock within the lower portions of the Pit, and all infiltrating water would ultimately being captured by the Pit dewatering system. In postclosure, the consolidated tailings mass would have reduced permeability, encapsulate pit rock, and provide potential alkalinity to partially neutralize acidic water that would be collected in the Pit dewatering system.

The proposed Amendment contrasts with previous EIS analysis, which considered using waste rock as Pit backfill (DEQ and BLM 2007). In the previously analyzed scenario, the waste rock was found to have higher permeability and higher sulfide concentrations than what would be found in the reprocessed tailings proposed in this amendment. The waste rock backfill would not have contained alkalinity to neutralize Pit rock seepage. The previous EIS analysis determined that the waste rock backfill would increase potential reactivity and would contribute additional acidity and metals to the Pit ground water.

The previous EIS recognized that the Pit dewatering system would be inaccessible under waste rock backfill (DEQ and BLM 2007). Since that time, the extent of underground workings in the bottom of the Pit has expanded and the workings now provide additional water storage around the sump that was established in one of the underground drifts. As the surface of the reprocessed tailings would rise in the Pit, the existing dewatering system well would be sequentially raised so that the current infrastructure could be used to control ground water levels in the Pit bottom. In the event that the pumping system cannot be maintained or repaired from the surface, the underground workings provide sufficient targets to install additional dewatering controls. This contingency is considered in the current Operations and Reclamation Plan: "Additional horizontal drains and highwall dewatering wells may be maintained where necessary to relieve hydrostatic pressure and capture ground water before it enters the pit. Dewatering wells, pumps, access roads, power lines, and pipelines will be repaired/replaced as needed to maintain dewatering system operations" (GSM 2014).

1.9 Issues of Concern—Scoping

Based on comments received during the public scoping process, DEQ prepared a Scoping Report that included a summary of all comments received (organized by issue). Substantive comments pertained to the analysis and contained information or suggestions to be carried forward into the alternative development process. DEQ identified four topic issues to be considered in more detail in the EIS, which are briefly discussed in the following sections.

1.9.1 Alternatives or Permit Stipulations

The EIS should evaluate alternatives or consider permit stipulations for water sources, groundwater monitoring, tailings stockpile amounts, and well-pumping rates. These issues are discussed in Section 2.4, DEQ's Permit Stipulations.

A comment was received that the permit should include a stipulation to include additional monitoring wells and increased monitoring frequency around TSF-1 and TSF-2, and downgradient alluvial flow paths. The Project does not include modifications to TSF-2; therefore, the review of this comment was limited to the TSF-1 area. The Rattlesnake flow path runs right through the middle of TSF-1 and runs right into the south pumpback wells and there are numerous other wells directly south of TSF-1 and further south in the presumed flow path toward the Jefferson Slough. These wells appear to adequately characterize the water quality in that area. Further, if there were an increase migration of contaminants in the future, the contamination would likely be detected by the existing wells and captured by the existing pumpback wells. Per the Amendment Application (Section 4.6), the TSF-1 pumpback well system will continue to operate and capture impacted groundwater downgradient from TSF-1. GSM also committed to modify the monitoring programs, including monitoring frequency if requested by DEQ and BLM. If the current network indicates migration of contaminants south of TSF-1 during reprocessing operations, more monitoring/collection wells could be installed in a short time period. The same could be said for additional wells within TSF-1. DEQ does not believe additional ground water monitoring points are presently needed. The current ground water monitoring system and impacts are discussed in Section 3.3, Ground Water Hydrology and Geochemistry.

1.9.2 Socioeconomics

The EIS should evaluate the economic and social impacts of the Project. This issue is discussed in Section 3.10, Socioeconomics.

1.9.3 Ground Water

The EIS should review the impacts to ground water quality and quantity associated with the Project. This issue is discussed in Section 3.3, Ground Water Hydrology and Geochemistry.

1.9.4 Surface Water

The EIS should examine the Project's water balance and impacts to surface water quality and quantity associated with the Project. This issue is discussed in Section 3.4, Surface Water Resources.

2.0 DESCRIPTION OF ALTERNATIVES

This chapter describes the alternatives that were evaluated in the environmental review, the alternative screening process, and the rationale for alternatives considered but not analyzed in detail.

2.1 DEVELOPMENT OF ALTERNATIVES

This section describes the process and outcomes of considering reasonable alternatives to the Project. Alternatives with different processes or designs that could potentially minimize the environmental impacts of the Project are included in Sections 2.5 through Section 2.7.

To be considered for further analysis, each potential alternative had to meet the purpose and need of reprocessing tailings. An alternative must be reasonable in that it is (1) achievable under current technology, (2) economically feasible as determined solely by the economic viability for similar projects having similar conditions and physical locations, and (3) determined without regard to the economic strength of the specific project sponsor (Montana Environmental Policy Act [MEPA] Section 75-1-201, (1)(b)(iv)(C)(I), *et seq.,* Montana Code Annotated [MCA]). Alternatives may include design parameters, mitigation, or controls other than those incorporated into a Proposed Action by an applicant or by Department of Environmental Quality (DEQ) before preparing an Environmental Assessment or draft Environmental Impact Statement (EIS) (Administrative Rules of Montana 17.4.603(2)(a)(ii)). An alternatives analysis under MEPA does not include an analysis of alternatives to the proposed Project itself (MEPA Section 75-1-220(1), *et seq.,* MCA).

MEPA requires the analysis of environmental impacts of the Proposed Action, a range of reasonable alternatives, and the No Action Alternative. Potential alternatives were identified and developed based on the Amendment 017 Application including DEQ's comments, internal DEQ deliberations and analysis of technical documents (e.g., technical memoranda in Appendices A through C), and public scoping comments. During an initial review of the application and potential alternatives, DEQ considered and dismissed several alternatives that had greater impacts to the human environment than the Proposed Action, or would not meet the purpose and need. These alternatives are summarized in Section 2.6, Alternatives Considered but Dismissed From Detailed Analysis.

2.2 NO ACTION ALTERNATIVE: EXISTING PERMIT

The No Action Alternative compares environmental conditions with the proposal and establishes a baseline for evaluating the Proposed Action and other alternatives. MEPA requires that the No Action Alternative be considered even if it fails to meet the purpose and need or would not satisfy environmental permitting standards.

2.2.1 No Action Overview

Under the No Action Alternative, Golden Sunlight Mines, Inc. (GSM) would continue to reclaim its mine facility under the existing operating permit. Open-pit mine operations ceased in 2015 and underground operations ceased in 2019. Mining could resume contingent on market prices, ore quality, and ore recovery efficiency and would be limited to the current permit (i.e., Operating Permit No. 00065) and the associated amendments, modifications, and revisions. The operating permit and amendments are summarized in Section 1.3, Project Location and History.

2.2.2 Permit Boundary and Description of Disturbed Areas

The permit boundary for the currently permitted Operating Permit No. 00065 is shown on **Figure 1.3-1**. The current permitted boundary encompasses 6,205 acres located in portions of Sections 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, and 33 of Township 2 North, Range 3 West; Sections 4, 5, and 6 in Township 1 North, Range 3 West; and Sections 13, 24, 25, and 36 in Township 2 North, Range 4 West, Montana Meridian. Under the No Action Alternative, no acreage would be disturbed outside of the current permitted disturbance area. The permitted disturbance area is 3,399 acres. As of May 2021, approximately 2,576 acres have been disturbed, including 1,256 acres that have been reclaimed with topsoil and seeded. **Table 2.2-1** is a summary of the disturbed and reclaimed areas at the Golden Sunlight Mine. Based on the Amendment Application, GSM and DEQ committed to reevaluating the dump acreages in 2020–2021 because many acres were listed as permitted disturbance versus actual disturbance. The entire site was reevaluated in 2021, and the resulting acreage estimates are shown in **Table 2.2-1**. Disturbance and reclaimed acres reported in the text of this EIS are plan-view acres.

2.2.3 Mine Permit and Operations

Operating Permit No. 00065 for the Golden Sunlight Mine was approved by the Montana Department of State Lands on June 27, 1975. Montana Department of State Lands preceded DEQ as the administrator of the Metal Mine Reclamation Act. The Plan of Operations (No. MTM-82855) was approved by the Bureau of Land Management (BLM) in 1982. GSM has subsequently obtained 16 amendments to Operating Permit No. 00065.

Table 2.2-1
Summary of Disturbed and Reclaimed Areas at the Golden Sunlight Mine as of May 2021

Area	Total Feature Disturbed (plan-view acres)	Total Feature Disturbed (slope acres)	Reclaimed [a] (plan-view acres)	Reclaimed [a] (slope acres)	Notes/Comments
WEST AND SOUTH WASTE ROCK DUMPS (South Intra-Dump, East Intra Dump, North Intra Dump, South & North Intra-Dump Misc., Wind Tunnel Dump, South Dump)	466.7	519.7	334.9	374.0	Area does not include stockpile areas or undisturbed areas within general dump complex but does include minor roads (rather than in Roads category).
EAST WASTE ROCK DUMP COMPLEX (Off-Load Area, North East Dump, Fuel Bay Excavation Project)	455.0	483.6	328.6	403.5	
EAST WASTE ROCK DUMP COMPLEX: FAR EAST DUMP (Includes Dump Toe, Formerly East Waste Rock Dump Misc.)	88.4	92.9	73.3	77.2	
BUTTRESS WASTE ROCK DUMP + EXTENSION AREA (Formerly 5BOP Buttress Dump, nearby Rattlesnake Dump)	185.1	194.5	163.6	172.7	GSM nomenclature for Buttress Dump Extension was 5BOP Buttress Dump in previous years. Includes 6.6 acres of flat area disturbance associated with the proposed Re-Pulping Plant area and associated power-line reroute.

Area	Total Feature Disturbed (plan-view acres)	Total Feature Disturbed (slope acres)	Reclaimed [a] (plan-view acres)	Reclaimed [a] (slope acres)	Notes/Comments
PITS (Mineral Hill Open Pit)	**258.4**	395.1			Includes acreage for Pit facilities (3.5 acres). This footprint includes the potentially reclaimable benches (10.2 acres) and the 50-acre tailings surface that would form within the Pit.
MINERAL HILL OPEN-PIT MISC. (South Area Layback, North Area Pit)	43.2	51.7	15.8	18.0	Includes minor roads within the Pit disturbance areas (particularly North Area Pit).
FACILITIES	116.3	143.9	37.2	38.6	Pit facilities (access to Switchback #2 and South Well) are counted within Pit acreage total and not repeated here (3.5 acres). Other facilities include offices, mill and flotation plant, thickener facilities, core shed, tailings shop and old delivery lines, pump houses, and water lines.
TAILINGS STORAGE FACILITY #1	191.7	195.6	184.6	188.1	To be redisturbed through Amendment 017.
TAILINGS STORAGE FACILITY #1 MISC.	2.4	2.5			Includes down stream dike for TSF-1, Old Seepage Area.
TAILINGS STORAGE FACILITY #2	326.5	337.1	36.6	39.6	
TAILINGS STORAGE FACILITY #2 MISC + PROCESS PONDS	41.7	44.4			Down stream dike for TSF-2, Witlock Test Area, Drain Collection Area.
BORROW AREAS	231.9	245.8	79.5	87.1	Includes borrow areas (some reclaimed) across the site and nearby Industrial Business Park.

Area	Total Feature Disturbed (plan-view acres)	Total Feature Disturbed (slope acres)	Reclaimed [a] (plan-view acres)	Reclaimed [a] (slope acres)	Notes/Comments
STOCKPILES, MINE AREA	14.1	16.1			
MISCELLANEOUS	31.6	33.7			Includes Midas Collection Area, LAD Area, All surface water/runoff diversions, Rattlesnake Collection Area.
ROADS	122.9	142.3	2.2	2.2	Includes only the features called out as separate Roads under primary disturbance area (not including minor roads depicted within dump areas). Does not include roads under Exploration License.
TOTAL	**2,576**	**2,899**	**1,256**	**1,401**	

[a] "Reclaimed" is defined by the multiple layers depicted by GSM with partial bond release for grading, soil placement, and/or revegetation. This is not the entire "Reclaimed" layer provided by GSM, which also tracks completed work which has not yet received partial release.

The general locations of mine facilities are shown on **Figure 2.2-1** and the current mine site includes the following:

- Three pits: Mineral Hill Pit, East Area Pit, and North Area Pit;
- Three waste rock dump complexes:
  - West Waste Rock Dump Complex, which includes the South Dump;
  - East Waste Rock Dump Complex; and
  - Buttress Waste Rock Dump Complex, formerly Phase 5B Open Pit (5BOP), Buttress Dump which includes the East Buttress Dump Extension; and
- Two tailings storage facilities: Tailings Storage Facility 1 (TSF-1) and Tailings Storage Facility 2 (TSF-2).

The Mineral Hill Pit (Pit) covers an area of 258 acres (plan view) and ranges in depth from approximately 728 feet (ft) (mine datum) deep on the south end of the Pit to approximately 1,048 ft (mine datum) deep on the north end, with a Pit bottom elevation of approximately 4,525 ft (mine datum). The mine Pit is constructed using 50-ft benches with 24-ft-wide catch benches at 50-ft intervals. The single-lane access ramp is located on the southeast wall of the Pit and has a 12 percent grade. Mining in the Pit and underground workings was suspended in November 2015 and April 2019, respectively. The approved Operations and Reclamation Plan (GSM 2014) for the Pit would continue under this alternative and include the following operational and monitoring elements:

- Overall highwall design configuration incorporates benches to provide for limited raveling of slope and maintain overall competency of slope.
- Ground water flow and precipitation directly running into the Pit are managed by the dewatering well (South Well) located at Switchback #2. An array of monitoring wells surround the Pit.
- Abrupt Pit perimeters are bermed and/or fenced.
- Berms and storm water run-on diversions constructed around the Pit perimeter are designed to handle a 100-year, 1-hour storm event.
- Warning signs are placed around the Pit perimeter.
- The Pit haul road is and will be maintained for access.
- Rock raveling and sloughing from the highwall that escapes the safety benches and berms are removed from the Pit haul road as safe access allows.
- Ground movement, particularly the west highwall, is and will continue to be monitored according to the site ground monitoring plan and includes surveying radar, InSAR satellite, total station, and Global Positioning System measurements.

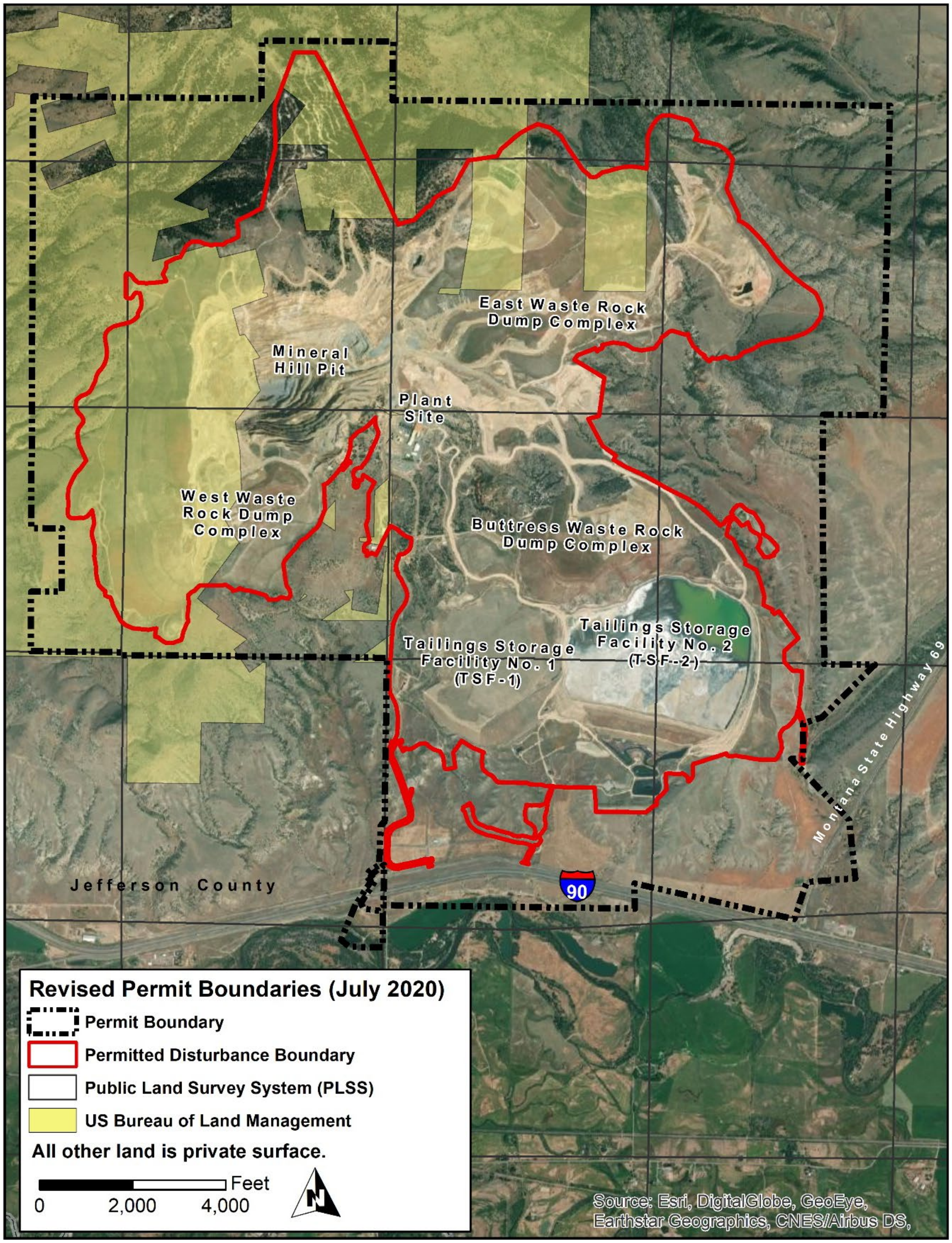


Figure 2.2-1
Site Details and Facility Layout (DEQ and BLM 2018)

Overburden and waste rock have been placed across the site in three disposal areas within the GSM permit boundary: West Waste Rock Dump Complex; East Waste Rock Dump Complex; and Buttress Waste Rock Dump Complex. The permitted area for each rock disposal facility includes a 100- to 300-ft buffer zone at the toe of the dump which provides space for access roads, runoff control ditch/infiltration systems, rock-roll control berms, and general flexibility in placement of non-ore rock (GSM 2014). The site contains approximately 1,305 acres of waste rock dumps; the West Waste Rock Dump Complex and East Waste Rock Dump Complex areas are the largest and cover approximately 479 acres and 455 acres, respectively. Portions of these waste rock disposal areas have been reclaimed and are listed in **Table 2.2-1**. Approximately, 64 percent of the 1,305 acres of waste rock dumps have been reclaimed (GSM 2021a). Tailings-disposal areas are discussed in Section 2.2.4, Tailings Storage Facilities.

Under the No Action Alternative, workforce levels would be expected to remain the same and reclamation activities would continue into approximately 2028. Based on current economic conditions, the mine is not anticipated to begin mining ore in the near future. The Golden Sunlight Mine currently employs 16 employees to manage the stabilization of the site, repurposing of the mill facility, and sitewide cleanup during 2021. Beginning in 2022, the mine would employ 12 people for approximately 6 years until the TSF-2 is consolidated, the Water Treatment Plant is constructed, and the remaining reclamation is completed. After the reclamation of TSF-2 around 2028, the employment at the mine would decrease to six employees for long-term management of the water systems and Water Treatment Plant.

2.2.4 Tailings Storage Facilities

The mine has two tailings impoundments: TSF-1 and TSF-2. A “TSF” is specifically defined under the Metal Mine Reclamation Act (82-4-303(34)(a), MCA) and despite the persistent naming convention, TSF-1 does not technically qualify as a TSF; hence statutes do not apply (see Section 1.7, Issues of Concern—Tailings Storage Facilities). TSF-1 construction was approved in the first permit amendment of 1981, constructed on compacted natural clay, and unlined. Deposition within the facility occurred from 1982 to 1994 and then was capped and reclaimed in 1998–2001. TSF-1 contains approximately 26.2 million tons (Mt) or 20.8 million cubic yards (yd^3) of tailings. The facility has a relatively flat, reclaimed surface area of about 130 acres and the total footprint covers 190 acres, including embankments. The depth or thickness of tailings within TSF-1 ranges from 30 to 35 ft at its northern end to over 170 ft at its southern end. Finer-grained tailings are found within the western and central portions of TSF-1 while the perimeter of the deposit consists of coarse-grained tailings materials.

TSF-2 was authorized in Amendment 008 in 1990 and approved under Amendment 014 in 2010. TSF-2 has a capacity 50.2 Mt of tailings storage at an embankment elevation of 4,774.5 ft (mine datum), was constructed on compacted natural clay with a high-density poly ethylene liner, and includes a number of lined basins downgradient of TSF-2. TSF-2 covers 326 acres and began receiving tailings in 1994. This facility is not currently receiving tailings but rather receives water from across the site.

2.2.5 Flotation Plant

In 2010, GSM applied for a Flotation Plant under Amendment 013 for reprocessing tailings from the active tailings stream (i.e., ore from Pit mining) and tailings previously deposited within TSF-2 to recover residual gold from the sulfide portion of the tailings. However, the final permit amendment approval was not issued by DEQ in 2010 because the reclamation bond was not posted, and the project was never implemented at the mine. On March 11, 2020, GSM applied for a modification to Amendment 013 to DEQ for retrofitting a portion of the existing mill building to house a Flotation Plant rather than constructing a new Flotation Plant between TSF-1 and TSF-2, as approved in the original Amendment 013 in 2010. DEQ approved the modification to Amendment 013 on March 23, 2020, and determined that the modification was not a substantial change to the original amendment that was reviewed in 2010. DEQ determined that the modification eliminated the potential impacts of new facility construction, and reprocessing the tailings could extend site activity beyond the life of mine. This approved modification for the relocation of the Flotation Plant to the existing mill building would not disturb the 1.57 acres for the original Flotation Plant location that was to occur near TSF-1.

2.2.6 Water-Management System

2.2.6.1 Site Water Balance

The average annual precipitation in the Golden Sunlight Mine area is approximately 13 inches and evaporation from the Pit is estimated to be approximately 30 inches (GSM 2021a). Ground water flow through bedrock into the Pit occurs mainly through faults and fractures (Gallagher 2003). Based on 2020 averages, approximately 218 gallons per minute (gpm), primarily from Pit dewatering (72 gpm), direct precipitation (86 gpm), and seepage capture water from pumpback systems, would be routed for disposal into TSF-2. GSM manages TSF-2 water through natural and forced evaporation. A total of approximately 24 gpm would be required from GSM’s existing freshwater supply (Jefferson River Slough) for dust suppression, fire control, and potable use. GSM operates a plant located near the water storage tanks to treat water from the Jefferson River Slough in accordance with their existing public water supply permit (PWSID#02916) and water right (S41G 95773 00). The current site water balance for the No Action is provided on **Figure 2.2-2** and in **Table 2.2-2**.

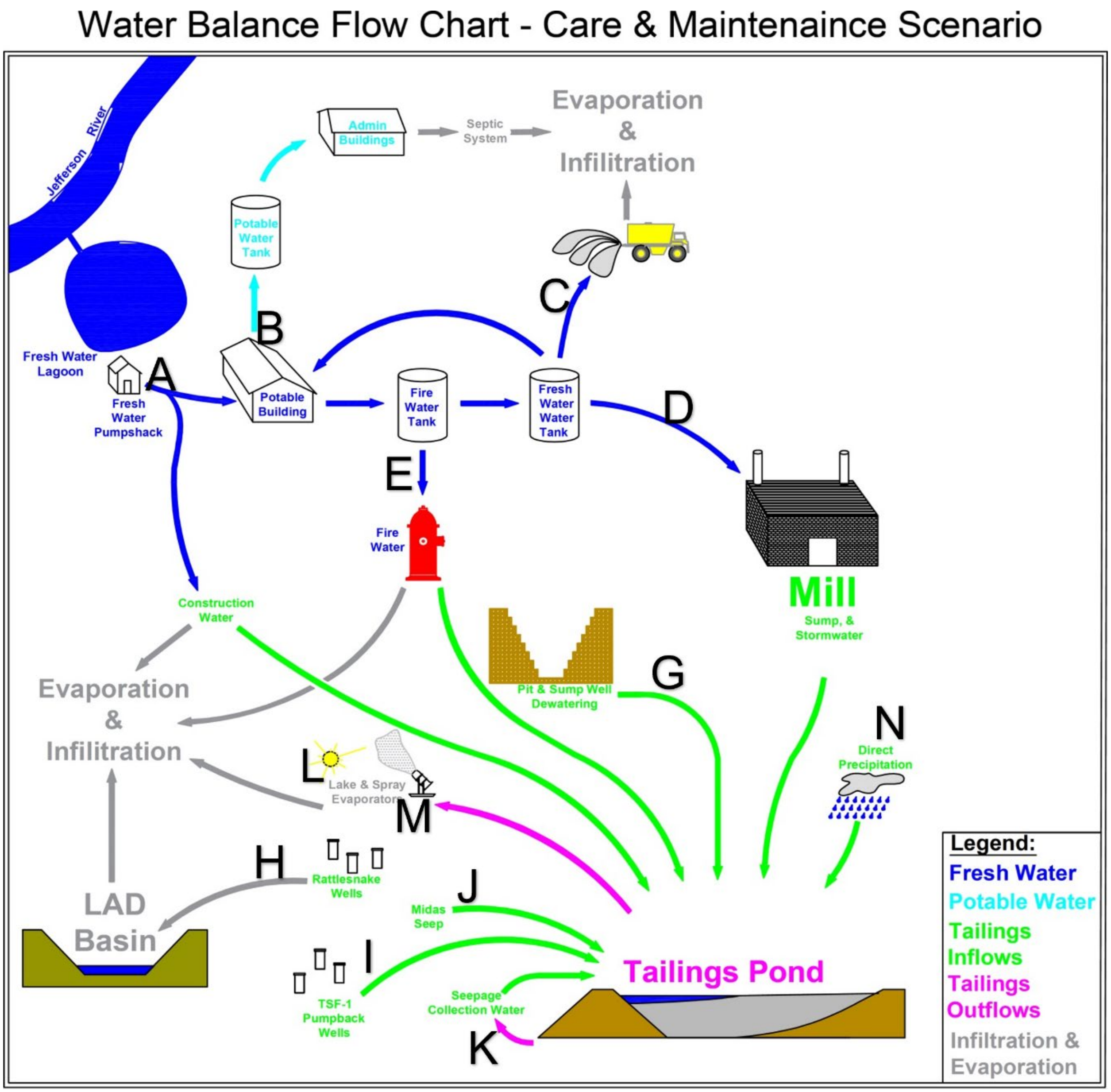


Figure 2.2-2
No Action (Current) Site Water Balance (Pfister 2021)

Under the No Action Alternative, the current site water balance would not change. As part of their Operations and Reclamation Plan, GSM would continue to use fresh water for dust suppression, fire control, and potable use. Also, a Water Treatment Plant would still be constructed by GSM after reclamation of remaining facilities (before 2028) to provide long-term treatment of flow from several sources, including: TSF-1 pumpback well systems; TSF-2 underdrain; Pit dewatering; and any water from waste rock dump capture systems (GSM 2014).

Ongoing ground water quality monitoring and surface water monitoring would continue under this alternative.

Table 2.2-2
No Action (Current) Site Water Balance (Pfister 2021)

Description	I.D.	2020 Average Flow (gpm)
Fresh Water	A	24.1
Potable Water	B	8.6
Water Trucks	C	8.3
Fresh Water to Mill	D	0.7
Fire Water	E	6.3
Construction Water	F	0.2
Pit Dewatering	G	71.8
Rattlesnake Wells	H	38.1
TSF-1 Pumpback Wells	I	47.8
Midas Seep	J	0.3
TSF-2 Seepage	K	157.0
TSF-2 Evaporation	L	71.2
TSF-2 Forced Evaporation	M	146.4
Direct Precipitation	N	85.8
Miscellaneous (Sumps, Storm Water, Construction Pond)		11.9

2.2.6.2 Tailings Storage Facility 1

Several Rattlesnake Gulch Area interception wells were installed in 1998 to capture water that created seeps upgradient and in the northern portions of TSF-1. These interception wells are pumped an average of 38 gpm to the Land Application Disposal Area to reduce pore pressure in the foundation of the East Buttress Dump Extension and reduce ground water inflow in TSF-1.

Since 1983, ground water downgradient of TSF-1 has been intercepted because of a failure of a clay slurry wall when mining began at the site. The ground water interception program uses several galleries of wells including the South Pumpback and the East Flank Pumpback systems (**Figure 2.2-3),** which are directed to TSF-2. The overall pumping rate has declined from over 350 gpm in 1983 to approximately 40 gpm currently (combined from both pumpback systems).

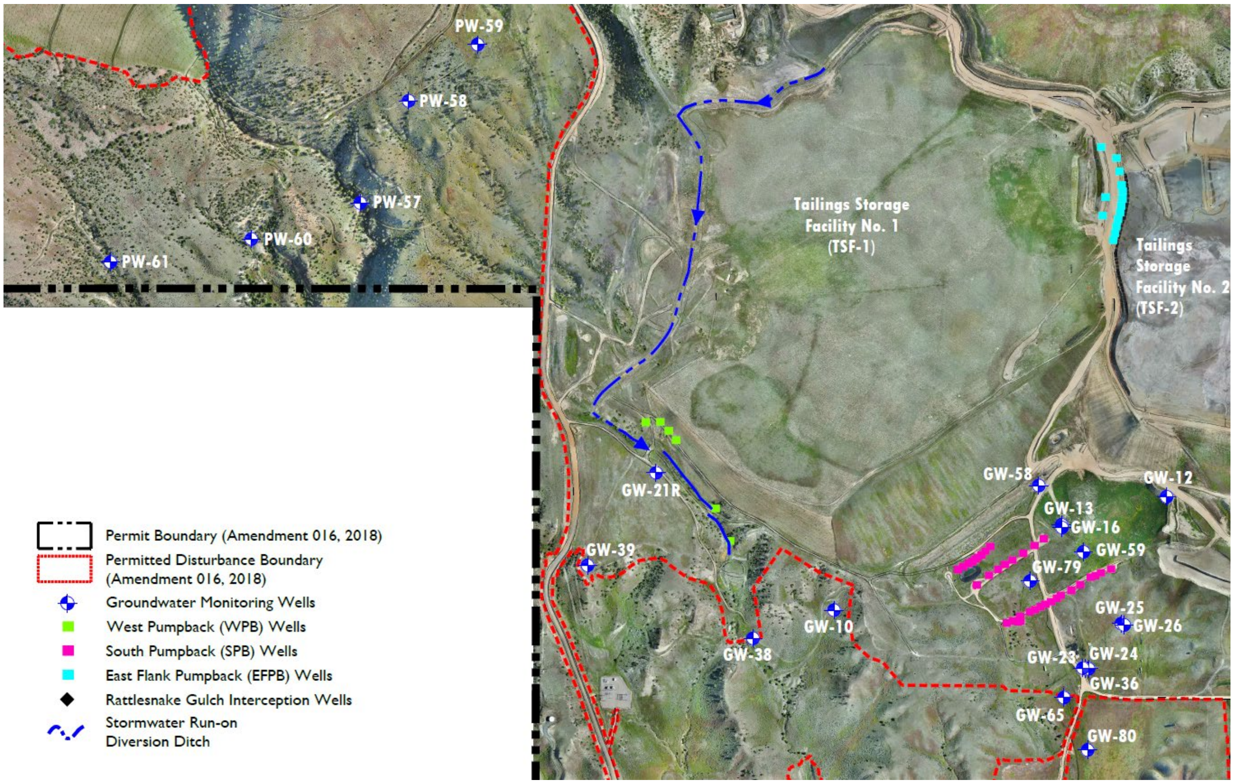


Figure 2.2-3
Pumpback Wells at Tailings Storage Facility 1 (GSM 2021a)

2.2.6.3 Mineral Hill Pit

Water that enters the Pit from surface runoff, direct precipitation, and ground water seepage is subject to evaporation or infiltration into the bedrock on the Pit floor. Water is then collected in the underground mine workings beneath the Pit and is pumped from a sump in the South Well drift (originally called the Pit Sump Well) at an average annual rate of 57 gpm over the period of record. The rate of pumping fluctuates annually to maintain the sump-water level. Active pumping maintains a ground water cone-of-depression below the Pit floor. Active pumping maintains a ground water cone-of-depression to approximately 4,488 ft (mine datum). The cone-of-depression maintains ground water below the base of the Pit and prevents ponding. Water is pumped from the South Well to a collection tank on Switchback #2 in the Pit and then conveyed to TSF-2 through aboveground piping. The Pit's sump-water quality represents the interaction of runoff and ground water inflow from mineralized rock with varied water quality conditions depending on the time it reacts with mineralized rock before being pumped out via the South Well. The Pit dewatering system would continue under this alternative and remain active until no longer needed, and wells would be abandoned as per state regulations.

2.2.7 Reclamation

GSM's Operating Permit No. 00065 requires reclaiming disturbed lands as outlined in the approved Operations and Reclamation Plan (GSM 2014). As of May 2021, GSM has revegetated approximately 1,875 disturbed acres. Reclamation cover thickness guidelines (i.e., soil or growth media) and seed mixtures have been developed for various slopes. Most of the reclaimed areas have reestablished a grassland vegetation cover with shrubs established in some areas. Noxious weed infestations are monitored and controlled using standard practices summarized in annual reports to DEQ and BLM. GSM has salvaged soil and growth media before constructing any facility and stockpiled the material, which consists of suitable topsoil and subsoil, to use for future reclamation. These soil stockpiles are seeded for temporary cover, dust abatement, and erosion control. GSM currently has 23 soil stockpiles covering 62 acres that contain approximately 5,934,303 yd^3. Existing stockpiles located within the mine site are shown on **Figure 2.2-4**.

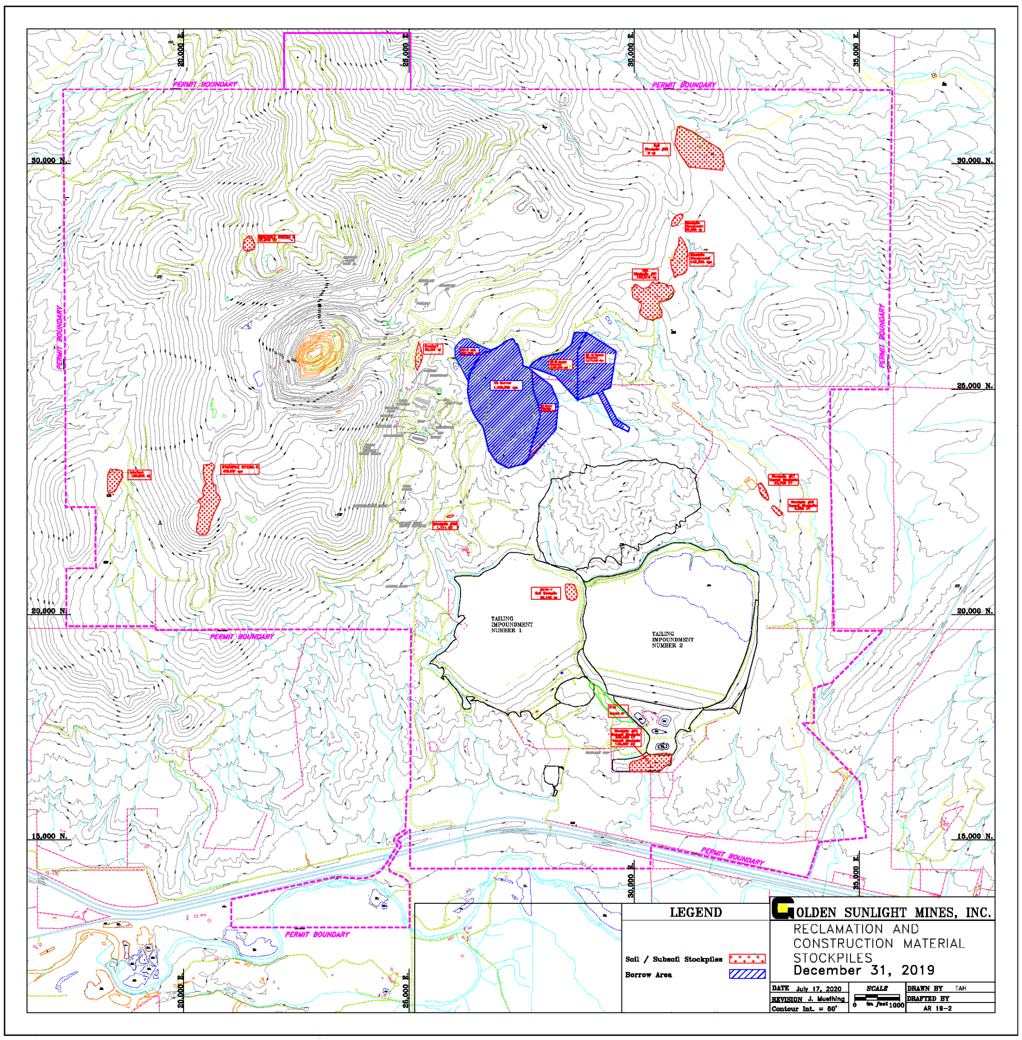


Figure 2.2-4
Reclamation and Construction Material Stockpile Locations (GSM 2020)

2.2.7.1 Tailings Storage Facility 1

Reclamation at TSF-1 was finalized in 2001 by placing capping/growth media material, establishing grass/shrub vegetation, continuing dewatering activities, and removing and/or plugging and abandoning surface and buried pipelines (GSM 2014). The TSF-1 capping material consists of approximately 1.2 million yd^3 of material (approximately 2 ft of growth media [0.6 million yd^3] and 2 to 3 ft of subsoil/oxidized capping material [0.6 million yd^3]). A self-sustaining vegetation cover comprising crested wheatgrass, intermediate wheatgrass, and Russian wildrye; native perennial grasses including slender wheatgrass, thickspike wheatgrass, and western wheatgrass; and native shrubs consisting of fourwing saltbush is established on TSF-1. Reclamation of TSF-1 met closure criteria and bond levels were reduced to 187 acres. No changes to TSF-1 would occur and the reclamation status will remain the same under the No Action Alternative.

2.2.7.2 Mineral Hill Pit

Reclamation has not occurred in the Pit or on the highwalls, and little to no vegetation has been established on these areas. Under the No Action Alternative, the Operations and Reclamation Plan reclamation would continue and includes the following reclamation components:

- Major benches, which are not likely to become buried with rubble from the Pit highwall over time and that have sufficient width to allow machinery access and Pit haul roads will be capped with a 3-ft-thick soil cover and revegetated.
- The access road from Switchback #2 to the bottom of the Pit will be reclaimed because underground access will not be necessary.
- Oxidized benches containing enough fine material to support plant life will be seeded and/or planted with trees where safety allows.

The Pit highwalls currently provide nesting sites on each highwall for raptors, bats, and other avian species, and these sites are concentrated mainly in the upper one-third of the Pit highwalls. No active raptor nesting sites have been observed in the Pit, although hundreds of rock pigeons and numerous cliff swallows are active at the Pit. Rock pigeons are prey for golden eagles and mine personnel have reported seeing golden eagle activity.

2.3 PROPOSED ACTION

2.3.1 Proposed Action Overview

The Proposed Action would allow GSM to excavate and reprocess 26.2 Mt of tailings in TSF-1 to recover a fine gold and sulfide concentrate. The Proposed Action is intended to remove the tailings from the previously reclaimed facility and return the TSF-1 area to postclosure land uses for grazing, recreation, and wildlife habitat. The Proposed Action may also eventually reduce the need for long-term, on-site water treatment by eliminating discharge from TSF-1 and by reducing the amount of water pumped from the Pit. However, the actual elimination of water capture or dewatering systems is not a component of the Proposed Action.

Tailings would be recovered from TSF-1 using conventional excavation and haulage, and removing the 26.2 Mt of tailings material is expected to take 12 years. The tailings would be excavated from northeast to southwest, and reclamation of the area underlying TSF-1 would be completed concurrently with the excavation.

The excavated tailings would be transported to a Re-Pulping Plant. The Re-Pulping Plant would mix the tailings with water to create a slurry that can be pumped uphill to the Flotation Plant within the mill. Water from the existing freshwater supply would be used in the Flotation Plant to recover gold and sulfide minerals. Reprocessed tailings would be pumped to a thickener plant to increase the pH (or alkalinity) of the solids as needed and create a slurry of 65 percent solids. The slurry would be pumped to the Pit for final disposal. Water accumulating on top of the tailings mass, as well as ground water captured within the mine workings below the bottom of the Pit, would be pumped back to the mill for reuse in the process or piped to TSF-2.

Tailings disposal in the Pit would result in a final surface level of 5,173 ft (mine datum), which is approximately 650 ft above the Pit bottom. The partial filling of the Pit would reduce highwall instability as well as reduce water acidity that accumulates at the base of the Pit. After reprocessed tailings placement is complete, the consolidated tailings would be covered with capping material, growth media, and revegetated. Pit ground water would continue to be pumped from the underground dewatering system and treated similar to currently approved water-management operations. Reclamation of the Pit roads, benches, and highwalls would remain as detailed in the Operations and Reclamation Plan (GSM 2014). At closure, the reclaimed tailings surface within the Pit would be approximately 50 acres with no permanent ponding.

2.3.2 Project Boundary and Description of Disturbed Areas

The permit boundary for the currently permitted Operating Permit No. 00065 is shown on **Figure 2.2-1**. The current permitted boundary legal location is discussed in Section 2.2.2, Permit Boundary and Description of Disturbed Areas. Under the Proposed Action, all activities would occur on currently disturbed or previously disturbed and reclaimed land and would not result in new disturbance or changes to the permit boundary. Under the Proposed Action Alternative, no acreage would be disturbed outside of the current permitted disturbance area. The permitted disturbance area is 3,399 acres. As of May 2021, approximately 2,576 acres have been disturbed, including 1,256 acres that have been reclaimed with topsoil and seeded. **Table 2.2-1** is a summary of the disturbed and reclaimed areas at the Golden Sunlight Mine. The 190--acre reclaimed area of TSF-1 would have the vegetation, growth media, and capping material sequentially removed under the Proposed Action Alternative.

2.3.3 Tailings Reprocessing Operations

2.3.3.1 Excavation and Hauling

Tailings would be recovered and transported from TSF-1 over a period of approximately 12 years using conventional excavation, loading, and haulage equipment (i.e., dozers, excavators, front-end loaders, and haul trucks). The 26.2 Mt of tailings at TSF-1 encompass an area of approximately 190 acres (including embankments) and have a dry density of approximately 93.6 pcf. The Proposed Action would mine tailings from TSF-1 in benches from northeast to southwest using conventional excavation equipment. The first cut at the north end of TSF-1 would be approximately 30 to 35 ft deep, with tailings thickness increasing to the south end of the facility at the main embankment (up to 170 ft thick).

Before tailings are removed from the first cut, the north end of the TSF-1 site would be stripped of vegetation, growth media, and capping material from the previous reclamation. This growth media and capping material would be placed in separate, temporary stockpiles within the northern portion of TSF-1, as shown on **Figure-2.3-1**, and used for reclamation of the exposed native-ground area after the first cut is completed.

Ongoing excavation of the growth medium and capping materials would be limited to the areas directly above the tailings to be excavated to limit dust and water runoff from exposed tailings. The upper 2 ft of growth media would be salvaged from each active excavation area and stockpiled in an area where tailings have already been removed, and the underlying 2 ft of capping material would be salvaged and placed in a separate stockpile.

During the TSF-1 recovery process, tailings excavated to original ground surface would be loaded and hauled to the Re-Pulping Plant, which would be constructed on a pad located in an area near the north end of the TSF-1 site and the toe of the East Buttress Dump Extension, as shown on **Figure 2.3-1**. Coarse waste rock (e.g., cobbles and boulders) used as fill during TSF-1 construction would be separated from the tailings at the Re-Pulping Plant and trucked to an existing waste rock disposal area or, if determined to be oxide waste rock, placed as capping material for reclaiming TSF-1.

Depending on the conditions observed during tailings removal, the upper 1–2 ft of native ground located immediately below the tailings could be removed to ensure that tailings material is fully recovered. Any removed foundation material, which consists of sediment of the Bozeman Formation, would be separated at the Re-Pulping Plant and placed in a waste rock disposal area. A general schematic of the TSF-1 facility is shown on **Figure 2.3-1** and the Proposed Action mine facilities layout is shown on **Figure 2.3-2**.

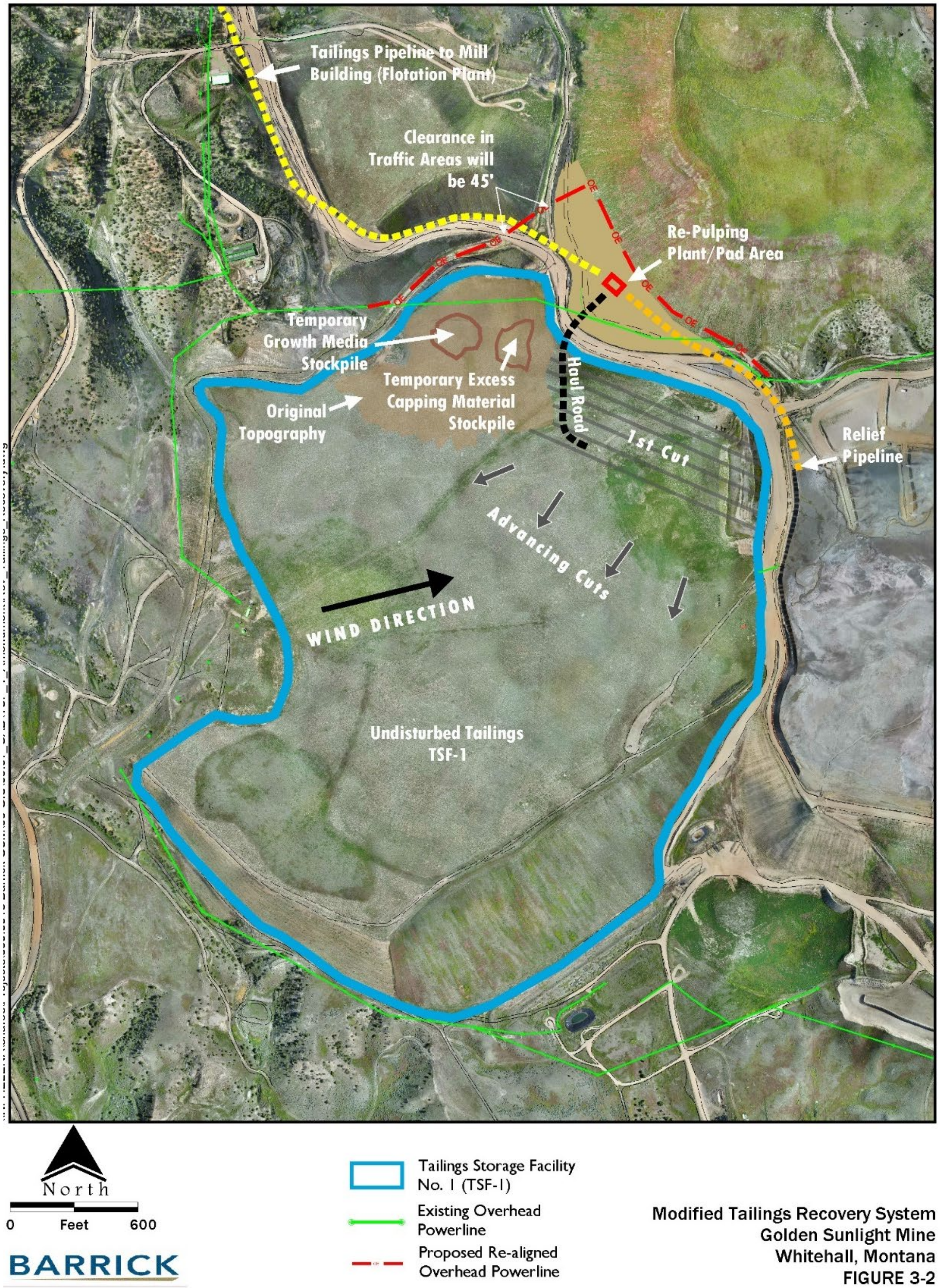


Figure 2.3-1
Proposed Tailings Recovery System at Tailings Storage Facility 1 (GSM 2021a)

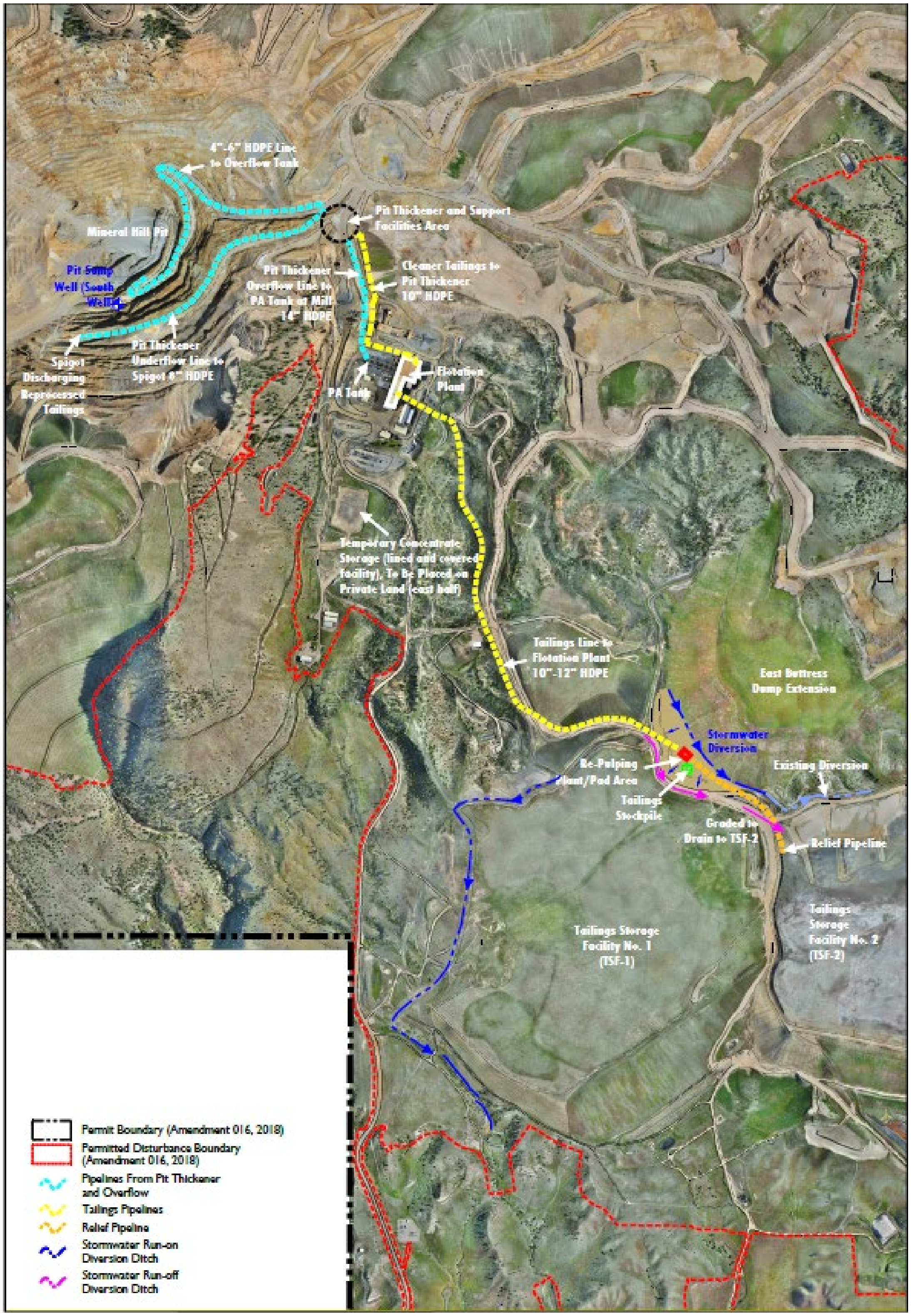


Figure 2.3-2
Proposed Mine Facilities Layout (GSM 2021a)

2.3.3.2 Re-Pulping Plant

The Re-Pulping Plant area would encompass approximately 6 acres that were previously disturbed and reclaimed (still bonded) at the toe of the East Buttress Dump Extension. The yard area would be constructed of borrow material sourced from either the East Pit Borrow or capping material from TSF-1. Existing vegetation would be grubbed before borrow material is placed on the existing surface. The growth media would not require stripping or being stored separately because the existing material would be consistent with the new borrow material that would be placed to support the pad construction. A site geotechnical investigation was completed to ensure that construction and operation of the Re-Pulping Plant would not affect the stability of the East Buttress Dump Extension and other areas in the vicinity of TSF-1 (NewFields 2021).

Tailings would be transported by haul truck to the Re-Pulping Plant area and placed in a feed stockpile. A loader would recover the tailings from the stockpile and place them into a hopper/conveyor that would feed into the Re-Pulping Plant. The Re-Pulping Plant would mix water sourced from GSM's existing freshwater supply (Jefferson River Slough) and reclaim water with the tailings to produce a slurry that would be pumped in a new 10- to 12-inch-diameter pipeline located along existing roads to the Flotation Plant, which would be constructed in the existing mill building.

The Re-Pulping Plant would be heated and weatherized to ensure that tailings repulping would not be affected by freezing conditions. A portion of the existing power line that runs across the northern edge of TSF-1 would be relocated and realigned to parallel the northern side of the Re-Pulping Plant with an adjacent access road. Up to 0.6 acre of existing disturbed or reclaimed area (still bonded) would be redisturbed to support the updated alignment construction (primarily associated with road access for power-line installation vehicles). This relocated power line would be raised for improved equipment safety (45-ft height), and the new alignment would better support the Re-Pulping Plant construction and operations. The slurry pipeline extending to the Flotation Plant would be equipped with a pressure-sensing safety valve and additional piping that would provide for gravity drainage of tailings slurry in the pipeline to TSF-2 in the event that maintenance is needed on the pipeline or in the case of power failure. Under such conditions, tailings would drain by gravity to TSF-2 from the Re-Pulping Plant pipeline and would be managed consistent with current methods and procedures in place for existing tailings in TSF-2, including reclamation and closure of TSF-2.

The Re-Pulping Plant and associated infrastructure would be dismantled and removed from the site after the tailings recovery is completed. After the site is graded, the compacted borrow would be ripped before a minimum of 1 ft of growth media sourced from TSF-1 is placed.

2.3.3.3 Flotation Plant

The Flotation Plant would process approximately 6,400 tons per day of tailings obtained from TSF-1. Water used in the Flotation Plant would be provided from GSM's existing freshwater supply and reclaim water from TSF-2. The Flotation Plant would produce a concentrate of residual fine gold and sulfide minerals (predominantly pyrite), thus reducing the potential reactivity of the reprocessed tailings. The sulfide concentration of incoming TSF-1 tailings averages 4 percent and concentration would be reduced in reprocessed tailings to a target average of 0.5 percent total (or nonsulfate) sulfur. Outgoing concentrate is expected to have a sulfide content of approximately 42 percent (GSM 2021a). The produced concentrate would be loaded from the Flotation Plant into covered over-the-highway semitrucks for transporting to Barrick's existing mines in Nevada (GSM 2021a).

2.3.4 Reprocessed Tailings Disposal

Reprocessed tailings from the Flotation Plant would be pumped to a thickener tank located near the Pit to thicken the tailings slurry to approximately 65 percent solids with lime added from a lime silo, as needed, to raise the final tailings slurry pH. The thickened tailings slurry would then be pumped to the Pit for final storage. The thickened tailings would be conveyed through a pipeline to a spigot system located in the Pit. Spigot operations would be managed to distribute tailings into the Pit from one or more discharge points along the southern side of the Pit to create a pond comprising process solution to the eastern portion of the Pit surface. Power interruption at the thickener would result in the pump stopping and the slurry in the feed line would drain back to the Flotation Plant; under such a scenario, approximately 15,000 gallons would fill the sump-box and 3,000 gallons would overflow onto the plant floor. Slurry on the floor would be pumped back into the sump-box when power resumes.

Reprocessed tailings backfill in the Pit would initially reach an elevation of approximately 5,191 ft (mine datum) and then settle to an elevation of approximately 5,173 ft (mine datum) after consolidation (sloping 1 percent from southwest to northeast) (**Figure 2.3-3**). The final tailings surface area in the bottom of the Pit would be approximately 50 acres. A portion of the tailings material in the Pit after backfilling would cover approximately 1.4 acres of land on the west highwall managed by BLM, which is the only BLM-managed land affected by the Proposed Action. BLM-managed lands would be impacted when the backfilled tailings reach a Pit elevation of approximately 5,060 ft, which would not occur for at least 5 or more years after Project initiation.

Water that infiltrates the reprocessed tailings material in the Pit and bedrock beneath the Pit would be captured by the underground dewatering system. Water management of the Pit are discussed in Section 2.3.5.3, Mineral Hill Pit.

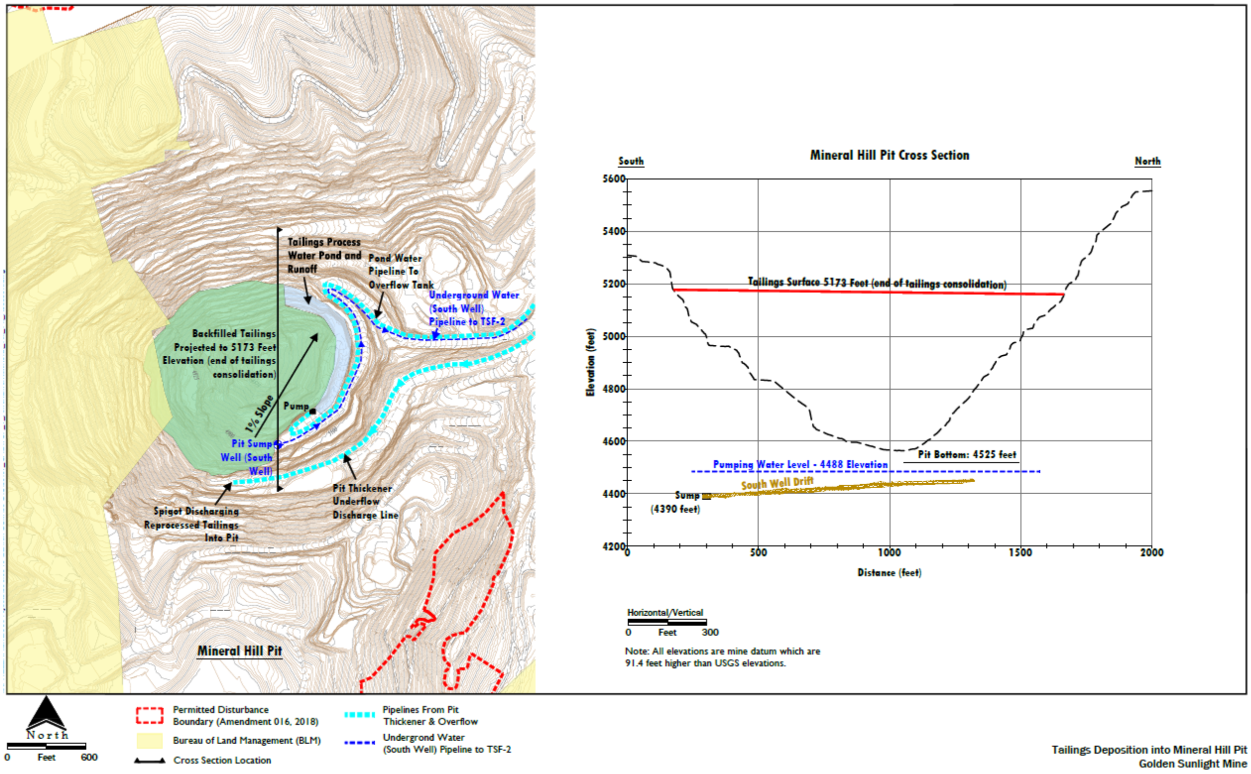


Figure 2.3-3
Plan and Cross-Section View of Disposed Tailings Surface (GSM 2021a)

As the tailings material rises in the Pit during the filling period, the tailings would eventually provide enough confinement to inhibit movement of the highwall. Based on stability modeling (Subterra 2020a), the highwall should be stable after the reprocessed tailings reach a thickness of approximately 240 ft or an elevation of 4,950 ft. GSM would maintain its current standard of monitoring and managing the highwall deformation.

2.3.5 Water-Management System

2.3.5.1 Site Water Balance

The site water balance for the Proposed Action is provided on **Figure 2.3-4** and in **Table 2.3-1**. As part of the Proposed Action, the process solutions from the reprocessed tailings in the Pit would infiltrate the wall rock and combine with runoff, direct precipitation, and ground water. The Pit would be dewatered using the South Well. Water would be pumped at a rate increasing from the current 57 gpm to a maximum of approximately 130 gpm at the end of tailings reprocessing and then gradually decreased to approximately 38 gpm. Pit sump water would continue to be directed to TSF-2. Reclaim water from the in-pit pond would be routed to the Flotation Plant after about 3 years.

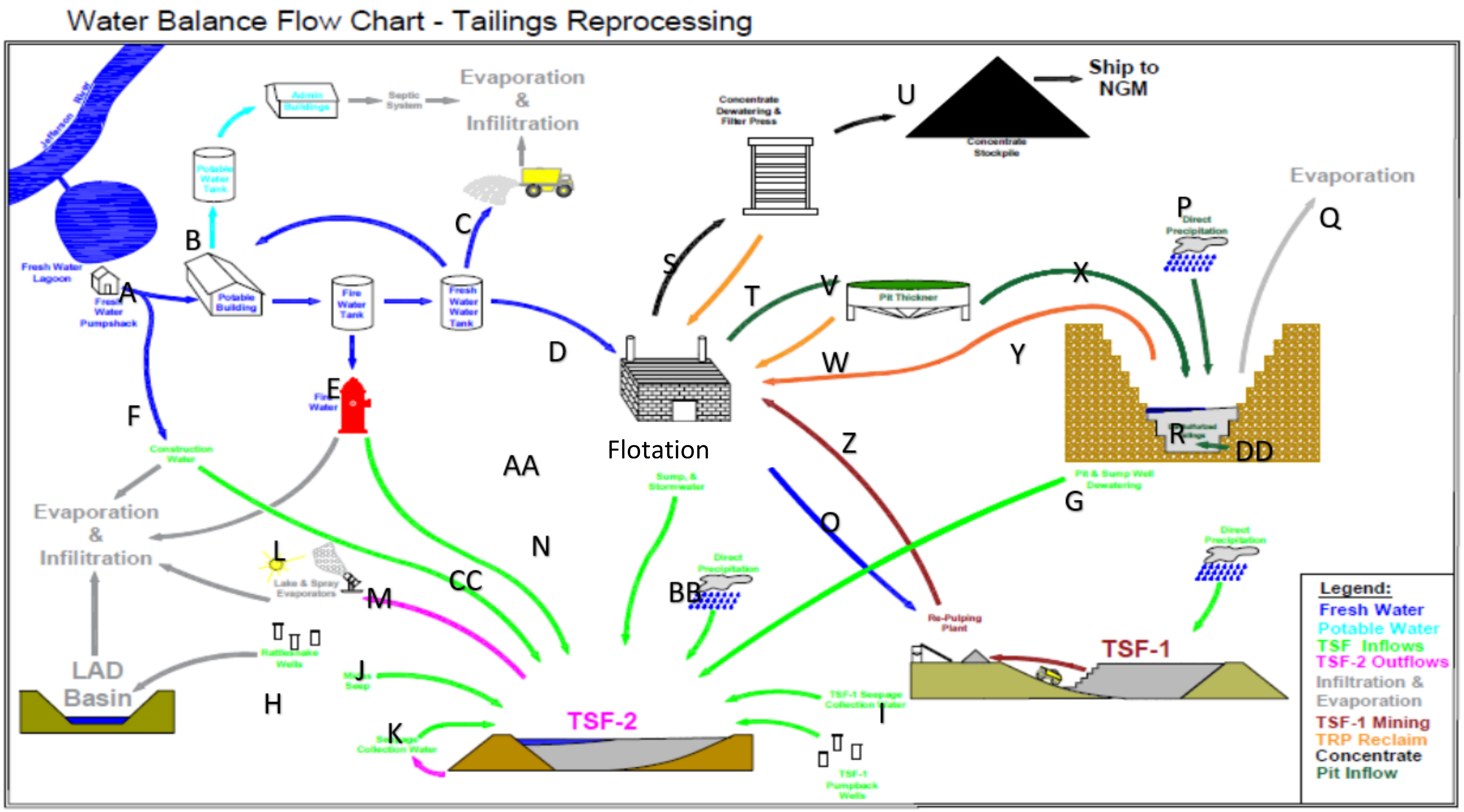


Figure 2.3-4
Proposed Action Site Water Balance (Pfister 2021)

Table 2.3-1
Proposed Action Site Water Balance (Pfister 2021)

Description	I.D.	2033 Average Flow (gpm)
Fresh Water	A	396.0
Potable Water	B	8.6
Water Trucks	C	8.3
Fresh Water to Mill	D	372.6
Fire Water	E	6.3
Construction Water	F	0.2
Pit Dewatering	G	128.0
Rattlesnake Wells	H	38.1
TSF-1 Pumpback Wells and TSF-1 Seepage Collection	I	47.8
Midas Seep	J	0.3
TSF-2 Seepage	K	157.0
TSF-2 Evaporation	L	71.2
TSF-2 Forced Evaporation	M	74.6
Direct Precipitation	N	85.8
Fresh and Reclaim Water to Re-Pulping Plant	O	1,586.3
Direct Precipitation and Runoff to Pit	P	51.0
Pit Evaporation	Q	85.0
Pit Tailings Entrainment	R	364
Flotation Plant to Filter Press	S	61.8
Filter Press Return to Flotation Plant	T	54.0
Filter Press to Concentrate Stockpile (Ship to Nevada)	U	7.8
Flotation Plant to Pit Thickener	V	2,610.4
Pit Thickener Return to Flotation Plant	W	2,042.4
Pit Thickener to Pit	X	568.0
Pit Pool Water to Re-Pulping Plan	Y	80.0
Re-Pulping Plant to Flotation Plant	Z	1,709.5
Fire Water to Sumps	AA	5.7
Sumps and Stormwater to TSF-2	BB	6.2
Construction Water to TSF-2	CC	0.1
Ground water to Pit	DD	38.0

During tailings removal from TSF-1, a Re-Pulping Plant located northeast of the impoundment would pipe tailings mixed with water sourced from GSM's existing freshwater supply and reclaim water to the flotation circuit. During tailings excavation, lined storm water basins would be constructed at low points to collect runoff from the exposed tailings. Runoff would be pumped to the Re-Pulping Plant or to TSF-2 if the Re-Pulping Plant is temporarily shut down.

Diversion systems would also be used to divert runoff from the facility into drainages farther south. An existing underdrain and seepage collection pond at TSF-1 would capture water that may infiltrate through exposed tailings and pump the water to TSF-2.

Fugitive dust would be controlled by using spray from water trucks that would use freshwater sources. Freshwater supply would also be used in the Flotation Plant and Re-Pulping Plant from the Jefferson River Slough.

2.3.5.2 Tailings Storage Facility 1

GSM maintains an array of ground water monitoring wells and pumpback wells located downgradient of TSF-1. No modifications to the current pumpback wells and monitoring wells surrounding TSF-1 would occur. Ongoing ground water monitoring and modeling would allow for updated predictions to the system after tailings are removed over time.

Storm water collection ponds would be constructed on original ground surface in topographical low points within each active cut area of TSF-1 where tailings are being removed. The geomembrane-lined ponds would collect runoff associated with direct precipitation events and snowmelt on a seasonal basis from within the relatively small active portion of the TSF-1 tailings removal process. Collected water would be pumped periodically when needed to the Re-Pulping Plant for use in the process. The ponds would move periodically within the exposed topographic low points on original ground surface as each cut of active tailings removal advances to the south. When ponds are relocated to new low points that would be created with the progressive advancement of tailings removal, the liners associated with the previous pond location would be removed, inspected for reuse, and installed in the new pond locations. If the pond liners could not be reused, then new liners would be installed. The previous pond locations would be graded to eliminate low points and covered with growth media.

The bench and cut face orientation of the TSF-1 tailings recovery excavation would direct runoff from active tailings recovery areas to the storm water collection ponds. Water collected seasonally in the ponds would be pumped to the Re-Pulping Plant or TSF-2 if the Re-Pulping Plant or Project is temporarily shut down. Because of the potential acidity of storm water runoff from exposed tailings, the lined storm water collection ponds would be periodically sampled and measured for pH. Precipitation not captured by the collection ponds that may infiltrate through exposed tailings would be intercepted by the existing underdrain and seepage collection pond at TSF-1 or ground water pumpback systems downgradient of TSF-1. This intercepted water would be pumped to TSF-2 using the existing water control system.

The existing storm water diversion ditch located immediately upgradient (north) of TSF-1 and the Re-Pulping Plant area would remain to capture any run-on water from upgradient areas (including the face of the East Buttress Dump Extension area). Runoff from the Re-Pulping Plant area would be directed in a ditch and culvert to TSF-2.

As tailings removal advances to a point where the southern and western embankments of TSF-1 are removed, a runoff control ditch would be constructed along the southern end of the TSF-1 footprint. The ditch would collect storm water and sediment from portions of the TSF-1 site exposed during final tailings recovery and reclamation. The ditch would convey storm water and sediment to the existing lined seepage collection pond previously connected to the TSF-1 underdrain system. The ditch and pond would remain until the TSF-1 site stabilizes with vegetation cover and sediment collection is no longer required.

2.3.5.3 Mineral Hill Pit

The Proposed Action would not require a change in the approved water-management system for the Pit. GSM would continue to maintain a cone-of-depression and thus capture ground water inflow and tailings water that encounters ground water in the Pit. GSM would continue to dewater at a rate that results in zero outflow and maintains a water level below the 4,750-ft (mine datum) elevation. Consistent with the current Operations and Reclamation Plan, long-term water management and water treatment would be performed, as necessary, to prevent impacts to off-site water resources.

The process solution for reprocessed tailings that infiltrates into the wall and bottom rock of the Pit would combine with meteoric water and ground water from the bedrock aquifer associated with the Pit. The combined water sources would continue to be managed according to the current approved system (i.e., collecting and pumping water from the underground mine workings). GSM maintains the South Well that pumps water from the underground sump and conveys the water through a pipeline to TSF-2. Water would be pumped at a rate increasing from the current 57 gpm to a maximum of approximately 130 gpm at the end of tailings reprocessing and then gradually decreased to approximately 38 gpm.

Reclaim water from the tailings surface pond in the Pit would be returned to the thickener tank overflow and Flotation Plant using a new return pipeline system. This water would be used as makeup water in the Flotation Plant. Returning the ponded process solution to the Flotation Plant and thickener tank during the subsequent years of tailing reprocessing would also have the net effect of reducing the amount of water entering into and being pumped from the underground workings (sump) and may potentially reduce the use of freshwater sources.

Process water in the tailings slurry would collect in a pond on the eastern side of the tailings surface in the Pit. This process water would be pumped through a pipeline at approximately 50 gpm to the thickener tank overflow and then to the PA Tank for distribution to the Flotation Plant and/or Re-Pulping Plant for reuse. The process water cannot be pumped until about Year 3 of tailings deposition because of access from existing ramps; pumping would then continue through the end of processing. A portion of process water on the tailings surface would evaporate or seep into ground water beneath the Pit, rinsing previous oxidation products from highwalls and fractures, and then be removed by the underground sump pump (Schafer Limited LLC 2020b). After tailings disposal ceases, the surface pond is expected to become nonexistent because of evaporation and infiltration, although possible short-term seasonal ponding of precipitation in the low point on the eastern side of the tailings surface may occur.

During tailings placement, lime would be consistently added for the first few years to the tailings to maintain pH levels around 9.0 standard units within the process solution pond on top of the tailings. Lime would offset the expected decline in pH in the ponded water in the Pit caused by accumulated salts on the Pit bottom and highwalls. GSM would monitor the pH of the ponded water on top of the tailings surface in the Pit, and after the first few years, lime would be added as needed to keep the pH at approximately 7.6 standard units for reuse in the reprocessing circuit. After cessation of tailings placement and before long-term disappearance of the pond, a separate pipeline would be used to convey lime slurry to the pond from the lime silo, if necessary. Water directed to the mill would consist of three sources: draindown water pumped back from the underground workings in the Pit, reclaim water from the overlying tailings pool, and a limited amount of makeup water from other sources as needed. Lime added for pH control would neutralize acidity from these three sources.

As the level of tailings rises during placement in the Pit, access to the South Well head would be maintained through periodic placement of lifts of oxidized waste rock sourced from 5BOP2 to form an access road to the well site. GSM would place an initial 25-ft lift of waste rock on the South Well bench. The South Well casing would be extended so that the well collar is above the 25-ft lift. As the tailings continue to rise, additional 25-ft lifts would be made to the access road and additional extensions would be added to the South Well casing. The South Well casing currently extends 640 ft from the South Well bench to the underground sump, and the casing would be extended upward by another 235 ft to maintain access during tailings placement.

2.3.6 Reclamation

2.3.6.1 Tailings Storage Facility 1

The footprint of the TSF-1 site would be reclaimed by covering the area with approximately 1.2 million yd^3 of material and seeding to establish vegetation under the Proposed Action. Before tailings are removed from the first cut, the northern end of the TSF-1 site would be stripped of vegetation, growth media, and capping material from the previous reclamation. This growth media and capping material would be placed in separate, temporary stockpiles within the northern portion of TSF-1, as shown on **Figure 2.3-1**, and used for reclamation of the exposed native ground after the first cut is completed. Ongoing excavation of the growth medium and capping materials would be limited to the areas directly above the tailings to be excavated to limit dust and water runoff from exposed tailings. The upper 2 ft of growth media would be salvaged from each active excavation area and stockpiled in an area where tailings have already been removed, and the underlying 2 ft of capping material would be salvaged and placed in a separate stockpile.

The growth media and capping material would be used to concurrently reclaim areas where tailings have been removed and the original ground surface can receive the capping material followed by placing the growth media. After placing the capping and growth material, the areas readied for reclamation would be seeded. The final reclaimed surface, as shown on **Figure 2.3-5**, mimics the original topography of the TSF-1 area before tailings placement. Disturbed areas would be reclaimed to comparable stability and ecologic function as that of adjacent areas, as specified in the Operations and Reclamation Plan (GSM 2014). Specific grading thickness, controls, or stabilization practices are not detailed in the Amendment 017 Application. Final reclamation of TSF-1 would be completed within 2 years after tailings removal ceases.

2.3.6.2 Mineral Hill Pit

Reprocessed tailings in the Pit would initially reach an elevation of approximately 5,191 ft (mine datum) and then eventually settle to an elevation of approximately 5,173 ft (mine datum) after consolidation. The tailings would have an approximate grade of 1 percent to the northeast at the end of the reprocessing period, and the Pit would have a surface area of approximately 50 acres. After tailings disposal in the Pit is complete, 4 ft of capping material (comprising 2 ft of oxidized overburden and limestone and 2 ft of growth media) sourced from the East Pit Borrow site would be placed over the final tailings surface to reduce the net infiltration of precipitation and influx of oxygen into tailings material as well as support the establishment of vegetation. No changes to the use of soil amendments described in the current Operations and Reclamation Plan (GSM 2014) are proposed. GSM may use organic matter and/or fertilizer to condition growth media to support revegetation, as needed.

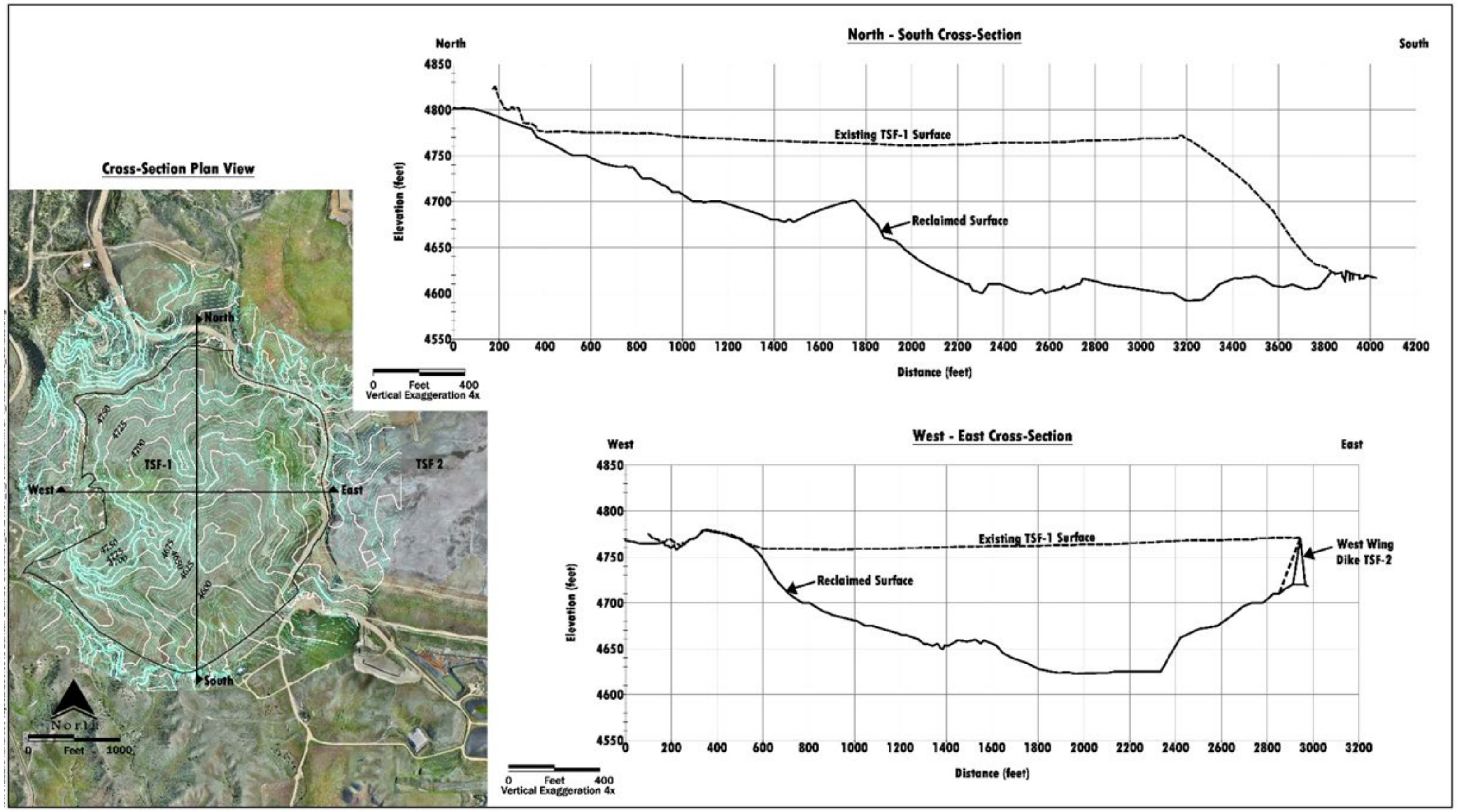


Figure 2.3-5
Final Grading Plan for Tailings Storage Facility 1 (GSM 2021a)

GSM would plug a vertical ventilation raise in the Pit to prevent reprocessed tailings from infiltrating the underlying underground workings and dewatering system. Stope accesses and haul ramps leading to excavations below the Pit floor would be filled with waste rock to prevent tailings from migrating into open stopes. This work would be performed by an underground mine contractor using an underground load, haul, and dump method. Many, but not all, of the stopes near the surface of the open Pit have caved because of blasting and weathering; however, some remain open at depth. The upper one-third of the highwalls in the Pit would remain unchanged and follow the current reclamation plan.

2.4 DEQ's Permit Stipulations

DEQ evaluated the addition of Permit Stipulations to address additional permit approvals that are needed, as well as reclamation timelines following temporary shutdowns and contingencies for operational monitoring. The following stipulations have been developed:

Before conducting any activities described in this amendment, GSM is required to obtain approval from the DEQ Air Quality Bureau for any necessary modifications to the existing Montana Air Quality Permit (MAQP) #1689-08.

GSM shall receive approval from BLM prior to the disturbance of the 1.4 acres of public land within the Pit. Approval would be required before backfilled tailings impact BLM lands at a filled elevation of approximately 5,060 ft. BLM must conduct the appropriate level of environmental review required under the National Environmental Policy Act.

As stated in the Amendment Application, "Once authorization for Amendment 017 is received, GSM will update the Operations and Reclamation Plan (GSM 2014) under Operating Permit No. 00065 and Plan of Operations No. MTM-82855 and will include these changes in that update." To facilitate the agencies' review of the Annual Progress Report (required in Section 82-4-339, MCA) and the annual bond overview (required in Section 82-4-338(3),MCA), the Operations and Reclamation Plan shall be updated to reflect the changes approved for Amendment 017 and submitted to DEQ and BLM no more than 180 days after the amendment authorization.

GSM shall provide as-built drawings for the new facilities that would be constructed as part of Amendment 017. The amendment modifications submitted in February 2021 and April 2021 addressed the relocation of the Re-Pulping Plant and the thickener facilities, respectively. The modification to relocate the thickener and supporting facilities included a figure showing a general location footprint, which was sufficient for the analysis of disturbance and potential environmental impacts. The final facility locations and construction details shall be provided to the agencies within the updated Operations and Reclamation Plan, which shall be submitted no more than 180 days after the amendment authorization.

GSM shall limit the volume of tailings stockpiles and duration of stockpiles located by the Re-Pulping Plant to ensure that stockpiled tailings or exposed TSF-1 tailings do not become a source of contamination during delays or shutdown. As soon as a shutdown or delay longer than 1 year is anticipated, or 1 year has lapsed since active tailings excavation and reprocessing, the proposed reclamation activities should begin. Stockpiled tailings would be removed and placed in lined TSF-2; under such a condition and assuming the Re-Pulping Plant is still mechanically functional, stockpiled tailings would be slurried in the Re-Pulping Plant and moved via the pipeline from the Plant to TSF-2.

GSM shall develop a tailings sampling and analysis program to ensure the quality of the concentrate product to verify that the residual sulfide content of the flotation tailings meets the proposed design criteria (0.5 percent total sulfide) and the thickened tailings received adequate neutralization potential to meet the stated water quality objectives for the process solution pond. Within 180 days after the amendment authorization, GSM will provide DEQ and BLM a description of this operational monitoring program for the composition of residual tailings that would be disposed within the Pit, including sampling frequency, parameters for analysis, and reporting schedule. The monitoring results will be used to optimize the flotation system and the adjustment of lime addition rates at the thickening plant while also demonstrating that the target concentration of 0.5 percent (or less) of total sulfur minus sulfate is being consistently achieved for the residual tailings before disposal. GSM should also develop a response protocol or automated lime injection mechanism that adjusts the pH of the flotation tailings such that excess neutralization potential is established, dependent on its sulfide content.

As recommended in the Amendment Application, GSM shall update the existing Ground Control Management Plan to address the following topics and submit the plan to DEQ and BLM no more than 180 days after the amendment authorization:

- At the Pit, GSM shall revise the Ground Control Management Plan to include measures for protecting in-pit infrastructure (specifically the South Well) from rockfall impacts during and after the TRP.
- GSM shall update its Ground Control Management Plan for the TRP to include specific monitoring at the Flotation Plant, the Rattlesnake Earth Block immediately upslope of TSF-1, and the Pit. If acceleration of the west wall failure is observed, tailings deposition in the Pit should be ceased until a root-cause analysis has been performed and a mitigation plan has been developed.

2.5 DEQ Modified Alternative—Enhanced TSF-1 and Pit Reclamation

2.5.1 Introduction to the Alternative

Proposed alternative reclamation methods of TSF-1 and the Pit were evaluated to reduce environmental impacts. The proposed reclamation design for TSF-1 is described in Section 4.2 of the Amendment 017 Application (GSM 2021a), and the proposed reclamation design for the Pit is described in Section 4.5 of the Amendment 017 Application (GSM 2021a). Additional information regarding these reclamation alternatives are discussed in EIS Appendix C, Technical Memorandum 3—Reclamation Alternatives Evaluation(RESPEC 2021).

Upon reviewing the Proposed Action and preliminary environmental impacts, the final reclamation design of TSF-1 could be improved to reduce visual impacts, diversify vegetation, and enhance wildlife habitat. Although the Proposed Action consists of returning the land to its predisturbance topography, specific reclamation techniques such as controls for maintaining the original topography, grading designs, thickness, or stabilization practices were not provided. Therefore, under this alternative, TSF-1 reclamation would ensure that landforms would be created to increase vegetation and improve wildlife habitat. This alternative includes recommendations for grading configuration, capping material, habitat, vegetation, and seed mixes. The final reclamation design of the Pit could be improved to enhance vegetation diversity; seed mix alternatives were investigated to provide reclamation options for the Pit. The technical feasibility and environmental impacts of this alternative are discussed in the following sections.

2.5.2 Alternative Components Different From the Proposed Action

2.5.2.1 Alternative Micro-Topography and Mosaic Vegetation of TSF-1

The alternative geomorphic design at TSF-1 would create a final grade and mosaic vegetation that is closer in appearance to the original topography regarding drainages, swales, and swells in the reclaimed area. Swell, swale, and drainage density criteria would be measured based on predisturbance imagery and topography for TSF-1 or a suitable undisturbed control area using AutoCAD or similar software; these characteristics would provide measurable criteria for determining reclamation grading success and would not hinder concurrent reclamation. For operators to accurately create these features, a Global Positioning System unit can be used in the equipment to identify the cut or fill required for a given area to meet the reference topography. As under the Proposed Action, concurrent tailings excavation and reclamation would occur under this alternative. This alternative would increase wildlife habitat compared to the Proposed Action, which may grade over these topographical features. Under this alternative, the original topography (or if not available, a suitable undisturbed control area) would be used to calculate drainage footages and numbers of swells and swales for each cut. The elevation, proposed contours, and size of TSF-1 would remain as shown in the Proposed

Action, although, the micro-topography would create sufficient drainage density to restore a stable hydrologic balance and blend TSF-1 into the existing topography.

Best management practices for grading swells and swales with primary and secondary drainages are different than those previously used at GSM. Specifically, the density of drainage, swells, and swales present in the original topography would be maintained to avoid long, even slopes. The density and location of these features would be measured in the predisturbance topography and used to annually confirm that the approximate original contour is restored as concurrent reclamation advances. This alternative would create landforms that are standard industry practices and would not hinder the final grading during the proposed concurrent reclamation. Low-compaction, modified seeding equipment and machinery may or may not be needed to ensure that the designed topography is not impacted during seeding after final grading.

The environmental benefits from this alternative's varying landforms at TSF-1 would create grass, forb, and shrub mosaic vegetation patterns and microclimates that support multiple habitats for vegetation and wildlife. This alternative would include the following benefits:

- Specific plant species would be encouraged and vegetative diversity would be promoted. The variability in sunlight, water infiltration, and topsoil thickness would benefit volunteer and seeded grass, forb, and shrub species within the Proposed Action seed mixture and positively impact wildlife habitat.
- Ensure a drainage density and pattern to form land features with long-term erosion control would be created. Storm water would be conveyed in a nonerosive, natural manner and result in a stable, natural-acting, and generally maintenance-free surface that behaves more like a native surface in high runoff events. Thus, erosion of reclaimed topsoil would be reduced. This is the same goal as the Proposed Action, and would be confirmed though measurable success criteria.
- The visual impact of the TSF-1 reclaimed area would be enhanced. This alternative would be comparable to the original topography and surrounding undisturbed lands after a representative population of vegetation is successfully established.
- Overall reclamation would be more successful and would lead to bond release.

2.5.2.2 Suitability Testing of Capping Material

Under the Proposed Action, mixing between the tailings and the capping materials may occur during salvage, which could degrade the quality of the capping material, reduce its capacity to support plant life after replacement, and hinder establishment of vegetation on the TSF-1 area, particularly shrubs and plants with roots that may extend below the upper 2 ft of growth media. The boundary between the capping material and the tailings may have elevated levels of contamination from decades of vadose zone activity and upward migration of elements to this boundary. The suitability of the capping material would be evaluated to confirm contaminants have not migrated into the capping material and ensure its capacity to support grass, forb, and shrub seeding and plantings on reclaimed areas. The visual impacts of subsuitable capping media could be a noticeable reduction in vegetation and potentially areas devoid of vegetation. The tailings/capping material boundary in the excavation would be tested quarterly during mining advancement to confirm or deny the toxicity of that material and inform potential effects of upward migration and reduce the likelihood of inadvertent mixing of the two. Approximately three to five samples would be collected, representatively spaced along the length of the exposed tailings/capping material boundary at the time of sampling. Adequate material characterization would also be performed on the stockpiled capping material before replacement for reclamation. The suitability testing would ensure that appropriate capping material and growth media would be used for establishing vegetation on reclaimed areas. Suitability criteria would be based on the information provided by GSM's vegetation consultant (Cedar Creek Associates), as provided in EIS Appendix C (RESPEC 2021).

2.5.2.3 Modified Seed Mix of TSF-1

The Proposed Action would continue using the currently approved seed mix that has a heavy component of aggressive rhizomatous grasses for rapid stabilization, which limits shrub establishment and reduces grass and forb diversity. Although the seed mix was modified in 2019 to increase species diversity, data to support the performance of this revised seed mix are not yet available. In the TSF-1 area, this alternative would use at least two seed mixes or modify the current seed mix to significantly increase shrubs and forbs and replace some of the rhizomatous grasses with bunch grasses. The current seed mix detailed in the Operations and Reclamation Plan could be used as one seed mix. A second mix with heavier shrub and forb components as well as a minimal bunch grass component could be planted in drainage and swale areas where a shrub mosaic is preferred. Under this alternative seeding mixes would not be combined, seed mixes would be planted separately on mix-specific areas, and multiple seeders would be used (or a single seeder would need to be cleaned between seeding applications). In addition to the shrub direct seeding and recruitment of seedlings, this alternative would also include using bareroot and container shrub species to establish shrub stands or shrub islands on smaller areas near swells, swales, and drainages to develop manageable plots, site-specific planting procedures, and potential local seed sources. This alternative planting has been attempted previously on rock dumps at the site with low success rates' therefore, the potential success rate is uncertain. Under this alternative, a grazing plan would also be developed to schedule livestock grazing to achieve the Historic Climax Plant Community or Reference State that would improve wildlife habitat of the reclaimed areas. The availability of livestock and wildlife water sources would also be assessed to determine if water developments are needed within the reclaimed areas.

The environmental benefit of this alternative would be enhanced vegetation type and diverse species by reducing competition from aggressive grasses and improving shrub and forb establishment, which improves wildlife habitat and accelerates Historic Climax Plant Community or Reference Site development. The visual impacts of this alternative would blend the disturbed area with the surrounding landforms and mimick nearby native vegetation communities.

2.5.2.4 Modified Seed Mix of the Pit

In the Pit, the Proposed Action uses a grass-heavy seed mix designed for rapid erosion control. This alternative would use a modified seed mix in the Pit area to increase shrub establishment and forb diversity. This alternative would cut the grass Pure Live Seed (PLS)/ft^2 by one-half and replacing some of the rhizomatous grasses with bunch grasses while also significantly increasing the shrub PLS/ft^2. Overseeding the shrub component relative to grasses and forbs would encourage their establishment and would not likely outcompete or hinder the establishment of grasses. Successful establishment of shrubs and improved grass species diversity would increase the vegetation diversity and improve wildlife habitat.

2.6 Alternatives Considered but Dismissed From Detailed Analysis

Under MEPA, a reasonable alternative is practical, achievable under current technology, and economically feasible. Economic feasibility is determined solely by the economic viability for similar projects having similar conditions and physical locations and determined without regard to the economic strength of the specific project sponsor (MEPA Section 75-1-201II, MCA). Pursuant to MEPA Section 75-1-220(1), MCA, an “alternative analysis” under MEPA does not include evaluating an alternative facility or an alternative to the proposed Project itself. Any alternative under consideration must meet the purpose and need of the Proposed Action.

During scoping activities, alternatives to the Proposed Action were suggested and discussed by DEQ agency representatives and GSM as required by MEPA. This section discusses alternatives or alternative components that were considered and eliminated from the detailed study. For each alternative discussed, a synopsis of the changes proposed and a discussion of why the alternative or component was dismissed from further analysis are included.

2.6.1 Alternative Tailings Excavation

Several options were evaluated to determine if alternative modes of tailings excavation are technically feasible and environmentally beneficial. Alternate excavation scenarios that were reviewed included smaller bench heights, excavating in lifts, and hydraulic mining. The Proposed Action does not mention bench design for removing material from TSF-1. A description of tailings excavation as part of the Proposed Action is described in Section 2.3.3.1, Excavation and Hauling.

2.6.1.1 Small Bench Heights

As an alternative, the excavation design would consider smaller bench heights and large working areas to improve safety and excavation stability. Benches would be designed in a way that no risk of instability at the working face is created. The alternative excavation design could slightly reduce the risk associated with erosion issues caused by wind and improve mining safety. Excavating smaller benches would also allow for rapid mining progression, thus allowing the newly exposed tailings time to dry if moisture became an issue (particularly in the presence of clay minerals in the tailings). Impacts caused by this alternative would be similar to the Proposed Action with no significant environmental benefit.

2.6.1.2 Excavating in Lifts

The alternative of excavating in lifts was considered because it would accomplish the same results as the Proposed Action. Excavation of one bench at a time would also allow for rapid mining progression, thus allowing the newly exposed tailings time to dry if moisture becomes an issue. **Figure 2.6-1** shows the proposed excavation sequence. Bench heights of 50 ft were used in this analysis. An optimized sequence of excavation would improve mining safety, reduce or eliminate water ponding, and improve water drainage. This scenario would require an alternative topsoil storage location because the excavation does not reach the existing topography in the first year of operation. A larger surface area would be exposed at any point in time, which increases erosion potential. Excavating in lifts would eliminate the ability to conduct concurrent reclamation as included in the Proposed Action and, hence, would increase the length of time to reclaim TSF-1. This alternative was dismissed because the environmental benefit is less than the Proposed Action.

2.6.1.3 Hydraulic Mining

A mining method using high-pressure water to excavate the material in TSF-1 was evaluated. This method would erode the tailings in sections and wash the material downstream, which would need to be collected in a sump and pumped to the Flotation Plant or the Re-Pulping Plant for solids and water content control. This option is suitable for tailings with low moisture content and with a large amount of fines. This method, however, may present a negative effect on water drainage and collection systems because fine sediments would be transported downstream. This mining method would require a reliable and uninterrupted supply of considerable water. The addition of water into the tailings mass may have negative impact because water could further oxidize the material and aid contaminant migration. The additional water volume would also require collection and treatment. The hydraulic mining method eliminates the work of loading and trucking material as well as needing a stockpile near the Re-Pulping Plant. Dust issues would be reduced. However, this option does have a potentially negative environmental impact and was dismissed from detailed analysis.

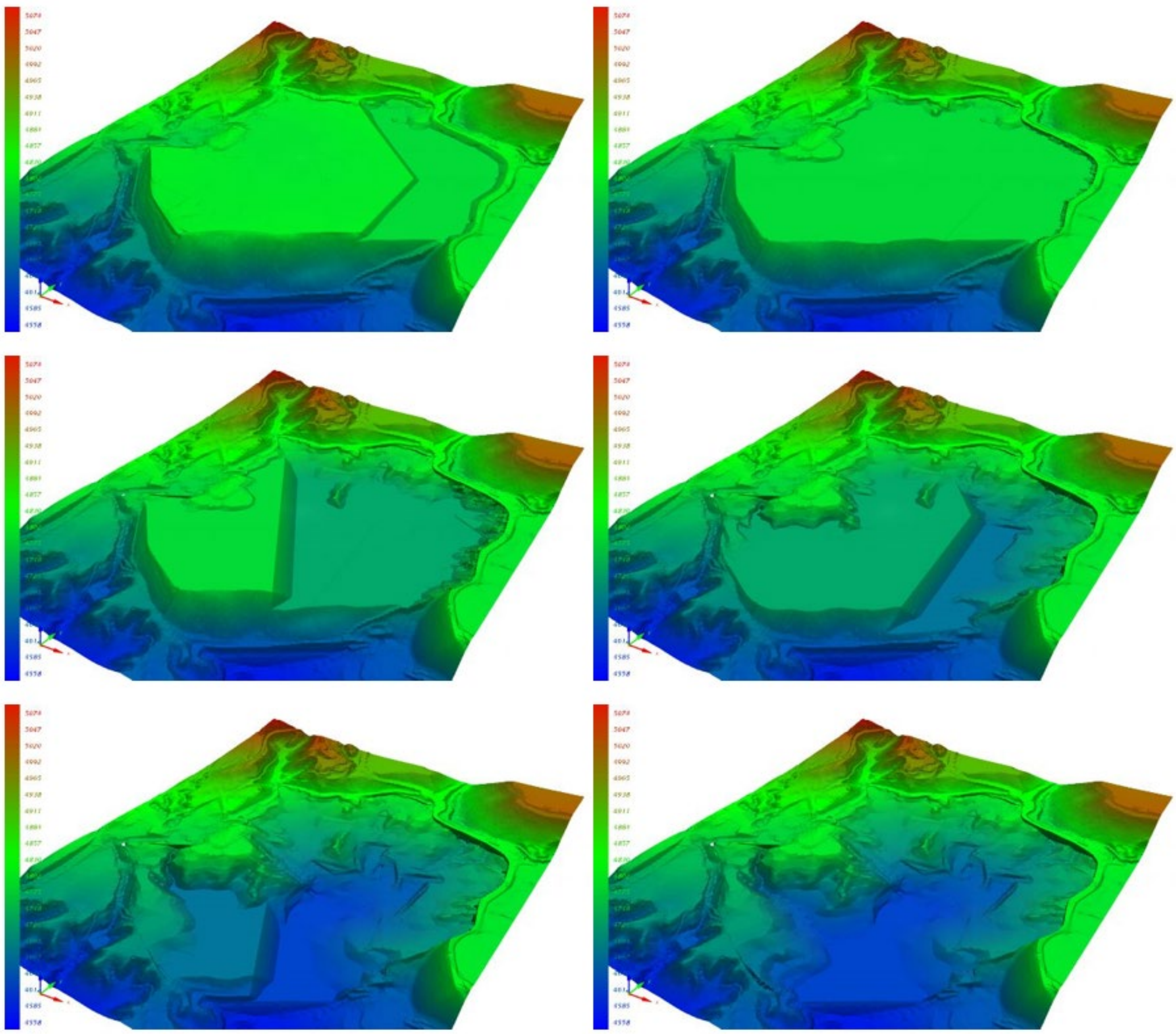


Figure 2.6-1
Excavating in Lifts Mining Sequence

2.6.2 Alternative Tailings Conveyance

A description of tailings conveyance as part of the Proposed Action is described in Section 2.3.3.1, Excavation and Hauling. An analysis of the Proposed Action conveyance was performed to determine if alternative conveyance would reduce impacts of the Project. The alternative of using conveyors to transport the tailings to the Re-Pulping Plant and trucking or conveying tailings directly to the Flotation Plant was considered.

The use of conveyors, as opposed to trucking tailings to the Re-Pulping Plant, would present operational limits and require routinely readjusting the location as well as length and angles of conveyors during the life of the Project. Mining safety would be negatively impacted because of the movable nature of conveyors; many safety accidents are reported each year related to moving, inspecting, maintaining, and adjusting conveyors. Tailings material would also need to be stockpiled near the conveyors and could potentially increase the number and volume of temporary tailings stockpiles. Conveyors would reduce the number of trucks and fuel used on site. However, this scenario was not carried forward for detailed analysis because a notable positive benefit would not be provided.

The option of trucking TSF-1 tailings directly to the Flotation Plant was considered. A Re-Pulping Plant would not need to be constructed and earthwork would not occur at the proposed Re-Pulping Plant site. Compared to the Proposed Action, truck transportation would increase traffic on the site road from the tailings facility to the mill building and increase fuel consumption and gas emissions. Because the road from the Re-Pulping Plant to the mill is approximately 1 mile, hauling tailings directly from TSF-1 to the mill would require over 1,624,400 haul miles compared to approximately 576,400 miles if hauled to the Re-Pulping Plant. This alternative would also increase safety risks versus the Proposed Action. Because the environmental and safety impacts would not have an impact and would not be a change from the Proposed Action, this alternative was dismissed from further analysis.

2.6.3 Replace Re-Pulping Plant With High-Pressure Slurry Ablation Technology

Using a modular high-pressure slurry ablation technology developed by DISA, LLC was reviewed. This technology is used to help liberate and put all of the desirable ore fraction into the size gradation that can be more easily segregated during processing. The process could enhance liberating the sulfides before they enter the circuit, facilitate separation mechanisms, and ultimately reduce the sulfide content within the residual tailings. Ensuring a lower sulfide content in the tailings would minimize longer-term risks of acid generation. The technology could also be used to replace the proposed Re-Pulping Plant because the tailings materials are slurried as a part of the high-pressure slurry ablation process. However, this technology is new and still being tested in pilot projects, and the large percentage of fines could interfere with the Flotation Plant circuit. This technology is not proven to be feasible and, therefore, this scenario was eliminated from detailed analysis.

2.6.4 Dispose Unprocessed Tailings in the Mineral Hill Pit

To address future potential ground water impacts associated with reactive tailings located in the unlined TSF-1 facility, GSM analyzed removing the tailings from the facility and placing the unprocessed tailings directly into the Pit. This scenario would not involve reprocessing the tailings but would still excavate and transport the tailings to the Pit in a method similar to the Proposed Action. This alternative was dismissed from further consideration because it does not meet the purpose and need of the Project, which is to separate marketable commodities from the TSF-1 tailings. Further, redisposing unconsolidated tailings would allow oxygen ingress into the high sulfide tailings where acid-infiltrating contract water is likely to result in further degradation of water quality. Similarly, the supplemental EIS prepared for Amendment 11 (DEQ and BLM 2007) found that placing waste rock in the Pit had unfavorable ground water quality impacts.

2.6.5 Dispose Reprocessed Tailings in an Alternate Location

The Proposed Action would remove TSF-1 as a source of contamination and dispose of reprocessed tailings within the Pit as described in Section 2.3.4, Reprocessed Tailings Disposal. Approximately 23.6 Mt of reprocessed tailings would be placed in the Pit according to the Proposed Action presented in Amendment 017. This section provides an overview of three alternative locations for the final disposal of reprocessed tailings: TSF-1, TSF-2, and Tailings Storage Facility 3 (TSF-3).

2.6.5.1 Dispose Reprocessed Tailings in Tailings Storage Facility 1

GSM presented the alternative of placing reprocessed tailings back into lined cells within the TSF-1 footprint. A sufficiently large area would need to be excavated for placing reprocessed tailings in lined cells; therefore, another location for tailings disposal would be necessary for the first few years of operation until sufficient space in TSF-1 is available for receiving the new reprocessed material. This scenario was dismissed because it is not feasible to create sufficient space in TSF-1 to concurrently recover tailings and dispose of reprocessed tailings. Further, disposing reprocessed tailings back into TSF-1 would delay the reclamation of this area and the environmental benefit would be less than the Proposed Action.

2.6.5.2 Dispose Reprocessed Tailings in Tailings Storage Facility 2

Two designs for placing the reprocessed tailings into the existing TSF-2 were analyzed. The first design would maintain the existing TSF-2 area and require a 75-ft vertical raise for tailings placement; this expanded capacity was approved under Amendment 014. The second design considers expanding the original TSF-2 footprint to the north to minimize the vertical height of the facility to accommodate the new material. In the second option, a 60-ft vertical raise would be required. A layout for both options is presented on **Figures 2.6-2** and **2.6-3**. Embankment rises would be constructed with upstream construction methods, which is less geotechnically stable than downstream dam construction.

For both of these TSF-2 design options, potential risks associated with geotechnical stability, drainage, and soil contamination could increase. Obtaining permits for increasing the capacity of TSF-2 and future planned reclamation activities of TSF-2 would require more time. An elevated TSF-2 would also require additional maintenance work, including new diversion ditches and possibly new water collection wells that could result in a small increase to disturbed acres. This alternative would also present a greater visual impact than the Proposed Action as a result of increases in elevation. Therefore, this alternative was dismissed from consideration.

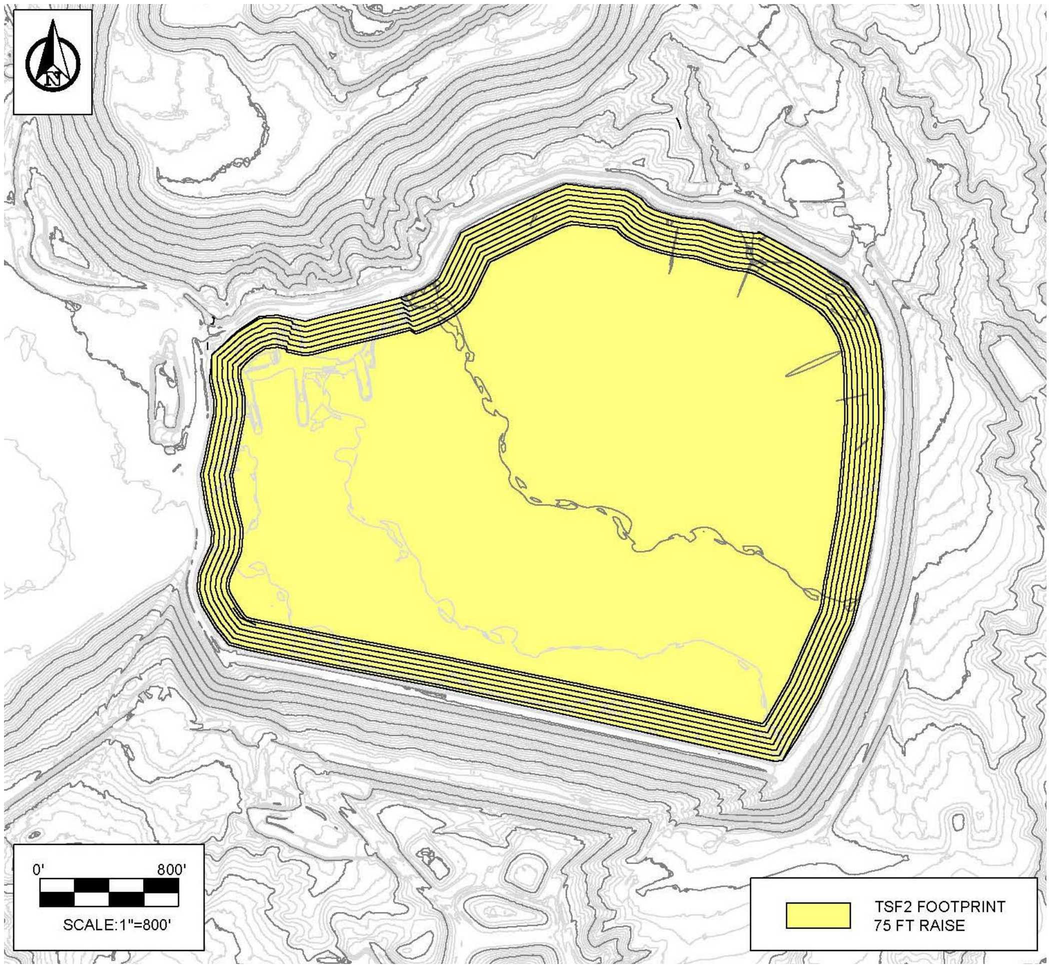


Figure 2.6-2
Tailings Storage Facility 2 Tailings-Disposal Location Using Existing Footprint

2.6.5.3 Dispose Reprocessed Tailings in New Tailings Storage Facility 3

In this scenario, reprocessed tailings would be disposed in a new TSF-3. TSF-3 would be constructed as a state-of-the-art facility with a liner system, stable embankment, and pond system. It is expected that tailings going to TSF-3 would come from reprocessed TSF-1 tailings and currently undeveloped sources of ore. Conceptually, TSF-3 could cover apprixmately 200 acres and contain up to 35 Mt. GSM previously evaluated a variety of locations for TSF-3 to support continued mining and potential tailings reprocessing projects, including a location for TSF-3 that would share an embankment with TSF-2.

Constructing a new tailings storage facility would result in a high likelihood of substantially greater environmental long-term impacts. Aesthetics, land disturbance, drainages, soils, and vegetation would be negatively impacted with a new TSF. If the facility were subaqueous (i.e., containing a pond on top of tailings), the potential for dust and water quality issues during operations and closure is an additional concern. A new facility may further delay the timeline for completing reclamation. Based on this review, an alternative for constructing a new tailings storage facility was dismissed from consideration.

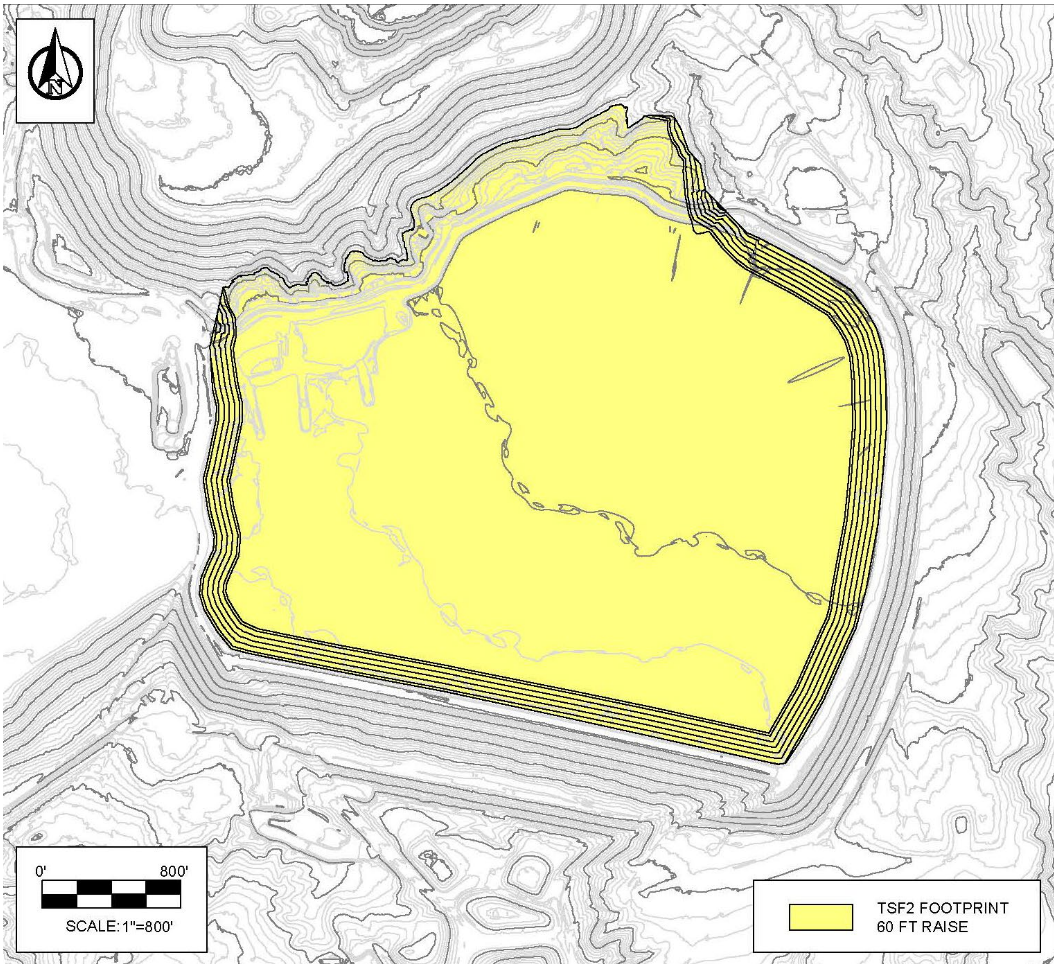


Figure 2.6-3
Tailings Storage Facility 2 Tailings-Disposal Location Using Expanded Footprint

As documented in GSM's Amendment Application, one of the preliminary scenarios that was considered involved adding cement or other materials to solidify reprocessed tailings. GSM assessed the need or benefit of treating or conditioning the reprocessed tailings before (or during) placement in the Pit. The evaluation was based on whether or not solidifying the tailing mass was warranted or if any advantage or benefit could be realized for long-term closure of the Pit related to water quality.

2.6.6 Amend Tailings With Cement

This option was dismissed because adding cement or other agents to solidify the tailings mass would have the net effect of decreasing the infiltration of process solutions into the bedrock (and thus the effectiveness of ground water capture) and would increase the potential for long-term ponding to occur on the tailings surface. Based on current hydrogeologic modeling (i.e., without solidified tailings), no long-term ponding of water or process solutions would occur under the Proposed Action. Interstitial process solutions, over the life of the Project, would either be pumped as reclaim water to the Flotation Plant or infiltrate/evaporate within the Pit. Establishing a vegetative cover would also reduce infiltration into the tailings mass and underlying sump. Depositing a nonsolidified mass provides the benefits of allowing porewater flux into and through the tailings mass, draining the surface of the final landform, and enabling the ability to seed and vegetate the final surface.

The geochemical testing indicated that the tailings materials may have some capacity to attenuate or absorb additional metals and constituents from the acidic ground water in the Pit. The addition of lime during tailings deposition would also contribute to the neutralizing potential of the consolidated tailings. Adding cement or other agents to solidify the tailings would create a solid plug, which would reduce or eliminate the acid-neutralizing potential of the reprocessed tailings; thus, the potential for water quality improvements of ground water captured within the Pit is reduced. Because of high pH levels associated with cement porewater chemistry, this option has the potential to cause accelerated release and mobilize arsenic into solution in the ground water within the Pit.

2.6.7 Amend Tailings With EnviCore

Tailings amendments were evaluated to determine the feasibility for use in the tailings reprocessing Project. An inexpensive, nontoxic reagent has been designed by EnviCore Inc. to treat tailings. The right combination of reagents could have the benefit of increasing tailings strength and compaction and reducing contaminants from process water. The treatment mechanism facilitates mineral binding and ensures sediment fortification on the time scale of days following the treatment, which makes it suitable for fast land reclamation. Because the released water can be quickly recovered and reused, EnviCore's products and services have the benefit of reducing the demand for freshwater sources. The blended reagents and tailings may also sorb or attenuate heavy metals within the discharged mass, and the deposit could have the capacity to continue to attenuate metals over time. Because EnviCore reagents are a newer technology, testing would need to be completed to understand the actual project outcomes, including consolidation rates, strength, hydraulic conductivity, and potential impacts on ground water geochemistry. EnviCore reagents are not anticipated to impact pond water or the flotation circuit because contaminants and impurities bond with the solids in the process. The resulting amended tailings could also increase ponding in the Pit. The potential environmental impacts of EnviCore have not been proven to be technically feasible so it has a low likelihood of occurring; therefore, this scenario was eliminated from detailed analysis.

2.6.8 Amend Tailings With Foam

This scenario would be similar to the Proposed Action with the exception that tailings would be amended with a foam additive. Aerix Industries offers a foam product, ARX-Transport, which could potentially serve two combined or separate purposes. The foam can be added to granular sand and fines materials to facilitate displacement from one location to another via pumping. The second use of the foam is in producing permeable, low-density cellular concrete.

Rather than slurrying tailings at the Re-Pulping Plant, foam would be added in place of water. The foam facilitates laminar flow and does not impact the geochemical characteristics of the materials being moved. The benefits of using the foam include a reduced volume of water and a reduced amount of energy required for pumping to transport the materials (the foam reduces the material density by 25 to 35 percent, which reduces pumping costs). The foam could interfere with the flotation process; therefore, this scenario is not recommended for this transport requirement. This alternative does not meet the purpose and need of the Project and was eliminated from detailed analysis.

For producing permeable, low-density cellular concrete in the Pit, a high-strength, environmentally safe foam and uniquely designed cement and foam mixture would be added to the reprocessed tailings at the point of the thickener discharge. The cured product would allow water to move through the solidified concrete mass while still maintaining strength. The benefits of using the foam include more equal dispersal of homogeneous tailings materials across the Pit floor, more rapid and equal consolidation rates, recovery of water for reuse in the circuit, and a reduced volume of the pond created from pore water released from the thickened tailings. Unlike the option of adding simple cement to the tailings, this scenario would allow ground water flux through the tailings rather than creating an impermeable plug in the base of the Pit. Lime could still be added to the foam product, although neutralization potential benefits would need to be tested and would likely be less than the Proposed Action. This scenario is dismissed primarily because this is a relatively new application of a technology that would require geochemical and material properties testing to determine the exact additive mixture and understand the resulting material properties. Further, the Pit floor would likely require a thicker cap to be placed over the deposit, and local acidic water would gradually degrade the concrete if water elevations increased.

2.6.9 No Growth Media Placement in the Mineral Hill Pit

Approximately 4 ft of capping material (consisting of 2 ft of oxidized overburden and limestone and 2 ft of growth media) would be required to cover the Pit floor in preparation for reclaiming and seeding under the Proposed Action. As documented in GSM's Amendment Application, a preliminary scenario that was considered but dismissed involved not placing growth media on the Pit floor. Under this option, no growth media would be placed on the final Pit floor. Once the tailings surface stabilizes and consolidates sufficiently to support equipment, GSM would place a 2-ft-thick cap of coarse limestone rock. The coarse rock cap would preclude seasonal ponded water from forming, which would be exposed to wildlife, and could temporarily raise the pH of meteoric water that infiltrates into the underlying tailings.

Without the capping material, seeding and revegetation would not occur and the Pit floor would not be converted to wildlife habitat. Reducing available habitat does not align with reducing environmental impacts. Under the Proposed Action, placing growth media on the stabilized tailings surface would create a vegetative cover that would limit infiltration of meteoric water as a consequence of evapotranspiration and would promote more wildlife use of the Pit beyond the approved closure plan, which supports raptor and bat habitat. This alternative was dismissed from consideration.

2.6.10 Pit Perimeter Rockfall Catch Ditch

A proposed alternative to the Proposed Action grading of the Pit would be to include a perimeter ditch around the edge of the backfilled tailings within the Pit bottom. The primary purpose of the perimeter ditch would be to collect rocks from rockfalls and raveling as well as fine materials transported down the Pit walls.

The biggest concern for the geotechnical stability of the Pit is in the southwest corner; however, a geotechnical analysis (Subterra 2020a) indicates global slope stability after the Pit is backfilled with tailings, so only smaller rockfall events would likely occur in the future. Regardless of the final perimeter ditch design and location of the rockfall, the perimeter ditch may not contain all of the potential falling rocks; large boulders or debris flows could still be transported onto the reclaimed Pit surface. It is difficult to define how much rock fall onto the reclaimed Pit floor is too much or too large and whether or not boulders pose a risk to degrade the quality of the reclaimed surface.

Data presented in the Amendment Application indicate that the reclaimed and revegetated surface is not expected to result in ponded water; therefore, the ditch is not needed to aid in drainage. This alternative would not significantly impact ground water quality because all water would likely still sufficiently mix within and around the Pit before dewatering pumping.

Although this alternative is technically feasible following tailings consolidation, creating a Pit perimeter ditch is dismissed from detailed analysis because it would not provide sufficient environmental benefit to justify increasing the site reclamation time, fuel usage, and additional mining or purchase of nonreactive rock to create the ditch.

2.6.11 Improved Habitat Creation in the Mineral Hill Pit

Under this alternative, habitat in the Pit would be improved by placing features such as boulders, mosaic rock features with overhangs and shelters, and mature dead trees. These and other habitat features would provide shelter from predators, wind, and rain and facilitate animal borrows, hollows, and other areas for habitation in and around them. Placing these features close together would allow for increased sheltered movement of prey animals and would increase the diversity of small mammals and reptiles that could use the reclaimed Pit as long-term suitable habitat. Habitat features increase hibernation and hibernacula sites. Dead-tree litter provides a long-term source of soil nutrients and would create micro-variation in sunlight, snow capture, and drainage to increase the diversity of available sites for establishing vegetation. Intentionally placing rock and boulder features comprising limestone or other nonacid-generating material is recommended. Habitat features would be placed after seeding on the reclaimed surface by low-compaction equipment. In comparison, under the Proposed Action, highwall raveling and loose materials in the Pit would already provide some habitat for small spieces, and the vegetated Pit floor would still serve as grass habitat. Because the Pit has limited egress that signifcantly limits the number and type of wildlife that might take advantage of created habitat features, environmental benefits of this option are likely minimal and limited. This alternative was dismissed from further consideration.

2.6.12 Variable Water Management Near Tailings Storage Facility 1

The Proposed Action includes continuing currently approved ground water management at TSF-1 and includes the continued operation of the Rattlesnake Interception wells at an average of 38 gpm. As part of this alternative, the Rattlesnake wells would be discontinued after TSF-1 reprocessing and removal is completed. The upgradient ground water would be allowed to flow under the former TSF-1 footprint rather than being captured, which could flush out poor water quality currently being captured by the wells and remaining contaminants from tailings. However, water from the Rattlesnake wells is poor and may indicate premining or natural acid-rock drainage. Therefore, additional water could potentially flush contaminants under TSF-1 and toward the downgradient pumpback wells thus causing a spike in contaminant concentration. Further, the Rattlensnake wells were constructed to eliminate flow to the surface in the original Buttress Dump footprint as well as in the northern portion of TSF-1; this action could therefore destablize the Buttress Dump. This alternative was dismissed from consideration.

2.6.13 Alternate Water Source

During scoping activities, a concern was expressed about the quantity and source of fresh water used under the Proposed Action. In 2020, the mine used approximately 24 gpm of fresh water compared to a maximum of 400 gpm (0.89 cubic feet per second) of fresh water that would be needed for 12 years under the Proposed Action (Pfister 2021). GSM holds numerous water rights, including their water right (WR No. 41G 95773 00) to use 5 cubic feet per second or approximately 2,244 gpm from the Jefferson River for use at the mine site. Upon a review of the site water balances under the No Action and Proposed Action alternatives, previously discussed in Section 2.2.6.1, Site Water Balance and Section 2.3.5.1, Site Water Balance, potential alternate water sources could include (1) the Pit sump, (2) the TSF-1 area pumpback and interception wells, and (3) sooner access to the temporary pond that may form on tailings during operations.

Under both the No Action Alternative and Proposed Action, the Pit Sump Well is pumped at an average of 57 gpm and water is sent to lined TSF-2 where it is reduced in volume by evaporation. As reprocessed tailings are backfilled into the Pit, the sump may be pumped up to a maximum of 130 gpm. Under both the No Action and Proposed Action Alternative, approximately 38.1 gpm of water is pumped from the Rattlesnake Wells and a combined 47.8 gpm of water is pumped from the TSF-1 pumpback wells; under both alternatives, this water is sent to TSF-2. The combined amount of water available from the pit sump and TSF-1 area wells ranges from 142.9 to 215.9 gpm; therefore, approximately 184.1 to 257.1 gpm (0.41 to 0.57 cubic feet per second) of fresh water from the Jefferson River would still be necessary to meet the needs of the Proposed Action. Analysis of the Proposed Action water balance is provided in Section 3.4, Surface Water Resources. Considering the water quality of the other potential water sources, it is unclear whether or not this alternative would impair recovery in the Flotation Plant. Therefore, the technical feasibility of this alternative is unknown and the environmental benefit of this scenario is not significant enough to warrant detailed analysis.

The other suggested alternative involved providing access to any water that may pond in the Pit during the first 3 years of disposal. Options include modifying the ramp to allow safe access sooner or an alternative that would not entail needing the ramp to access water. Hoses and lines could provide access to this water in the event that water rapidly ponds in the Pit. However, ponded water could take a period of time to develop over the tailings and would not be immediately available for reuse. Further, the pond water would also eventually percolate through the tailings and report to the Pit sump and be recovered as part of Pit dewatering; therefore using ponded water in the early years would not necessarily result in additional available water in comparison to water from the sump.

2.7 Preferred Alternative

Administrative Rules of Montana 17.4.617(9) requires an agency to state a preferred alternative in the EIS, if one has been identified, and to provide reasons for the preference. DEQ has identified the Micro-Topography of TSF-1 Alternative, the Suitability of TSF-1 Capping Material Alternative, and the developed permit stipulations as the Preferred Alternative.

The Proposed Action consists of returning the land to its predisturbance topography, but specific grading techniques are not detailed. Without specifying success criteria and grading methodology, the resultant final grade may fill in drainages and eliminate swell/swale features to produce a more regular and smooth grading. Where infilling of micro-topography occurs, common erosion-control features employed elsewhere at GSM may then be required to stabilize the reclaimed surfaces. Upon reviewing the Proposed Action, the final reclamation methods and design of TSF-1 could be improved to reduce visual and environmental impacts and increase vegetation diversity and wildlife habitat.

Under the Preferred Alternative, TSF-1 reclamation would be modified to ensure that landform variation is created that would support an increase in vegetation type and thereby improve the quantity and quality of wildlife habitat. The density and location of small topographic changes of the native ground surface would be measured in the predisturbance imagery and topography, then used as criteria to confirm that the approximate original contour is restored as concurrent reclamation advances. The environmental benefits from varying landforms at TSF-1 would create a mosaic of grass, forb, and shrub vegetation patterns and microclimates that support multiple habitats for vegetation and wildlife. The microenvironments would encourage the growth of specific plant species and promote greater biodiversity within the Proposed Action seed mixtures. Vegetation diversity would be enhanced by the variations in sunlight, water infiltration, and topsoil thickness that would provide favorable sites for volunteer and seeded species. In addition to varied species of grasses and forbs, shrubs, which require more water, would be more likely to grow and thrive within swales and drainages. Vegetation diversity would positively impact wildlife diversity.

The modified seed mixes for TSF-1 and Pit Alternatives which were analyzed are not included in the Preferred Alternative (see Section 2.5.2.3, Modified Seed Mix of TSF-1 and Section 2.5.2.4, Modified Seed Mix of the Pit). The Proposed Action includes a modified seed mix that was developed by GSM and a vegetation consultant in 2019 (Minor Revision 19-002) based on decades of past species performance on revegetation at the mine. As noted in Minor Revision 19-002, one of the main goals of the vegetation communities is to reduce or eliminate infiltration into potentially reactive or contaminated materials beneath the reclaimed surface. This goal entails employing vegetation that use as much water as possible, for as much of the year as possible, while still being a sustainable community during drought times. The root system of the vegetation must also be relatively shallow in order to minimize intrusion in the potentially unfavorable material below the upper growth media. The most desirable vegetation species have high water use efficiencies, which is defined as the ratio of biomass produced compared to the amount water consumed. The seed mix modifications from 2019 include particular species and varieties of grasses, forbs, and shrubs that are well-suited to achieve the revegetation goals. With only one growing season to evaluate the performance of areas that received this revised seed mix, the comparable environmental benefits of further modifying the seed mixes for TSF-1 and the Pit through the Agency Modified Alternative are not clear.

Successful tree and shrub establishment on the GSM site has been challenging, particularly for historic test plots for bareroot and container trees and shrubs. Additional studies conducted in 2017 and 2018 indicated that initial plant survival appeared good; however, the following winter survival was poor for all species. This challenge is partially caused by competing aggressive grasses, forbs, and invasive species; smooth and level reclaimed slopes; and depth of growth media. GSM's vegetation consultant (Cedar Creek Associates, Inc.) has found that establishing shrubs on reclamation in Montana, Wyoming, and Colorado requires exclusion or limited inclusion of grasses and alfalfa in the seed mixes. However, shrub establishment is usually slow and the reclamation is subject to erosion issues and noxious weed invasion until the shrub get established which can often take 10 years or more. GSM's vegetation consultant stated that with erosion and evapotranspiration as the paramount goals in reclamation at GSM, quick grass and forb establishment to reduce surface material movement take immediate precedent to shrub establishment. One of the goals for the 2019 seed mix modification was to establish a scattering of big sagebrush that would eventually become an important part of the composition of the revegetation as the alfalfa and tall grasses slowly reduce in coverage (over 20+ years). This aligns with GSM's observation of increasing recruitment of shrub species on locations with older reclamation. As stated above, a mosaic of vegetation types would be supported by controlling the micro-topography of the reclaimed surface during grading, but further modifications to the seed mix are not included in the Preferred Alternative.

The Proposed Action would involve removing the 4 ft of cover material at TSF-1, which would be separated into two piles (growth media and underlying capping material). The upper growth media has proven to support vegetation, but some unintentional mixing between the tailings and the intermediate capping material may occur during salvage operations. The boundary between the capping material and the tailings may also have elevated levels of contamination from decades of vadose zone activity and upward migration of elements to this boundary. In either scenario, there may be potential to degrade the quality of the capping material and reduce its capacity to support plant life after replacement, particularly for shrubs and plants with roots that may extend below the upper 2 ft of growth media.

Under the Suitability of TSF-1 Capping Material Alternative, the intermediate capping material would be evaluated to ensure its future capacity to support grasses, forbs, and shrubs on the reclaimed TSF-1 area. The tailings/capping material boundary would be tested during mining advancement to confirm or deny the toxicity of that material and identify potential effects of upward contaminant migration and reduce the likelihood of inadvertent mixing of the two. Adequate material characterization would also be performed on the stockpiled capping material before replacement for reclamation. Unsuitable and poor-quality material would hinder the successful establishment of vegetation on the TSF-1 reclamation area; as a result, the quality of wildlife habitat would be reduced. The visual impacts of inferior capping and/or growth media would be a noticeable reduction in vegetation cover and potentially areas devoid of vegetation. The suitability criteria for the capping material would align with the existing sampling guidance provided by GSM’s vegetation consultant.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 INTRODUCTION

This chapter describes the affected environment and potential impacts of the No Action Alternative, Proposed Action, and the Agency Modified Alternative. The affected environment is the portion of the existing natural and human environment that could be impacted and serves to describe the baseline condition of the site. Environmental consequences are also referred to as potential impacts.

The analysis of environmental consequences is based on a thorough review of relevant scientific information, an evaluation of proposed and industry practices, and results from on-site surveys and studies. Each resource area discussion includes information on the data reviewed, how each data source was collected, and the geographic limits of the review. Most resources are described for the area in and around the Golden Sunlight Mine permit boundary, but some may cover larger areas relevant to the potential for impacts. With several narrow exceptions, an environmental review conducted under Montana Environmental Policy Act (MEPA) “may not include a review of actual or potential impacts beyond Montana borders. The environmental review may not include actual or potential impacts that are regional, national, or global in nature” (§ 75-1-201(2)(a), Montana Code Annotated [MCA]). The resource topics that could be subject to potential impacts are discussed in this chapter and include the following:

- Geology and Geotechnical
- Ground Water Hydrology and Geochemistry
- Surface Water Resources
- Soils and Reclamation
- Vegetation
- Wildlife
- Land Use and Recreation
- Visual Resources
- Socioeconomics
- Noise.

3.1.1 Location Description and Study Area

The Golden Sunlight Mine is an open-pit and underground gold mine located in southern Jefferson County, Montana, and is located 5 miles northeast of Whitehall, Montana (**Figure 1.3-1**). The permitted disturbance boundary of the Golden Sunlight Mine currently covers 3,399 acres in a total mine permit area of 6,205 acres, and the Proposed Action would not increase the size of the mine permit boundary or the currently approved disturbance boundary. The Study Area includes all lands and resources in the Golden Sunlight Mine boundary as well as additional areas identified in each resource-specific analysis area as defined with its respective subsection in this chapter.

The Golden Sunlight Mine is located in the Middle Jefferson River Watershed situated between the Whitetail Creek and Boulder River watersheds and the Jefferson River to the south. Elevations in and around Golden Sunlight Mine range from approximately 4,300 feet (ft) to 6,505 ft above mean sea level (amsl). Daily precipitation data are available from the Butte Airport weather station, which is located approximately 24 miles west of the Golden Sunlight Mine at an elevation of 5,550 ft. For the period 1981–2010, annual precipitation averaged 12.77 inches at the Butte Airport (Station 241318) weather station (Western Regional Climate Center 2021). Precipitation is greatest in May and June and least during December through February. The Golden Sunlight Mine Study Area is located in a semiarid climate with 13 inches of annual precipitation; the winters are cold and the summers are warm (GSM 2021a). A Bureau of Land Management (BLM) climate station in Whitehall (2001–2016 period of record) recorded an average of 11.6 inches of precipitation, 40 inches of estimated potential evaporation (Penman), an average temperature of 46.2 degrees Fahrenheit (°F), an average wind speed of 6.5 miles per hour from the southwest, and average relative humidity of 54 percent (GSM 2021a).

3.1.2 Impact Assessment Methodology

The Project team used information and data from desktop analysis, field surveys, and professional judgment to identify potential environmental consequences of the Project for each resource area. The Project and alternatives were then evaluated to assess their potential impacts on resources.

The environmental consequences sections that follow describe potential impacts from the Project or alternatives during construction, operation, and reclamation and closure phases. These potential impacts may be beneficial or adverse. Furthermore, potential impacts may be direct or secondary. Direct impacts are those that occur at the same time and place as the action that triggers the impact. Secondary impacts are further impacts to the human environment that may be stimulated or induced by, or otherwise result from, a direct impact of the action. Residual impacts are those that are not eliminated by mitigation.

The level of assessment is generally proportionate to its potential impacts. Potential impacts were characterized in terms of impact duration, severity, and likelihood. Where impacts would occur, the duration is quantified as follows:

- Short term: Impacts that would not last longer than the life of the project, including final reclamation; and
- Long term: Impacts that would remain or occur following project completion.

The severity of the impact is a function of its geographic extent, magnitude, duration, reversibility, as well as if the impact surpasses an environmental threshold such as a water quality or air quality standard. The severity of the impacts is evaluated using the following categories:

- No impact—No change from the current conditions;
- Negligible—An adverse or beneficial effect would occur but would be at the lowest levels of detection;
- Minor—The effect would be noticeable but would be relatively small and would not affect the function or integrity of the resource; and
- Moderate—The effect would be easily identifiable and would influence the function or integrity of the resource.

The likelihood of a potential impact occurring comprises the following categories:

- Low likelihood—Rare (e.g., few or no occurrences in the hard-rock mining industry);
- Medium likelihood—Uncommon (e.g., documented occurrences in the hard-rock mining industry); and
- High likelihood—Common (e.g., occurs within the hard-rock mining industry).

3.2 Geology and Geotechnical Engineering

Geology provides the framework for this environmental assessment and influences the geochemistry of TSF-1 tailings and contributions of constituents to water quality. This section also reviews the ground stability on the Earth Blocks and in the TSF-1 and Pit areas.

3.2.1 Analysis Methods

The analysis area for geology includes the TSF-1 area (including current tailings geochemistry) and the Pit. The analysis area for geotechnical engineering includes the TSF-1 area (shared embankment separating TSF-1 and TSF-2 and the Re-Pulping Plant site), the Pit (west highwall and underground crown pillars), and Earth Blocks upgradient from TSF-1. Information for the geology analysis and geotechnical engineering issues was obtained from the Amendment Application (GSM 2021a) and Appendices B, D, E, and G of the referenced document as well as past permit amendments.

Slope stability in the TSF-1 area was evaluated by NewFields, and the stability of the Earth Blocks was evaluated by Subterra LLC (Subterra). Pit slope and underground stability evaluations were performed by Subterra and Barrick, respectively. These stability assessments are reviewed and evaluated as described in EIS Appendix B, Technical Memorandum 2—Ground-Movement Model Assessment.

NewFields (2020) performed a stability analysis of the shared dike between TSF-1 and TSF-2. A geotechnical assessment for the proposed Re-Pulping Plant site was also conducted by NewFields (2021); the assessment included reviewing foundation and fill materials and recommending suitable materials for use in constructing the fill pad. MCA requirements related to tailings storage facilities, and their applicability to this project are discussed in Section 1.7, Issues of Concern—Tailings Storage Facilities.

Four relevant geotechnical studies for the Pit (included as Appendix G to the Amendment Application) were performed; three of the studies were performed by GSM personnel (Barrick 2020a) (Barrick 2020b) (Barrick 2020c) and one was performed by Subterra (2020a). Two of the three GSM studies (Barrick 2020a) (Barrick 2020b) focused on tailings consolidation and draindown parameters during the Proposed Action. These parameters would influence surface and subsurface ground stability in the Pit and were used by Barrick (2020c) and Subterra (2020a) in their stability analyses.

Subterra (2020a) reconstructed the sequencing of the West Wall slope failure from slope-monitoring data. Based on the reconstructed sequence of events, a series of three-dimensional (3D) finite element models of the slide were built to calibrate the model to known behavior and predict the slide's behavior at various stages of tailings backfilling. GSM commissioned an internal study (Barrick 2020c) to evaluate the stability of underground workings under excess loads and pore pressures caused by the deposition of reprocessed tailings in the Pit and determine whether or not stope collapses pose a risk to the dewatering system. Barrick's (2020c) study included empirical, kinematic, and finite element modeling analyses of the stopes during the Tailing Reprocessing Project (TRP) and 8 and 16 years after backfilling was completed.

Movement of Earth Blocks that are upgradient (north) of TSF-1 has been measured in the past and continues to be monitored. To assess the ground stability of Earth Blocks upgradient from TSF-1 during and after the Proposed Action, Subterra (2020b) built and ran a 3D finite element, slope-stability model that included eight "stages" in which a sequence of events and measured movements were simulated. The model was calibrated using ground-movement measurements between 1993 and 2014 and the final stage was used to predict the likelihood of ground movement after removing the TSF-1 tailings.

3.2.2 Affected Environment

The site geology and geotechnical stability have been described in several publications and maps and are summarized in GSM's Amendment Application (GSM 2021a), previous applications, and MEPA documents. The 1997 Draft EIS included a detailed discussion on the regional and local geology of the mine site as well as the geotechnical aspects of Earth Block movement. The following subsections summarize this information.

3.2.2.1 Geology

GSM is located on the southern flank of the Bull Mountains. **Figure 3.2-1** illustrates a general map of the surficial geology in the vicinity of the mine. Bull Mountain consists of meta-sedimentary rocks that are part of the Precambrian Belt Supergroup (also referred to as the LaHood, Greyson, and Newland formations) and the Bull Mountain Shale (DEQ and BLM 2007). During the Laramide Orogeny (75 to 85 million years ago), rocks in the vicinity of the mine became compressed, folded, and faulted and were intruded and overlain by Tertiary igneous materials.

GSM is located in a breccia-hosted gold deposit with Tertiary breccias (consisting of hydrothermally altered latite and Proterozoic wallrock clasts) hosted by Proterozoic sedimentary rocks. The breccias are part of the Tertiary volcanic system common in upland areas of the southern Bull Mountains. Pyrite is abundant throughout the breccia and, in some cases, matrix-forming. Phyllic (quartz-sericite-pyrite) and argillic alteration have removed most primary breccia silicates, and the rocks have very little remaining alkalinity (although some younger vicinity host rocks have carbonates). Natural (i.e., premining) acid-rock drainage (ARD) is common at the site, and mining disturbance is likely to amplify acidity and metals loading.

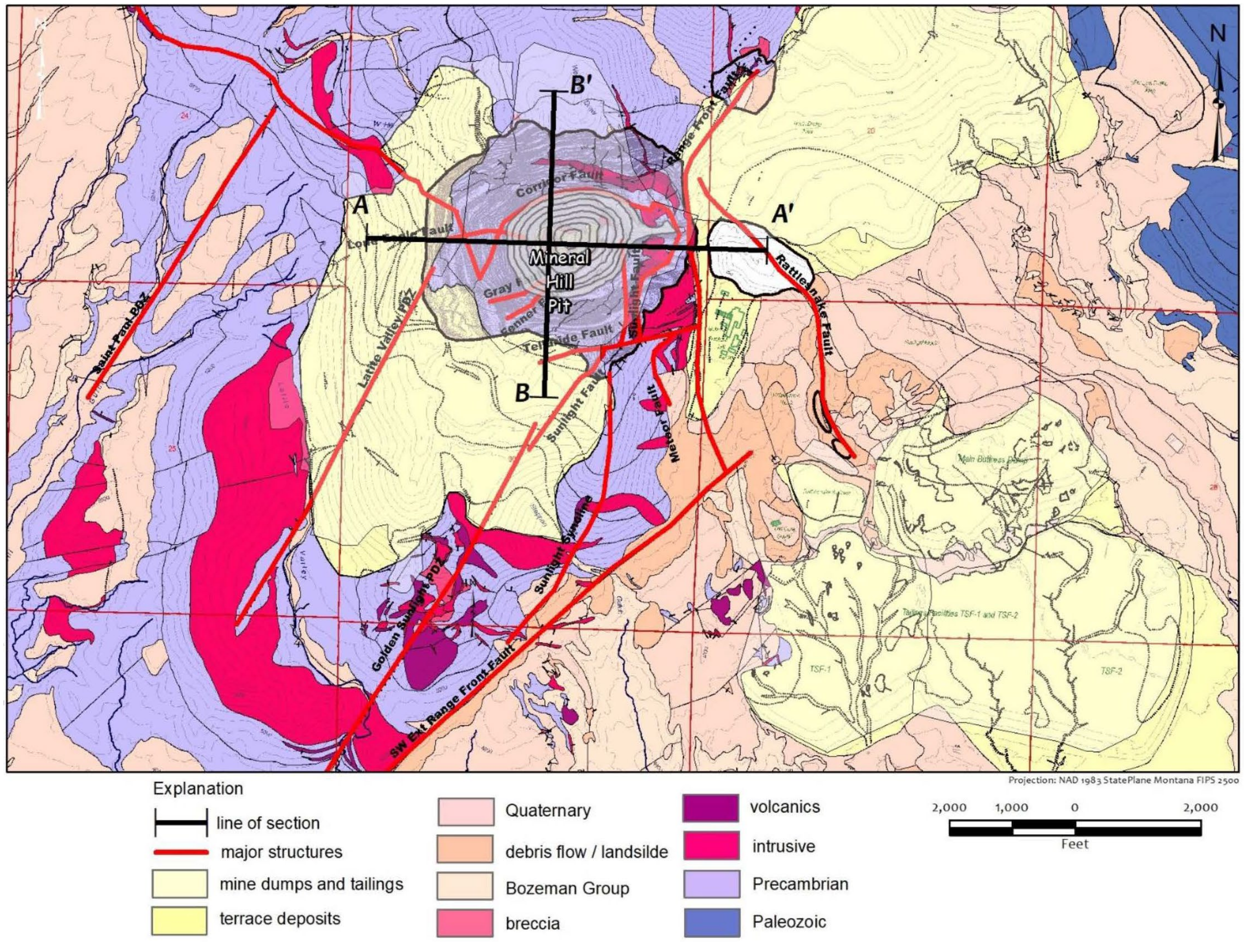


Figure 3.2-1
Golden Sunlight Mine and Vicinity Geologic Map (JSAI 2020)

The ore body at the Pit is a breccia pipe intruded into late-Precambrian Belt Supergroup host rocks in the southern Bull Mountains (**Figure 3.2-1**). The mineralized breccia pipe is generally bounded by faults on the east and west in the host rock. The breccia pipe is mineralized and contains gold-bearing sulfide deposits. The surrounding host rock has been hydrothermally altered and includes pyritic sulfide zones and gold-quartz veins.

The TSF-1 area is underlain by Tertiary Bozeman Group sediments. These rocks and sediments are up to 1,650 ft thick and consist of clays, sandstone, conglomerate, shale, and limestone (Hanneman 1989). In the vicinity of the mine, the fluvial and alluvial components of the Bozeman Group fill a network of buried channels with higher-permeability materials that form pathways for ground water flow.

Downgradient and south of TSF-1, Quaternary-age alluvial deposits of the Jefferson River Alluvium underlie the floodplain of the Jefferson Slough. Tertiary debris flow/landslide materials exist in the vicinity of the mine. The materials are present as fill within ancestral drainage originating in the Pit area, continuing southward underneath the Rattlesnake drainage to TSF-1 and south toward the Jefferson Slough. Similar debris flow deposits also fill a channel underneath the existing Sheep Rock drainage at the northeast end of the mine permit area.

3.2.2.2 Tailings Storage Facility 1 Tailings Geochemistry

TSF-1 contains approximately 26.2 million tons (Mt) of tailings and is unlined and constructed on compact natural clay; TSF-1 was capped and reclamation was finalized in 2001. The tailings in TSF-1 comprise finely ground rock, including the host sedimentary and volcanic units and ore minerals. Based on X-Ray Diffraction analysis, primary minerals within the tailings include potassium (K)-feldspar, quartz, and plagioclase, with lesser amounts (1 to 10 percent) of pyrite (iron sulfide), illite/muscovite, barite, gypsum, and dolomite (Gallagher 2021). While much of the gold was removed by leaching, residual gold associated with sulfide often remains and predominantly resides in the finer particle-size fractions. The tailings have an average 15 weight percent moisture content; a dry density of approximately 93.6 pounds per cubic foot; and are consolidated in a drained-down, steady-state condition.

Tailings from TSF-1 were sampled from 1990 through 2019 and included compiling a bulk sample for metallurgical testing through an extensive drilling campaign in 2018. Tests have included total metals, X-Ray Diffraction, Meteoric Water Mobility Procedure tests, acid-base accounting, paste pH, humidity cell tests, and leach environmental assessment framework tests. The geochemical characterization program and closure evaluations used to support the Proposed Action are summarized in Appendices B and F of the Amendment Application, respectively (Schafer Limited LLC 2020a) (Schafer Limited LLC 2020b) and further discussed in EIS Appendix A, Technical Memorandum 1—Hydrologic and Geochemical Model Assessment.

Tailings have an average sulfide concentration of 4.0 to 4.5 percent. The tailings have the potential to become acidic when oxidized, as is demonstrated by surficial tailings (less than 6-ft depth) exhibiting acidity in TSF-1. Below 6 ft, the tailings are unoxidized and nonacidic with pH varying between 5 to 8.5 standard units, which indicates that the capping material and vegetation are having the benefit of precluding infiltration of water and oxygen and further widespread oxidation of sulfides.

Given the relatively low carbonate and aluminosilicate-based acid neutralization capacity, tailings currently stored in TSF-1 have considerable ARD potential. Leach tests conducted on TSF-1 tailings indicate that acidification of tailings would result in acidic water as well as mobilizing multiple constituents, including sulfate, iron, manganese, arsenic, cadmium, copper, and nickel.

The pore water in the TSF-1 tailings has moderate total dissolved solids of approximately 2,400 milligrams per liter [mg/L]) and sulfate of 1,300 to 1,400 mg/L (Schafer Limited LLC 2020a). Cyanide and nitrate levels in interstitial fluids are low because of the age of the tailings, which have resulted in levels degrading over time. Ground water quality downgradient of TSF-1 is described in Section 3.3, Ground Water Hydrology and Geochemistry.

3.2.2.3 Geotechnical

TSF-1 Area

TSF-1 has a relatively flat surface and covers a total area of about 190 acres, including embankments, and contains approximately 26.2 Mt of tailings. Reclamation at TSF-1 was finalized in 2001 with revegetation. TSF-1 is located immediately west of and shares a berm with TSF-2. TSF-2 is lined, covers 326 acres, and has a capacity of 50.2 Mt of tailings storage. The status of TSF-1 reclamation and water management is described in Section 2.2, No Action Alternative: Existing Permit.

The shared embankment between TSF-1 and TSF-2, also known as the West Wing Dike, is an engineered embankment. The material for the shared berm was characterized by NewFields (2020) as “compacted fill similar to the material used in the TSF-2 embankment construction” that comprises “alluvium/colluvium sourced from on-site borrow areas.” The method used to construct the West Wing Dike is uncertain but is most likely to have been either centerline or upstream. Downstream embankment construction methods are not likely to have been used because of their increased cost and footprint.

Mineral Hill Pit

A large, complex, wedge-type slope failure began developing in the Pit in early 2011 (Subterra 2020a). The 2011 slide mass was located on the west highwall of the Pit and was bracketed by faults on either side (the Fenner and Gray faults). The slide began when mining had reached the 5,400-ft elevation. Step-outs and buttresses were used to control the progression of the failure. The failure continued to progress up until September 2012 as mining reached the 4,875-ft elevation. By that time, tension cracks behind the Pit crest (and through some waste rock) had developed and dilation of another fault (the Lone Eagle Fault) indicated that the slope had become globally unstable. Mining continued to advance using step-outs and buttressing to limit ground movement. Because of the heavy deterioration of the west highwall and rockfall concerns, surface mining in the Pit ceased in April 2015 with the bottom of the pit at the 4,525-ft elevation. The west highwall failure is controlled by unfavorable fault orientations.

An annotated photograph of the West Wall slope failure in the Pit is shown on **Figure 3.2-2**. The West Shear Fault that forms the primary sliding plane at depth is hidden from view because it nearly parallels the orientation of the west highwall. Slope deformation slowed after mining reached more competent materials below the failure and again after surface mining ended.

When underground mining began in May 2015 (1 month after surface mining ended), the failure reaccelerated, and the most rapid accelerations were directly correlated to underground blasts. When underground mining ceased in 2019, ground-movement rates again began to slow. As of early 2020, total deformations in some areas of the failure were as much as 75 ft. In March 2020, the central portion of the West Wall slope failure was moving at a rate of 0.0151 inch per day (Subterra 2020a).

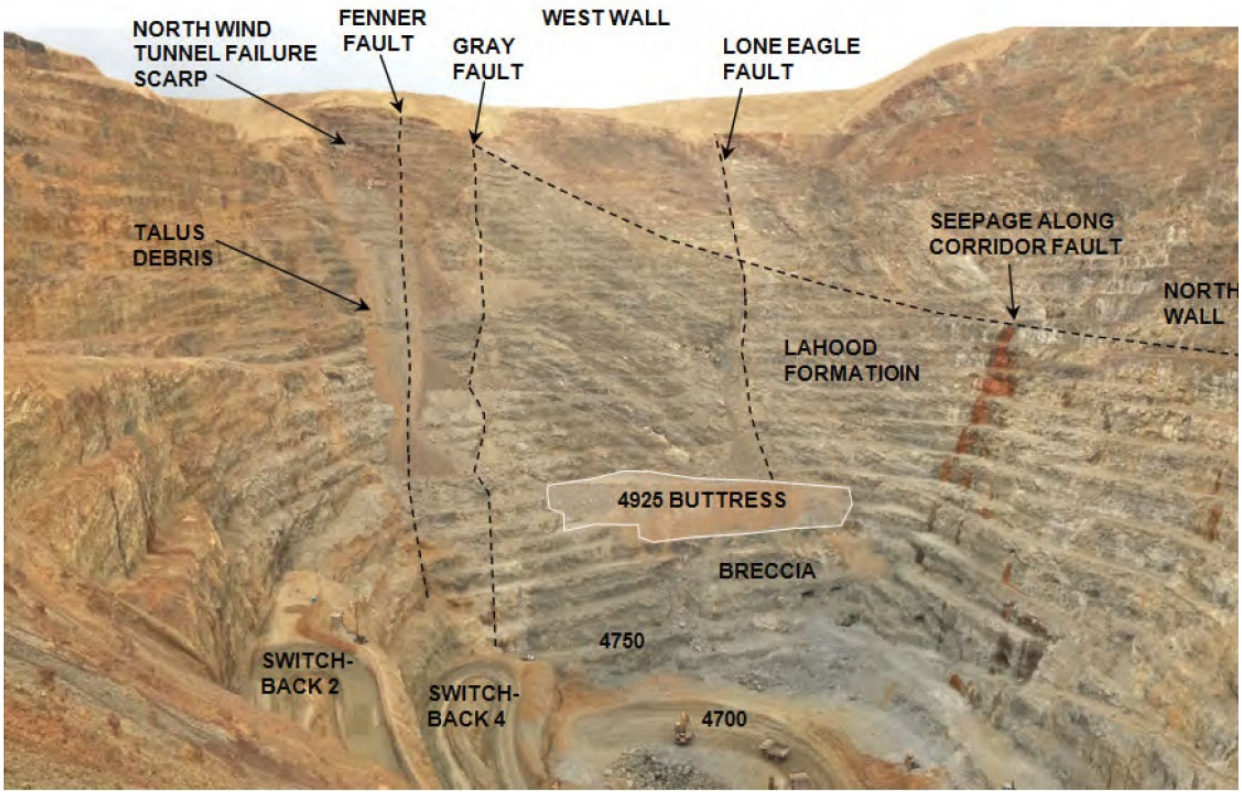


Figure 3.2-2
Annotated Photograph of the West Highwall of the Mineral Hill Pit (From Subterra [2020a])

Underground mining occurred in phases completed in 2011 and 2015–2019. The depths of underground workings below the Pit range from tens to hundreds of feet. The crown pillars of some formerly open stopes have caved and collapsed portions of the Pit while other stopes remain open, as illustrated on **Figure 3.2-3**. The extent of underground working and the primary stope of concern, the “NEV” stope, are shown in **Figure 3.2-4.**

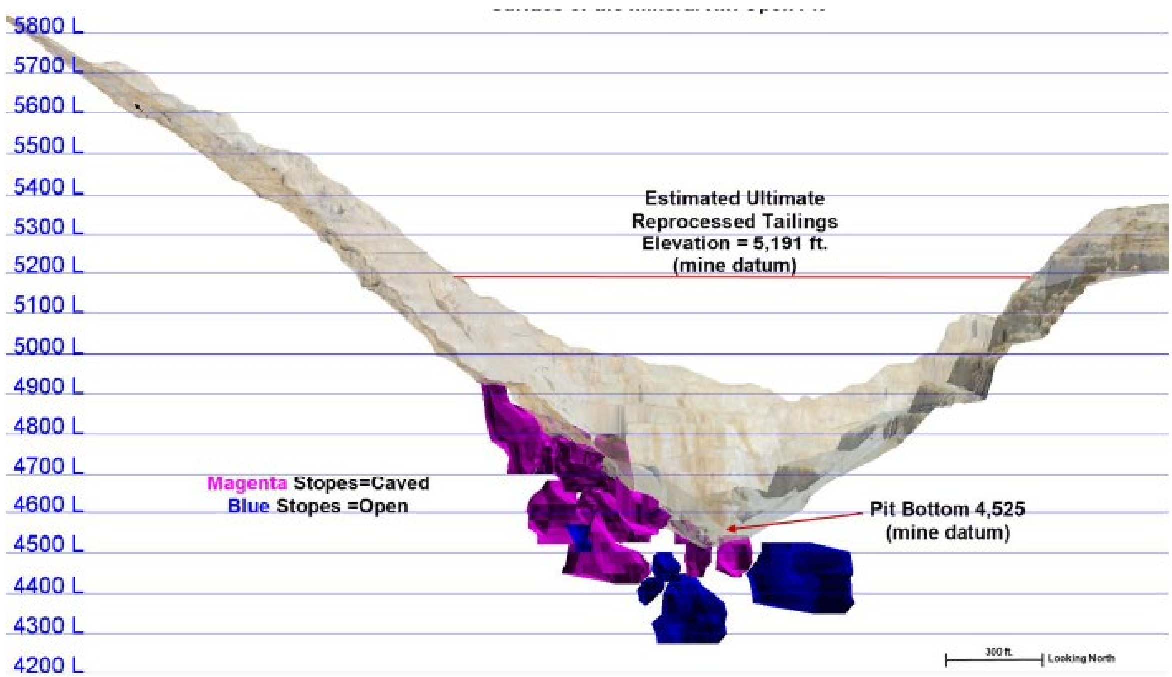


Figure 3.2-3
North Looking Section at the Mineral Hill Pit with Caved Stopes (Magenta) and Open Stopes (Blue) Below the Pit Bottom (Barrick 2020c)

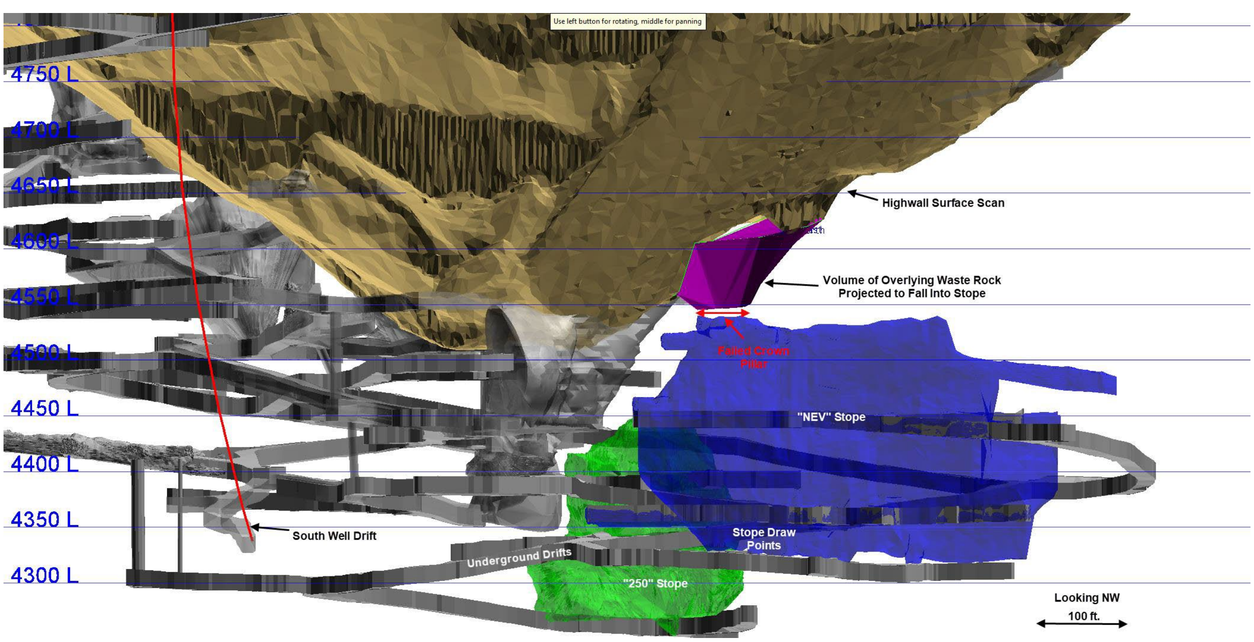


Figure 3.2-4
Isometric View of the Mineral Hill Pit (Brown) and Underground Workings Showing the Location of the South Well Drift and Dewatering Well Where Water Will Be Pumped for

Processing (Red Line on the Left), and the Failure Area (Red Arrows and Magenta) in the NEV Stope (Blue) (From Barrick [2020c])

Earth Blocks

Dumping, stockpiling, and borrowing activities at the site have caused instability in two large Earth Blocks (the Rattlesnake Block and the Sunlight Block) that are immediately upgradient of TSF-1 and TSF-2 and shown on **Figure 3.2-5**. The Earth Blocks are part of a large (400 million-ton) historical landslide complex that is thought to have been reactivated by the construction of waste rock dumps and other mining activity that changed the loading conditions on the blocks. Movement of the Earth Blocks has slowed significantly in recent years but given the loading-controlled nature of the failures, de-buttressing the toes of either of the blocks may cause unwanted ground movement.

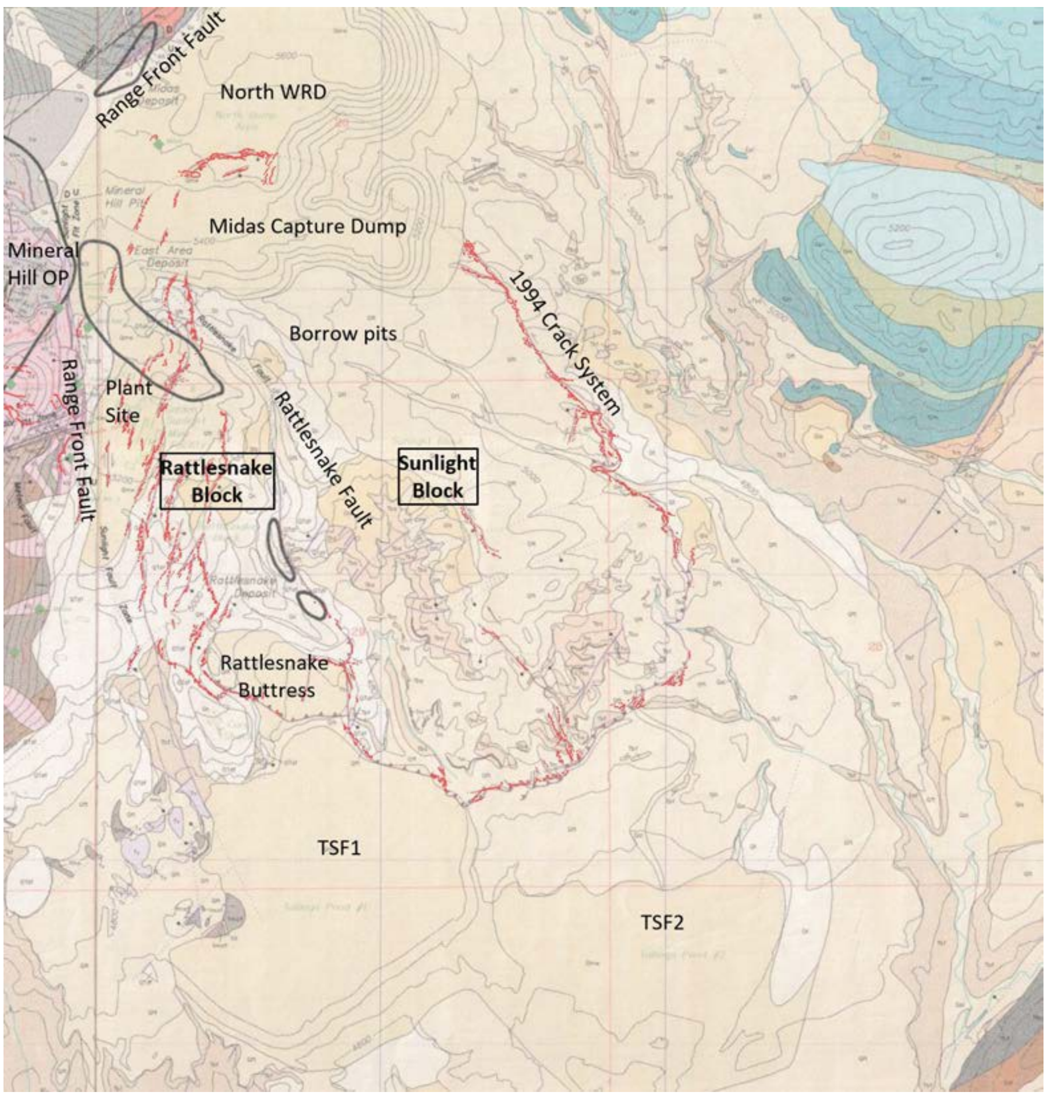


Figure 3.2-5
Map Showing the Rattlesnake (West) and Sunlight (East) Earth Blocks That Comprise the

Reactivated Historical Landslide North of Tailings Storage Facility 1 and Tailings Storage Facility 2 (Adapted From Figure 1 of Subterra [2020b])

According to Subterra (2020b), block movement accelerated in June 1994 because portions of a larger, inactive landslide were head-loaded with waste rock. The largest displacement measured at the time was 4.6 ft, and the movement of the blocks caused “undesirable settlement” at the plant site. The toe of the western block (i.e., the Rattlesnake Block) was buttressed that summer and, by October 1994, the movement rates had receded. Whether or not ground movement occurred before 1994 is unclear, but Subterra (2020b) appears to have reviewed movement data from as early as 1983. Conversely, in its Amendment Application, GSM states that the Earth Blocks have been “subject to instability since June 1994” without indicating any previous movement.

A waste rock buttress was constructed at the toe of the Rattlesnake Block beginning in August 1994. By February 1995, the movement of the Rattlesnake Block was nearly halted. In 2007, however, alternating periods of increased movement occurred in the Rattlesnake and Sunlight (eastern) Blocks because of “a series of dumping, stockpiling, and borrowing activities.” As recently as 2016, Subterra (2020b) reported that “[no] cohesive overall block movement” exists in the Sunlight Block and that the Rattlesnake Block continues to move slowly as a single cohesive slide mass. Movement in the Sunlight Block is evident in the upper (north) section and the toe of the Sunlight waste rock buttress that was constructed between 2011 and 2012. In 2012, tailings deposition in the northern portion of TSF-2 was ceased out of caution.

3.2.3 Environmental Consequences—Geology

3.2.3.1 No Action Alternative

Under the No Action Alternative, the proposed Amendment would not be approved, and GSM would continue reclamation and closure activities under its existing operating permit. There would be no impacts on the geology and mineral resources from what has been permitted. The geochemistry of tailings material in unlined TSF-1 could continue to leach and contribute to constituents of concern (including sulfates, iron, manganese, arsenic, cadmium, copper, and nickel) in downgradient pumpback wells (see Section 3.3, Ground Water Hydrology and Geochemistry).

3.2.3.2 Proposed Action

Under the Proposed Action, impacts to geology are negligible as no new production of ore or waste rock would occur beyond what is currently permitted. Approximately 26.2 Mt of previously mined tailings in TSF-1 would be disturbed and removed. The underlying Bozeman Group materials would be temporarily exposed during excavation and then covered with capping and growth media as part of the TSF-1 reclamation. The reprocessed tailings would be disposed of in the Pit, and bedrock material in the bottom of the Pit that is currently exposed would be covered. Processing would reduce total sulfide content of the tailings from an average of 4 percent to a proposed design criteria of 0.5 percent. Outgoing concentrate is expected to have a sulfide content of approximately 42 percent and would be transported to Barrick's existing mines in Nevada (GSM 2021a). Ground water quality impacts of the Project are discussed in Section 3.3, Ground Water Hydrology and Geochemistry.

3.2.3.3 Agency Modified Alternative

No aspect of the Agency Modified Alternative would affect the overall excavation of tailings at TSF-1 nor the backfilling of the Pit. The impacts to the geology resources under this alternative would be identical to the Proposed Action.

3.2.4 Environmental Consequences—Geotechnical

3.2.4.1 No Action Alternative

Under the No Action Alternative, the proposed Amendment would not be approved, TSF-1 and the West Wing Dike (between TSF-1 and TSF-2) would not be impacted, and reprocessed tailings would not be disposed of in the Pit.

TSF-1 Area

The West Wing Dike is stable and would likely remain so under the No Action Alternative. The risk of embankment collapse or adverse geotechnical impacts is negligible. The entirety of TSF-1 would remain in place and be expected to remain stable. If no action is taken, the construction of the Re-Pulping Plant to the north of TSF-1 would not occur and the surrounding area would not be affected. The West Wing Dike would not be exposed or susceptible to failure.

Mineral Hill Pit

The West Wall failure into the Pit would likely continue under the No Action Alternative. Although movement rates have receded significantly since mining ceased, the West Wall failure is controlled by large-scale structures and movement appears to be continuous creep at a rate of approximately 0.01 to 0.02 inch per day that, over a long-term period, would unlikely be abated without active mitigation measures (e.g., buttressing). Catastrophic failure of the West Wall into the Pit is unlikely, but seismic or unusually heavy precipitation events could accelerate slope movement of the failure into the Pit.

The underground workings beneath the Pit would not likely be affected under the No Action Alternative. Pit stopes and drifts would be expected to remain in a quasi-static stability condition and would be subject to typical long-term deterioration of underground mine workings. The underground workings are expected to be fully submerged below the estimated water table elevation (4,750 ft). Submerged working are expected to be more stable than dry working because of hydrostatic pressures.

Earth Blocks

Movement of the Earth Blocks would likely continue at the current rate under the No Action Alternative and, therefore, there is no impact. Any potential mining activity is unlikely and remaining reclamation activity is not likely to trigger/reactivate a greater degree of Earth Block movement. Minor accelerations associated with fluctuations in pore pressures in the slip planes of the blocks may occur; however, barring significant changes in the loading conditions, substantial movement would not be expected.

3.2.4.2 Proposed Action

The Proposed Action has manageable and reasonable geotechnical risks. With appropriate ground-movement monitoring procedures in place and pending the evaluation of any additional modeling that may be required, the TRP would be expected to reduce the risk of slope failures and rockfall in the Pit and would not be expected to cause collapses of underground workings that could damage the Pit dewatering system. The geotechnical risks associated with excavating TSF-1, altering the West Wing Dike, and reactivating the Earth Blocks are manageable if appropriate geotechnical monitoring is performed.

TSF-1 Area

TSF-1 would be excavated in stages using mechanical methods (e.g., excavators and dozers). Each stage would be a narrow northwest-southeast-oriented swath of ground beginning on the upgradient (northeast) side of TSF-1. Reclamation and final grading and slope configurations would be developed progressively as the excavation of each stage is completed.

The primary ground-stability concern in the TSF-1 area is the alteration of the West Wing Dike separating TSF-1 from TSF-2. The embankment would need to be altered or buttressed so that it remains stable during and after the TSF-1 excavation. GSM is proposing to use nonacid-generating borrow material to buttress the embankment. The existing tailings embankment would be cut back at a 2.5H:1V angle during excavation and the buttressing material would be emplaced on the bottom half of the slope.

According to the stability analysis performed by NewFields (2020), the reworked dike is expected to be stable under static (i.e., nonseismic) loading conditions with either a 3H:1V layback configuration extending from native ground elevation to the west side of the crest of the Dike or a 2.5H:1V configuration with a “30-foot-wide by 50-foot-high common fill” berm constructed on the lower half of the slope. The minimum factors of safety used in the analysis for temporary static, long-term static, and pseudo-static conditions were 1.3, 1.5, and 1.0, respectively. The Proposed Action would recover “most of the tailings from the embankment and place construction borrow material from the East Pit Borrow site” at a slope of 2.5H:HV

(GSM 2021a). Based on the NewFields (2020) analysis and pending any additional information, the Proposed Action would not likely cause the West Wing Dike to fail during or after construction. As described in Section 1.7, Issues of Concern—Tailings Storage Facilities, MCA requirements for tailings storage facilities require the Engineer of Record to review, certify, and seal documents pertaining to tailings storage facilities; the analysis report was certified by the Engineer of Record (GSM 2021a, Appendix D) and the Complete and Compliant Determination provides further details.

The Re-Pulping Plant would be constructed on a pad located in an area near the northern end of the TSF-1 site and the toe of the East Buttress Dump Extension. According to NewFields (2021), the Re-Pulping Plant would be constructed on a graded pad over in-place soil cover overlying buttress fill and overburden soil overlying Bozeman Group materials. These materials are generally well-suited for construction and are low-plasticity, silts, sands, and gravels. Construction of the Re-Pulping Plant would create negligible ground instability.

Mineral Hill Pit

After reprocessing, the TSF-1 tailings would be deposited in the Pit as a thickened slurry via a spigot located on the southwest side of the Pit. In terms of geotechnical risk, GSM expects rockfall conditions and stability of the Pit’s West Wall to be improved by emplacing tailings, thus resulting in a minor beneficial effect. Analysis indicates that the “stability of the west highwall will increase over time” because blasting would no longer be occurring, creep would allow for stress relaxation, and reprocessed tailings would buttress the failure (Subterra 2020a). Based on stability modeling (Subterra 2020a), the highwall should be stable after the reprocessed tailings reach a thickness of approximately 240 ft or an elevation of 4,950 ft. After consolidation, the final tailings elevation in the Pit is expected to be 5,173 ft. Additional details regarding the influence of tailings on the stability of the West Wall failure is included in EIS Appendix B, Technical Memorandum 2—Ground-Movement Model Assessment.

Depositing tailings in the Pit could overstress the crown pillars above stopes in the underground workings beneath. Collapses in the underground workings could potentially damage or disable the sump, pump, and/or well that is used to dewater the Pit and underground workings. If the crown pillars of currently open stopes collapse, the dewatering system may be damaged or disabled. Finite element and empirical methods were used to evaluate the stability of the five open stopes beneath the Pit (Barrick 2020c). The stability analysis indicated that only the NEV stope’s crown pillar (the shallowest stope with a crown pillar only 25 ft thick) would collapse during backfilling. Additional information is included in EIS Appendix B, Technical Memorandum 2—Ground-Movement Model Assessment.

Barrick’s (2020c) analysis showed that a failure of the southwestern portion of the NEV crown pillar would result in the collapse of crown pillar rock, waste rock, and reprocessed tailings into the stope. Barrick (2020c) expects that the material that falls into the stope would "choke off draw points and drifts," resulting in a limited amount of tailings or other materials reaching other parts of the underground workings. Barrick (2020c) also notes that the exit points of the NEV stope are at a lower elevation than the South Well Drift where the dewatering well sump would be (i.e., potential tailings entry from a failure would not migrate uphill within the saturated workings to reach the dewatering well). Given these factors, the potential failure of the NEV crown pillar would not be expected to damage the dewatering system (Barrick 2020c).

Earth Blocks

Removing tailings from TSF-1 during operation of the TRP is a geotechnical concern because doing so could potentially destabilize the Sunlight or Rattlesnake Earth Blocks slope failures upslope of TSF-1 and TSF-2. The numerical 3D model by Subterra (2020b) concluded that removing the TSF-1 tailings would not "convey additional movement to the Sunlight or Rattlesnake blocks." Because "instability of the Rattlesnake Block is more complex and subjected to more uncertainty compared to the Sunlight Block" and the Rattlesnake Block is more likely than the Sunlight Block to be destabilized by TRP activities, monitoring ground movement is critical in this area. The ground monitoring program, including survey monuments, inclinometers, piezometers, ShapeAccelArray sensors, Global Positioning System devices, and intermittent InSAR surveys, would continue under the Proposed Action.

The supplementation stability analysis concluded that the local area around the Re-Pulping Plant would remain stable under the TRP. The new plant would be located outside the boundaries of the Earth Blocks and is not expected to impact their stability.

3.2.4.3 Agency Modified Alternative

No aspect of the Agency Modified Alternative would affect the overall excavation of tailings at TSF-1, buttressing of the shared berm with TSF-2, nor the backfilling of the Pit. Pit highwall stability under this alternative would be similar to the Proposed Action. The impacts to the geotechnical stability at TSF-1 and Earth Blocks under this alternative would be similar to the Proposed Action.

3.3 GROUND WATER HYDROLOGY AND GEOCHEMISTRY

This section summarizes the regulatory framework, describes the ground water environment in detail, and presents a discussion of primary impacts to ground water resources in the area surrounding the Golden Sunlight Mine for the proposed alternatives. The regulatory framework for water resources in Montana includes but is not limited to the following:

- The Federal Clean Water Act;
- The Montana Water Quality Act (Section 75-5-101, *et seq*., Montana Code Annotated [MCA]);
- Nondegradation Rules (Administrative Rules of Montana [ARM] 17.30.701, *et seq*.);
- Montana Metal Mine Reclamation Act (Section 82-4-301, *et seq*., MCA);
- Montana Pollutant Discharge Elimination System (MPDES);
- Montana Nonpoint Source Management Plan; and
- Comprehensive Environmental Response, Compensation, and Liability Act.

The Federal Clean Water Act provides for the maintenance and restoration of the physical, chemical, and biological integrity of the nation's water (33 USC 1251 *et seq*.). The U.S. Environmental Protection Agency delegated most of the implementation of the Clean Water Act to the state of Montana. Designated beneficial uses of Montana's state waters include recreation, water supply, fisheries, aquatic life, and wildlife.

DEQ may not approve a reclamation plan unless the plan provides sufficient measures to prevent water pollution. The reclamation bond that a mine operation must submit before DEQ issues a permit or approves a permit amendment must also be sufficient to comply with the Montana Water Quality Act, which provides a regulatory framework for protecting, maintaining, restoring, and improving the quality of water for beneficial uses.

Pursuant to the Montana Water Quality Act, DEQ developed water quality classifications and standards and a permit system to control discharges into state waters. Mining operations must comply with Montana's regulations and standards for surface water and ground water. Pertinent state laws and administrative rules related to surface and ground water resources are listed above.

3.3.1 Analysis Methods

Analysis methods for understanding the existing ground water conditions at the Golden Sunlight Mine included reviewing the Amendment Application and supporting documentation provided by GSM, including studies, reports, and testing conducted by GSM and others. Specifically, the following primary resources were reviewed and relied upon for this section:

- JSAI (John Shomaker & Associates, Inc.). 2020. Golden Sunlight Mine Groundwater Flow Model. Appendix A. Barrick Golden Sunlight Mine. Whitehall, Montana.
- Schafer Limited LLC. 2020a. Golden Sunlight Mine, Geochemical Characterization Report A Compendium of Historic and On-Going Geochemical Tests and Water Quality Data. Barrick Golden Sunlight Mine. Whitehall, Montana.
- Schafer Limited LLC. 2020b. Golden Sunlight Mine Closure Option Evaluation. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

DEQ analyzed the ground water and geochemistry models provided in the Amendment Application, and the analysis is provided in EIS Appendix A, Technical Memorandum 1—Hydrologic and Geochemical Model Assessment.

3.3.2 Affected Environment

GSM is located in a breccia-hosted gold deposit with Tertiary breccias (consisting of hydrothermally altered latite and Proterozoic wallrock clasts) hosted by Proterozoic sedimentary rocks. The ore body at the Pit is a breccia pipe intruded into late-Precambrian Belt Supergroup host rocks in the southern Bull Mountains (**Figure 3.2-1**). Pyrite is abundant throughout the breccia and, in some cases, matrix-forming. Phyllic (quartz-sericite-pyrite) and argillic alteration have removed most primary breccia silicates, and the rocks have very little remaining alkalinity (although some younger vicinity host rocks have carbonates). Natural (i.e., premining) ARD is common at the site, and mining disturbance may have amplified acidity and metals loading.

Ground water occurs in limited quantities in the bedrock and mineralized zone within fractures and faults in the otherwise solid rock and within sedimentary deposits flanking the Bull Mountains. Ground water flow direction is generally to the south, southwest, and southeast toward the Jefferson Slough. Section 3.3.2.1, Hydrostratigraphy provides a detailed description of aquifer materials, and Section 3.3.2.2, Potentiometric Surface and Flow Paths provides information on ground water flow directions and pathways.

Current ground water monitoring wells, the location of the Pit South Well, and the TSF-1 pumpback wells are shown on **Figure 3.3-1**. The current approved water-management system and monitoring plan are described in the Amendment Application and Operations and Reclamation Plan (GSM 2014).

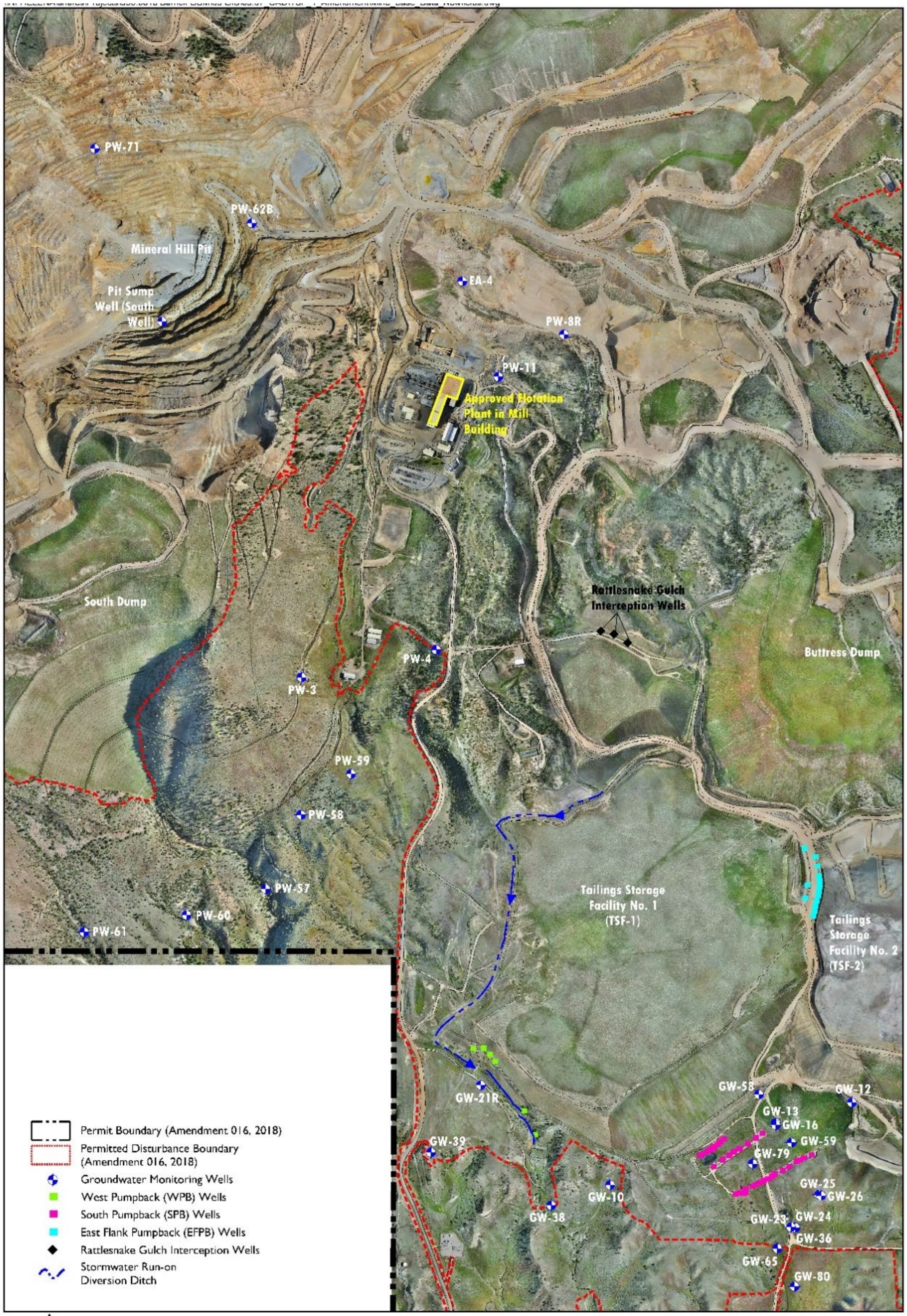


Figure 3.3-1
Current Facilities Layout, Monitoring Wells, and Pumpback Wells (GSM 2021a)

3.3.2.1 Hydrostratigraphy

Ground water flow occurs in the mine area through the fractured and faulted bedrock and mineralized zones. The flanks of the Bull Mountains are overlain by generally fine-grained Tertiary Bozeman Group sediments and sedimentary rocks, which are in turn overlain by coarse younger Tertiary and Quaternary alluvial, fluvial, and debris flow deposits that can also store and transmit ground water.

JSAI (2020) developed a comprehensive numeric flow model for the GSM area, including TSF-1 and the Pit, using MODFLOW (McDonald and Harbaugh 1988) and MT3D (Zheng 1996). Based on previous work and current information, JSAI summarized the hydrostratigraphy of this area as follows:

- **Tertiary/Quaternary Alluvium** – Locally derived gravels in a silty sand matrix and may include reworked Bozeman Group sediments and older Tertiary fan terrace deposits. The main aquifers are the recent alluvium along the Jefferson River, including the Jefferson River Alluvium.
- **Tertiary Debris Flow/Colluvium** – Present on the east side of the Bull Mountains and along the Range Front Fault in the vicinity of the North Area Pit. The deposit consists of angular debris flow and landslide deposits. This material fills an ancestral drainage originating in the Pit area and flowing southward, underneath the existing Rattlesnake drainage to TSF-1, and then to the Jefferson River Alluvium. Unconsolidated materials also fill a channel underneath the existing Sheep Rock drainage (see **Figure 3.3-2**).
- **Bozeman Group** – Located east and south of the Bull Mountains and separated from Belt Supergroup bedrock by the Range Front Fault. The aquifer consists of alternating and interfingering layers and lenses of sand, silt, and clay deposited in a fluvial (river or stream) environment. The late Tertiary Bozeman Group overlies the Proterozoic-age bedrock.
- **Bedrock** – The Proterozoic bedrock in the Pit area and west of the Bull Mountain area includes units in the Belt Supergroup comprising the Greyson Shale and LaHood Sandstone. Within the bedrock, the Corridor Fault separates the Upper Proterozoic unit from the Lower Proterozoic unit.

Hydraulic properties of the various units were compiled by JSAI and generalized into the five-layer numeric model as summarized in **Table 3.3-1**. The modeling results are presented in JSAI (2020) and summarized under the impacts discussed in Section 3.3.3.2, Proposed Action.

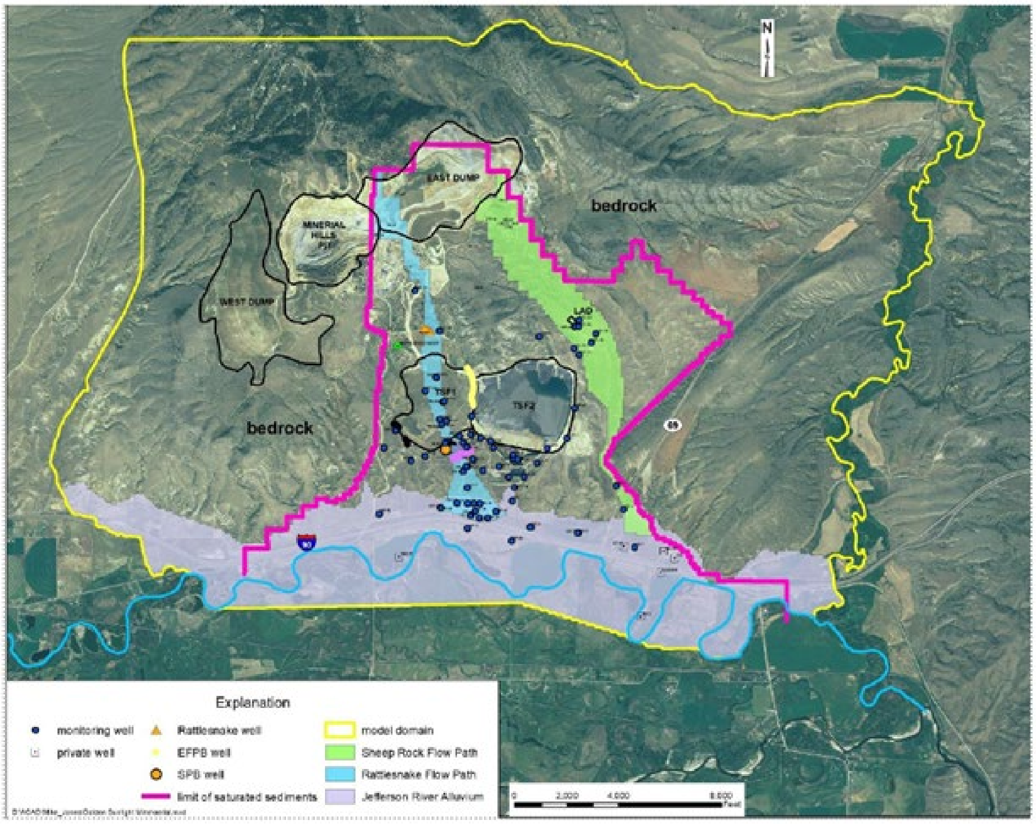


Figure 3.3-2
Golden Sunlight Mine Hydrogeology (JSAI 2020)

Table 3.3-1
Modeled Aquifer Characteristics (JSAI 2020)

Zone		Transmissivity (ft^2/day)	Saturated Thickness (ft)	K (ft/day)	Vertical Anisotropy Ratio	Specific Yield	Specific Storage
Layer 1							
1	Bozeman Group			0.1	0.2	0.1	1.0E-06
2	Jefferson River Alluvium			60	0.2	0.2	1.0E-06
10	Rattlesnake/Sheep Rock Flow Path			2.5	0.4	0.1	1.0E-06
Layer 2							
1	Bozeman Group			0.002	0.4	0.1	1.0E-06
6	Jefferson River Alluvium			60	1.0	0.2	1.0E-06
10	Rattlesnake Flow Path			0.5	0.1	0.05	1.0E-06

Zone		Transmissibility (ft^2/day)	Saturated Thickness (ft)	K (ft/day)	Vertical Anisotropy Ratio	Specific Yield	Specific Storage
Layer 3							
1	west			0.07	0.2	0.001	1.0E-06
2	east			0.002	0.4	0.002	1.0E-06
Layer 4							
1	upper			0.01	0.3	0.002	1.0E-06
2	lower			0.002	0.4	0.002	1.0E-06
Layer 5							
1	lower	7	3,500	0.002	0.3	2	1.0E-06

3.3.2.2 Potentiometric Surface and Flow Paths

Ground water flow occurs in the mine site area through the fractured and faulted bedrock and mineralized zones. The younger, overlying sediments can contain ground water recharged from precipitation and higher-elevation fractured flow with shallow ground water generally flowing downgradient toward the Jefferson Slough (see **Figures 3.3-2** and **3.3-3**). Preferential flow paths are formed by ancestral channels filled with coarse sediments (e.g., Rattlesnake and Sheep Rock flow paths shown on **Figure 3.3-2**).

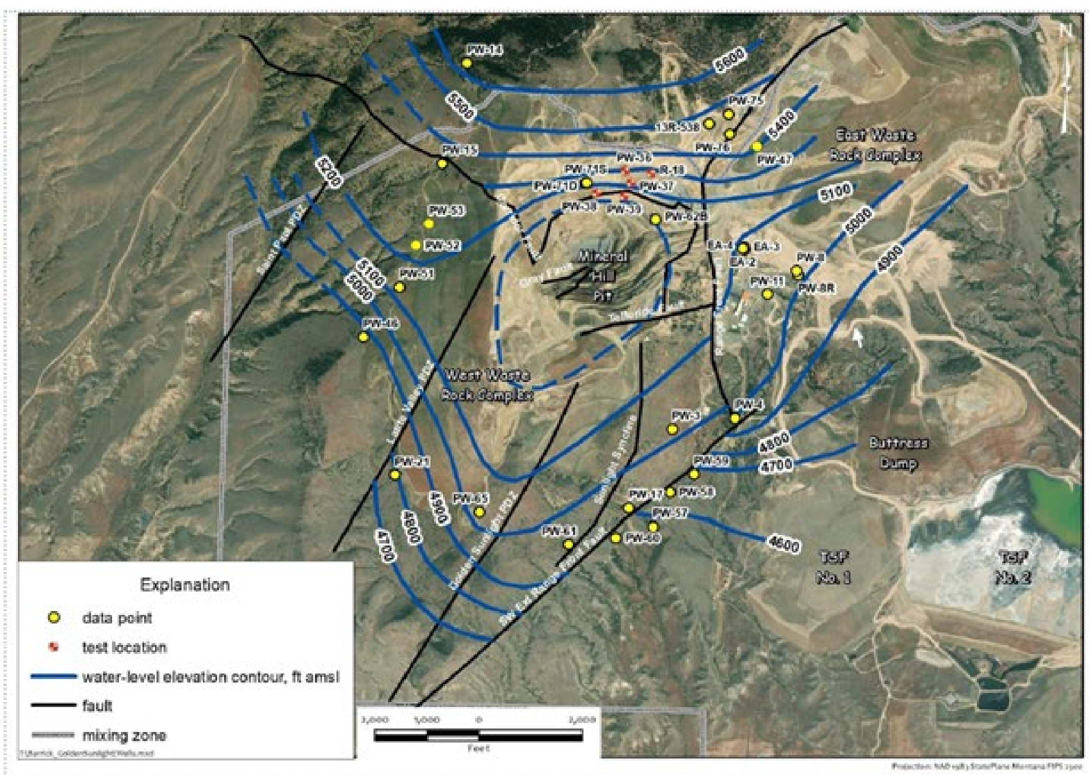


Figure 3.3-3
Golden Sunlight Mine Area Potentiometric Surface From Recent Data (JSAI 2020)

The numeric ground water flow model created by JSAI produced two calibrated potentiometric surfaces used to simulate ground water flow from TSF-1: one for the sedimentary units (shown on **Figure 3.3-4**) and one for the underlying bedrock units (shown on **Figure 3.3-5**). The simulated potentiometric surfaces are similar to actual mapped data and show ground water continuing to flow generally southward toward the Jefferson Slough for both confined and unconfined aquifers.

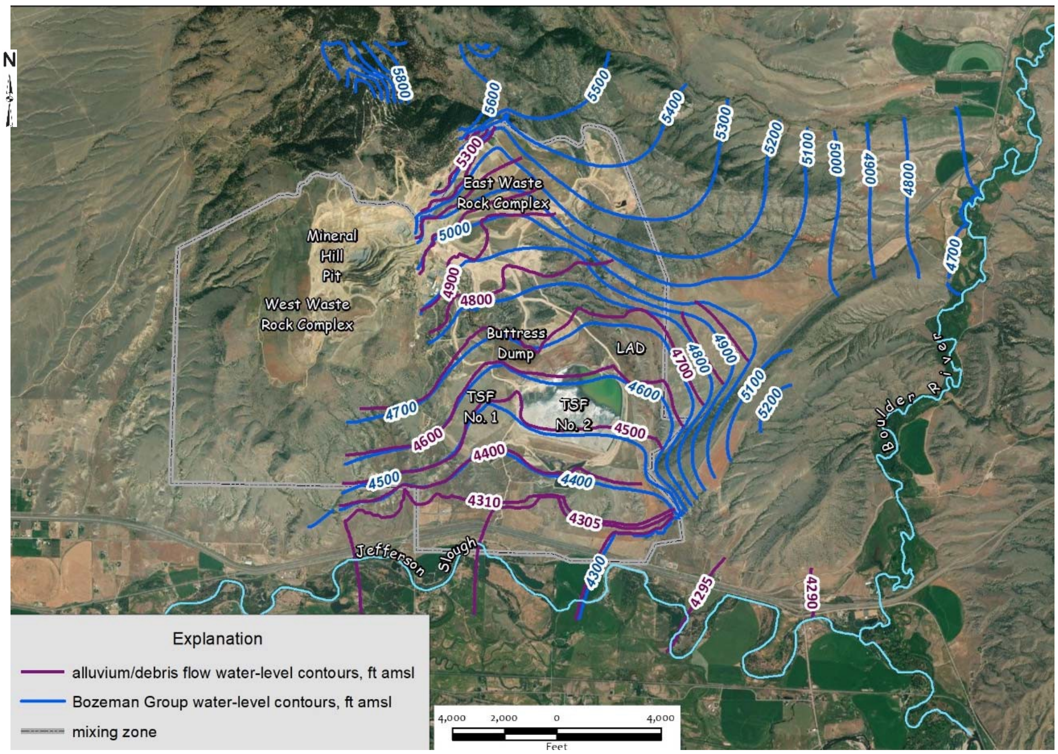


Figure 3.3-4
Golden Sunlight Mine Area Model-Simulated Potentiometric Surface for Sedimentary Units (JSAI 2020)

3.3.2.3 Tailings Storage Facility 1 Area Water Management and Water Quality

TSF-1 construction was approved in the first permit amendment of 1981, constructed on compacted natural clay without a liner system. Since 1983, ground water downgradient of TSF-1 has been intercepted. TSF-1 process water that was released into ground water has been intercepted and recovered through pumpback wells. The ground water interception program uses several galleries of wells including the South Pumpback and the East Flank Pumpback systems which are directed to TSF-2 (**Figure 3.3-1)**. The overall pumping rate has declined from over 350 gallons per minute (gpm) in 1983 to approximately 40 gpm currently (combined from both pumpback systems). The facility is expected to be fully drained with net infiltration of approximately 15 millimeters per year through the final cover, which equates to 4 gpm of flux. TSF-1 is unlined; thus, inflow through the cover and outflow to ground water are equal.

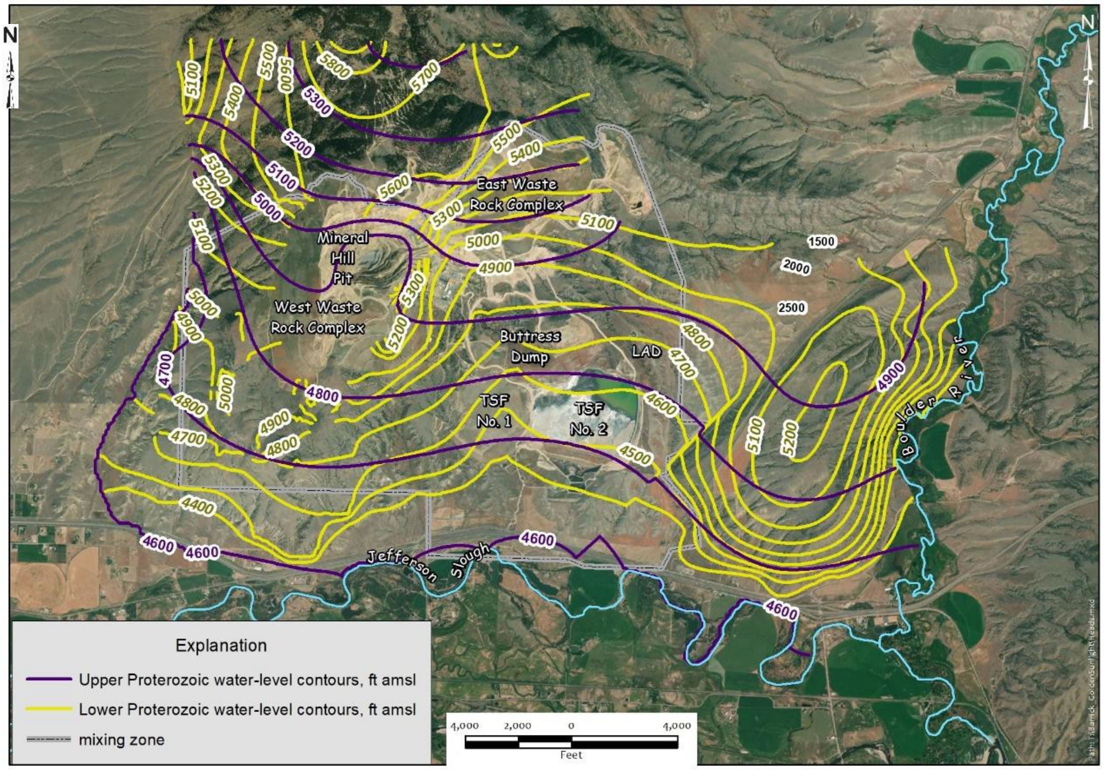


Figure 3.3-5
Golden Sunlight Mine Area Model-Simulated Potentiometric Surface for Bedrock Units (JSAI 2020)

Several Rattlesnake Gulch Area interception wells were installed in 1998 to capture water that created seeps upgradient and in the northern portions of TSF-1. These interception wells are pumped an average of 38 gpm to the Land Application Disposal Area to reduce pore pressure in the foundation of the original Buttress Dump Extension and reduce ground water inflow in TSF-1.

According to annual reports submitted by GSM to DEQ (2019 GSM Annual Permit Report, July 2020) water quality is monitored from 100 monitoring wells, pumpback wells, springs, seeps and sumps, in addition to three surface water sites and 16 nearby domestic wells, in and around the GSM operating footprint. The sample collection schedule varies from monthly to semi-annually but most groundwater sites are sampled quarterly and analyzed for standard and other specified parameters (GSM 2020). Eleven TSF-1 downgradient monitoring wells are sampled quarterly. The schedule and analytical results are included in the most recent annual monitoring report (GSM 2020). The existing ground water monitoring system downgradient of TSF-1 adequately measures and monitors the flow system and would detect any changes in contamination resulting for current or future actions at TSF-1. This level of monitoring and reporting appears adequate to detect off-site contaminant migration and/or changes to the underlying groundwater flow system and water quality.

Pumpback systems at TSF-1 have been installed to collect ground water that infiltrates and drains through the tailings deposited there. Constituents of interest for TSF-1 monitoring include the following:

- Total acidity and pH;
- Nitrate + nitrite and ammonia;
- TCN (cyanide);
- Total dissolved solids (TDS) (including sulfate); and
- Metals.

From the approximately 45 pumping and monitoring wells sampled in and around TSF-1, data graphs for the constituents of concern from 11 downgradient monitoring wells are show in **Figures 3.3-6** through **3.3-11**. These wells represent the area most likely to be impacted by changes occurring at TSF-1. The trends displayed on the graphs generally show stability of concentrations in ground water over the past 10 years.

The quality of the downgradient pumpback well water confirms that the tailings contain high levels of mobile, soluble constituents of concern, including sulfates, iron, manganese, arsenic, cadmium, copper, and nickel. The pore water in the TSF-1 tailings has moderate total dissolved solids of approximately 2,400 milligrams per liter (mg/L) and sulfate of 1,300 to 1,400 mg/L (Schafer Limited LLC 2020a). Cyanide and nitrate levels in interstitial fluids are low because of the age of the tailings. Water collected around TSF-1 has shown a decline in total cyanide and sulfate concentration over the period of record. Wells downgradient of TSF-1 have historical pH values from 6.5 to 8.1.

The Bozeman Group sediments contain sufficient alkalinity to neutralize any acid produced by the TSF-1 tailings as any seepage flows through the ground water system. Despite acid neutralization, sulfate and metals released into the ground water during pyrite oxidation of the tailings may continue to result in elevated concentrations. Geochemistry of TSF-1 tailings are described in Section 3.2.2.2, Tailings Storage Facility 1 Tailings Geochemistry.

3.3.2.4 Mineral Hill Pit Area Water Management and Water Quality

The ore body at the Pit and surrounding mineralized zone produces natural ARD. Mining of this material has exposed mineralized material that produces additional ARD (Schafer Limited LLC 2020a), and some of this water flows into the current Pit. The South Well located in the Pit dewaters the Pit material from below the Pit floor at an average annual rate of 57 gpm to maintain ground water levels below the Pit floor. According to the most recent annual monitoring report (GSM 2020), the water table elevation at the Pit is 4,489 ft. Dewatering water is currently discharged to TSF-2 and allowed to evaporate.

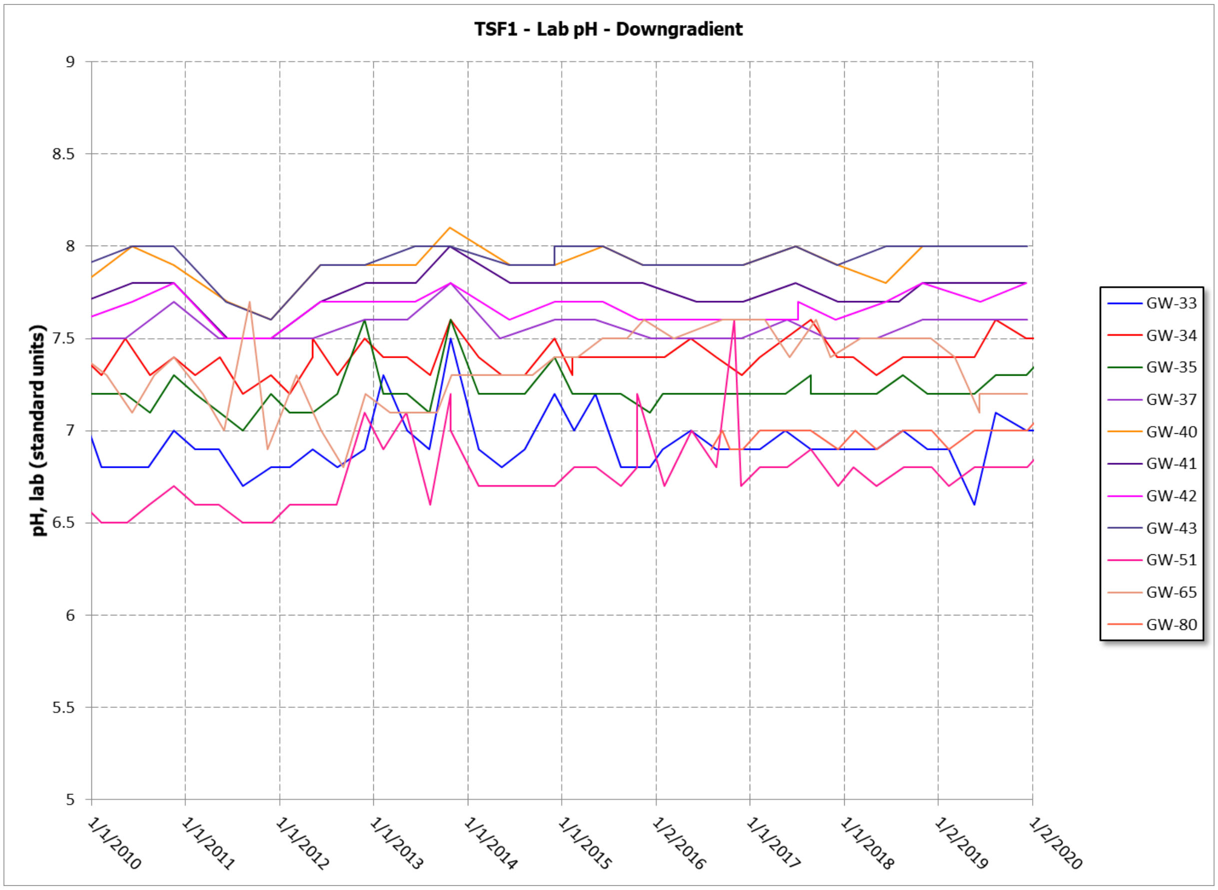


Figure 3.3-6
Tailings Storage Facility 1 Area pH (GSM 2020)

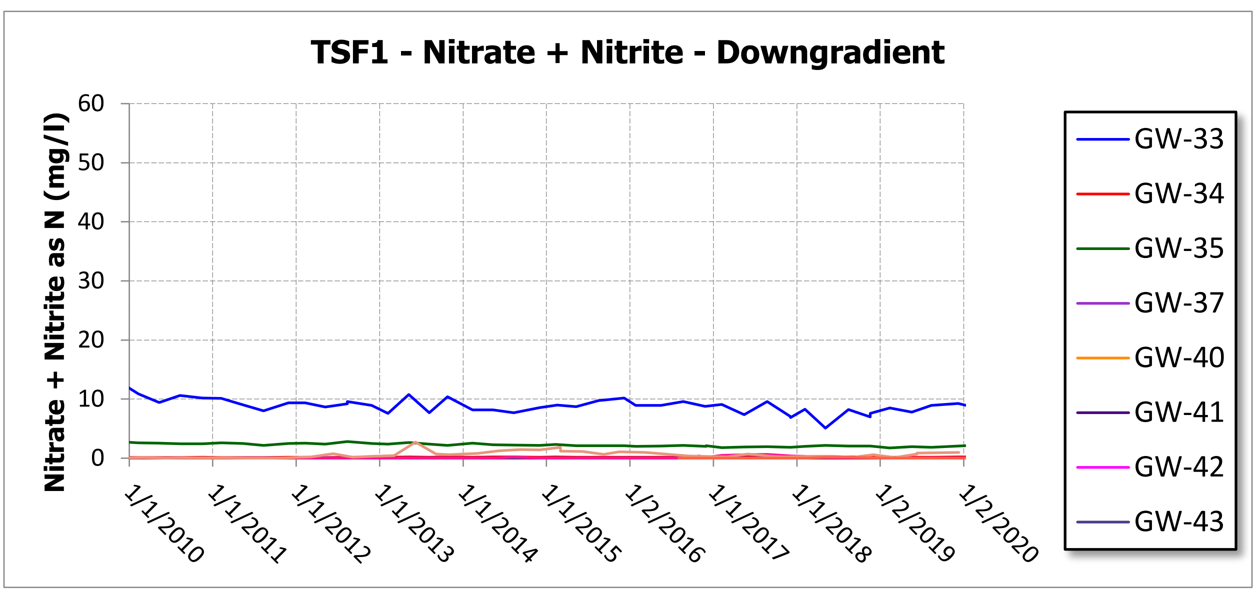


Figure 3.3-7
Tailings Storage Facility 1 Area Nitrate + Nitrite Drinking Water Standard 10 mg/L (GSM 2020)

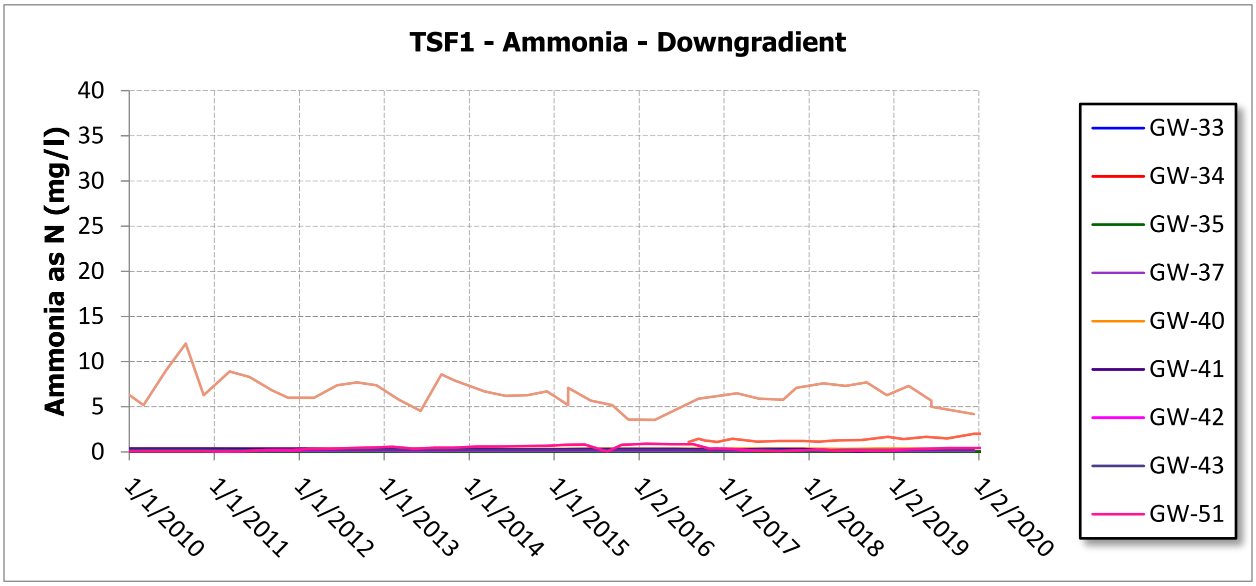


Figure 3.3-8
Tailings Storage Facility 1 Area Ammonia (GSM 2020)

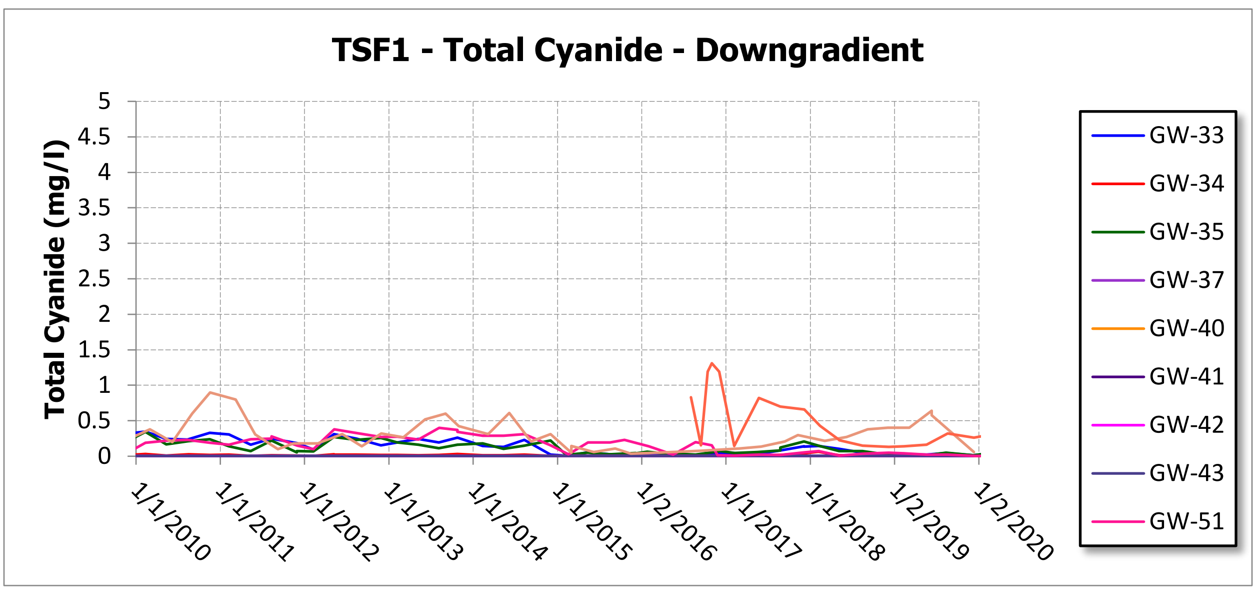


Figure 3.3-9
Tailings Storage Facility 1 Area Cyanide (GSM 2020)

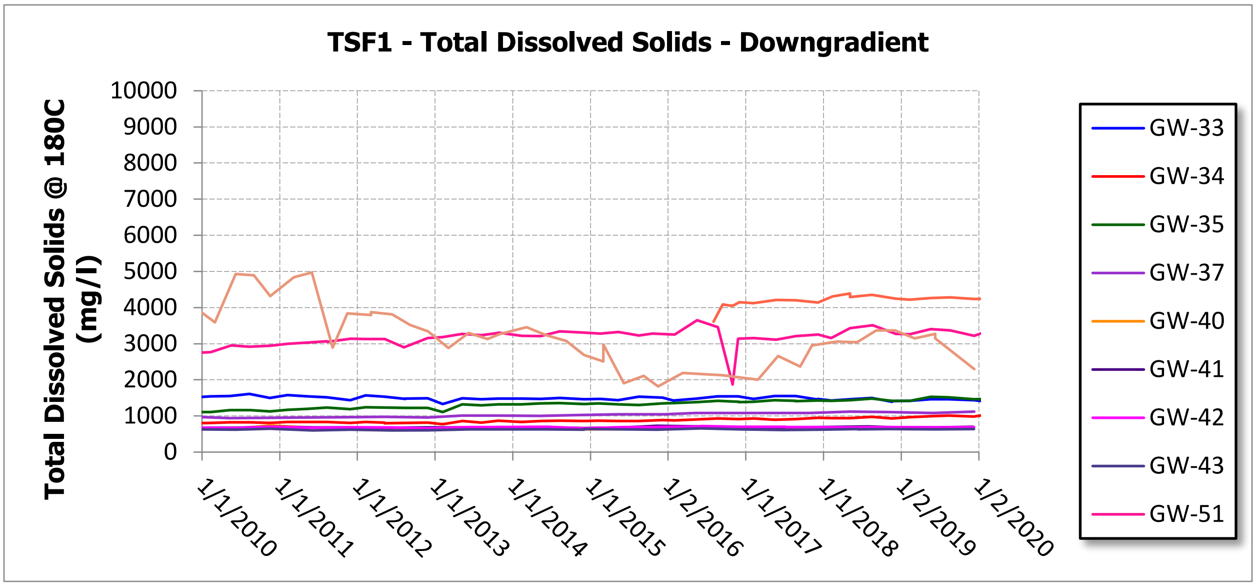


Figure 3.3-10
Tailings Storage Facility 1 Area Total Dissolved Solids (GSM 2020)

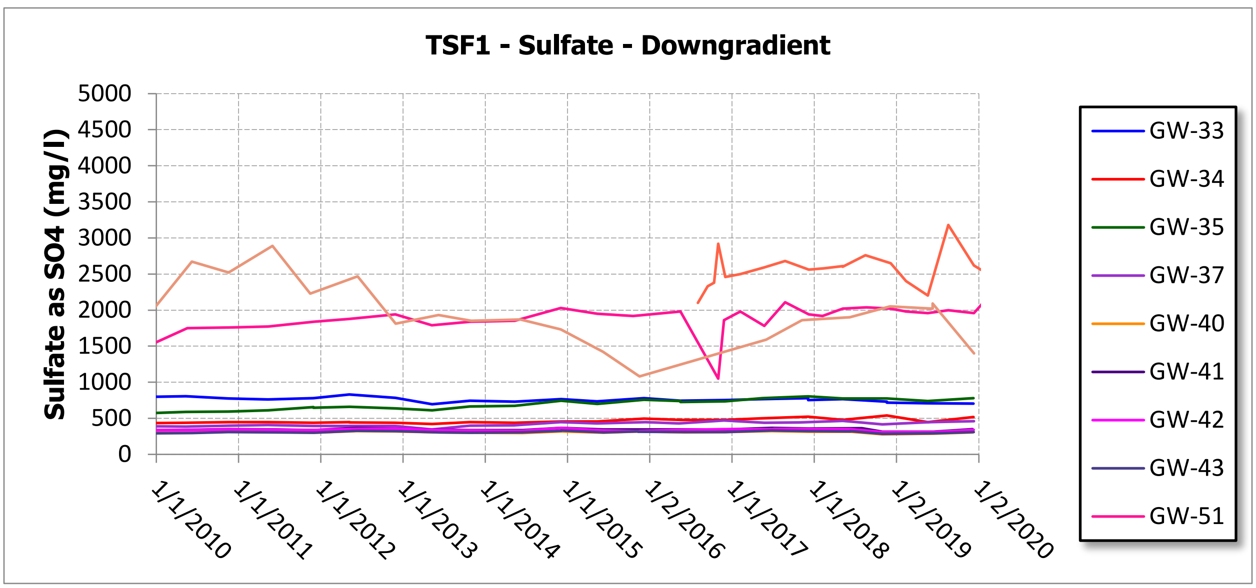


Figure 3.3-11
Tailings Storage Facility 1 Area Sulfate Drinking Water Standard 250 mg/L (GSM 2020)

Discharge from the Pit dewatering system is routinely monitored. Since the mine has discontinued processing ore in the mill, pit water is discharged directly to TSF-2. All flows are captured, so the pit water does not impact downgradient ground water quality. A number of monitoring wells have been drilled on the margins of the Pit, but the Sump Well (also called the

South Well) is used to lower the ground water level in the Pit and also collects seepage from the Pit walls and discharge from the underground mine workings. This water quality reflects acid-generation (both natural and mine-produced) and typically has low pH and high TDS.

Constituents of interest for the Pit area sampling are by-products of ARD. Ammonia and nitrate may be present because of the blasting agents historically used in mining. Low pH results are typically associated with increased concentrations of dissolved metals. Constituents of interest include:

- Total acidity and pH;
- Nitrate + nitrite and ammonia;
- TDS;
- Sulfate; and
- Metals.

Recent trends for these constituents are shown on **Figures 3.3-12** through **3.3-15** and discussed in the following text. **Figure 3.3-12** shows that pH ranges from about 2.5 to 6 but has stabilized around 3 over the previous five years. Ammonia and Nitrate/Nitrite have decreased since active mining (and therefore blasting activity) was discontinued in 2018. Metals concentrations show some seasonal variability generally within their historical range.

3.3.3 Environmental Consequences

3.3.3.1 No Action Alternative

Under the No Action Alternative, GSM would continue to operate under its existing Operating Permit. GSM would continue current land disturbance reclamation activities, TSF-2 consolidation and reclamation, and Water Treatment Plant construction. Ground water conditions at the Golden Sunlight Mine would likely remain the same. Tailings currently stored in TSF-1 would not be reprocessed and would remain in place through closure. As opposed to the Proposed Action, the No Action Alternative would have no impact on current conditions and would not likely have the positive water quality effects for both the TSF-1 area and the Pit.

Leaving TSF-1 tailings in place would result in two on-site ARD sources (i.e., TSF-1 and the Pit). Both sources would have actively acid-generating components and would require separate closure planning and long-term ARD management strategies such as described in the Operations and Reclamation Plan (GSM 2014). More importantly, two spatially separate areas remain that would potentially risk impacting downgradient water quality.

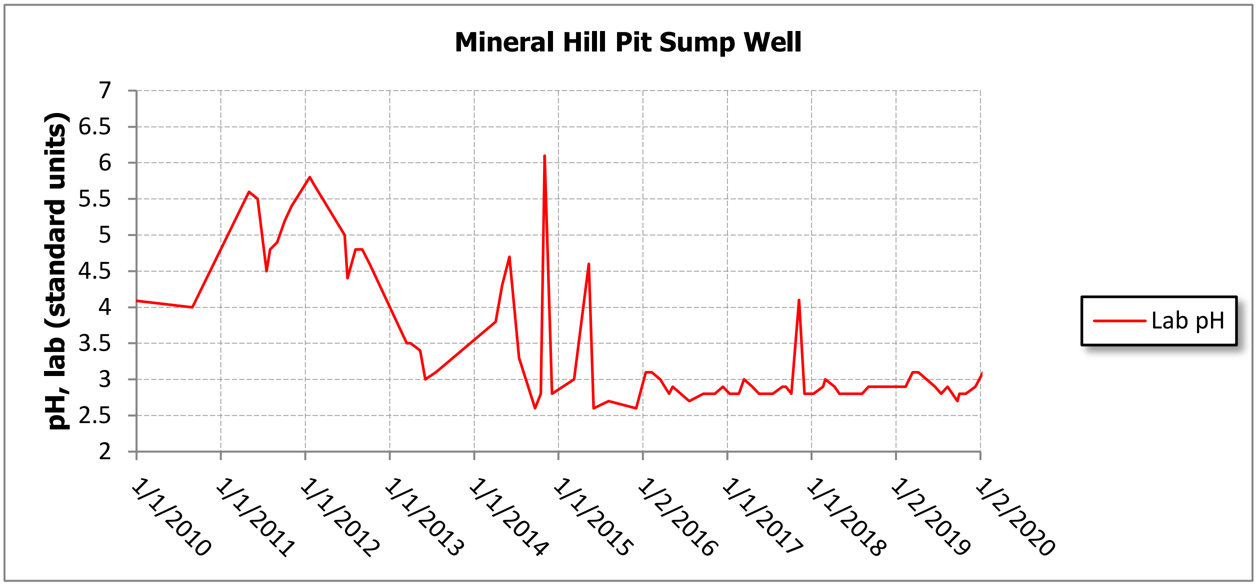


Figure 3.3-12
Mineral Hill Pit Sump Well pH (GSM 2020)

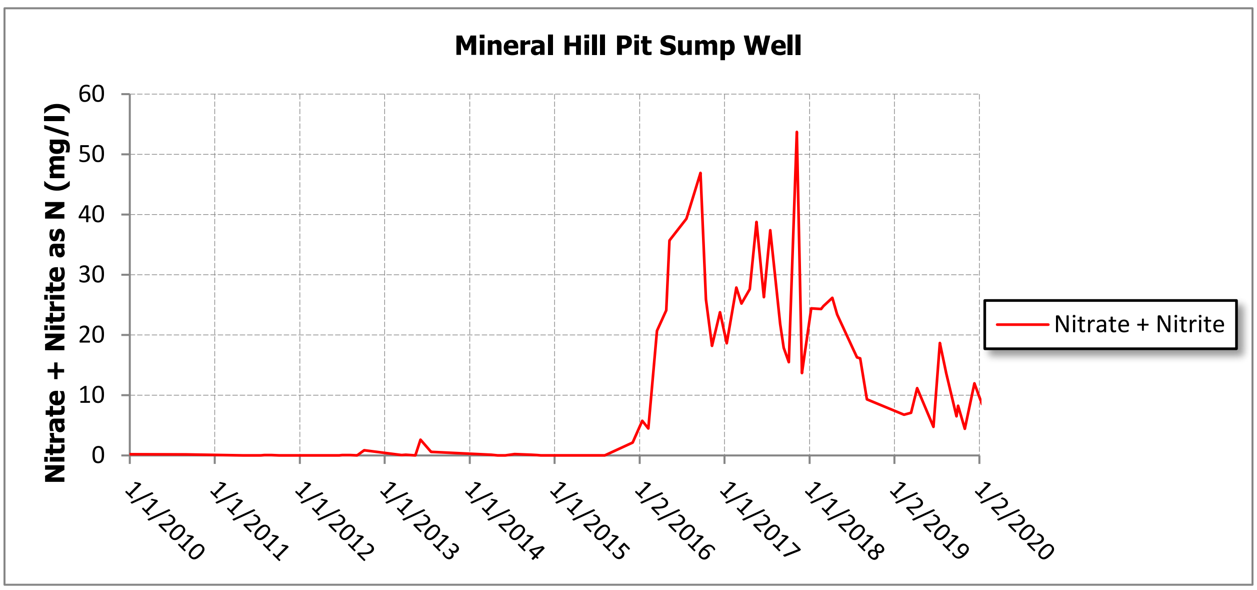


Figure 3.3-13
Mineral Hill Pit Sump Well Nitrate + Nitrite Drinking Water Standard 10 mg/L (GSM 2020)

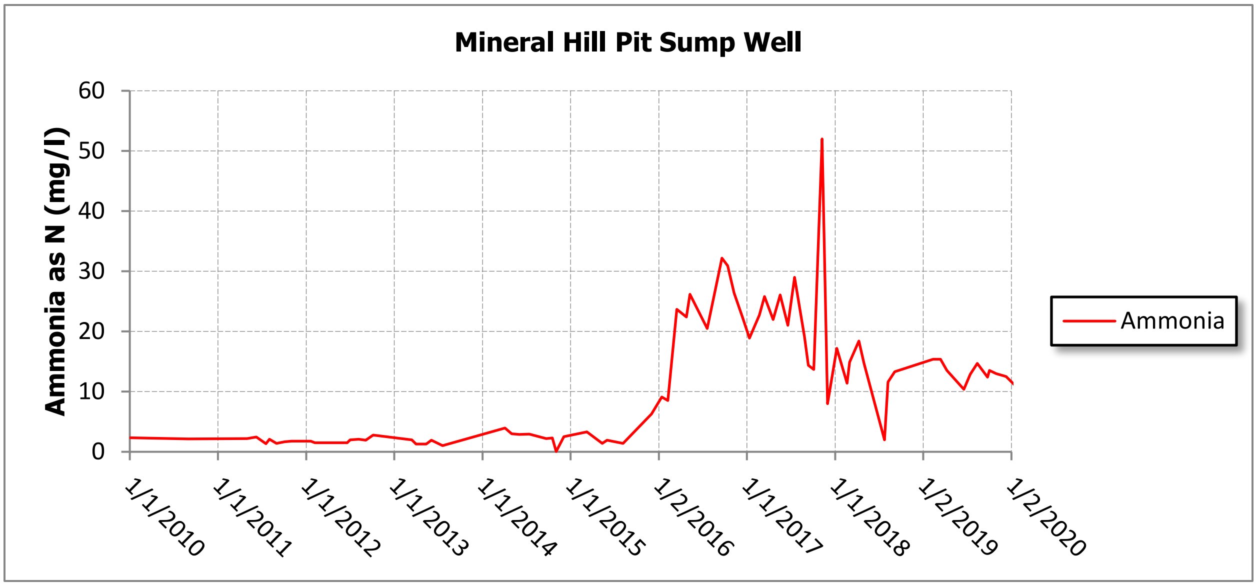


Figure 3.3-14
Mineral Hill Pit Sump Well Ammonia (GSM 2020)

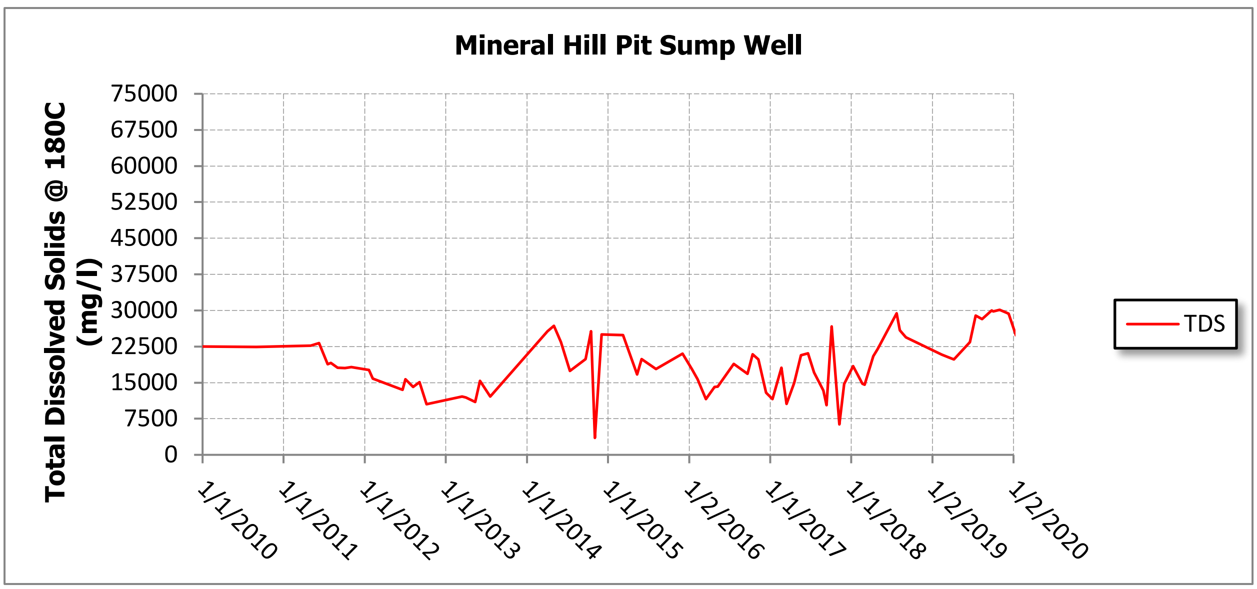


Figure 3.3-15
Mineral Hill Pit Sump Well Total Dissolved Solids (GSM 2020)

TSF-1

The pumpback wells at TSF-1 would continue to operate and likely at rates similar to current rates of 40 gpm. Pumped water would continue to be routed to TSF-2; although as the mine facility moves to final closure and TSF-2 is reclaimed (before 2028), water would be routed to a water treatment plant. The resulting ground water conditions downgradient of TSF-1 would be similar to current conditions. Tailings in TSF-1 are currently considered potentially acid-generating based on static and kinetic testing results (Schafer Limited 2020a); however, only the upper 6 ft of tailings are currently acid-generating because of the higher oxygen consumption rates in this area is a barrier to deeper oxygen ingress. The bulk of the tailings mass is not expected to become acid-generating, and ground water wells downgradient from TSF-1 do not currently exhibit signs of decreasing pH to indicate that acidity generated within TSF-1 is affecting ground water (see Section 3.3.2.3, Tailings Storage Facility 1 Area Water Management and Water Quality). Nonetheless, the upper layer of tailings in TSF-1 is actively acid-generating and the remainder of the impoundment has considerable acid-generating potential. Simulated sulfate concentrations for year 2030 in ground water under the No Action Alternative are shown on **Figure 3.3-16** and indicates a continued plume in the downgradient vicinity of TSF-1, under a hypothetical scenario where pumpback well systems are discontinued in 2030.

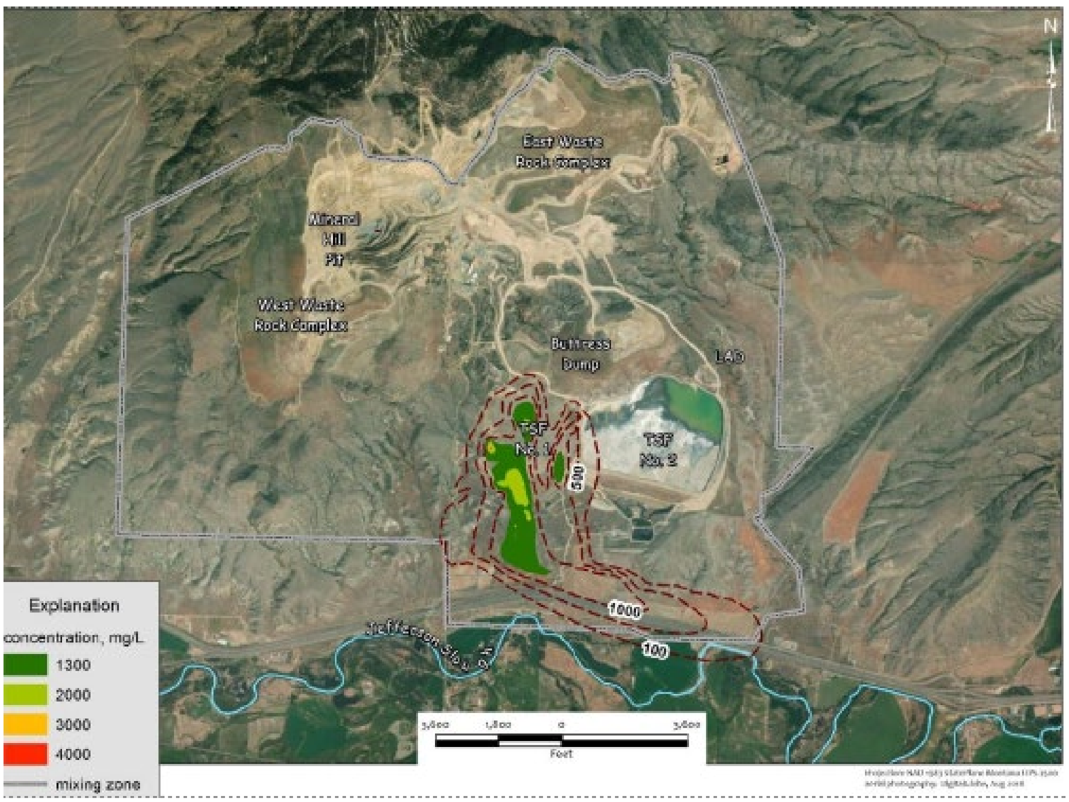


Figure 3.3-16
Model Predicted (2030) Sulfate Concentration From the Tailings Storage Facility 1

If the tailings at TSF-1 are left in place, these concentrations would likely decrease very slowly over time. The results of simulations of the approved closure plan with tailings remaining in TSF-1 (No Action Alternative) (JSAI 2020) predict that downgradient ground water would be impacted on the order of hundreds of years in the absence of water pumpback systems (modeled to cease in 2030). Unlike the simulated scenario, the pumpback systems would continue to operate under the No Action Alternative until monitoring demonstrates that water quality has sufficiently improved to allow cessation of pumping.

Mineral Hill Pit

Under the No Action Alternative, operating the existing Pit dewatering system would continue indefinitely under postclosure conditions. Operation of the Pit sump (South Well) would maintain a cone-of-depression near the currently maintained elevation of 4,500 ft (GSM Mine datum) and thus capture ground water inflow in the Pit. GSM would continue to dewater at a rate that results in zero outflow and capture water flowing into the Pit, while also precluding the formation of a pit lake above the bottom surface of the Pit (4,525-ft elevation). The average annual pumping rate from the Pit sump is 57 gpm for the period of record. The rate of pumping would fluctuate to maintain the sump-water level below the Pit bottom. Water collected from the Pit area would temporarily continue to be piped to TSF-2 and ultimately a permanent water treatment plant would be built to treat Pit water.

Under the No Action Alternative, no new source of neutralization potential would be provided to the Pit, and residual surface acidity and metals would be flushed (un-neutralized) into underground workings and the existing Pit water capture system. Under the No Action Alternative, the mitigation of Pit wall oxidation would not occur, which would result in additional acidity and metals loading to the subsurface that would be managed through the currently approved postclosure activities including a new water treatment plant. Therefore, impacts to water quality under the No Action alternative would be similar to current conditions and are expected to be negligible at the Pit as long as active dewatering and water capture is occurring.

3.3.3.2 Proposed Action

Implementing the Proposed Action would not require a change in the approved water-management system for TSF-1 or the Pit. Current ground water monitoring systems would remain in place, and monitoring locations and frequency would remain the same as the No Action Alternative.

TSF-1

The Proposed Action entails removing tailings from TSF-1 and, therefore, the source of acidic and metalliferous leaching to downgradient subsurface aquifers. Reprocessing tailings is expected to result in a considerable reduction of sulfide concentrations to an average of 0.5 weight percent. Reprocessed tailings would be thickened before being gravity-pumped to the bottom of the inactive Pit. Lime would be added to the slurry so that the initial tailings slurry has the capacity to neutralize in-pit generated acidity; there is a certain amount of internal alkalinity bound within the tailings slurry but also a portion going into the pond.

The Proposed Action of reprocessing mine tailings from TSF-1 and depositing the reprocessed tailings in the Pit would result in reduced contamination in the ground water system around both TSF-1 and the Pit because of removing the tailings source of contamination at TSF-1 and the depyritization and lime amendment of tailings filling the Pit. The base-case simulation was modified to simulate a hypothetical end to the operation of the TSF-1 pumpback systems in 2030; however, it should be clear that ceasing pumping activities is not proposed in this amendment. Existing background concentrations of sulfate, which are naturally elevated in some areas around the mine site, are not represented in the model results. The simulation results of the Project indicate that removing the contaminant source (finishing in 2030) would result in a more rapid improvement of ground water quality than under the No Action Alternative.

Numeric ground water modeling by JSAI (2020) indicates that recovering tailings from TSF-1 would result in a long-term, positive effect on downgradient water quality. Removing partially saturated, acid-generating tailings and residual, steady-state porewater would eliminate the primary source of acidity and metals loading currently captured by pumpback systems. However, uncertainty remains as to the extent that stored acidity and metals (from TSF-1 seepage over time) exist in underlying alluvial soils, and whether or not those metals might be remobilized as hydrogeologic conditions change after excavation. Continued operation of the TSF-1 pumpback systems (which is the requirement under the current permit) would continue to remove contamination from ground water and result in a smaller contaminated ground water footprint.

The Proposed Action does not directly propose to alter flow or pumping rates at TSF-1. Water from pumpback recovery wells would continue to be pumped and disposed of at TSF-2 and ultimately a new water treatment plant. Rattlesnake wells would also continue to pump intercepted water above the tailings facility. After TSF-1 is excavated, removing the tailings source of contamination may allow for a reduced or eliminated pumpback well system in the future. However, that action must be submitted for review and approval by DEQ and BLM, based on operational evidence that modification or elimination of the systems is appropriate. No alterations to the water-management system are included in the Proposed Action.

Mineral Hill Pit

Under the Proposed Action, the thickened tailings slurry would be pumped to the Pit for final disposal. Spigot discharge points along the southern side of the Pit would initially cause the tailings to slope and would create a temporary pond comprising process solution to the eastern portion of the Pit surface. This process water would be pumped through a pipeline at approximately 50 gpm to the thickener tank overflow and then to the PA Tank for distribution to the Flotation Plant and/or Re-Pulping Plant for reuse. The process water cannot be pumped until about year 3 of tailings deposition because of access from existing ramps; pumping would then continue through the end of processing. Returning the ponded process solution to the Flotation Plant and thickener tank during the subsequent years of tailings reprocessing would also have the net effect of reducing the amount of water entering into and being pumped from the underground sump. By recirculating this water, the amount of fresh water that would be needed from the Jefferson River Slough may also be reduced. A portion of process water on the tailings surface would evaporate or seep into the Pit area ground water beneath the Pit, rinsing previous oxidation products from highwalls and fractures, and then be removed by the underground sump pump.

After tailings disposal ceases, the surface pond is expected to become nonexistent because of evaporation and infiltration, though possible short-term seasonal ponding of precipitation in the low point on the eastern side of the tailings surface may occur. Placing tailings in the Pit would not result in a permanent Pit pool. Further discussion on the temporary Pit pond, lime amendment to adjust pH, and the site water balance is discussed in Section 2.3.5, Water Management System. Following completion of disposal, the consolidated tailings surface would be graded to 1 percent, capped, and revegetated, limiting both runoff and future ponding (see Section 2.3.6, Reclamation).

The process solution for flotation tailings that infiltrates into the wall and bottom rock of the Pit would combine with meteoric water and ground water from the bedrock aquifer associated with the Pit. The combined water sources would continue to be managed according to the current approved system (i.e., collecting and pumping water from the underground mine workings and sump). GSM maintains the South Well that pumps water from the underground sump and conveys the water via pipeline to TSF-2.

Under the Proposed Action, lime-amended process water within the Pit area would provide a new source of acid-buffering that is not currently present, which would help to flush and mitigate stored acidity and metals on the Pit wall surfaces. After tailings placement, the primary sources of potential acid generation and metal loading are the reaction products that remain in the weathered highwall zones and minor loading from underground. Partial backfill of reprocessed tailings would result in approximately 630–648 ft of the Pit wall surface area being covered by the low-permeability tailings, which would reduce oxygen ingress and considerably mitigate acidity and metals production at the Pit wall surface. A mass balance developed by Schafer (2020b) estimated that the reprocessed tailings and amendments provide approximately 4.2 times the mass of acidity that may be generated from the highwall. Further discussion is provided in Technical Memorandum 1—Hydrologic and Geochemical Model Assessment (RESPEC 2021). Consolidation of tailings over time would reduce downward water infiltration and, therefore, reduce acidity and metals from being transported to the subsurface.

Through the methods described above, the low-sulfide, acid-neutralizing tailings would likely improve the chemical quality of water pumped from the underground mine. However, the final reprocessed tailings disposed in the Pit could potentially have a higher sulfide fraction than what is currently projected (some operational fluctuations around the target of 0.5 percent total sulfur), which would slightly increase the acid-generating potential of the tailings. More importantly, if tailings porewater alkalinity and the residual neutralization potential in the disposed, reprocessed tailings are consumed by neutralizing surface acidity stored in the Pit wall materials or Pit ground water, then the reprocessed tailings may become net acid-generating over time. The impacts from this would likely be minimal in comparison to current water quality because disposed tailings are expected to settle quickly and become a barrier to downward oxygen ingress, limiting the long-term ARD potential of the bulk of the disposed tailings. Simulation results indicate that any ground water quality effects would be confined to the immediate vicinity of the Pit and ultimately captured by the dewatering system and treated in a similar method as the No Action Alternative.

GSM would continue to maintain the cone-of-depression in the ground water table surrounding the Pit by managing the underground sump dewatering system. The existing dewatering system would effectively control seepage water from the tailings into the fractured bedrock of the Pit's walls and bottom. Currently, and under the No Action Alternative, the ground water level would be kept below the pit bottom at around 4,500 ft, and under the Proposed Action the water table would be allowed to increase to approximately 4,750 ft. Ground water modeling indicates that maintaining the phreatic surface at the 4,750-ft elevation would generate a cone-of-depression that would be sufficient for containing ground water, meteoric water, and tailings water that commingle with ground water in the Pit (i.e., zero outflow). Dewatering rates currently average 57 gpm. Under the Proposed Action, dewatering rates are projected to peak at 100-130 gpm near the end of tailings reprocessing and then gradually decrease to 38 gpm over 100 years as the tailings drain down. The model results do not indicate that surrounding ground water quality would be affected with long-term dewatering from the underground mine because all ground water flowing to the Pit or tailings would be captured with zero outflow to the ground water system.

3.3.3.3 Agency Modified Alternative

The only aspect of the Agency Modified Alternative that differs from the Proposed Action would occur during reclamation. Minor alterations to the topography and vegetation would have localized changes in infiltration rates; however, the majority of water that infiltrates into soils over TSF-1 and the Pit would be absorbed by vegetation and very little, if any, would be expected to enter into the respective ground water systems. The Agency Modified Alternative would not change the geochemistry of the tailings material or notably change the site water balance. Impacts to ground water resources would be similar to the Proposed Action.

3.4 SURFACE WATER RESOURCES

Surface water resources at the Golden Sunlight Mine include ephemeral stream channels, seeps, and springs. The proposed Amendment does not include expanding the permitted disturbed area but rather reconfigures the existing site to mine and reprocess tailings. The reconfiguration is not anticipated to alter surface water discharges from the site; therefore, modifications to GSM's existing stormwater permit are not required. The Proposed Action does require a surface water-management strategy to remain in compliance with existing permits, primarily in managing storm water. Before operation of the TRP, Golden Sunlight Mine will submit an updated Notice of Intent application form to update Section F – Facility or Operation Description of the Storm Water Pollution Prevent Plan under Multi-Sector General Permit Number MTR00498.

Changes are likely to occur in the quantity of surface water and sediment loading internal to the site that differ from the existing, permitted condition. The variation in quantity is attributed to changes to where storm water is captured, diverted, stored, or used for processing. These changes also influence the quantity of storm water that is lost through infiltration or evaporation.

Off-site surface water resources related to increased consumptive use may also be impacted to support the Proposed Action. Tailings mining and processing will require additional fresh water, which will be extracted from an off-site source.

This section evaluates the impact of the proposed activities on the site's overall water resources.

3.4.1 Analysis Methods

Analysis methods included reviewing the proposed Amendment, annual reports, EISs from past amendments, comments and reviews by DEQ, water-balance calculations furnished by GSM, and other documents related to the site. All of the information was used to evaluate the overall impact of the Proposed Action on surface water resources.

3.4.2 Affected Environment

Riverine surface water features near the Project Area consist of the Jefferson River, Boulder River, and Whitetail Creek. Jefferson Slough contains surface water but is generally fed by ground water in the floodplain of the Jefferson River except during high flows. Jefferson Slough was once a side channel of the Jefferson River that now serves as an important water conveyance for agricultural water users with the water flowing into the slough originating in Pipestone Creek, Whitetail Creek, and the Jefferson River. The latter first flows through Slaughterhouse Slough before being diverted into Jefferson Slough through a regulated headgate (Confluence Consulting 2020). Below the town of Cardwell, Montana, Jefferson Slough flows into the Boulder River, which joins the Jefferson River just a few miles downstream. All of these features are located off of the Project Area.

Surface water quality monitoring is ongoing for the Jefferson Slough. Water quality in the Jefferson Slough is monitored by GSM at one site upgradient and two sites downgradient of the mine. Water quality is not significantly impacted in the Jefferson Slough from the mine (Barrick 2020d).

A state-listed aquatic noxious weed, Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM), was identified in the Jefferson River Slough in 2013, which prompted the Jefferson County Board of Commissioners to develop a plan to reduce and eradicate the EWM infestation within Jefferson Slough using aquatic herbicides, modifying irrigation structures, reducing sediment input from tributaries to Jefferson Slough, and implementing channel modifications to improve sediment transport through infested areas (Confluence Consulting 2020). Aquatic herbicide applications to control EWM began in 2014 and the Phase 1 channel modification project was completed in 2018, which involved constructing a new, 3,440-ft channel alignment beginning several hundred feet above the upstream-most known point of EWM infestation and extending downstream to the confluence with Sheep Gulch (Confluence Consulting 2020). Monitoring occurred in July 2020 in the reach of the Jefferson Slough in which EWM was previously found in 2013; the results indicated that herbicide applications coupled with the Phase 1 channel modification project have potentially eradicated EWM from 19 percent of the channel length and has been controlled in 30 percent of the channel length (Confluence Consulting 2020).

Within the Project Area, surface water generally exists as ephemeral flow in several channels for a short period following rainfall or snowmelt. The major ephemeral channels include Sheep Rock Creek, Saint Paul Gulch, and Conrow Creek. Several unnamed tributaries to these major channels exist.

Ephemeral surface water from Sheep Rock Creek and Saint Paul Gulch flow into the Jefferson Slough. Ephemeral surface water in Conrow Creek and its unnamed tributaries flow into the Boulder River, not far above its confluence with the Jefferson River.

Ephemeral drainages rarely flow; thus, flow records in these drainages are rare. GSM has reported flow in Sheep Rock Creek of 3–4 cubic feet per second (cfs) following a precipitation event during July 1995 (DEQ 2013). They have also noted flow in various unnamed tributaries of Conrow Creek on two occasions during May 1995. Flow in these unnamed tributaries was estimated to be as much as 4–5 cfs.

Flow in the Jefferson River has been measured by the U.S. Geological Survey (USGS) at several locations and for many years. The nearest long-term measuring station on the Jefferson River is approximately 32 miles downstream of the Project Area, near Three Forks, Montana, where the mean flow is 2,750 cfs. The USGS Gage 06026500 (Jefferson River near Twin Bridges MT) is located upstream of the diversion, and USGS Gage 06026650 (Jefferson River near Three Forks MT) is located downstream. During the 2020 water year, the gage near Twin Bridges recorded an annual low flow in mid-August of approximately 400 cfs (USGS 2021a) and the gage near Three Forks recorded an annual low of approximately 310 cfs (USGS 2021b).

The mine area contains springs and seeps that are generally associated with geologic contacts, topographical depressions, bedrock fractures, and collapsed adits. These springs and seeps generally flow at less than 1 gallon per minute (gpm). The exception to this low flow rate is Beaver Spring (north of the mine), which can flow at rates of 25 gpm for a month in the spring. Major surface water resources in the vicinity of the mine are shown on **Figure 3.4-1**.

Surface water resources are monitored as part of GSM's current monitoring program. GSM holds a Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activity (Permit No. MTR00498) for Industrial Facilities which is regulated by the DEQ Water Protection Bureau. Outfall locations are sampled and inspections conducted per requirements of that permit and the approved Storm Water Pollution Prevention Plan. Sample locations are shown on **Figure 3.4-2**. Grab samples of outfall discharges are collected when triggered by sufficiently large storm events (rare occasions) and quarterly benchmark samples are collected.

3.4.3 Environmental Consequences

3.4.3.1 No Action Alternative

No impacts would occur to surface water if the No Action Alternative is selected. Current surface water drainage patterns and runoff volumes and rates would have a high likelihood of remaining similar to current conditions. Current groundwater conditions south of TSF-1, as described in other sections, would also continue. Over the long term and as vegetation on reclaimed surfaces becomes denser, ephemeral surface water runoff rates would likely decrease. GSM would maintain surface water runoff features on the mine site postclosure. The existing permitted operation under the Maintenance and Care scenario consumes on average 24 gpm, as shown in the water balance provided in **Figure 2.2-2** and **Table 2.2-2**. No impact would occur to surface water under the No Action Alternative, and the current EWM control efforts would continue on the reach of the Jefferson Slough with no changes to current conditions.

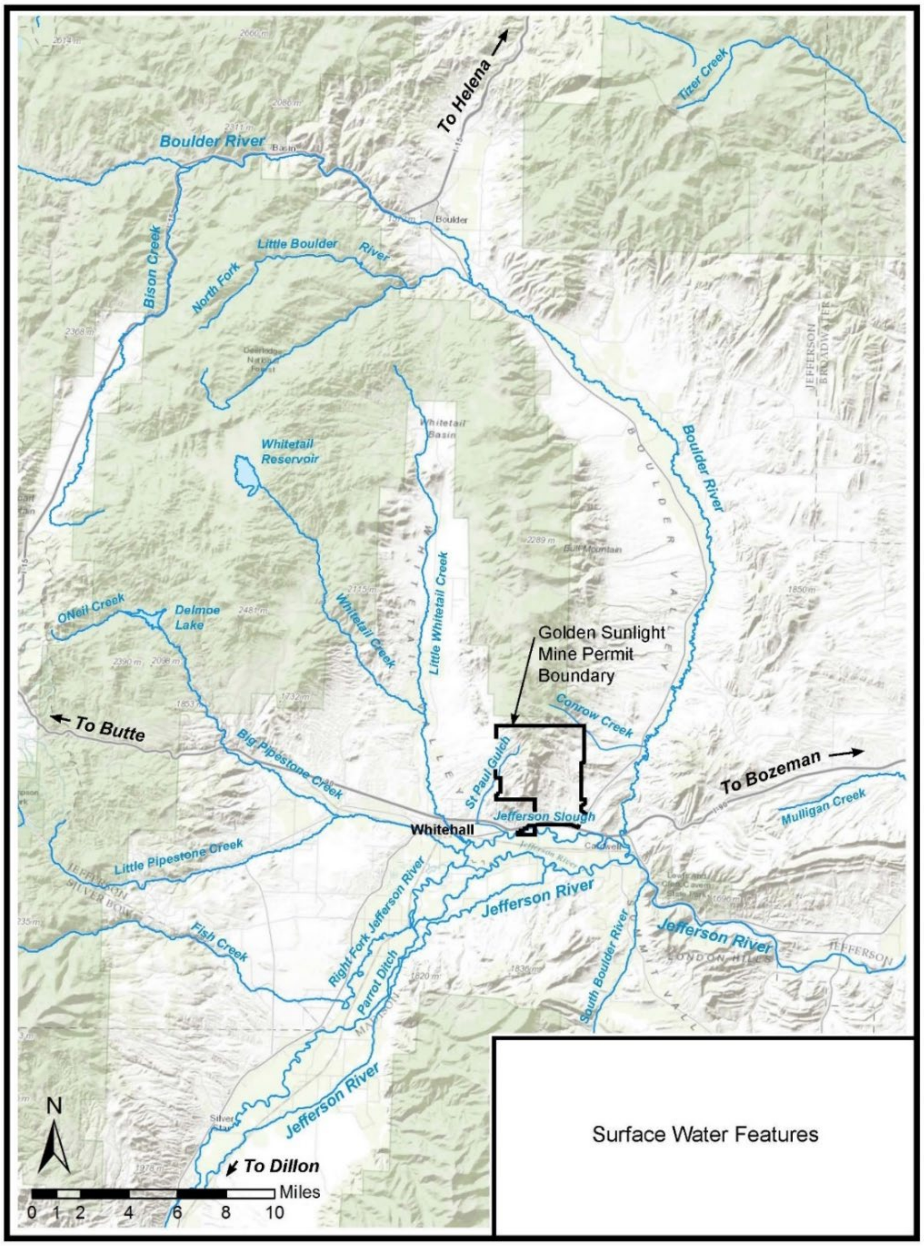


Figure 3.4-1
Major Surface Water Resources in the Vicinity of the Golden Sunlight Mine

3.4.3.2 Proposed Action

Under the Proposed Action, no additional new area would be proposed for disturbance; therefore, the majority of impacts to surface water resources would be minor and internal to the existing mine site. The primary components that may affect surface water resources would include tailings mining and processing from TSF-1 and the associated reclamation of TSF-1.

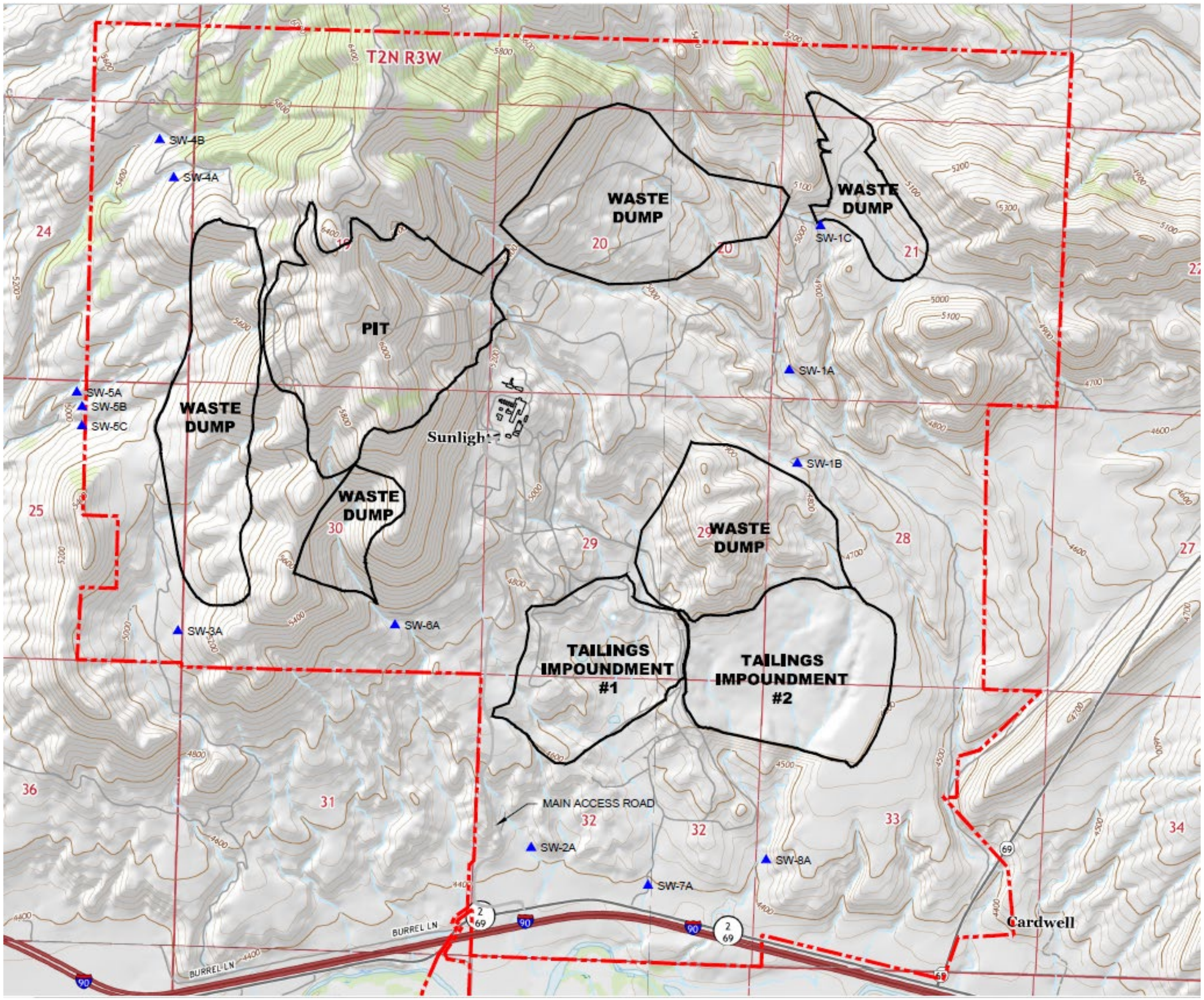


Figure 3.4-2
Outfall Monitoring Locations (Hydrometrics 2018)

Mining and reprocessing of tailings material from TSF-1 is expected to take 12 years. The effects to surface water resources, as compared to the existing permitted condition, can be categorized as short term and long term. The short-term impacts would be temporary effects during the 12-year period of mining TSF-1, and the long-term impacts would be permanent effects to the reclaimed site after completion.

Mining of TSF-1 would occur in phases, where growth media and substrate would be salvaged from the active phase and immediately used to reclaim the previously mined phase. This phased approach would leave the active mining and reclaiming areas exposed to direct precipitation, erosion, and runoff, while the unmined portions of TSF-1 would be presumed stable. The active mining areas of TSF-1 would include lined temporary storm water ponds that would capture and store storm water. During periods of precipitation, ponds would fill, and the captured water would be used for re-pulping purposes or routed to TSF-2 during periods of inactivity. The storm water may have degraded water quality associated with erosion during runoff or direct precipitation on exposed materials and may also include contaminants from direct contact with tailings. No additional storm water is anticipated to leave the overall mine.

The Project would not alter any current storm water flow paths, storm water best management practices, outfall locations, or sampling points until all of the TSF-1 tailings material has been excavated.

The proposed mining activity would alter the existing land use of TSF-1. Currently, TSF-1 is reclaimed, vegetated, and stable. While being mined, TSF-1 would be exposed and runoff from direct precipitation would increase from what may have previously infiltrated. The difference in the proportion of surface water that otherwise would become groundwater may be inconsequential, however; because all infiltrated precipitation would presumably be captured downgradient and pumped to TSF-2.

After the final portions of TSF-1 are mined, a runoff control ditch would be constructed along the southern limit to capture and convey storm water, which could potentially be laden with sediment, to an existing seepage pond associated with the TSF-1 underdrain system. When the site is fully stabilized, the ditch and pond would be removed because natural runoff conditions would have been achieved.

During mining of TSF-1, the excavated tailings would enter the Re-Pulping Plant where fresh and reclaimed water would be mixed and the slurry conveyed to the Flotation Plant. The Flotation Plant would also consume fresh water for processing.

The Proposed Action would consume an average of 396 gpm as shown in the water balance for the Proposed Action in **Figure 2.3-4** and **Table 2.3-1** (see Section 2.3.5.1, Site Water Balance). The Proposed Action would require an increase in consumptive use by approximately 372 gpm (0.83 cfs) over current (No Action) fresh water use (see Section 2.2.6.1, Site Water Balance).

The fresh water is sourced from an existing water right (41G 95773 00) that is held on the Jefferson River and allows for a maximum diversion of 2,244 gpm (5 cfs) over the duration of a water year. The water right is for a ditch from the Jefferson River for the purpose of mining with a priority date of July 18, 1934. Substantial withdrawals from rivers can generally adversely affect the physical, chemical, and biological characteristics of the river system downstream. During the 12-year active mining phase, the Proposed Action would divert 0.83 cfs from the Jefferson River. This volume is small relative to the maximum diversion allowed under the existing water right, and this flow corresponds to 0.21 percent and 0.27 percent of the flows at the Twin Bridges and Three Forks gages on the Jefferson River, respectively. During periods of low flows in the Jefferson River, withdrawals from the mine associated with the Proposed Action continue to be low relative to the flow in the river, therefore the proposed water usage would have negligible impact on the Jefferson River.

A temporary impact to surface water resources would be related to dust control during mining activities. Fresh water would be applied to roadways and stockpiles to increase the moisture content. If water is applied in excess, it may behave similarly to storm water and cause erosion and sedimentation. However, this impact is negligible because existing and temporary storm water-management facilities would contain this source within the mine. Because a negligible impact would occur to surface water under the Proposed Action, the likelihood would be low of any negligible changes to the current EWM control efforts on the reach of the Jefferson Slough.

As described in Section 3.3, Ground Water Hydrology and Geochemistry, no alterations to the groundwater pumping system at TSF-1 are included in the Proposed Action. Therefore, the quantity of groundwater flow into the Jefferson Slough should not change. After TSF-1 is excavated, removing the tailings source of contamination may allow for a reduced or eliminated pumpback well system in the future, which may have a low likelihood to increase surface water flows in the Jefferson Slough over the long term. However, modifications to the water-management system must be submitted for review and approval by DEQ and BLM, based on operational evidence that modification or elimination of the systems is appropriate.

Long-term, permanent effects to water resources may have a low likelihood of a minor impact from the final reclaimed condition of TSF-1. The Proposed Action is to reclaim TSF-1 to the original ground topography. Storm water may respond differently when compared to the current permitted, existing condition of TSF-1. The current condition of TSF-1 is vegetated and primarily flat and promotes localized storage and infiltration of direct precipitation (rather than producing runoff). The Proposed Action would return the TSF-1 site to its original topography and would have more variability, including steeper slopes, which provide less time and opportunity for direct precipitation to infiltrate. Steeper slopes may result in increased storm water runoff volume and rate as compared to the existing condition but may have a medium likelihood to have a minor beneficial impact compared to the current condition. These changed conditions are minor and internal to the mine site and will be subjected to the existing storm water controls.

3.4.3.3 Agency Modified Alternative

The Agency Modified Alternative focuses on modifications to reclamation. The modifications from the Proposed Action that affect surface water resources focus on incorporating enhanced topological features to TSF-1. The micro-topography would increase localized storage, retention, and infiltration of direct precipitation. With enhanced vegetation diversity, interception of direct precipitation as well as evapotranspiration would increase. These increases, when applied on the landscape scale, would have a medium likelihood of moderately impacting the current conditions by overall reducing the quantity of storm water runoff and erosion within the site. Under the Agency Modified Alternative, current EWM control efforts would continue on the reach of the Jefferson Slough.

3.5 Soils and Reclamation

The soil resources at the Golden Sunlight Mine were described in the 1997 Draft EIS (DEQ and BLM 1997) and the 2013 Final EIS (DEQ 2013). Final reclamation at the Golden Sunlight Mine will return the reclaimed areas to similar utility, vegetative cover, and stability as compared to adjacent undisturbed lands. Amendment 17 provides information on reclaimed materials and borrow sources to be placed as cover material for use in reclamation (GSM 2021a).

This section discusses the soil resources and reclamation of the proposed and alternative actions under Amendment 17. No changes are proposed to the approved postmining land uses of wildlife habitat and grazing for any of the affected areas. Additional reclamation information under the existing permit is provided in Section 2.2.7, Reclamation, and further discussion of the Proposed Action reclamation is detailed in Section 2.3.6, Reclamation.

3.5.1 Analysis Methods

During the process of GSM's 1995 permit Amendment Application, a site-specific soil survey of the mine was completed and released electronically by Jefferson County Soil Survey in 2003 (USDA NRCS 2003). The Natural Resources Conservation Service (NRCS) Web Soil Survey has mapped soil units available online for the Golden Sunlight Mine site. Mapped soil units were assessed while evaluating the environmental impacts of the No Action Alternative, Proposed Action, and Agency Modified Alternative.

There were four small mapped soil units that were shown as "prime farmland if irrigated" according to the NRCS Web Soil Survey within the GSM permitted mine boundary. However, after further investigation, the NRCS soil survey work was determined to be completed after the GSM site was operating for some time after it was permitted. The Web Soil Survey shows a 14.8-acre area northeast of TSF-2 but that area has been disturbed mine land for more than two decades. Another 5.1-acre area is shown east of TSF-2 along the GSM permit boundary that is not irrigated. The other two areas (10 acres total area) are located south of I-90 Interstate and have been irrigated before the GSM was permitted in 1975. These areas are not within the permitted mine disturbance area under either the No Action Alternative or the Proposed Action.

The Operations and Reclamation Plan provides the basis for reclamation that will occur at the site and specific reclamation details for all areas of the Golden Sunlight Mine, including disturbed acreage, seed mixes, bonding, and success criteria (GSM 2014). The status of the current reclamation areas is provided in the latest GSM annual report (GSM 2020). Borrow material sources and quantities for the areas addressed in this EIS are provided in the Amendment 17 Application. The suitability and quantity of reclaimed material and borrow material were reviewed and potential environmental impacts were assessed based on the information provided, publicly available sources, and industry best practices.

3.5.2 Affected Environment

The analysis area for soils and reclamation includes the three areas at the Golden Sunlight Mine proposed to be disturbed in Amendment 017: TSF-1, Pit, and the Re-Pulping Plant. The Flotation Plant is located within the existing mill facilities, so it is proposed to remain in place for future industrial use and/or economic development and will not be reclaimed. All soils that would be disturbed under Amendment 017 are on currently reclaimed areas and have been previously disturbed. The native soils at the mine are primarily rocky, shallow, and poorly developed on slopes. Historical salvage and stockpiling of soils have blended the various soil types to create a soil complex. Materials would be salvaged from tailings excavation at TSF-1 with additional required material sourced from the East Pit Borrow site.

3.5.2.1 Tailings Storage Facility 1

The primary affected area of Amendment 017 is the 190-acre surface of TSF-1, which contains approximately 1.2 million yd^3 of salvageable material for reclamation. This area has achieved final reclamation and is relatively flat. On top of the mine tailings is approximately 4 ft of reclamation material, which consists of 2 ft of suitable growth media on top of approximately 2 ft of capping material.

3.5.2.2 Mineral Hill Pit

Operations were suspended on the surface of the Pit in November 2015 and underground workings were suspended in April 2019. The Pit covers a total area of 258 acres (plan view), and the lower portion of the Pit to be filled with thickened tailings slurry would result in a consolidated tailings surface of approximately 50 acres. Growth media placement and seeding have not occurred on the Pit floor, highwalls, or benches. Final reclamation outlined in the Operations and Reclamation Plan states major benches that can be safely accessed and unlikely to be covered with slough or rubble will be prepared and seeded (GSM 2014).

3.5.2.3 Re-Pulping Plant

The Re-Pulping Plant site contains approximately 6 acres of land that would be affected. The area contains previously disturbed and reclaimed land at the toe of the East Buttress Dump Extension.

3.5.3 Environmental Consequences

3.5.3.1 No Action Alternative

Under the No Action Alternative, the permit amendment would not be approved and ongoing land uses would continue. No impacts to the soil resources at TSF-1 and the Re-Pulping Plant would occur and the likelihood that current conditions would remain in their reclaimed state is high. The base elevation of the Pit would not change, and no placement of thickened tailings and subsequent settling would occur. No changes to the approved 2014 Operations and

Reclamation Plan would be made and Pit reclamation would continue as currently approved. Beginning in 2022, the mine would maintain a workforce for approximately 6 years until TSF-2 is consolidated, the Water Treatment Plant is constructed, and the remaining reclamation is completed. After TSF-2 reclamation around 2028, site activities would include long-term management of the water systems and water treatment plant.

3.5.3.2 Proposed Action

Under the Proposed Action, the primary environmental impact to soil resources would occur at TSF-1. TSF-1 has achieved final reclamation and this area would be stripped of suitable growth media and capping material and vegetation would be removed. If appropriately removed and separated during excavation and stockpiling, these stripped materials would continue to be suitable growth media for the growth and establishment of vegetation.

The top 4 ft of material would be salvaged for use in concurrent reclamation during tailings extraction and processing under Amendment 017. Salvaged material would initially be stockpiled north of TSF-1 until a sufficient quantity of material has been excavated for hauling the salvaged material for placement on the to-be reclaimed surface.

The upper 2 ft of materials would be salvaged as suitable growth media, and the underlying 2 feet of material would be salvaged as capping material. The actual separation depth of these two materials from each other and from the underlying tailings would be made in the field based on visual observation of the material. These surface materials would be stockpiled nearby while the first cut is made and then be placed over the final reclamation surface that would approximate the original contours. This action would have a temporary minor impact on these soil resources as they are disturbed over the short term but would have a high likelihood of moderately impacting and ultimately improving the reclamation of this area by introducing topographic variation to the final reclaimed surface over long term.

Disturbed areas would be reclaimed to comparable stability and ecologic function as that of adjacent areas, as specified in the 2014 Operations and Reclamation Plan. The final reclamation surface would change from a relatively flat plateau to an approximation of the original undisturbed topography, as shown on **Figure 3.5-1**. The application of organic matter and fertilizer can be used to support revegetation as needed. Application of fertilizer and organic matter may encourage the establishment of substantial weed populations. In areas where the growth media is not sufficient to support vegetation without amendments, these areas may result in unsuccessful revegetation.

Specific grading thickness, controls, or stabilization practices are not detailed in the Amendment Application. Without specifying the success criteria and grading methodology, it is possible the resultant final grade may fill in drainages and eliminate swell/swale features; thus, the original topography would not be accurately reflected. Where infilling of micro-topography occurs, the capacity of the landscape to control erosion would be reduced, and common erosion-control features employed elsewhere at the Golden Sunlight Mine may then be required to stabilize the reclaimed surfaces, which would further change the final surface from the original topography.

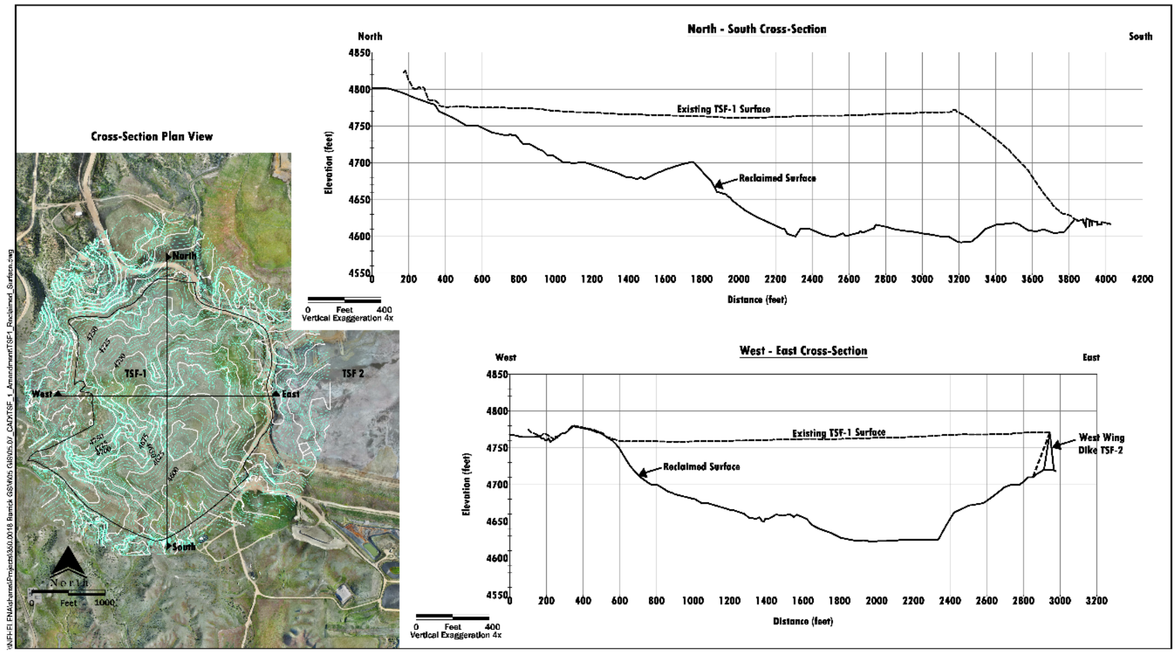


Figure 3.5-1
Proposed Final Reclamation Contours at Tailings Storage Facility 1 (GSM 2021a)

Potential chemical and/or mechanical mixing of capping material and suitable growth media is not addressed in the Proposed Action. Deleterious elements from the tailings may have migrated into the capping material over decades of infiltration and capillary exchange and reduced the capacity of that material to support plant life. Unintentional mixing may occur between tailings and the capping material during excavation, which may also degrade the quality of the material and reduce its capacity to support plant life.

The tailings materials below the surface materials would be beneficially impacted by the Proposed Action. The tailings currently contain elevated concentrations of sulfide-sulfur with an average of approximately 4 percent. Reprocessing the tailings in the Flotation Plant should reduce concentrations of sulfide-sulfur to approximately 0.5 percent in the resulting thickened tailings; consequently, the toxicity and acid generation potential of the material being disposed within the Pit would be reduced.

The area to be reclaimed in the Pit bottom would be substantially increased under the Proposed Action, which would improve Pit reclamation. The thickened tailings slurry would be placed in the Pit with pumps from the Flotation Plant via a pipeline spigot and contain approximately 65 percent solid material. These slurry materials should create a final 1 percent grade to the northeast during consolidation and separation from the process solution pond. If the final grade of deposited slurry material does not meet this criteria, grading would occur to create this drainage gradient after the tailings have consolidated sufficiently to allow safe access. Final placement of slurry material is expected to create a surface in the Pit floor at an elevation of 5,191 ft (mine datum) and settle to an elevation of 5,173 ft (mine datum) after consolidation. The settling process is expected to require a minimum of 5 years after final placement of tailings before low-compaction equipment can safely access the Pit.

Under the current Operations and Reclamation Plan, the haul roads and access road from Switchback #2 will be reclaimed. By adding the tailings material, the bottom of the Pit would increase from less than 5 acres to approximately 50 acres, which would be capped and seeded. As a result, the total reclaimed acreage within the Pit would increase from roads only to 50 acres, and the potential remains for safely accessible benches to be reclaimed.

The Re-Pulping Plant construction would disturb approximately 6 acres of previously disturbed and reclaimed land at the toe of the East Buttress Dump Extension. Existing vegetation would be grubbed before construction, and any additional material required to create a suitable construction pad would be sourced from either the East Borrow Pit site or from TSF-1 capping material. After the slurry processing and final material placement are completed, the Re-Pulping Plant would be dismantled. The disturbed area would be ripped to alleviate compaction, and 1 ft of suitable growth media would be placed before seeding.

The timeline for reclamation and closure activities described in the No Action Alternative, such as the reclamation of TSF-2 and construction of a long-term water treatment plant, would be delayed by the duration of the TRP under the Proposed Action (approximately 12 years).

3.5.3.3 Agency Modified Alternative

Under the Agency Modified Alternative, material impacts to soil resources and reclamation are primarily at TSF-1 and the Pit. The alternative geomorphic design (i.e., grading and mosaic vegetation) at TSF-1 would create a final grade to better approximate native topography regarding drainage density and length as well as the number of swales and swells present in the reclaimed area. The Agency Modified Alternative proposes that the predisturbance topography be used to calculate the total footage of primary and secondary drainage and the number of swells and swales for each cut. These features would then be incorporated into a design so that they can be quantified and maintained on the reclaimed topography.

The elevation, proposed contours, and size of the area underlying TSF-1 would remain as shown in the Proposed Action. The alternative geomorphic design would ensure that the original micro-topography (i.e., small topographic changes) of the native ground surface is honored, thus sufficient drainage density would be created to restore a stable hydrologic balance. Erosion control would be improved, and a drainage density and pattern created that would form stable land features with long-term erosion control. The design would allow the landform to convey storm water in a nonerosive, natural manner. The alternative design surface would be a stable, natural-acting, and generally maintenance-free surface that behaves more like a native surface in flood events, thereby reducing erosion. Standard erosion-control mechanisms that are used on smoother slopes found elsewhere on the site would not be required. Additional more-defined channels around the upper edge of TSF-1 for erosion control may also be eliminated. The alternative geomorphic design would also better blend TSF-1 into the existing topography. The resulting post-reclamation landscape would be superior to the Proposed Action in terms of appearance and performance.

The Agency Modified Alternative also proposes to sample the quality of the capping material at the interface of the tailings and stockpiled material that would be used at TSF-1. The sampling would ensure that the material is suitable growth media for supporting plant life and has not mixed with or been contaminated by tailings such that its capacity to support plant life is significantly reduced. The environmental impact to soil resources would be reduced by confirming that the materials are appropriate for use as growth media before the seedbed is prepared and seeding begins. The Agency Modified Alternative would have a medium likelihood of moderately impacting soil resources and reclamation during the long term.

3.6 VEGETATION

This section describes the affected environment and potential impacts of the proposed tailings reprocessing and disposal on vegetation.

3.6.1 Analysis Methods

Existing information regarding vegetation within the proposed Amendment 017 Project area was obtained from a variety of sources, including annual monitoring reports prepared by GSM (2020) and the modified application for Amendment 017 to Operating Permit No. 00065 submitted by GSM to DEQ in February 2021. Annual revegetation monitoring reports prepared by Cedar Creek Associates, Inc. (2018, 2019, 2020) were used to describe vegetation communities within the mine permit boundary and evaluate revegetation success in previously reclaimed areas of the mine. Plant nomenclature follows that of the *Manual of Montana Vascular Plants* (Lesica 2012). An environmental summary report from the Montana Natural Heritage Program (MTNHP) was obtained on April 6, 2021, which describes land-cover types in the Project vicinity (MTNHP 2021a).

3.6.1.1 Special-Status Plant Species

Special-status plant species include those listed under the Endangered Species Act as threatened and endangered (T&E) by the U.S. Fish and Wildlife Service (USFWS) and Species of Concern (SOC) that are tracked by the MTNHP. The SOCs represent plants and animals that are rare or have declining populations and, as a result, are potentially at risk of becoming federally listed as T&E or are at risk of extinction in Montana. Special-status plant species that are not federally listed as T&E are not offered the same regulatory protection as T&E species, but a designation as an SOC provides resource managers and decision-makers the information needed to make informed, proactive decisions regarding species conservation.

The environmental summary report prepared by MTNHP (2021a) contains information pertaining to threatened, endangered, and SOC plant species observed or thought to occur in the Project area. The USFWS (2021) Information for Planning and Consultation database was queried for T&E species that could potentially occur in the Project area and to identify designated critical habitat in the vicinity of the Project.

3.6.1.2 Noxious Weeds

State and county noxious weed lists were obtained from the Montana Department of Agriculture (2019a, 2019b). Noxious weeds previously identified within the mine permit boundary are identified in GSM’s 2019 monitoring report (GSM 2020) as well as the mine’s 2014 Operations and Reclamation Plan (GSM 2014).

3.6.2 Affected Environment

The Golden Sunlight Mine is located 5 miles northeast of the town of Whitehall in Jefferson County, Montana. The mine site lies within the Boulder/Elkhorn Mountains ecological unit (Nesser *et al*. 1997). This ecological unit consists of mountains that formed in granitic and volcanic bedrock. Much of the area has been glaciated. Elevations in this ecological unit range between 4,500 and 9,400 feet. Mean annual precipitation ranges from 13 to 30 inches with approximately 20 percent of the precipitation falling as snow. Soil temperature and moisture regimes are described as frigid and typic ustic, respectively. The primary natural disturbance is fire. Land use is predominantly grazing, timber harvest, mining, and suburban development (Nesser *et al.* 1997).

The MTNHP environmental summary report for the Project area identifies "Quarries, Strip Mines, and Gravel Pits" as the only land-cover type present within the mine permit boundary (MTNHP 2021a). However, reclaimed areas within the permit boundary more closely resemble land-cover types found immediately adjacent to the mine, including Rocky Mountain Lower Montane, Foothill, and Valley Grassland, Montane Sagebrush Steppe, and Rocky Mountain Montane Douglas-fir Forest and Woodland.

3.6.2.1 Tailings Storage Facility 1

TSF-1 is a 190-acre tailings facility that was constructed in 1982 on a compacted, natural-clay surface of the Bozeman Group Formation and operated until 1994. The facility contains 26.2 Mt of tailings and has a relatively flat surface area consisting of approximately 1.0 million yd^3 of surface capping material of 4 ft-thick soil and growth media cover over the TSF-1 embankment slopes (GSM 2021a). TSF-1 reached final reclamation in 2001 and has not been active since (GSM 2021a). A limited amount of cattle grazing has occurred within TSF-1 and most recently occurred in 2019 (GSM 2020). A self-sustaining vegetation cover has been established on the facility that consists of crested wheatgrass (*Agropyron cristatum*), intermediate wheatgrass (*Elymus hispidus*), and Russian wildrye (*Elymus junceus*); native perennial grasses including slender wheatgrass (*Elymus trachycaulus*), thickspike wheatgrass (*Elymus lanceolatus*), and western wheatgrass (*Elymus smithii*); and native shrubs including four-wing saltbrush (*Atriplex canescens*) (GSM 2021a). Other plant species occurring in adjacent reclaimed areas include alfalfa (*Medicago sativa*), common kochia (*Kochia scoparia*), and cheatgrass (*Bromus tectorum*) (Cedar Creek Associates, Inc. 2020).

3.6.2.2 Re-Pulping Plant

The Re-Pulping Plant area would encompass approximately 6 acres that were previously disturbed and reclaimed at the toe of the East Buttress Dump Extension immediately north of TSF-1 (GSM 2021a). The East Buttress Dump Extension has shown a positive trend in vegetation cover in recent years with a total cover of 56.3 percent recorded in 2019 (Cedar Creek Associates, Inc. 2020). This vegetation cover is significantly greater than previously observed on the East Buttress Dump Extension (Cedar Creek Associates, Inc. 2016). Dominant vegetation in this area includes thickspike wheatgrass, cheatgrass, and bluebunch wheatgrass (*Pseudoroegneria spicata*) (Cedar Creek Associates, Inc. 2020).

3.6.2.3 Mineral Hill Pit

The Pit covers an area of 258 acres (plan view). Highwalls in the Pit extend from an elevation of 4,525 ft at the Pit bottom to 6,240 ft along the northwest highwall. Mining in the Pit and underground workings was suspended in November 2015 and April 2019, respectively (GSM 2021a). Seeding has not occurred in the Pit, on benches, or highwalls, and little to no vegetation has been established on these areas. The upper portion of the northwest highwall is lined with coniferous trees, including ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*).

3.6.2.4 Special-Status Plant Species

According to the MTNHP Species Snapshot database, 26 SOC, potential SOC, or special-status species are known to occur in Jefferson County (MTNHP 2021b). Past surveys indicate that suitable habitat for two of these species, Parry's fleabane (*Erigeron parryi*) and limestone larkspur (*Delphinium bicolor*), occurs near the mine property, but neither species has been observed on site (Garcia and Associates 2013). The MTNHP environmental summary report for the Project area lists elemental occurrence records for two additional SOCs, silver bladderpod (*Physaria ludoviciana*) and annual Indian paintbrush (*Castilleja exilis*), near the mine property; however, both species were recorded several miles from the mine, and suitable habitat does not exist for either species within the proposed Project area (MTNHP 2021a). According to the USFWS Information for Planning and Consultation database, the only T&E species known to occur in the area is Ute ladies'-tresses (*Spiranthes diluvialis*) (USFWS 2021). This species is typically associated with wet meadows near river bottoms (such as the Jefferson River located immediately south of the mine), and no suitable habitat exists within the Project area. No special-status plant species have been observed within TSF-1 or the Pit.

3.6.2.5 Noxious Weeds

Noxious weeds have been actively controlled by GSM since 1984 (GSM 2020). Seven species of state-listed noxious weeds have been identified on site during previous surveys: Canada thistle (*Cirsium arvense*), whitetop (*Cardaria draba*), spotted knapweed (*Centaurea maculosa*), leafy spurge (*Euphorbia esula*), dalmation toadflax (*Linaria dalmatica*), yellow toadflax (*Linaria vulgaris*), and common hound's-tongue (*Cynoglossum officinale*) (GSM 2014). One state-listed Priority 3 regulated plant (cheatgrass) is also common across portions of the site (Cedar Creek Associates, Inc. 2020). Noxious weed mapping prepared by GSM indicates that little to no noxious weed growth occurs in TSF-1 or the Pit and infestations in areas between the two locations have been kept under control (GSM 2020).

GSM obtains fresh water for mine operations from the nearby Jefferson River Slough (water right S41G 95773 00), which would continue under Amendment 017 as fresh water would be used at the Re-Pulping Plant and the Flotation Plant (GSM 2021a). One state-listed aquatic noxious weed, Eurasian watermilfoil (*Myriophyllum spicatum*) (ESM), has previously been identified in the Jefferson River Slough (Confluence Consulting 2020). EWM monitoring conducted in 2020 suggests that EWM presence is limited to downstream portions of the Jefferson Slough beginning approximately 3 miles east of GSM's existing water intake point (Confluence Consulting 2020). Therefore, continued use of this intake point for Amendment 017 operations should not facilitate the spread of EWM to other areas.

3.6.3 Environmental Consequences

Amendment 017 would result in excavating approximately 26.2 Mt of tailings from the previously reclaimed TSF-1, constructing a new Re-Pulping Plant, reprocessing the excavated tailings to extract sulfur and gold, and disposing of the remaining tailings in the Pit (GSM 2021a). Reclaiming the TSF-1 surface would occur concurrently with tailings excavation in areas where excavation is already complete, and reclaiming the Pit surface would occur after tailings disposal and settlement in the Pit is completed. Post-project land use would include grazing and wildlife habitat in TSF-1 and wildlife habitat in the Pit. This section describes impacts to vegetation resources as a result of the No Action Alternative, Proposed Action, and Agency Modified Alternative.

3.6.3.1 No Action Alternative

Under the No Action Alternative, the permit amendment would not be approved and ongoing land uses would continue. No impacts to vegetation directly related to the proposed Amendment would occur under the No Action Alternative. TSF-1 reached final reclamation in 2001, and no changes to the existing vegetation community would occur. Similarly, without the construction of the Re-Pulping Plant, the previously reclaimed East Buttress Dump Extension would not be disturbed. The Pit would not yet have been reclaimed, and little to no vegetation would have been established in these areas. Under the No Action Alternative, reclamation would follow the existing Operations and Reclamation Plan established in 2014. Major benches that are unlikely to become buried with rubble from the Pit highwall over time and have sufficient width to allow machinery access, as well as Pit haul roads, would be capped with a 3-ft-thick soil cover and revegetated. The access road from Switchback #2 previously used for underground mine access would be reclaimed, and oxidized benches containing enough fine material to support plant life would be seeded and/or planted with trees where safety allows (GSM 2014). GSM would continue to control noxious and invasive weed species in accordance with the approved county weed control program. A noxious weed control contractor would continue to treat the property annually during the spring and summer months by using back-pack and all-terrain vehicle spraying to maintain noxious weeds at a level less than or equal to surrounding lands in the area (GSM 2014, 2020). Reclaimed areas would be monitored for noxious weeds until the reclamation bonds for those areas are released (GSM 2014).

3.6.3.2 Proposed Action

All activities resulting from the Proposed Action would occur within the existing mine permit boundary. Under the Proposed Action, there is a medium likelihood that moderate impacts to the vegetation resources near TSF-1 would occur during the Project. Primary disturbance areas would include 190 acres within TSF-1, 50 acres within the Pit, and 6 acres within the East Buttress Dump Extension at the site of the Re-Pulping Plant. Each of these sites is discussed in further detail in the following text.

TSF-1

Tailings would be recovered and transported from TSF-1 for approximately 12 years by using conventional excavation, loading, and haulage equipment (i.e., dozers, excavators, front-end loaders, and haul trucks). Tailings recovery would begin on the north end of TSF-1 and work in a southwesterly direction. All vegetation, growth media, and capping material from the previous 190-acre reclamation area of TSF-1 would be removed, and the ground surface would be returned to an elevation and topography similar to predisturbance conditions. Growth media and capping material would be stockpiled in areas where tailings have already been removed and would be used to reclaim these previously excavated areas concurrently with active tailings recovery. All existing vegetation within TSF-1 would be lost over the course of the Project, but concurrent reclamation would keep the unvegetated area at any one time to a minimum.

After placing the stockpiled capping material and growth media on areas where tailings have already been removed, the TSF-1 flat areas and the east-, west-, and south-facing sloped areas readied for reclamation would be seeded as specified in Appendix H, Reclamation Seed List of the Amendment Application (GSM 2021a). This seed mix would contain a mix of native and nonnative perennial grasses similar to the current species composition of the existing TSF-1 surface, and the final reclaimed surface would be similar in species composition to the current surface. However, a return to original topography (as opposed to the current TSF-1 surface, which is largely flat) would likely encourage an increase in vegetation diversity over the long term to include more forbs and shrubs in addition to grasses.

The Proposed Action would continue to monitor seedling emergence, measure point-intercept transects, take photo-points, and analyze soils on problematic areas to support revegetation efforts on reclamation areas (GSM 2021a). GSM would continue to control noxious and invasive weed species in accordance with the approved county weed control program. Revegetation methods may be modified per DEQ and BLM consultation and approval based on results of ongoing local evaluations, availability, and changes in reclamation technology.

Re-Pulping Plant

The Re-Pulping Plant yard area would be constructed of borrow material sourced from either the East Pit Borrow site or capping material from TSF-1. Existing vegetation would be grubbed before placing borrow material on the existing surface (GSM 2021a), which would result in vegetation loss from 6 acres of the previously reclaimed East Buttress Dump Extension for the life of the Project. However, the Re-Pulping Plant and associated infrastructure would be dismantled and removed from the site after the Project is completed, a minimum 1-ft growth media would be placed over the site, and the area would be reseeded (GSM 2021a).

Mineral Hill Pit

Reprocessed tailings from the Flotation Plant would be pumped to a thickener tank located near the Pit to thicken the tailings slurry to approximately 65 percent solids. Lime would be added as needed to raise the final tailings slurry pH. The thickened tailings slurry would then be pumped to the Pit for final placement. Flotation tailings would initially reach an elevation of approximately 5,191 ft (mine datum) and then settle to an elevation of approximately 5,173 ft (mine datum) after consolidation. The tailings would have an approximate grade of 1 percent to the northeast at the end of the reprocessing period, and the Pit would have a surface area of approximately 50 acres. After the tailings processing is completed, the final surface would cover approximately 1.4 acres of land managed by BLM on the west highwall.

An estimated 5 years after the final tailings placement in the Pit is complete, the surface would be expected to have settled sufficiently to allow for equipment to safely access the area. The tailings surface would be graded so that water does not accumulate on the reclaimed surface. After grading the surface, 4 ft of capping material (comprising 2 ft of oxidized overburden and limestone and 2 ft of growth media) sourced from the East Pit Borrow site would be placed over the final tailings surface to reduce the net infiltration of precipitation and influx of oxygen into tailings material as well as support the establishment of vegetation. After placing the capping and growth material, the reclaimed tailings surface would be seeded as specified in Appendix H, Reclamation Seed List (for north-facing slopes) within the Amendment Application (GSM 2021). The seed mix would contain a variety of perennial grasses similar to other reclaimed areas of the mine as well as forbs such as common yarrow (*Achillea millefolium*) and shrubs such as four-wing saltbrush and Wyoming big sagebrush (*Artemisia tridentate spp. Wyomingensis*).

There is a medium likelihood that moderate impacts to the vegetation resources in the Pit would occur during the Project.

3.6.3.3 Agency Modified Alternative

The Agency Modified Alternative geomorphic design at TSF-1 would create micro-topography and mosaic vegetation that would be closer in appearance to the original topography regarding drainages, swales, and swells in the reclaimed area. While the Proposed Action would reclaim the site to similar predisturbance topography, this alternative provides fine, micro-topography that provides greater opportunities for vegetation diversity. The Agency Modified Alternative would have a medium likelihood of moderate impacts to the vegetation resources near TSF-1 during the project and minor beneficial effects after reclamation. Stockpiled capping material at TSF-1 would be regularly tested to determine the suitability of this material for reclamation purposes, and the TSF-1 seed mix would either be modified to reduce the number of rhizomatous grasses and increase the number of forbs and shrubs, or a second seed mix with heavy forb and shrub components would be used with the seed mix in the Proposed Action. Planting of bare-root and containerized shrubs would also occur under the Agency Modified Alternative; success rates of shrub planting is uncertain based on previous attempts on site rock dumps. The vegetation benefits within TSF-1 would include increased vegetation diversity, improved volunteer and seeded plant establishment, reduced soil erosion, enhanced visual impacts to the reclaimed area, and an overall increased reclamation success. Specific plant species would be encouraged and vegetative diversity would be promoted. The variability in sunlight, water infiltration, and topsoil thickness would benefit volunteer and seeded grass, forb, and shrub species and positively impact wildlife habitat.

In the Pit, the Agency Modified Alternative would involve using a modified seed mix that would cut the grass Pure Live Seed (PLS)/ft^2 by one-half, replace some of the rhizomatous grasses with bunch grasses, and significantly increase the shrub PLS/ft^2. The Agency Modified Alternative would encourage shrub establishment in the Pit without hindering grass establishment, which would increase the overall vegetation diversity within the Pit.

3.7 WILDLIFE

This section describes the affected environment and potential impacts of the proposed tailings reprocessing and disposal on wildlife.

3.7.1 Analysis Methods

Existing information regarding wildlife within the proposed Amendment 017 Project area was obtained from a variety of sources, including annual monitoring reports prepared by GSM (2020), previous wildlife surveys conducted on the mine property (Garcia and Associates 2014), and bat and raptor habitat assessments conducted by NewFields (2019) within the Pit. The MTNHP Species Snapshot Database was also queried for animal species known to occur in Jefferson County (MTNHP 2021a).

3.7.2 Special-Status Species

Special-status species include those listed under the Endangered Species Act as T&E by the USFWS and species of concern (SOC) that are tracked by the MTNHP. The SOC represents plants and animals that are rare or have declining populations and, as a result, are potentially at risk of becoming federally listed as threatened or endangered or are at risk of extinction in Montana. Special-status species that are not federally listed as T&E are not offered the same regulatory protection as T&E species, but a designation as an SOC provides resource managers and decision-makers the information needed to make informed, proactive decisions regarding species conservation.

An environmental summary report prepared by MTNHP (2021b) contains information pertaining to threatened, endangered, and SOC animal species observed or thought to occur in the Project area. The USFWS (2021) Information for Planning and Consultation (IPaC) database was queried for T&E species that could potentially occur in the Project area and to identify designated critical habitat in the vicinity of the Project area.

3.7.3 Affected Environment

The Golden Sunlight Mine is located 5 miles northeast of the town of Whitehall in Jefferson County, Montana. According to the MTNHP Species Snapshot Database, 65 mammal species, 218 bird species, 7 reptile species, 5 amphibian species, and 16 fish species are known to occur in Jefferson County (MTNHP 2021a). Species likely to occupy the Project area are those associated with grassland, sagebrush steppe, cliff, and coniferous forest habitats. Amphibians and fish are not discussed further because aquatic habitat would not be impacted by the proposed Project.

3.7.3.1 Mammals

Mammal species observed on or near the mine property during previous surveys include big game such as mule deer (*Odocoileus hermionus*), elk (*Cervus elaphus*), and moose (*Alces alces*); carnivores such as black bear (*Ursus americanus*), mountain lion (*Puma concolor*), and coyote (*Canis latrans*); small mammals including mountain cottontail (*Sylvilagus nuttallii*); and several species of bats (Garcia and Associates 2014). Mine personnel report regular sightings of mule deer and elk on site, which often used previously reclaimed areas such as the East Buttress Dump Extension and the West and East Waste Rock Dump complexes. Other mammal species with the potential to occur on site include meadow vole (*Microtus pennsylvanicus*), pronghorn (*Antilocarpa americana*), and Richardson's ground squirrel (*Urocitellus richardsonii*) (MTNHP 2021a).

The two areas of the mine that are affected by Amendment 017 would include TSF-1 and the Pit. TSF-1 is a 190-acre facility that reached final reclamation in 2001 (GSM 2021a). A limited amount of cattle grazing has occurred within TSF-1 and most recently occurred in 2019 (GSM 2020). The facility supports a self-sustaining vegetation cover that consists primarily of rhizomatous grasses (GSM 2021a). Topography within TSF-1 is mostly flat. The current topography and vegetation within TSF-1 provide suitable habitat for small mammals such as mice, voles, and rabbits, as well as forage for larger mammals such as mule deer and elk. However, the entire facility (as well as the adjacent TSF-2) is currently surrounded by fencing that is intended to keep large mammals from entering the enclosure.

The Pit covers an area of 258 acres. Highwalls in the Pit extend from an elevation of 4,525 ft at the Pit bottom to 6,240 ft along the northwest highwall. The Pit has not been seeded, and little to no vegetation has been established. Suitable bat-roosting habitat occurs within crevices and holes found in the Pit highwalls, although no acoustic or night video surveys have been conducted to determine if bats are using this habitat (NewFields 2019).

3.7.3.2 Birds

Previous wildlife studies documented 26 species of birds that occur on or near the mine property (Garcia and Associates 2014). Common bird species that are likely to occur within TSF-1 include those that occupy grassland habitats, such as the brown-headed cowbird (*Molothrus ater*) and western meadowlark (*Sturnella neglecta*). Birds of prey such as the American kestrel (*Falco sparverius*) and several other hawk and owl species likely hunt for small mammals and birds within TSF-1.

NewFields (2015) found that the highwalls of the Pit provide suitable nesting and foraging habitat for five raptor species: golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), and American kestrel. Hundreds of rock pigeons (*Columba livia*) have been observed using crevices and depressions within the Pit highwalls for nesting, and GSM employees have observed golden eagles preying on the pigeons (NewFields 2019). Cliff swallows (*Petrochelidon pyrrhonota*) were also observed nesting on the lower portion of the Pit highwall (NewFields 2019). No active raptor nests within the Pit were observed during the 2019 habitat assessment (NewFields 2019). However, a golden eagle was heard above the Pit highwall intermittently during the survey, and raptor droppings were observed on the highwalls of another open pit within the mine, the North Area Pit, which suggests that raptors use both of these areas (NewFields 2019).

3.7.3.3 Reptiles

TSF-1 provides suitable habitat for several snake species, including the common garter snake (*Thamnophis sirtalis*) and prairie rattlesnake (*Crotalus viridis*). Reptile use of the Pit is likely limited because of a lack of access and suitable habitat.

3.7.3.4 Special-Status Species

The MTNHP environmental summary report for the Project area lists elemental occurrence records for eight bird SOC and four mammal SOC within 1 mile of the mine (MTNHP 2021b). Most of these observations were made near the Jefferson River to the south; however, several of the species listed have the potential to occur within the Project area. Bird species such as the bald eagle (*Haliaeetus leucocephalus*), burrowing owl (*Athene cunicularia*), and Clark’s nutcracker (*Nucifraga columbiana*) could use TSF-1 or adjacent forested habitat for roosting or feeding. Three of the four mammal SOC observed near the Project area are bats with the potential to use highwall habitat within the Pit (NewFields 2019). These species include Townsend’s big-eared bat (*Corynorhinus townsendii*), spotted bat (*Euderma maculatum*), and little brown myotis (*Myotis lucifugus*). Other bird SOC observed or with the potential to occur in the Project area include golden eagle, sharp-tailed grouse (*Tympanuchus phasianellus*), Brewer’s sparrow (*Spizella breweri*), and sagebrush sparrow (*Artemisiospiza nevadensis*) (MTNHP 2021b). Sagebrush habitat adjacent to TSF-1 has the potential for use by the greater sage-grouse (*Centrocercus urophasianus*); however, no designated core or general habitat for the species has been identified within the Project area, and impacts to the greater sage-grouse as a result of the Project are unlikely (Montana Sage Grouse Habitat Conservation Program 2021).

In addition to the bat SOC identified by the MTNHP, three bat species identified as sensitive by the U.S. Bureau of Land Management are known to occur at abandoned mine sites in western Montana and have the potential to occur in the Project area (Tigner 2011). These species include Townsend’s big-eared bat, long-legged myotis (*Myotis volans*), and long-eared myotis (*Myotis evotis*).

The USFWS IPaC database identified one listed threatened mammal species, Canada lynx (*Lynx canadensis*), with the potential to occur in the Project area (USFWS 2021). Canada lynx typically occupy high-elevation subalpine forest habitat, and while the occasional lynx may pass through the general Project area, lynx would not be expected to regularly occur in the area. This Project does not occur within designated critical habitat for the Canada lynx.

3.7.4 Environmental Consequences

Amendment 017 would result in excavating approximately 23.6 MT of tailings from the previously reclaimed TSF-1, constructing a new Re-Pulping Plant, reprocessing the excavated tailings to extract sulfur and gold, and disposing of the remaining tailings in the Pit (GSM 2021a). Reclaiming the TSF-1 surface would occur concurrently with tailings excavation in areas where excavation is already complete, and reclaiming the Pit surface would occur after tailings disposal and settlement in the Pit is completed. Postclosure land use would include grazing and wildlife habitat in TSF-1 and wildlife habitat in the Pit. This section describes impacts to wildlife resources as a result of the No Action Alternative, Proposed Action, and Agency Modified Alternative.

3.7.4.1 No Action Alternative

Under the No Action Alternative, the permit amendment would not be approved and ongoing land uses would continue. No impacts would occur, and current conditions of wildlife resources would continue. TSF-1 was reclaimed in 2001 and currently supports a self-sustaining population of grasses and forbs that provide suitable habitat for several small mammals, birds, and snakes, as well as foraging opportunities for large mammals and raptors. Access to TSF-1 by mule deer and elk is currently restricted by fencing that is intended to keep wildlife out of TSF-2, which would be removed upon final TSF-2 reclamation.

Under the No Action Alternative, Pit reclamation would follow the existing Operations and Reclamation Plan established in 2014. Major benches and haul roads that can be safely accessed would be capped with soil and reseeded/revegetated (GSM 2014). Any additional wildlife habitat establishment in the Pit would be dependent on the success of revegetation. The objectives of GSM’s 2015 Bat and Raptor Habitat Plan have been met; the Pit contains at least ten potential nesting sites within the upper one-third of the Pit highwalls for raptors as well as suitable roosting habitat for bats (NewFields 2015).

3.7.4.2 Proposed Action

All activities resulting from the Proposed Action would occur within the existing mine permit boundary, primarily within TSF-1 and the Pit. Tailings would be recovered and transported from TSF-1 for approximately 12 years by using conventional excavation, loading, and haulage equipment; the ground surface would be returned to an elevation and topography similar to predisturbance conditions; and growth media and capping material from the previous reclamation would be stockpiled and used to reclaim previously excavated areas concurrently with active tailings recovery (GSM 2021a). Excavation of growth media and capping material would be limited to the areas directly above the tailings to be excavated, which would reduce the amount of wildlife habitat being impacted at any given time. However, direct impacts (e.g., mortality) to wildlife occupying these habitats still have the potential to occur during the short term, primarily to species with limited mobility and/or occupants of burrows or nests at the time of construction. Mobile species would avoid direct mortality by moving to adjacent habitats but would still be temporarily displaced during tailings recovery. The final reclaimed surface of TSF-1 would more closely resemble predisturbance elevation and topography, which should increase vegetation diversity and variety of wildlife habitat compared to the existing (largely flat) surface.

Reprocessed tailings would be pumped to a thickener tank located near the Pit to thicken the tailings slurry to approximately 65 percent solids. The thickened tailings slurry would then be pumped to the Pit for final placement. Flotation tailings would initially reach an elevation of approximately 5,191 ft (mine datum) and then settle to an elevation of approximately 5,173 ft (mine datum) after consolidation. The tailings would have an approximate grade of 1 percent to the northeast at the end of the reprocessing period, and the Pit would have a surface area of approximately 50 acres. After tailings disposal in the Pit is complete, capping material sourced from the East Pit Borrow site would be placed over the final tailings surface, which would then be seeded as specified in Appendix H, Reclamation Seed List (for north-facing slopes) within the Amendment Application (GSM 2021a).

After tailings disposal is completed, the floor of the Pit would be approximately 5,173 ft and would result in a net loss of approximately 630 vertical ft of highwall habitat available to rock pigeons, raptors, and bats for nesting and roosting. However, potential raptor nest sites identified by NewFields (2019) occur on the upper one-third of the highwall where the tailings would not reach, and the Pit would still meet the objectives of the 2015 Bat and Raptor Habitat Plan (NewFields 2015). The 50-acre reclaimed Pit surface would offer suitable habitat for various mammals, birds, and other species that do not currently occupy the Pit.

Tree and/or shrub removal is not anticipated as part of the Proposed Action. However, if tree/shrub removal would be deemed necessary, all removal should occur between August 16 and April 15 to comply with the Migratory Bird Treaty Act. Active raptor nests within the Pit shall not be disturbed while in use. Golden eagle nests found within the Pit would be afforded additional protection under the Bald and Golden Eagle Protection Act. There is a high likelihood that no impacts to SOC or T&E species would occur long term as part of the Proposed Action.

3.7.4.3 Agency Modified Alternative

The Agency Modified Alternative geomorphic design at TSF-1 would create a final grade and mosaic vegetation that would be closer in appearance to the original topography regarding drainages, swales, and swells in the reclaimed area. Stockpiled capping and growth media material at TSF-1 would be regularly tested to determine the suitability of this material for reclamation purposes, and the TSF-1 seed mix would either be modified to reduce the number of rhizomatous grasses and increase the number of forbs and shrubs, or a second seed mix with heavy forb and shrub components would be used with the seed mix in the Proposed Action. Planting of bareroot and containerized shrubs would also occur under the Agency Modified Alternative. The Agency Modified Alternative could create a larger diversity of wildlife habitat within TSF-1 compared to the Proposed Action. Drainages, swales, and swells would lead to a greater diversity of plant species establishing within TSF-1 that could be used by several small mammals and birds, and an increase in the number of shrubs would create more habitat for nesting birds.

In the Pit, the Agency Modified Alternative includes using a modified seed mix that would cut the grass PLS/ft^2 by one-half, replace some of the rhizomatous grasses with bunch grasses, and significantly increase the shrub PLS/ft^2. The Agency Modified Alternative would encourage an increase in the overall vegetation diversity within the Pit and, thus, could lead to a minor increase in wildlife habitat diversity over the long term.

3.8 Land Use and Recreation

The following sections discuss the affected environment of Golden Sunlight Mine and potential impacts of the No Action Alternative, Proposed Action, and an Agency Modified Alternative on land use and recreation. The Amendment Application provides additional land use information including the history of use in the permit area.

3.8.1 Analysis Methods

The GSM operating permit, Amendment Application, Geographic Information System data, and various online databases were reviewed to evaluate land use at and near the Golden Sunlight Mine. The area evaluated for land use and recreation impacts includes the land within the GSM permit boundary, especially the area of TSF-1 and the Pit, and land immediately adjacent to the GSM permit boundary.

3.8.2 Affected Environment

The Golden Sunlight Mine is located in a rural area in Jefferson County in portions of Sections 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, and 33 of Township 2 North, Range 3 West; Sections 4, 5, and 6 in Township 1 North, Range 3 West; and Sections 13, 24, 25, and 36 in Township 2 North, Range 4 West, Montana Meridian. Whitehall, Montana, is the nearest major population area and is located approximately 5 miles southwest of the mine. The Golden Sunlight Mine permit area includes land that is privately owned as well as controlled by BLM. Land ownership is shown on **Figure 2.2-1** in Section 2.2.3, Mine Permit and Operations.

The current operating permit area covers 6,205 acres and the permitted disturbance area covers 3,399 acres (GSM 2021a). Current land use within the boundaries of the existing permit of the Golden Sunlight Mine includes mining-related activities primarily associated with reclamation and revegetation. The main features of the Golden Sunlight Mine include three pits (including the primary Mineral Hill Pit and two smaller, adjacent pits), three waste rock dump complexes, two tailings impoundments, and other ancillary mining facilities and utilities.

Current postmining land use within TSF-1 is grazing and wildlife habitat. Reclamation at TSF-1 was finalized in 2001 by placing capping/growth media material, establishing grass/shrub vegetation, continuing dewatering activities, and removing and/or plugging and abandoning surface and buried pipelines (GSM 2014). A self-sustaining vegetation cover consists primarily of grasses.

The current land use for the Pit is mining, although the post-reclamation land use is approved for wildlife habitat. Reclamation has not occurred in the Pit or on the highwalls, and little to no vegetation has been established on these areas. The Pit highwalls currently provide nesting sites on each highwall for bats and other avian species, and these sites are concentrated mainly in the upper one-third of the Pit highwalls. No raptor nests were observed in the Pit highwalls during a 2019 habitat assessment, but raptor predation of pigeons and raptor droppings were observed (Newfields 2019).

Land outside of GSM's property is typically used for ranching and livestock grazing and provides wildlife habitat. Public lands, including BLM land outside the permit, provide for public recreation opportunities. One of GSM's largest projects was the purchase of Candlestick Ranch, 3,500 acres on the Boulder River. The ranch is mostly open to the public for hunting and contains fisheries and wildlife habitat and is detailed in Section 3.10.2.3, Community. The GSM-owned Candlestick Ranch is open for public access for recreational opportunities. Outside the GSM permit boundary, Lewis & Clark Cavern State Park is located approximately 5 miles southeast of the GSM permit boundary. Interstate I-90 exists at the southern GSM permit boundary and BLM land borders the west and northwest GSM permit boundary.

3.8.3 Environmental Consequences

3.8.3.1 No Action Alternative

If the proposed Project is not approved, 26.2 Mt of tailings would remain at TSF-1 and GSM would continue complete reclamation and prepare for final mine closure under the existing Operating Permit No. 00065. No acreage would be disturbed outside of the current permitted design area, and reclamation plans as outlined in GSM's Operations and Reclamation Plan would continue to be implemented (GSM 2014).

Current postclosure land use within TSF-1 is to support livestock grazing and wildlife habitat (GSM 2021a). No changes to TSF-1 would occur and the reclamation status would remain the same under the No Action Alternative. The current land use for the Pit is mining, although mining is not currently active. Open-pit mine operations ceased in 2015, underground mine operations ceased in 2019, and GSM does not plan to reinitiate mining. Pit reclamation would be complete by 2028 and long-term dewatering activities would occur. The currently approved postmining land use of the Pit is wildlife habitat and, under the No Action Alternative, would remain the same. Impact on adjacent land uses and ownership would be negligible under the No Action Alternative.

3.8.3.2 Proposed Action

Under the Proposed Action, excavating, reprocessing, and disposing of tailings would not directly affect any undeveloped land or vegetation. All activities proposed would affect currently or previously disturbed land and involve existing mine infrastructure and pits. Land outside of the GSM permit boundary would not be impacted for use by wildlife or humans over the long term.

Approval of the Proposed Action would include excavating and reprocessing 26.2 Mt of tailings currently stored at TSF-1 to recover sulfur and gold. After tailings are removed from TSF-1, the area would be capped with 1.2 million yd^3 of material and seeded for revegetation purposes. The postclosure land use for TSF-1 under the Proposed Action is the same as under the No Action Alternative (i.e., wildlife habitat). The facility would be reclaimed for foraging, nesting, and other habitat purposes. Vegetation would consist of herbaceous and shrub species. Following final reclamation, this facility would be evaluated for bond release and maybe open to public use and recreation. This area is subject to active mining operations and is currently not available to the public.

Reprocessed tailings would be pumped to the Pit for final disposal. Postclosure land use for the Pit would be the same as under the No Action Alternative; the objective land use would be wildlife habitat that provides nesting, rooting, and escape/cover on the Pit highwalls. However, the Proposed Action would also expand the Pit floor to 50 acres of reclaimed lands and expand potential post-reclamation wildlife habitat.

3.8.3.3 Agency Modified Alternative

The only aspect of the Agency Modified Alternative that differs from the Proposed Action would occur during reclamation. Under the Agency Modified Alternative, the final reclamation design of tailings at TSF-1 would be improved to reduce visual impacts, diversify vegetation, and enhance wildlife habitat. The disturbance footprint of the Agency Modified Alternative would be the same as described for the Proposed Action; therefore, no additional impacts to land use would occur. Because the Agency Modified Alternative would enhance vegetation diversity of TSF-1 and the Pit floor after reclamation is complete, postclosure use of TSF-1 and the Pit may provide a more diverse wildlife habitat than the Proposed Action. Land outside the GSM permit boundary would not be impacted for use by wildlife or humans over the long term.

3.9 VISUAL RESOURCES

Visual resources and aesthetics are visible physical features (i.e., landforms, water, vegetation, and structures) within the assessment area. The components contribute to the landscape's overall scenic and aesthetic quality. This section discusses the affected environment of the Golden Sunlight Mine and potential impacts on visual resources.

3.9.1 Analysis Methods

The assessment of impacts on visual resources included visual simulations developed for the Amendment Application (GSM 2021a) and a site visit on February 19, 2021, USGS topographic maps, and Google Earth mapping.

3.9.2 Affected Environment

The Golden Sunlight Mine is located in a rolling, open, foothill setting on the southern flank of the Bull Mountains. In addition to mining at the Golden Sunlight Mine, adjacent land use is used for livestock grazing and serves as open space for wildlife.

According to the U.S. Environmental Protection Agency mapping of ecoregions, the Project area is located in Level IV Ecoregion 17w – Townsend Basin, which is characterized as a broad, semiarid intermontane valley with floodplains, stream terraces, alluvial fans, and areas of treeless hills (Woods *et al.* 2002). Elevations range from approximately 4,360 ft at Whitehall to more than 6,500 ft in the mine area. Grasses and shrubs dominate vegetation with scattered trees and rock outcrops on hillsides. The vegetation communities provide an intermingled mosaic of color and texture near the Golden Sunlight Mine site. Mining and grazing have impacted the native landscape around the Project area.

The mine, including TSF-1 and the Pit, is a notable landform in the area as shown on **Figure 3.9-1**. The toe embankment of TSF-1 is visible from Interstate 90 and Montana Highway 69. The feature appears man-made because of its relatively flat-sloping surface, although TSF-1 somewhat blends into the landscape because it is reclaimed with vegetation, including native shrubs such as fourwing saltbrush (GSM 2021a). (**Figure 3.9-2**). TSF-1 is clearly visible when approaching the mine from Golden Sunlight Mine Road, but not noticeable at highway speeds. The uppermost highwalls of the Pit are viewable from long distances. The exposed orange to tan-colored rock contrasts with the surrounding grassland as shown on **Figure 3.9-1**. The majority of the Pit, including the Pit bottom and the area that would be backfilled with reprocessed tailings, are not visible from areas other than the edge of the Pit.

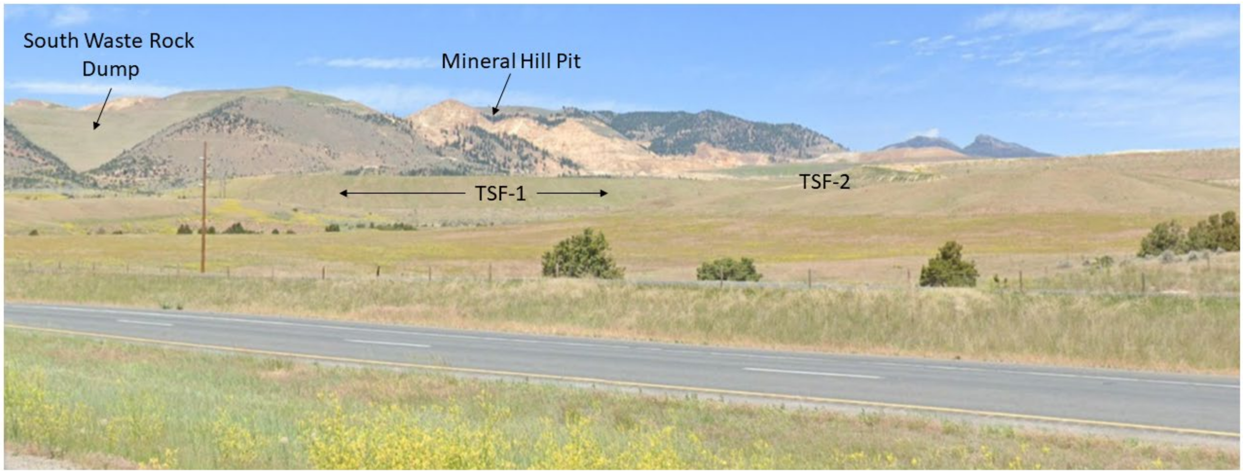


Figure 3.9-1
View From Interstate 90 Looking Northwest Toward Tailings Storage Facility 1 and the Mineral Hill Pit

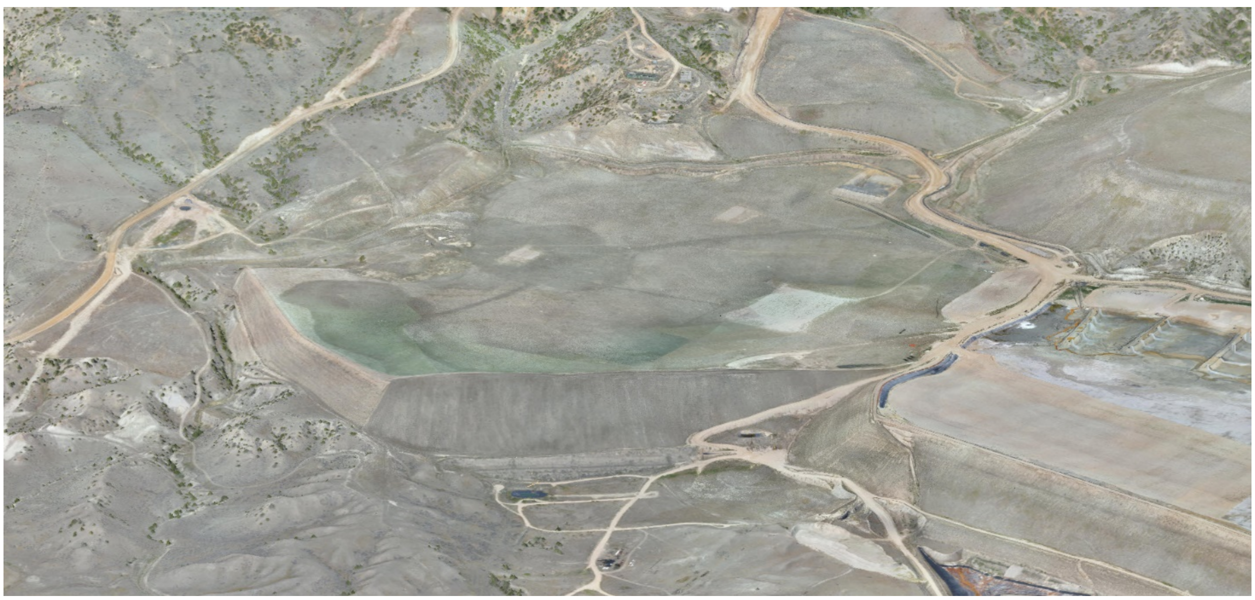


Figure 3.9-2
Current Oblique View of Tailings Storage Facility 1 (GSM 2021b)

3.9.3 Environmental Consequences

3.9.3.1 No Action Alternative

Under the No Action Alternative, the current landscape and visual resources would be unaffected and no impacts would occur. The mine would continue reclamation and closure activities under the existing permit until approximately 2028. Travelers on highways and local roads in the vicinity of the Golden Sunlight Mine would continue to view the existing TSF-1, Pit, and other features associated with mining and human development. After reclamation is complete, the visual contrast of the disturbed lands would be reduced but still evident over the long term. The large Pit would remain after Pit reclamation operations (GSM 2014), and the flat-topped TSF-1 would remain as is.

3.9.3.2 Proposed Action

Under the Proposed Action, the vegetation and capping material at TSF-1 would be excavated and removed over the next 12 years. Because the tailings are being excavated from north to south and most excavation would be below the surface grade of TSF-1, the view of extraction operations would be limited. The toe embankment would be the last phase of material to be removed from TSF--1. During and after toe embankment removal, the majority of the TSF-1 footprint would be visible from nearby roads. A conceptual view of the TSF-1 area after removing the tailings is shown on **Figure 3.9-3**. Compared to the current condition, the topography of the TSF-1 area after extraction and reclamation would improve the landscape over the long term to a more natural-appearing landscape that would be more similar to predisturbance topography.

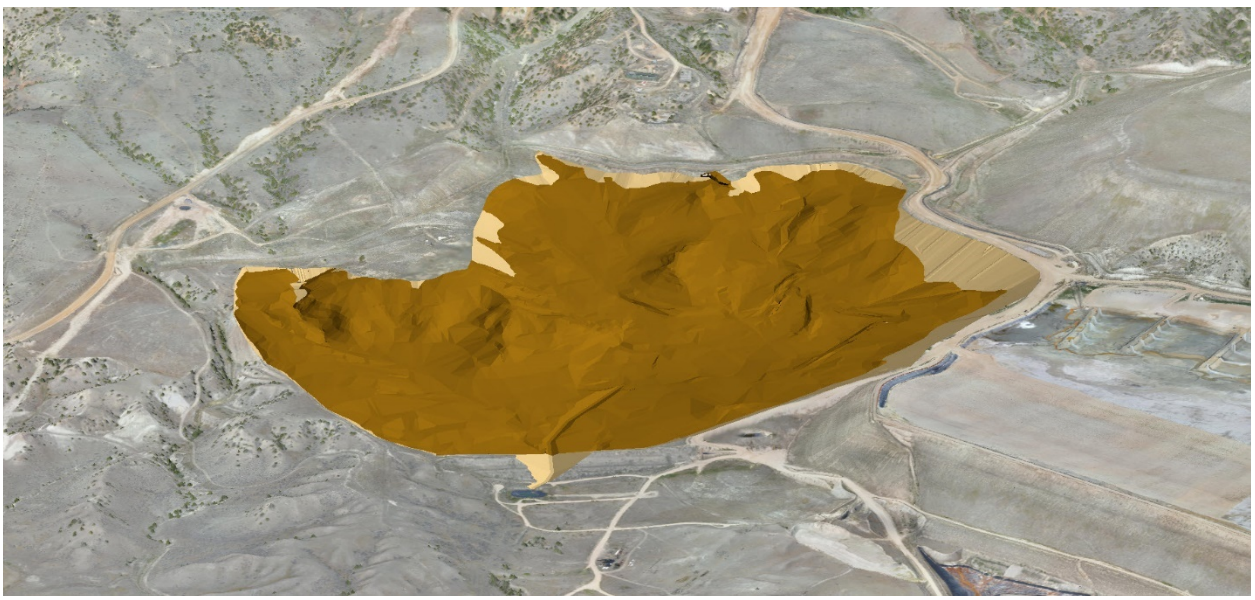


Figure 3.9-3
Conceptual View of Tailings Storage Facility 1 Topography Following Tailings Removal (GSM 2021b)

The public visibility of the Pit would not be different than the No Action Alternative. Only the uppermost portion of the highwalls are visible from nearby public roads. However, the view of the Pit from elevated locations adjacent to the Pit would be changed during backfill operations as reprocessed tailings slowly begin to backfill the Pit. After the tailings disposal is complete, the Pit floor would be capped and revegetated. At the end of the Project, the Pit floor would be approximately 50 acres. The final post-reclamation view of the Pit from vantage points near the Pit edge would be improved under the Proposed Action.

A description of the Proposed Action reclamation is provided in Section 2.3.6, Reclamation. The scoping process for the Proposed Action did not result in any comments or concerns about visual resources. Under the Proposed Action, there is a high likelihood that minor impacts to the visual resources would occur during the Project and minor beneficial visual impacts would remain long term after project completion.

3.9.3.3 Agency Modified Alternative

The only aspect of the Agency Modified Alternative that differs from the Proposed Action would occur during reclamation. During tailings removal and reprocessing, visual impacts would be the same as under the Proposed Action. The post-reclamation landscape of the Agency Modified Alternative would include a more natural appearance and vegetation of TSF-1 that better blends with the landscape and, therefore, produce more aesthetic premining views.

3.10 SOCIOECONOMICS

The Golden Sunlight Mine is located in Jefferson County near Whitehall, Montana. This section describes the existing socioeconomic conditions in the county and the potential impacts of each alternative.

3.10.1 Analysis Methods

The socioeconomic analysis area encompasses Jefferson County and considers impacts to employment and income, taxes, and the community from GSM's operation. The analysis period includes data from 2017 to 2020. Data used in this section are from the Montana Department of Labor & Industry and U.S. Bureau of Statistics. GSM provided additional information regarding employment and state and local taxes.

Public scoping comments expressed local employment, economic, and environmental concerns. The comments were received in February and March 2021 and submitted by residents, businesses, and organizations from nearby communities (e.g., Whitehall and Butte). A majority of the comments supported the proposed Amendment and acknowledged the mine's impact on employment, community contributions, and the overarching goal of reducing acid-generating minerals.

The mining industry consistently pays higher wages than nonmining occupations. GSM pays several types of taxes and fees to Jefferson County and the state of Montana, while GSM employees pay income and property taxes. This revenue, along with potential future changes to mine operations, is valuable to nearby communities, particularly Whitehall.

3.10.2 Affected Environment

3.10.2.1 Employment and Income

The Montana Department of Labor & Industry reports that the 2020 unemployment rate was 5.1 percent in Jefferson County and 5.9 percent in Montana (Montana Department of Labor & Industry 2021a). In 2019, the average wage for all industries and occupations was $43,366 in Jefferson County and $45,370 in Montana (U.S. Bureau of Labor Statistics 2021a) (Montana Department of Labor and Industry 2021b). **Table 3.10-1** compares the unemployment rates and average wages at the county, state, and national levels.

Table 3.10-1
Employment and Earnings

Location	Unemployment (%)	Average Wage ($)
Jefferson County	5.1 [a]	43,366 [b]
Montana	5.9 [a]	45,370 [c]
US	8.1 [d]	56,310 [e]

[a] Montana Department of Labor & Industry (2021a)
[b] U.S. Bureau of Labor Statistics (2021a)
[c] Montana Department of Labor & Industry (2021b)
[d] U.S. Bureau of Labor Statistics (2021b)
[e] U.S. Bureau of Labor Statistics (2021c)

3.10.2.2 Tax Revenues

GSM is currently engaged in site reclamation and construction of a Flotation Plant within the mill building, under the conditions approved under Amendment 013. GSM currently employs 16 full-time employees and 40 contractors (GSM 2021b) all of whom pay income tax and property taxes. In addition to income taxes paid by employees and contractors and payroll taxes paid by GSM, GSM's tax burden includes property taxes and payment of Montana Metal Mines Gross Proceeds Tax (GSM 2021b).

The Montana Metal Mines Gross Proceeds Tax is a property tax collected by the county treasurer. The tax base is generally allocated to taxing jurisdictions and is based upon their relative economic impacts. A yearly ad valorem tax is imposed on the gross proceeds of metal mines, pursuant to Section 15-23-801, MCA. Gross proceeds are the monetary payment or refined metal received by the mining company from the metal trader, smelter, roaster, or refinery. The payment is determined by multiplying the quantity of metal received by the quoted price for the metal and then subtracting basic treatment and refinery charges, quantity deductions, price deductions, interest and penalty, metal impurity, and moisture deductions as specified by the contract. The taxable value of metal mines is equal to 3 percent of the annual gross proceeds. This amount is subject to local mill levies in the jurisdiction in which the taxable value of the mining operation is allocated.

Recent annual property taxes and Montana Metal Mines Gross Proceeds Tax are shown in **Table 3.10-2**. Taxes in 2020 totaled less than $720,000, and contributions to the Montana Metal Mines Gross Proceeds Tax were limited to the base filing fee because gold was not produced on site (GSM 2021b).

Table 3.10-2
Summary of Golden Sunlight Mine's Taxes Paid From 2017 to 2020 (GSM 2021c)

Tax Category	2017 ($)	2018 ($)	2019 ($)	2020 ($)
Property Tax	1,194,386	1,316,006	1,050,410	717,247
Montana Metal Mines Gross Proceeds Tax	714,558	304,773	617,889	50

3.10.2.3 Community

GSM has a long history of contributing to the community, including cash donations and in-kind services. GSM has invested more than $3 million into the community since 1991; over the last several years, GSM has contributed between $70,000 and $137,000 annually to community organizations and programs within the Whitehall and Jefferson County area (GSM 2021c). Contributions include sponsoring high school scholarships, donating business park land, supporting Whitehall Chamber of Commerce, and participating in a local sportsmen association.

One of GSM's largest projects was the purchase of Candlestick Ranch, 3,500 acres on the Boulder River. The ranch is mostly open to the public for hunting, provides fishing access to the Boulder River, which contains good fisheries and wildlife habitat along with recreational activities such as hiking, horseback riding, and regulated trapping. GSM's Candlestick Ranch property has been enrolled in the Montana Fish, Wildlife, and Parks' Block Management Program since 2013. The property is open to recreation year round and is available for hunting access from September 1 to January 15 for white-tailed deer, mule deer, elk, moose, upland birds, fall turkey, and waterfowl. The property provides an average use of 1,656 hunter days per year from 2017 through 2020 (Dawson 2021). GSM also helped by donating land for the 20-acre Piedmont Pond Fishing Access Site southwest of Whitehall near the Jefferson River and has enrolled their property west of Piedmont Pond site in the FWP's Block Management Program, which is used for waterfowl hunting.

GSM also supports the community through employee participation in civic organizations and causes (i.e., organization/foundation benefit events and corporate sponsorships of local events) and has a program to donate used technology (e.g., computers and printers) to local schools. In collaboration with a local economic development corporation, GSM is helping to create a Community Development Council, which would be funded by GSM for local grant opportunities (GSM 2021c).

3.10.3 Environmental Consequences

3.10.3.1 No Action Alternative

Under the No Action Alternative, GSM would maintain the current level of employment for approximately 1 year and by 2022, employment would drop from 16 to 12 full-time employees to prepare for final mine closure (GSM 2021c). Twelve full-time employees would remain on the payroll for several years to accommodate TSF-2 consolidation, construct the Water Treatment Plant, and complete the reclamation work. As GSM moves toward final mine closure and reclamation activities in approximately 2028, employment would be reduced to six full-time employees to manage water systems and the Water Treatment Plant indefinitely under postclosure conditions.

GSM would continue to pay taxes at a rate similar to that paid in 2020. By 2022, a slight decrease in the number of full-time employees may slightly decrease taxes paid at the individual income, county, or state level. Base property taxes would decline as the site moves toward closure, and contributions to the Montana Metals Mines Gross Proceeds Tax would cease. Under the No Action Alternative, GSM's contributions to the community would decline from current levels and have a high likelihood of moderately impacting the socioeconomic resources during both the short term and long term.

3.10.3.2 Proposed Action

Under the Proposed Action, the total number of full-time employees at the mine would increase to 35, an additional 10 mining contractors would be retained on site, and an estimated 30 over-the-road contracted trucking positions would be needed for concentrate haulage. This increase in employment and contracted services would begin immediately upon Project approval and be maintained over the entire Project period. The number of full-time employees would revert to current levels (i.e., 16 employees) after the Project is completed (GSM 2021c); employment would then be further reduced to complete the reclamation and water-management activities described for the No Action Alternative.

Over the life of the Project, payroll would be approximately $50 million and GSM's purchases (including fuel) would total approximately $29 million. By comparison, the annual payroll in 2020 totaled approximately $3.2 million, and total purchases were approximately $1.5 million. GSM's property taxes and contributions to Montana Metal Mines Gross Proceeds Tax would increase up to approximately $2 million annually or $20 million over the life of the Project (GSM 2021c). Under the Proposed Action, GSM would likely continue or slightly increase its financial contributions, employee participation, and other positive local community impacts and have a high likelihood of moderately impacting the socioeconomic resources during both the short term and long term.

3.10.3.3 Agency Modified Alternative

The only aspect of the Agency Modified Alternative that differs from the Proposed Action would occur during reclamation. The effects of the Agency Modified Alternative on social and economic conditions would be the same as described for the Proposed Action. GSM's employment rate, property taxes and contributions to the Montana Metal Mines Gross

Proceeds Tax, and community contributions and participation would be equivalent to the Proposed Action and have a high likelihood of moderately impacting the socioeconomic resources during both the short term and long term.

3.11 NOISE

Noise is generally defined as unwanted sound and can be intermittent or continuous, steady or impulsive, stationary or transient. Noise levels heard by humans and animals depend on several variables, including the distance and ground cover between the source and receiver as well as atmospheric conditions. Perception of noise is affected by intensity, frequency, pitch, and duration.

3.11.1 Analysis Methods

The analysis area for noise includes the mine permit boundary and nearby adjacent receptors. Noise measurements were conducted by GSM in 1995 and impacts were evaluated by DEQ and BLM in the 1997 Draft EIS for Amendment 008 (DEQ and BLM 1997). In that study, GSM measured noise at 24 various receptor points during blasting and normal mine operations. Background noise measurements were 50-51 a-weighted decibels but increased to a maximum of 88 a-weighted decibels when traffic passed by on the interstate (DEQ and BLM 1997). During mining activity, which included blasting, noise measurements at the receptor sites appeared to be dominated by highway noise and blasting events yielded no change in peak background noise readings (DEQ and BLM 1997).

A brief note in the 1997 Draft EIS indicates that past noise disturbances caused by propane cannons (to keep birds and wildlife away from the tailings impoundments) were addressed by repositioning the devices away from residences (DEQ and BLM 1997). DEQ has no other records of noise complaints about the Golden Sunlight Mine. No recent noise monitoring or modeling has been conducted.

3.11.2 Affected Environment

The Golden Sunlight Mine area is located in a mountainous, rural environment with low ambient noise levels typical of sparsely populated rural areas. The major source of existing noise is associated with periodic short-term activities at the Golden Sunlight Mine and highway traffic on Interstate I-90 south of the mine site. In the past, noise impacts have been minimal beyond the permit boundary during operations. Minimal noise associated with current operations includes personal vehicle use, heavy machinery used for reclamation (e.g. haul trucks, loaders, and excavators), and construction of the Flotation Plant within the mill building.

The nearest community is Whitehall, Montana, and is located approximately 5 miles from the permitted mine disturbance boundary. Very few sensitive noise receptors exist near the mine. The closest sensitive human receptors include two private residences located approximately 1 and 1.2 miles south of the West Waste Rock Dump. Additional residences are located further away from the mine. Noise propagation from the mine to the residences is mitigated by the elevation difference, topography, and vegetation. Because of the mine's proximity to

Interstate I-90, which runs along the southern edge of the mine permit boundary, the nearest receptors are subjected to significant traffic noise that dominates the noise environment.

Sensitive animal receptors include terrestrial and avian wildlife. Because of the ongoing activity at the Golden Sunlight Mine, wildlife has been displaced by the past and current activity or has acclimated to mining operations. No active raptor nests within the Pit were observed during the 2019 habitat assessment (Newfields 2019).

3.11.3 Environmental Consequences

3.11.3.1 No Action Alternative

Under the No Action Alternative, currently approved operations and associated noise impacts would continue under Operating Permit 00065. Noise levels produced by the current operation would continue for approximately 1 year and would gradually reduce as GSM moves toward final closure in approximately 6 years. At that point, all mining-related noise would cease except for light vehicle use and postclosure activities (e.g., reclamation/vegetation maintenance, monitoring activities, and water management) and the permanent Water Treatment Plant; however, noise from these activities would be negligible. The mine currently operates from 6 a.m. to 5 p.m. Monday through Friday. Therefore, noise associated with the mine generally occurs within this time frame.

The Golden Sunlight Mine area is generally open hillside and the mine is located on privately owned land in a semi-remote setting, which is located 1 mile or more from the nearest residences or other areas of concentrated human activity. This setting reduces the potential for nuisance noise levels.

Since mining operations ceased in 2019, no noise related to blasting and ore hauling currently occurs at the site. Short-term construction activities to build the Flotation Plant within the mill would result in temporary noise increases near the plant and along portions of local roads adjacent to the mine. The greatest potential for annoyance associated with permitted mine-related sound would generally be produced by mine and contractor vehicle traffic along local roads and highways. During current and future permitted closure and reclamation activities, noise impacts would be similar to current levels. Dozers, haul trucks, and other equipment would still be used during reclamation for grading, soil placement, and seeding. After the site is reclaimed, minimal staff would continue to travel on local roads to and from the mine to maintain operations of the water-management systems and Water Treatment Plant, to conduct monitoring, and to maintain the reclamation/vegetation across the site.

3.11.3.2 Proposed Action

Under the Proposed Action, 26.2 Mt of tailings from TSF-1 would be excavated and hauled to the Re-Pulping Plant. Excavation and reprocessing of tailings material are expected to take 12 years. TSF-1 and the Pit would both be covered with growth media and reclaimed after the Project. During the TRP, mining of tailings would occur from 7 a.m. to 5 p.m. Monday through Friday, and the Flotation Plant within the mill would operate 24 hours a day 7 days a week. Therefore, noise associated with the mine would generally occur within this time frame.

Potential noise effects would primarily be from heavy equipment (haul trucks, loaders, bulldozers, graders, and other vehicles) related to excavation, haulage, and reclamation at TSF-1. Noise would be more noticeable at TSF-1 and immediately adjacent areas. However, once the first cut is made (approximately 30 to 35 ft deep), most of the heavy equipment would be below the surrounding topography and, hence, the travel distance for noise would be limited and negligible during the short term.

Noise from backfilling and reclamation of the Pit would primarily be contained to the immediate Pit vicinity based on topography, which would confine noise within the Pit over the short term. Noise created from the Re-Pulping Plant and Flotation Plant would primarily be inside processing buildings during the short term.

The produced concentrate would be loaded from the Flotation Plant into covered over-the-highway semitrucks for transporting to Barrick's existing mines in Nevada (GSM 2021a). An estimated 15 semitrucks per day would be loaded at the Flotation Plant and then would leave the mine site at the Frontage Road paralleling Interstate I-90. Material transport traffic would add to the traffic increase from personal vehicles to and from the site: 56 staff and contractors under the No Action Alternative to 85 staff and contractors under the Proposed Action. This increased mine traffic would have a high likelihood to increase mine-related noise but would be a minor impact and not be expected to become a nuisance in comparison to existing traffic noise.

Similar to the No Action Alternative, the site would be reclaimed after the end of processing in 12 years and, ultimately, all mining-related noise would cease over the long term except for the permanent Water Treatment Plant.

3.11.3.3 Agency Modified Alternative

The only aspect of the Agency Modified Alternative that differs from the Proposed Action would occur during reclamation. Noise from excavation, hauling, and other mining activities would be the same as described for the Proposed Action. The proposed changes to the TSF-1 reclamation would not appreciably change the amount of time or noise generated during reclamation activities; therefore, noise impacts would be the same as the Proposed Action.

4.0 CUMULATIVE, UNAVOIDABLE, IRREVERSIBLE AND IRRETRIEVABLE, AND SECONDARY IMPACTS AND REGULATORY RESTRICTIONS

4.1 METHODOLOGY

The cumulative impacts analysis for each potentially impacted resource is presented in Section 4.2, Cumulative Impacts. The cumulative impacts analysis for this Project was conducted in accordance with Montana Environmental Policy Act (MEPA) by completing the following:

- Identifying the location or geographic extent for each resource that may potentially be impacted by the Project;
- Determining the time frame in which the potential impacts of the Project could occur;
- Identifying past, present, and future actions or projects that overlap the Project's spatial and temporal boundaries and that, in combination with the Project, could impact a particular resource; and
- Analyzing the potential for cumulative impacts for each resource identified.

Unavoidable, irreversible, and irretrievable adverse impacts for each resource were identified during the impact evaluation described in Chapter 3.0, Affected Environment and Environmental Consequences. Unavoidable impacts are discussed in Section 4.3, Unavoidable Adverse Impacts, and irreversible and irretrievable impacts are discussed in Section 4.4, Irreversible and Irretrievable Commitment of Resources. Secondary impacts were evaluated by analyzing the Proposed Action for potential secondary effects over a larger geographic area than the mine disturbance, and this analysis is presented in Section 4.5, Secondary Impacts.

4.1.1 Identification of Geographic Extent

The geographic extent of potential cumulative impacts includes the area or location of resources potentially impacted by the Project. For many resources (e.g., soil, vegetation, and geology), the geographic extent used to assess direct and secondary impacts, such as the Project disturbance footprint, is the same area used to assess cumulative impacts. However, for other resources, the geographic extent is more expansive. The impacts analysis uses reasonable and rational spatial boundaries (e.g., hydrologic unit codes, wildlife management units, subbasins, areas of unique recreational opportunity, and viewshed) for a meaningful and realistic evaluation (Montana Environmental Quality Council 2017). **Table 4.1-1** describes the geographic extent where cumulative impacts from past, present, and future projects and actions could potentially impact each relevant resource outside of the disturbed area.

Table 4.1-1
Cumulative Impacts Assessment Areas

Resource	Assessment Area
Ground Water Hydrology	Sheep Rock Creek and Conrow Creek watersheds
Surface Water Hydrology	Sheep Rock Creek and Conrow Creek watersheds
Vegetation and Wildlife	1-Mile Radius From the Project

4.1.2 Identification of Past, Present, and Future Projects or Actions

Past, present, and future projects or actions that could impact individual resources when carried out in combination with the Project are included in this analysis. Permanent impacts caused by past and present projects and actions since mining began in the vicinity of the proposed project were considered as part of the existing baseline conditions for each resource addressed in Chapter 3.0, Affected Environment and Environmental Consequences. Therefore, potential impacts from past projects and actions are already included in the evaluation of direct and secondary impacts. Related future actions may have an impact on a resource when combined with the Project. However, future actions "may only be considered when these actions are under concurrent consideration by any agency through pre-impact statement studies, separate impact statement evaluations, or permit processing procedures" (Section 75-1-208(11), *et seq.*, Montana Code Annotated [MCA]). This Environmental Impact Statement (EIS) refers to these projects as future actions.

The following steps were completed to obtain information regarding present and pending actions and projects in the vicinity of the current and proposed mine-expansion areas:

- Contacting government staff at agencies with potential projects or actions in the area;
- Reviewing the EIS scoping comments for this Project; and
- Independently researching nearby projects and activities.

Future actions are defined as those that are related to the Proposed Action by location or generic type. Related future actions were considered in the cumulative impact analysis only if they met one of the following criteria in accordance with Section 75-1-208(11), *et seq.,* MCA:

- The project is currently under consideration by any agency through pre-impact studies;
- The project is currently under consideration by any agency through separate impact statement evaluations; or

- The project is currently under consideration by any agency through a permit processing procedure.

4.2 Cumulative Impacts

Cumulative impacts described in this chapter are changes to resources that can occur when incremental impacts from one project combine with impacts from other past, present, and future projects. Cumulative impacts are "the collective impacts on the human environment within the borders of Montana of the Proposed Action when considered in conjunction with other past, present, and future actions related to the Proposed Action by location or generic type," (Section 75-1-220(4), *et seq.,* MCA). Cumulative impacts can result from state or nonstate (private) actions that, "have occurred, are occurring, or may occur that have impacted or may impact the same resource as the Proposed Action," (Montana Environmental Quality Council 2002). Related future actions must be considered when these actions are under concurrent consideration by any agency through pre-impact statement studies, separate impact statement evaluations, or permit processing procedures (Section 75-1-208(11), *et seq.,* MCA).

Cumulative impacts are assessed using resource-specific spatial boundaries and often attempt to characterize trends over timescales that are appropriate to the alternatives being evaluated. Cumulative impacts can only be assessed for resources that are likely to experience primary or secondary impacts caused by an alternative.

At the time of this EIS publication, the present and pending future projects or actions that, in combination with the Project, could have cumulative impacts include the following:

- Golden Sunlight Mines, Inc. (GSM) Amendment to Bureau of Land Management (BLM) Plan of Operations;
- GSM Minor Revision MR21-004 to DEQ Operating Permit and BLM Plan of Operations; and
- GSM modifications to the Air Quality Permit.

These two projects or actions that, in combination with the Project, were identified as having the potential to result in cumulative impacts are described in the following sections. This EIS does not address the potential for additional future mine expansion at the Golden Sunlight Mine, because this option is not currently proposed or under consideration by any agency. The locations of these potential future projects are the same as the Proposed Action of the GSM's Amendment Application shown on **Figure 1.3-1.**

Possible projects managed by other local, state, and federal agencies were also researched for the area in and around the proposed Amendment. No other local, state, or federal actions with the potential to affect the area in or around the proposed Amendment to the GSM operating permit were identified as being under review at the time of this EIS publication.

4.2.1 Golden Sunlight Mines Amendment to Plan of Operations

In addition to GSM's Amendment Application submitted to the Montana Department of Environmental Quality (DEQ), GSM concurrently submitted the Amendment Application to BLM for approval of revisions to its current Plan of Operations (No. MTM-82855). As described in Section 2.3.4, Reprocessed Tailings Disposal, the Proposed Action would affect approximately 1.4 acres of BLM-managed land within the Mineral Hill Pit (Pit). The impacts of the Proposed Action evaluated by the BLM would be the same as those evaluated by DEQ, which is the same project. Therefore, impacts are considered in this EIS and no additional cumulative impacts from this action are considered.

4.2.2 Golden Sunlight Mines Minor Revision MR21-004

A Minor Revision (MR21-004) was submitted to DEQ and BLM on May 19, 2021 to update the existing Operating Permit and Plan of Operations. This revision expanded the footprint of the area defined as the Flotation Plant within the existing Mill Complex and allowed construction of additional processing equipment and facilities within this area.

The Flotation Plant was relocated to the existing Mill Complex through Amendment 013, but the amendment specified that all flotation equipment would be located within a particular building within the Mill Complex. This Minor Revision allows construction of some flotation process components around the exterior of the building, as well as concentrate storage and load-out features in adjacent existing structures. Although much of the area contained within the proposed footprint for the Flotation Plant is located on private land, there are small portions of BLM land (<0.1 acre) within the expanded Flotation Plant area. The Mill Complex and Flotation Plant are contained entirely within the existing permit boundary and permitted disturbance boundary. The expanded footprint modifies an administrative definition and does not result in new disturbance.

The proposed equipment and infrastructure upgrades in MR21-004 would support the flotation processing methods approved under Amendment 013 for tailings contained in TSF-2. Although this equipment and facility configuration would also likely be used for the activities proposed under Amendment 017 for TSF-1 tailings, the facility upgrades would not be needed exclusively for reprocessing TSF-1 tailings. The construction of other facilities related to Amendment 017, such as the Re-Pulping Plant and Thickener facilities, would not be authorized under MR21-004. The removal and reclamation methods for the equipment and infrastructure upgrades in MR21-004 are consistent with the existing Operations and Reclamation Plan. The approval of

MR21-004 and construction within the Flotation Plant area is not anticipated to have cumulative impacts to assessed resources with other primary or secondary impacts separate from the Proposed Action.

4.2.3 Golden Sunlight Mines Modifications to Air Quality Permit

Resources listed in **Table 4.1-1** were evaluated for cumulative impacts related to proposed modifications to GSM's Montana Air Quality Permit No. 1689-08. GSM submitted an application for modification to the DEQ Air Quality Bureau on February 25, 2021. The amended air quality application is directly associated with the Proposed Action and includes estimates of proposed emissions. Emissions sources noted in the application include fugitive dust from topsoil and other stockpiles, material handling and transfer, road dust, and emergency generator use. No modeling was conducted; however, compliance with national air quality standards is evident because of the nature of the emissions sources and qualitative analysis. Approval of modifications to the air quality permit is not anticipated to have cumulative impacts to assessed resources with other primary or secondary impacts separate from the Proposed Action.

4.3 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are environmental consequences of an action alternative that cannot be avoided, either by changing the nature of the action or through mitigation. Unavoidable adverse impacts are discussed in the following sections for each resource as identified during the impact evaluation described in Chapter 3.0, Affected Environment and Environmental Consequences. Unavoidable adverse impacts were not identified for the remaining resources evaluated in Chapter 3.0, Affected Environment and Environmental Consequences.

4.3.1 Geology and Geotechnical

No unavoidable adverse impacts on the geology and geotechnical resources are expected under the Proposed Action. Existing geotechnical risks, including the stability of the west wall of the Pit and the Earth Blocks are expected to be unaffected or improved by the Proposed Action.

4.3.2 Ground Water Hydrology and Geochemistry

Dewatering associated with the Proposed Action would continue to depress the potentiometric surface levels under the mine footprint; however, pumping rates would be slightly higher at 100 to 130 gallons per minute (gpm) during the project. The Pit and underground mine dewatering would be designed to capture current ground water flows and drainage from reprocessed Tailings Storage Facility 1 (TSF-1) tailings placed in the Pit; however, proposed dewatering is similar to that of the No Action. The potentiometric level in the Pit would increase to 4,750 ft during tailings placement. Ground water quality impacts would be contained to the immediate vicinity of the Pit as dewatering and the cone-of-depression limits migration of contaminants.

4.3.3 Surface Water Resources

Unavoidable adverse impacts to surface water resources originate in the mining of the stabilized tailings of TSF-1. After the stabilized soils are disturbed and excavated, the area would temporarily have increased storm water runoff and less infiltration. However, proposed temporary sediment ponds and storm water controls in the TSF-1 excavation area would limit discharge and erosion. Impacts would be brief as TSF-1 will be concurrently reclaimed and reestablished growth media and vegetation would have similar surface water impacts as the area today.

4.3.4 Soils and Reclamation

Unavoidable adverse impacts to reclamation and soils include the disturbance of the final reclamation on TSF-1. Any soil horizons that have developed during the period that reclamation has been completed would be removed during stockpiling of this material for future reclamation. This impact would be mitigated after the final topography surface is reclaimed and soil horizons can begin developing again. This impact is short term, and new soil horizons developing in the proposed final topographic surface are expected to create additional diversity in soil environments than that found in the current plateau at TSF-1.

4.3.5 Vegetation

Unavoidable adverse impacts related to vegetation would include removing existing vegetation from the previously reclaimed TSF-1 surface. TSF-1 would be reclaimed and reseeded concurrently with tailings recovery, and a return to premining topography should encourage an increase in vegetation diversity over time; however, impacts to existing vegetation in the short term would be unavoidable.

4.3.6 Wildlife

Unavoidable adverse impacts related to wildlife would include temporarily removing habitat within TSF-1, displacing wildlife species that currently occupy this habitat, and direct mortality of less mobile species, such as small mammals or nesting birds. Habitat loss within TSF-1 would occur gradually over approximately 12 years and allow most species time to move into adjacent habitat. A return to more natural topography should increase habitat diversity over time; however, short-term impacts would be unavoidable. Similarly, within the Pit, disposal of reprocessed tailings and reclamation of the final Pit surface will result in the creating approximately 50 acres of suitable habitat for various mammals, birds, and other species that do not currently occupy the Pit; however, highwall habitat in the lower portion of the Pit would be lost as reprocessed tailings are pumped into the Pit. While most raptor species typically prefer the upper portions of open-pit highwalls, rock pigeons have been observed using the lower portion of the Pit and would be displaced as the Pit is filled.

4.3.7 Land Use and Recreation

Unavoidable impacts on land use and recreation would include the short-term loss of vegetation and capping material at TSF-1 during the tailings recovery stage. Land at TSF-1 is currently used for grazing and wildlife habitat. Upon reclamation at TSF-1, which includes regrading and reseeding, the native vegetation would return to provide the same grazing and wildlife habitat. After tailings are processed in the mill, the processed tailings would be backfilled into the lower elevations of the Pit. After tailings disposal is completed in the Pit, the floor would be capped and reseeded. Recreation would not be impacted because the Proposed Action occurs within the active mine footprint and public recreation does not occur in the mine boundary.

4.3.8 Visual Resources

Unavoidable adverse impacts to visible physical features would include removing capping material and vegetation (mainly grasses) as well as the tailings pile at TSF-1. Tailings removal from TSF-1 and reclamation activities would return topography and vegetation to predisturbance grazing and wildlife habitat use conditions. The tailings reprocessing would remove the tailings material from TSF-1 and the postprocessing slurry product would be placed in the Pit. After being processed in the mill, the tailings would be placed into the lower elevations of the Pit. The lower elevations of the Pit are not currently visible unless from the edge of the Pit highwalls. Upon backfilling of the lower elevations and reclamation completion, visual changes within the Pit would be noticeable from the highwall.

4.3.9 Socioeconomics

Unavoidable impacts on socioeconomics from the Proposed Action would be beneficial only at the county to state level. Socioeconomic impacts include increased employment at GSM, increased tax revenue from GSM and GSM employees, and increased payroll to the increased employment; increased financial and community support as well as services; and continued or increased land donation. All of these impacts would affect Jefferson County, nearby counties, and the state of Montana.

4.4 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

MEPA requires a detailed statement on any irreversible and irretrievable commitments of resources that would be involved in the Proposed Action if implemented (Section 75-1-201(1)(b)(iv)(F), *et seq.,* MCA). Irreversible resource commitments generally refer to impacts on or a permanent loss of a resource (including land, air, water, and energy) that cannot be recovered or reversed. Examples include cultural resource losses or converting wetlands to another use. Irreversible commitments are usually permanent or at least persist for an extended period. Irretrievable resource commitments involve a temporary loss of the resource or loss in its value such as a temporary loss of vegetation while the land is being used for another purpose. Habitat loss during this period is irretrievable, but the loss of the vegetation resource is not irreversible.

Irreversible or irretrievable commitments of resources are described in the following sections for resources that were identified during the impact evaluation described in Chapter 3.0, Affected Environment and Environmental Consequences. Irreversible or irretrievable commitments of resources were not identified for the remaining resources.

4.4.1 Geology and Geotechnical

No irreversible or irretrievable commitments for geology and geotechnical resources are expected under the Proposed Action. Geology and geotechnical resources are expected to remain the same or be improved by the Proposed Action as backfill material will help stabilize the Pit walls. However, backfilling the Pit with tailings would reduce potential future access to underlying mineralization.

4.4.2 Ground Water Hydrology and Geochemistry

A cone-of-depression created by Pit dewatering would be maintained under the Proposed Action. Under the approved closure plan, continued dewatering of the Pit at a rate of 57 gpm from the underground mine is projected to result in a dry pit and complete capture of tailings seepage and groundwater flowing to the pit and underground mine.

With placement of tailings in the Mineral Hill Pit dewatering rates are projected to peak at about 100-130 gpm near the end of tailings repositioning, then gradually decrease to about 38 gpm, in order to completely prevent groundwater outflow from the backfilled pit and underground mine. Dewatering would be reduced over time as the reprocessed TSF-1 tailings drain down and could eventually be discontinued. Cessation of Pit dewatering is not included in the Proposed Action and would be dependent on volumes and quality of dewatering water and necessitate approval from BLM and DEQ as some impact to ground water would likely result.

4.4.3 Surface Water Resources

No irreversible impacts would affect surface water resources that result from the Proposed Action. Irretrievable impacts to surface waters may result from modifications to the water cycle that result from the Proposed Action. Under the Proposed Action, a greater portion of storm water would run off rather than infiltrate. The runoff water would be captured and used for processing tailings or pumped to TSF-2. In either case, the water would eventually leave the site as evaporation and not be infiltrated. Another irretrievable impact to surface water resources is reduced flow in the Jefferson River by a maximum of 396 gpm throughout the duration of the project as a result of the increased diversion of fresh water to support the Proposed Action.

4.4.4 Soils and Reclamation

Irreversible impacts to soils in the Pit include covering the Pit bottom with tailings to an elevation of 5,173 feet (mine datum), increasing the basal area available for reclamation to approximately 50 acres, and changing the materials in the base of the Pit from native rock to consolidated tailings overlain with growth media. Irreversible impacts to TSF-1 would include changing the topography of the area from a flat plateau to the approximate undisturbed original topographic surface. Irretrievable impacts to the soils at TSF-1 would include disturbing reestablishing soil horizons during stockpiling activities and removing established reclamation. No irretrievable impacts on soils or reclamation would be expected in the Pit.

4.4.5 Vegetation

Irretrievable impacts on vegetation would include the temporary loss of vegetation from the TSF-1 surface during tailings recovery activities. Vegetation would return to TSF-1 upon reclamation and reseeding. No irreversible impacts on vegetation would be expected.

4.4.6 Wildlife

Irreversible impacts on wildlife could include the direct mortality of young and/or immobile species (e.g. small mammals and ground nesting birds) that occupy habitat within TSF-1 during tailings recovery activities and are unable to disperse into adjacent habitat before tailings excavation and recovery taking place. Wildlife mortality could be minimized by conducting wildlife surveys before disturbance and conducting disturbance outside of typical nesting seasons. Other irreversible impacts would include the loss of highwall habitat within the lower portion of the Pit. Irretrievable impacts on wildlife would include the temporary loss of habitat within TSF-1 during tailings recovery and the displacement of wildlife occupying those habitats at the time of disturbance.

4.4.7 Land Use and Recreation

Irreversible impacts at TSF-1 with tailings reprocessing would include removing the tailings pile, reclaiming the ground beneath the current tailings pile, and backfilling processed tailings into the lower elevation areas within the Pit. After the tailings disposal is complete, the Pit floor would be capped and reseeded. The land use should return to predisturbance conditions at

TSF-1 upon reclamation, which includes placing capping material upon regraded topography and reseeding.

4.4.8 Visual Resources

Irreversible adverse impacts to visible physical features would include removing the tailings pile at TSF-1 and restoring the landscape to predisturbance conditions. Topographic changes would include regrading the ground beneath the current tailings pile, adding capping material, and reseeding with vegetation to encourage grazing and wildlife habitat use. Short-term adverse impacts to visible physical features would include removing capping material and vegetation (mainly grasses). After tailings are processed in the mill, backfilling of the postprocessing slurry into the lower elevations of the Pit would be another irreversible impact. The current reclaimed tailings pile at TSF-1 is visible from public roads. Permanent changes to the landscape associated with the Proposed Action would be minor. Reclamation and reseeding activities associated with the Proposed Action would represent a beneficial visual resource impact for grazing and wildlife habitat use.

4.4.9 Socioeconomics

Irreversible impacts on socioeconomics from the Proposed Action would be beneficial only at the county to state level. Socioeconomic impacts include increased employment at GSM, increased tax revenue from GSM and GSM employees, and increased payroll to the increased employment; increased financial and community support as well as services; and continued or increased land donation. All of these impacts would affect Jefferson County, nearby counties, and the state of Montana.

4.5 Secondary Impacts

Secondary impacts to the human environment are indirectly related to the agency action; i.e., they are induced by a primary impact and occur at a later time or distance from the triggering action. Secondary impacts are discussed in the following sections for each resource as identified during the impact evaluation described in Chapter 3.0, Affected Environment and Environmental Consequences. Secondary impacts were not identified for the remaining resources evaluated in Chapter 3.0, Affected Environment and Environmental Consequences

4.5.1 Geology and Geotechnical

No secondary impacts are expected to the geology and geotechnical resources identified from the Proposed Action. The geotechnical stability of the Pit highwall would be enhanced by the tailings emplacement, and this benefit would be maintained through postclosure and is a primary impact rather than a secondary, separate benefit.

4.5.2 Ground Water Hydrology and Geochemistry

No secondary impacts are expected to the ground water and geochemistry resources identified from the Proposed Action at the Pit because water would continue to be captured and treated indefinitely under postclosure conditions, which is similar to the No Action. A secondary impact at TSF-1 is expected because of tailings removal; an improvement of ground water quality in this area may occur over time as discussed in Section 3.3, Ground Water Hydrology and Geochemistry. Modeling suggests that dewatering rates at TSF-1 pumpback wells may be able to be reduced in the future, and impacts to downgradient ground water would be less severe over time compared to the No Action.

4.5.3 Surface Water Resources

Diversion of 396 gpm (0.83 cubic feet per second) of fresh water from the Jefferson River compared to 24 gpm diverted under the No Action scenario would imperceptibly reduce its flow quantity downstream. The reduced flow may be considered a secondary impact if the reduction results in a change to the physical, chemical, and biological characteristics of the river downstream from the diversion. This volume is small relative to the maximum diversion allowed under the existing water right, and this flow corresponds to 0.21 percent and 0.27 percent of low flows in 2020 at the Twin Bridges and Three Forks gages on the Jefferson River, respectively.

4.5.4 Soils and Reclamation

Secondary impacts to soils include the potential for windblown soil to move within and outside of the mine boundary. Exposed tailings contain elevated sulfur content along with other potentially deleterious elements. Monitoring soil moisture and wind conditions in conjunction with watering dry soils during high-wind conditions would mitigate this impact. No secondary impacts on reclamation are expected.

4.5.5 Vegetation

Disturbed soils and soil stockpiles within TSF-1 provide habitat for noxious weeds to establish during tailings recovery activities. Noxious weeds that establish in the disturbance area have the potential to spread to previously reclaimed areas within the mine boundary as well as to adjacent habitats outside of the mine. Noxious weed control measures would be implemented for the duration of the Proposed Action to prevent weeds from establishing in disturbed areas.

4.5.6 Wildlife

Increased noise levels associated with the Proposed Action, particularly near TSF-1, could displace wildlife from adjacent wildlife habitat within and outside of the mine boundary. However, noise impacts are expected to be minimal.

4.5.7 Land Use and Recreation

The secondary impact of the Proposed Action would be an increase in wildlife presence caused by reclaiming predisturbance topography and vegetation at the TSF-1 site and the Pit backfilled area. With the tailings removed from TSF-1, regrading topography, recapping, and reseeding would provide a natural landscape for wildlife habitat use. Another secondary impact would be improved surface water flow at the TSF-1 site from the natural, reclaimed landscape.

4.5.8 Visual Resources

Secondary impacts to visual resources would include improved views for the public of TSF-1 as it is reclaimed and revegetated, with improvements increasing over time.

4.5.9 Socioeconomics

Beneficial secondary impacts from the Proposed Action would be an improved economic opportunity to existing and new businesses that support the mining industry in Jefferson County, nearby counties, and Montana. Financial and community support in the forms of taxes, wages, and community engagement are specific examples of beneficial secondary impacts. Long-term secondary impacts occurring upon mine closure would include losses of GSM jobs, taxes paid by GSM, and economic support from wages and community engagement; this outcome is eventual under both the No Action and Proposed Action but would occur sooner under the No Action.

4.6 Regulatory Restrictions

MEPA requires state agencies to evaluate regulatory restrictions proposed to be imposed on private property rights as a result of major actions of state agencies, including an analysis of alternatives that reduce, minimize, or eliminate the regulation of private property (Section 75-1-201(1)(b)(iv)(D), *et seq.,* MCA). Alternatives and mitigation measures required by federal or state laws and regulations to meet minimum environmental standards, as well as actions proposed by or consented to by the applicant, are not subject to a regulatory restrictions analysis.

No aspect of the alternatives under consideration would restrict the use of private lands or regulate their use beyond the permitting process prescribed by the Montana Metal Mine Reclamation Act. The conditions that would be imposed by DEQ in issuing the permit would be designed to make the Project meet minimum environmental standards or have been proposed and/or agreed to by GSM. Thus, no further analysis is required.

5.0 CONSULTATION AND COORDINATION

The Montana Environmental Policy Act requires that Montana Department of Environmental Quality consult with and obtain comments from (1) any state agency that has jurisdiction by law or special expertise with respect to environmental or human resources that could be directly impacted by the Project and (2) any Montana local government (municipality, county, or consolidated city-county government) that could be directly impacted by the Project (§75-1-201(1)(c), Montana Code Annotated). The responsible state official shall also consult with and obtain comments from Montana state agencies with respect to regulating private property involved.

Consultation and coordination took place before and during the formal scoping period, as well as during the Environmental Impact Statement preparation. The names of individuals and organizations that Montana Department of Environmental Quality consulted during the development of this Environmental Impact Statement are listed in **Table 5-1**. DEQ also consulted with Montana tribes, including the Assiniboine, Sioux, Blackfeet, Chippewa Cree, Crow, Salish and Kootenai Tribes, Little Shell Chippewa, Nakoda and Aaniiih, and the Northern Cheyenne.

Table 5-1
List of Agencies Consulted

Agency	Individual	Title	Date
Montana Department of Commerce, Hard Rock Mining Impact Board			2/12/21
Montana Department of Natural Resources and Conservation			2/12/21
Montana Department of Natural Resources and Conservation, Mineral Management Bureau	Teresa Kinley	Geologist	2/12/21
Montana Department of Natural Resources and Conservation, Trust Lands Management Division			2/12/21
Montana Department of Natural Resources and Conservation, Water Rights Bureau			2/12/21
Montana Department of Transportation	Jean Riley		2/12/21
Montana Environmental Information Center	Jim Jensen		2/12/21
Montana Environmental Quality Council			2/12/21

Agency	Individual	Title	Date
Montana State Historic Preservation Office	Stan Wilmoth	State Archaeologist	2/12/21
Montana Fish, Wildlife & Parks			2/12/21
U.S. Fish and Wildlife Service			2/12/21
U.S. Environmental Protection Agency, Helena Office	Julie Dalsoglio		2/12/21
U.S. Environmental Protection Agency, Region VIII	James Hanley		2/12/21
U.S. Environmental Protection Agency, Region VIII		Director NEPA Program	2/12/21
Bureau of Land Management Butte Field Office	Joan Gabelman		2/12/21
Bureau of Land Management Billings Office	Jim Beaver		2/12/21
Jefferson County Commissioners			2/12/21
Whitehall Mayor and Town Council			2/12/21

6.0 LIST OF PREPARERS

Table 6-1 provides a list of individuals who contributed to writing, reviewing, and/or preparing this Environmental Impact Statement (EIS).

Table 6-1
List of Preparers

Name	Role or Resource Area	Education
Department of Environmental Quality		
Freshman, Charles	Mine Engineer	P.E. M.S. Geological Engineering B.S. Civil/Environmental Engineering B.S. Geology
Henrikson, Craig	Air Quality	M.S. Civil Engineering B.S. Chemical Engineering
Jepson, Wayne	Hydrologist	M.S. Geology B.S. Earth Science
Jones, Craig	Montana Environmental Policy Act Coordinator Project Manager	B.A. Political Science
Olsen, Millie	EIS Reviewer	M.S. Land Resources and Environmental Sciences B.S. Chemistry
Rolfes, Herb	Hard Rock Supervisor EIS Reviewer	M.S. Land Rehabilitation B.A. Earth Space Science A.S. Chemical Engineering
Smith, Garrett	Geochemist EIS Reviewer	M.S. Geoscience/Geochemistry B.S. Chemistry
Strait, James	Archaeologist	M.A. Archaeology B.S. Anthropology
Walsh, Dan	Hard Rock Bureau Chief EIS Reviewer	B.S. Environmental Engineering
Butler, Thomas	Legal Counsel	J.D. Attorney M.S. Psychology B.S. Zoology
RESPEC		
Cude, Seth	Soils Reclamation	M.S. Soil Science M.S. Water Resources B.S. Geology

Name	**Role or Resource Area**	**Education**
Haugen, Ben	Geotechnical Stability	M.S. Geological Engineering B.A. Geology
Hocking, Crystal	Project Manager Geology Noise	M.S. Geology and Geological Engineering B.S. Geological Engineering B.S. Geology
Johnson, Matt	Hydrology	B.S. Civil Engineering B.S. Environmental Science
Krajewski, Justin	Deputy Project Manager	B.S. Wildlife Conservation and Management
Lipp, Karla	Document Production	A.S. Word/Information Processing
Michalek, Tom	Ground Water Hydrologist	M.S. Geology B.S. Geology
Ricci, Mike	Mine Engineering	B.S. Mining Engineering
Rocha, Danielle	Mine Engineering	Ph.D. Mining and Earth Science Engineering M.S. Mining Engineering B.S. Mining Engineering
Rodman, Amy	Socioeconomics Land Use Visual	B.S. Geology
Traxler, Tanner	Vegetation Wildlife	B.S. Wildlife Biology
Life Cycle Geo		
Meuzelaar, Thomas	Geochemistry	Ph.D. Geology M.S. Geology B.S. Geology
Enviro Integration Strategies Inc.		
Chovan, Karen	Tailings	M.S. Mine Waste Management B.S. Geological Engineering

7.0 RESPONSE TO COMMENTS

This chapter will be completed in the Final Environmental Impact Statement.

8.0 GLOSSARY AND LIST OF ACRONYMS

8.1 GLOSSARY

Term	Definition
active mining	Mining operations such as drilling, blasting, excavation, loading, and/or hauling that are taking place during ore or mineral extraction, for the purpose of sale, beneficiation, refining, or other processing or disposition.
alkalinity	The buffering capacity of a water body, soil, or rock; a measure of the ability to neutralize acids and bases and thus maintain a fairly stable pH level.
alluvium	Unconsolidated material that is deposited by flowing water.
alternative	A Montana Environmental Policy Act (MEPA) term that refers to a way of achieving the same purpose and need for a project that is different from the recommended proposal; alternatives should be studied, developed, and described to address any proposal which involves unresolved conflicts concerning different uses of available resources. Analysis scenarios presented in a comparative form, to facilitate a sharp definition of the issues resulting in a basis for evaluation among options by the decision-maker and the public.
ambient	Surrounding, existing of the environment surrounding a body, encompassing on all sides. Most commonly applied to air quality and noise.
analysis area	The geographical area being targeted in the analysis as related to the area of the proposed project.
aquifer	A water-bearing geological formation capable of yielding water in sufficient quantity to constitute a usable supply.
attainment	In compliance with one or more of the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter, as designated by the U.S. Environmental Protection Agency (USEPA).
backfilling	The operation of refilling an excavation or filling underground mining voids.

Term	Definition
Bald and Golden Eagle Protection Act	An act enacted in 1940 that prohibits "take" of a bald or golden eagle without a permit from the Secretary of the Interior. "Take" is defined as "take, possesses, sell, purchase, barter, offer to sell, export, or import, at any time or in any manner, any bald eagle … [or any golden eagle], alive or dead, or any part, nest, or egg thereof."
base flow	Sustained flow of a stream in the absence of direct runoff and includes natural and human-induced stream flows. Natural base flow is sustained largely by ground water discharges.
baseline	The existing conditions against which impacts of the alternatives are compared.
bench	A horizontal ledge that forms a single level of operation above which mineral or waste materials are mined back to a bench face. The mineral or waste is removed in successive layers, each of which is a bench. Several benches may be in operation simultaneously in different parts of, and at different elevations in an open-pit mine.
beneficial use	Under the Clean Water Act, all surface waters are designated with specific beneficial uses they should be capable of supporting including drinking, food processing, bathing, recreation, wildlife, agriculture, and industry.
berm	A horizontal shelf or ledge built into the embankment or sloping wall of an open pit to break the continuity of an otherwise long slope and to strengthen its stability or to catch and arrest slide material. A berm may also be a mound or barrier constructed of fill material and may serve to create impoundments or direct storm water runoff.
best management practices	Structural, nonstructural, and managerial techniques that are recognized to be the most effective and practicable means to reduce or prevent pollution.
biodiversity	A term that describes the variety of life-forms, the ecological role they perform, and the genetic diversity they contain.
bond release	Return of a performance bond to the mine operator after the regulatory agency has inspected and evaluated the completed reclamation operations and determined that all regulatory requirements have been satisfied.

Term	Definition
catchment basin	A storage area (such as a small reservoir) that delays the flow of water downstream.
cone of depression	Occurs in an aquifer when ground water is pumped from a well. In an unconfined aquifer (water table), the cone-of-depression is an actual depression of the water levels. In confined aquifers (artesian), the cone-of-depression is a reduction in the pressure head surrounding the pumped well.
confluence	The point where two streams meet.
corridor	A defined tract of land, usually linear. Can also refer to lands through which a species must travel to reach habitat suitable for reproduction and other life-sustaining needs.
criteria pollutant	An air pollutant that is regulated by the NAAQS. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter, less than 10 micrometers (0.0004 inch) in aerodynamic diameter, and less than 2.5 micrometers (0.0001 inch) in aerodynamic diameter. Pollutants may be added to, or removed from, the list of criteria pollutants as more information becomes available. Note: Sometimes pollutants regulated by state laws also are called criteria pollutants.
cumulative impact	The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
cutoff wall	Wall of impervious material such as concrete or bentonite used to exclude or impede ground water flow.
degradation	A process by which water quality in the natural environment is lowered. When used specifically in regard to Montana Department of Environmental Quality's (DEQ) nondegradation rules, this term can relate to a reduction in quantity as well.
dewatering	Controlling ground water by pumping to locally lower ground water levels in the vicinity of an excavation.

Term	Definition
dike	A sheet or flat-lying tab of rock that is formed in a fracture in a preexisting rock.
dilution	The reduction of a concentration of a substance in air or water.
disturbed area	An area where vegetation, topsoil, or overburden is removed or upon which topsoil, spoil, and processed waste is placed as a result of mining.
downgradient	The direction that ground water flows, which is from areas of high ground water levels to areas of low ground water levels.
drawdown	Lowering of the ground water surface caused by pumping, measured as the difference between the original ground water level and current pumping level after a period of pumping.
drilling	The act of boring or driving a hole into something solid.
effluent	Waste liquid discharge.
embankment	A wall or bank of earth or stone built to prevent flooding of an area or to impound water and/or solid materials.
emission	Effluent discharged into the atmosphere, usually specified by mass per unit time, and considered when analyzing air quality.
endangered species	Any species of plant or animal that is in danger of extinction throughout all or a significant portion of its range. Endangered species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.
Endangered Species Act	An act of Congress, enacted in 1973, to protect and recover threatened or endangered plant or animal species and their habitats. The Secretary of the Interior, in accordance with the act, identifies or lists the species as “threatened” or “endangered.”

Term	Definition
Environmental Assessment (EA)	A concise public document that an agency prepares under MEPA to provide sufficient evidence and analysis to determine whether or not a proposed action requires preparation of an Environmental Impact Statement (EIS) or whether a Finding of No Significant Impact can be issued. An EA must include brief discussions on the need for the proposal, the alternatives, the environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted.
environmental consequences	Environmental effects of project alternatives, including the proposed action, which cannot be avoided; the relationship between short-term uses of the human environment and any irreversible or irretrievable commitments of resources that would be involved if the proposal should be implemented.
Environmental Impact Statement (EIS)	A document prepared to analyze the impacts on the environment of a proposed action and released to the public for review and comment. An EIS must meet the requirements of MEPA, Council on Environmental Quality, and the directives of the agency responsible for the proposed action.
ephemeral drainage	A system of streams that flows only as a direct response to rainfall or snowmelt events and has no baseflow from ground water.
evaporation	The physical process by which a liquid is transformed to a gaseous state.
fault	A fracture or fracture zone within rocks or sediment where there has been displacement of the sides relative to one another.
floodplain	Flat land bordering a river and made up of alluvium (sand, silt, and clay) deposited during floods. When a river overflows, the floodplain is covered with water.
flotation plant	A plant facility used for flotation, which is a method to process minerals by separating and concentrating ores based on the hydrophobic or hydrophilic (either repelled or attracted by water) characteristics.
forb	Any herbaceous plant, usually broadleaved, that is not a grass or grass-like plant.

Term	Definition
fugitive emissions	(1) Emissions that do not pass through a stack, vent, chimney, or similar opening where they could be captured by a control device. (2) Any air pollutant emitted to the atmosphere other than from a stack. Sources of fugitive emissions include pumps; valves; flanges; seals; area sources such as ponds, lagoons, landfills, piles of stored material (e.g., ore); and road construction areas or other areas where earthwork is occurring.
geomorphic	Relating to the form of the earth or the forms of its surface.
grading	The operation of finishing a surface after creating or backfilling an excavation.
growth media	The material that plants grow in consisting of soil and organic matter.
hardness	A measure of the amount of calcium and magnesium dissolved in the water.
heavy metals	Metallic elements with high molecular weights, generally toxic in low concentrations to plants and animals.
highwall	The face of exposed overburden and mineral in surface mining operations or for entry to underground mining operations.
home range	An area in which an individual animal spends most of its time doing normal activities.
hydraulic conductivity	The rate of flow of water through geologic material.
impoundment	A body of water or solid materials like tailings confined within a wall or bank of earth enclosure.
infiltration	Process by which water on the ground surface enters the soil.
incised	Having a margin that is deeply and sharply notched.
intermittent stream	A stream or reach of stream that is below the local water table for at least some of the year and obtains its flow from both surface runoff and ground water discharge.
land use	The activities and inputs undertaken in a certain land-cover type, or the way in which land is managed (e.g., grazing pastures, and managed forests).
life-of-mine	Length of time after permitting during which minerals are extracted and mine-related activities can occur.

Term	Definition
lithologic	Pertaining to the structure and composition of a rock formation.
loading	The quantity of material or chemicals entering the environment, such as a receiving waterbody.
mean	The average number of a set of values. The sum of the values divided by the count of values.
median	A numerical value in the midpoint of a range of values with half the value points above and half the points below.
Migratory Bird Treaty Act	Enacted in 1918 between the United States and several other countries. The act forbids any person without a permit to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of this Convention…for the protection of migratory birds…or any part, nest, or egg of any such bird."
mitigation	An action to avoid, minimize, reduce, eliminate, replace, or rectify the impact of a management practice.
Montana Natural Heritage Program	Provides information on Montana's species and habitats, emphasizing those of conservation concern.
No Action Alternative	A MEPA term that refers to the alternative in which the Proposed Action is not taken. For many actions, the No Action Alternative represents a scenario in which current conditions and trends are projected into the future without another Proposed Action, such as updating a land management plan. In other cases, the No Action Alternative represents the future in which the action does not take place and the project is not implemented.
nonpermeable/ impermeable	Preventing the passage of fluids.
noxious weed	Any exotic plant species established or that may be introduced in the state that may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses, or that may harm native plant communities.

Term	Definition
open pit mine	A method of mining, usually for metallic ores, in which the waste and ore are completely removed from the sides and bottom of a pit which gradually becomes a large, canyonlike depression.
overburden	Geologic material of any nature that overlies a deposit of ore or coal, excluding topsoil.
peak flow	The maximum flow of a stream in a specified period of time.
perennial stream	A stream or reach of a stream that flows continuously year round as a result of ground water discharge or surface runoff.
pH	A method of expressing the acidity or basicity of a solution; the pH scale is generally depicted from 0 to 14, with a value of 7 indicating a neutral solution. Values greater than 7 indicate basic or alkaline solutions, and those below 7 indicate acidic solutions.
postmining land use	The specific use or management-related activity to which a disturbed area is restored after mining and reclamation have been completed.
postmining topography	The relief and contour of the land that remains after backfilling of the mine pit, grading, and recontouring have been completed.
potentiometric surface	A hypothetical surface representing the level to which ground water would rise if not trapped in a confined aquifer (i.e., an aquifer in which the water is under pressure because of an impermeable layer above it that keeps it from seeking its level).
predisturbance	The time period before any mining-related disturbance (e.g. before extraction in pits or placement of waste or tailings). At TSF-1 predisturbance refers to the original native condition before tailings were emplaced.
primary impact	An impact caused by an action and occurs at the same time and place as the action. Also referred to as a "direct" impact.
prime farmland	Land that (a) meets the criteria for prime farmland prescribed by the United States Secretary of Agriculture in the Federal Register and (b) historically has been used for intensive agricultural purposes.

Term	Definition
Proposed Action	A MEPA term that refers to a plan that contains sufficient details about the intended actions to be taken, or that will result, to allow alternatives to be developed and its environmental impacts analyzed.
public health	The science of protecting the safety and improving the health of communities through education, policy making, and research for disease and injury prevention.
raptors	Birds of prey (e.g., hawks, owls, vultures, and eagles).
reclamation	Per the Metal Mine Reclamation Act (MMRA) (17.24.102, Montana Code Annotated (MCA)) reclamation means the return of lands disturbed by mining or mining-related activities to an approved postmining land use that has stability and utility comparable to that of the premining landscape except for rock faces and open pits, which may not be feasible to reclaim to this standard.
revegetation	Plant growth that replaces original ground cover following land disturbance.
rhizomatous	A growth form containing rhizomes, which are rootlike subterranean and commonly horizontal stems which send up shoots to the surface.
ripped	Torn, split apart, or opened.
secondary impact	An impact caused by an action but that occurs later in time (reasonably foreseeable) or farther away in distance.
sediment-control pond/sediment trap	A sediment-control structure, including a barrier, dam, or excavation depression, that slows down runoff water to allow sediment to settle out.
seep	A place where ground water flows slowly out of the ground.
seismic	Of or produced by earthquakes. Of or relating to an earth vibration caused by something else (e.g., an explosion).
sensitive species	Those species (i.e., plant and animal) identified by the Montana Natural Heritage Program for which population viability is a concern, as evidenced by (1) significant current or predicted downward trends in population numbers or density or (2) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.
soil texture	Soil textural units are based on the relative proportions of sand, silt, and clay.

Term	Definition
Species of Concern	Species that are either known to be rare or declining, or declining because of the lack of basic biological information.
specific storage	The volume of water released from a unit volume of aquifer under one unit decline in water level.
specific yield	The ratio of the volume of water that an aquifer will yield by gravity to the volume of aquifer material.
specified head boundary	In a numeric ground water model, a boundary where the head (water level) is set to a known value.
stope	Any excavation made in a mine, especially from a steeply inclined vein, to remove the ore that has been rendered accessible by the shafts and drifts.
stratigraphy	The arrangement of strata (layers).
sump	A small basin or low spot in the mine that collects precipitation and ground water inflow so that the water can then be pumped out.
sustainable	The ability of a population to maintain a relatively stable population size over time.
swale	A low-lying or depressed and often wet stretch of land
tailings storage facility	As provided by Section 82-4-303(34)(b), MCA "tailings storage facility" means a facility that temporarily or permanently stores tailings, including the impoundment, embankment, tailings distribution works, reclaim water works, monitoring devices, storm water diversions, and other ancillary structures.” TSF-1 does not retain any free water or process solution, which means that TSF-1 does not meet the definition of a TSF as provided by MCA.
taxonomic level	A hierarchical defined group of organisms such as genus, species, or family.
threatened species	Any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, as identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.
topsoil	The surface or uppermost layer of soil with typically a high content of organic matter and where the majority of soil microorganism activity and plant growth occurs.
total dissolved solids	A measure of the amount of material dissolved in water (mostly inorganic salts).

Term	Definition
total maximum daily load	A regulatory term in the Clean Water Act that describes a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a waterbody can receive while still meeting water quality standards.
total suspended solids	A measure of the amount of undissolved particles suspended in water.
toxic	Referring to a chemical that has an immediate, deleterious effect on the metabolism of a living organism.
transect	A line, strip, or series of plots from which biological samples, such as vegetation, are taken.
transmissivity	The rate of movement of ground water through an aquifer.
tributary	A stream that flows into a larger waterbody.
upgradient	The direction from which ground water flows.
vertical anisotropy ratio	Relationship of the aquifer hydraulic conductivity in the vertical direction to the horizontal direction.
viability	Ability of a population to maintain sufficient size so that it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a specific population for a specific period.
viewshed	The portion of the surrounding landscape that is visible from a single observation point or set of points.
water of the US	Waters including all interstate waters used in interstate or foreign commerce, tributaries of these, territorial seas at the high-tide mark, and wetlands adjacent to all of these.
water right	A property right to use (but not own) surface or ground water in Montana, as affirmed by the Montana Constitution, the Montana Supreme Court, and by state law. Because it is a property right, a water right can be sold, leased, and/or severed from the property where it has historically been put to beneficial use.
watershed	The lands drained by a system of connected drainages. The area of land where all of the water that falls in it and drains off of it goes to a common outlet.
wetlands	Areas that are inundated or saturated by surface or ground water for a sufficient duration and frequency to support a prevalence of vegetation typically adapted for such conditions and that exhibit characteristics of saturated soils.

8.2 Acronyms

Acronym	Definition
5BOP	5B Optimized
AMA	Agency Modified Alternative
amsl	above mean sea level
ARD	acid-rock drainage
ARM	Administrative Rules of Montana
BLM	Bureau of Land Management
cfs	cubic feet per second
DEQ	Department of Environmental Quality
EIS	Environmental Impact Statement
EWM	Eurasian watermilfoil (*Myriophyllum spicatum*)
ft	feet
gpm	gallons per minute
GSM	Golden Sunlight Mines, Inc.
IPaC	Information for Planning and Consultation
MAQP	Montana Air Quality Permit
MCA	Montana Code Annotated
MEPA	Montana Environmental Policy Act
mg/L	milligrams per liter
MMRA	Metal Mine Reclamation Act
MPDES	Montana Pollutant Discharge Elimination System
Mt	Million tons
MTNHP	Montana Natural Heritage Program
NRCS	Natural Resources Conservation Service
Pit	Mineral Hill Pit
PLS	Pure Live Seed
ROD	Record of Decision
SOC	Species of Concern
T&E	threatened and endangered
TRP	Tailings Reprocessing Project
TSF-1	Tailings Storage Facility 1
TSF-2	Tailings Storage Facility 2

Acronym	Definition
TSF-3	Tailings Storage Facility-3
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
yd^3	cubic yards
°F	degrees Fahrenheit
3D	three-dimensional

9.0 REFERENCES

Barrick. 2020a. Memorandum: GSM Reprocessing Tailings Consolidation. Prepared by Johnny Zhan, Ph.D. January 27, 2020.

______. 2020b. Memorandum: GSM Reprocessing Tailings Draindown. Prepared by Johnny Zhan, Ph.D. January 27, 2020.

______. 2020c. Memorandum: Mineral Hill Pit Stopes Subsidence Modeling Review, Golden Sunlight Mine. Prepared by Ryan Turner, Geotechnical Engineer. February 4, 2020.

______. 2020d. Golden Sunlight Mines, Inc. 2019 MDEQ Annual Permit Report OP#00065. Pg. 122.

Cedar Creek Associates, Inc. 2016. Golden Sunlight Mine Revegetation/Soil Monitoring – 2018 Buttress WRD, Buttress WRD Extension, East Intra-Dump, Northeast Dump (Portion), Offload Area, & South Intra-Dump. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2018. Golden Sunlight Mine Revegetation/Soil Monitoring – 2018 Buttress WRD Extension, Northeast Dump, Cheatgrass Study Area, & South Intra-Dump. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2019. Golden Sunlight Mine Revegetation/Soil Monitoring – 2018 Buttress WRD Extension, Northeast WRD, Cheatgrass Study Area, Tailings Dam SW Corner Northeast WRD. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2020. Golden Sunlight Mine Revegetation Monitoring – 2019 Buttress WRD Extension, Northeast WRD, Tailings Dam #2 SW Corner & Far East WRD. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Confluence Consulting, Inc. 2020. Jefferson Slough Eurasian Watermilfoil 2020 Monitoring Report, Jefferson County, MT. Confluence Consulting, Inc. Bozeman, MT.

Dawson, B. 2021**.** Email: Golden Sunlight Mine EIS. From Bill Dawson, Montana Fish, Wildlife, and Park, Boulder, Montana. To Justin Krajewski, RESPEC, Rapid City, South Dakota. April 29, 2021.

DEQ (Montana Department of Environmental Quality). 2013. Golden Sunlight Mine Amendment 015 To Operating Permit No. 00065. Final Environmental Impact Statement. Montana Department of Environmental Quality and the Bureau of Land Management. Helena, Montana

______. 2021. DEQ Seeks Public Comment and Announces Public Meeting on Developing a Draft Environmental Impact Statement for a Proposed Mine Amendment in Jefferson County; available online at http://deq.mt.gov/Public/PressRelease/deq-seeks-public-comment-and-announces-public-meeting-on-developing-a-draft-environmental-impact-statement-for-a-proposed-mine-amendment-in-jefferson-county. February 10, 2021.

DEQ (Department of Environmental Quality) and BLM (Bureau of Land Management). 1997. Volume 1: Draft Environmental Impact Statement Golden Sunlight Mine.

______. 2007. Final Supplemental Environmental Impact Statement Golden Sunlight Mine Pit Reclamation. Montana Department of Environmental Quality. Helena, Montana. U.S. Bureau of Land Management. Butte, Montana.

_______. 2018. Final Environmental Assessment Barrick Golden Sunlight Mines, Inc. Montana Department of Environmental Quality, Hard Rock Mining Bureau. Helena, Montana. U.S. Bureau of Land Management, Butte Field Office. Butte, Montana.

Gallagher, K. 2003. Environmental Data Compilation for the Open Pit Area and Potential Pit Backfill Material. Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2021. Technical Memorandum: Results of Quantitative Phase Analysis of 14 Powder Samples Using the Rietveld Method and X-Ray Powder Diffraction Data. Prepared by Kathy Gallagher, GHI, to Golden Sunlight Mines, Inc., Whitehall, Montana. March 30, 2021.

Garcia and Associates. 2013. Bonnie Project Vegetation Baseline Assessment, Bozeman, MT: Garcia and Associates. San Anselmo, California.

______. 2014. Bonnie Project Baseline Wildlife Assessment, Bozeman, MT. Barrick Gold Corp. Golden Sunlight Mines, Inc. Whitehall, Montana.

GSM (Golden Sunlight Mines, Inc.). 2014. 2014 Operations and Reclamation Plan Golden Sunlight Mine. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2020. 2019 MDEQ Annual Permit Report OP#00065, January 1, 2019 through December 31, 2019. Montana Department of Environmental Quality, Helena, Montana. U.S. Bureau of Land Management, Butte, Montana.

_______. 2021a. Modification to Application for Amendment 017 to Operating Permit No. 00065 and Plan of Operations No. MTM-82855 for Golden Sunlight Mine, Montana. Montana Department of Environmental Quality. Helena, Montana.

_______. 2021b. Email: Visual Renderings of TSF-1. From Laura Pfister, NewFields, Helena, Montana. To Craig Jones, DEQ, Helena, Montana. February 24, 2021.

______. 2021c. GSM Tailings Reprocessing Project Socioeconomic Summary; Barrick Golden Sunlight Mines Inc. Whitehall, Montana.

Hanneman, D. 1989. Cenozoic Basin Evolution in Part of Southwestern Montana. Dissertation for Doctor of Philosophy, University of Montana, Missoula, Montana.

Hydrometrics, Inc. 2018. Storm Water Pollution Prevention Plan Under the Multi-Sector General Permit for Golden Sunlight Mine, Whitehall, Montana MTR00498. Hydrometrics, Inc., Helena, Montana. Prepared for Golden Sunlight Mine, Whitehall, Montana.

JSAI (John Shomaker & Associates, Inc.). 2020. Golden Sunlight Mine Groundwater Flow Model, Appendix A. Barrick Golden Sunlight Mine. Whitehall, Montana.

Lesica, P. 2012. Manual of Montana Vascular Plants. Brit Press, Fort Worth, TX.

McDonald, M.G. and W.W. Harbaugh. 1988. A Modular Three-Dimensional Finite-Difference Groundwater Flow Model. Techniques of Water Resources Investigations Book 6 Chapter A1. U.S. Geological Survey. Reston, Virginia.

Montana Department of Agriculture. 2019a. Montana State Noxious Weed List. Montana Department of Agriculture. Helena, MT.

______. 2019b. Montana County Listed Noxious Weeds. Montana Department of Agriculture. Helena, MT.

Montana Department of Labor & Industry. 2021a. Wage Rates by Industry and Occupation. Montana Labor Market Information. Accessed April 13, 2021. Retrieved from https://lmi.mt.gov/lausCntyLabForce

_______. 2021b. Wage Rates by Industry and Occupation – *Occupational Employment Statistics.* Montana Labor Market Information. Accessed April 13, 2021. Retrieved from https://lmi.mt.gov/Home/DS-Results-OES

Montana Environmental Quality Council. 2002. A Guide to the Montana Environmental Policy Act. Helena, Montana.

_______. 2017. Guide to the Montana Environmental Policy Act. Legislative Environmental Policy Office. Helena, MT.

Montana Natural Heritage Program. 2021a. Environmental Summary Report for Latitude 45.84061 to 45.94561 and Longitude -111.95091 to -112.07180. Accessed April 6, 2021. Retrieved from http://mtnhp.org/

______. 2021b. Montana Natural Heritage – Species Snapshot for Jefferson County, MT. Accessed April 7, 2021. Retrieved from http://mtnhp.org/SpeciesSnapshot

Montana Sage Grouse Habitat Conservation Program, 2021. Montana Sage Grouse Habitat Conservation Map. Accessed May 11, 2021. Retrieved from https://sagegrouse.mt.gov/ProgramMap

Nesser, J. A., G. L. Ford, C. L. Maynard, and D. S. Page-Dumroese. 1997. *Ecological Units of the Northern Region: Subsections.* General Technical Report INT-GTR-369. U.S. Department of Agriculture, Forest Service, Intermountain Research Station. Ogden, Utah.

NewFields. 2015. Bat and Raptor Habitat Plan. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2019. Highwall Habitat Assessment – Golden Sunlight Mine. Barrick Gold Corporation. Whitehall, Montana.

______. 2020. Technical Memorandum: Review of TSF No. 2 Stability During TSF No.1 Reprocessing. Prepared by NewFields Helena, Montana, to Golden Sunlight Mines, Inc., Whitehall, Montana. January 7, 2020.

______. 2021. Technical Memorandum: Geotechnical Recommendations for Tailings Repulper Facility – Revision 1 Tailings Reprocessing Project, Golden Sunlight Mine, Jefferson County, Montana. Prepared by NewFields Helena, Montana, to Golden Sunlight Mines, Inc., Whitehall, Montana. February 4, 2021.

Pfister, L. 2021. GSM EIS - Data Request Response - Water Balance. Email from L. Pfister, Project Scientist, Newfields, Helena, Montana, to Craig Jones, Montana Environmental Policy Act Coordinator, and Garrett Smith, Geochemist, Montana Department of Environmental Quality, Helena, Montana. March 5, 2021.

RESPEC. 2021. Technical Memorandum 3: Golden Sunlight Mine Tailings Reprocessing Project – Reclamation Alternatives Evaluation. Prepared by RESPEC, Rapid City, South Dakota, to Montana Department of Environmental Quality, Helena, Montana. March 9, 2021.

Schafer Limited LLC. 2020a. Golden Sunlight Mine, Geochemical Characterization Report A Compendium of Historic and On-Going Geochemical Tests and Water Quality Data. Barrick Golden Sunlight Mine. Whitehall, Montana.

______ 2020b. Golden Sunlight Mine Closure Option Evaluation. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Smith, G. and E. Hayes. 2021. Requirements for Periodic Review of a Tailings Storage Facility by an Independent Review Panel: Example Case for Golden Sunlight Mine (Hard Rock Operating Permit No. 00065). Letter to Herb Rolfes, Operating Permit Section Supervisor, Hard Rock Mining Bureau and Dan Walsh, Chief, Hard Rock Mining Bureau. Helena, Montana.

Subterra LLC. 2020a. 5BOP West Highwall – Numerical Model of Interaction of Highwall with Deposited Tailings Material. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2020b. Earth Block Movement – Numerical Modeling. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Tigner, J. 2011. Bat Acoustic Surveys 2011. BLM Butte and Dillon Field Office Districts. Batworks, LLC. Rapid City, SD:

U.S. Bureau of Labor Statistics. 2021a. Census of Employment and Wages. Accessed April 13, 2021. Retrieved from http://data.bls.gov/PDQWeb/en

______. 2021b. News Release: Regional and State Unemployment – 2020 Annual Averages. Accessed April 13, 2021. Retrieved from https://www.bls.gov/news.release/pdf/srgune.pdf

______. 2021c. Occupational Employment and Wage Statistics. Accessed April 13, 2021. Retrieved from https://www.bls.gov/oes/current/oes_nat.htm.

US Department of Agriculture, Natural Resources Conservation Service. 2003. Soil Survey of Jefferson County Area and Part of Silver Bow County, Montana (MT627). Field work completed in 1996. Maps included.

USFWS (U.S. Fish and Wildlife Service). 2021. Environmental Conservation Online System (ECOS) Information for Planning and Consultation (IPaC). Accessed April 5, 2021. Retrieved from http://ecos.fws.gov/ipac/

USGS (U.S. Geologic Survey). 2021a. National Water Information System. Daily discharge records for USGS 06026500 Jefferson River near Twin Bridges MT, for April 14, 2020 to April 14, 2021. Accessed April 14, 2021. Retrieved from https://waterdata.usgs.gov/monitoring-location/06026500/#parameterCode=00060&period=P365D

______. 2021b. National Water Information System. Daily discharge records for USGS 06036650 Jefferson River near Three Forks MT, for April 14, 2020 to April 14, 2021. Accessed April 14, 2021. Retrieved from https://waterdata.usgs.gov/monitoring-location/06036650/#parameterCode=00060&period=P365D

Western Regional Climate Center. 2021. Cooperative Climatological Data Summary for Butte Bert Mooney AP, MT. Accessed April 13, 2021. Retrieved from https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?mt1318

Woods, A. J., J. M. Omernik, J. A. Nesser, J. Shelden, J. A. Comstock, S. H. Azevedo, and H. Sandra. 2002. Ecoregions of Montana. Second edition. Map scale 1:1,500,000. Draft 2.

Zheng, C. 1996. MT3D: A Modular Groundwater Transport Program User Manual.

APPENDIX A: TECHNICAL MEMORANDUM 1—HYDROLOGIC AND GEOCHEMICAL MODEL ASSESSMENT

Technical Memorandum 1

To:	Montana Department of Environmental Quality 1520 E. 6th Avenue Helena, MT 59601
From:	RESPEC Company, LLC P.O. Box 725 Rapid City, SD 57709
Date:	June 7, 2021
Subject:	Golden Sunlight Mine Tailings Reprocessing Project – Hydrologic and Geochemical Model Assessment

1.0 INTRODUCTION

Barrick Golden Sunlight Mines, Inc. (GSM) submitted an Application for Amendment 017 to Operating Permit No. 0065 and Plan of Operations No. MTM-82855 to implement the Tailings Reprocessing Project (TRP) at the Golden Sunlight Mine located near Whitehall, Montana on March 30, 2020.

At a high level, the Proposed Action results in disturbance to two areas: Tailings Storage Facility 1 (TSF-1) and Mineral Hill Pit (Pit). Excavating tailings would result in removing the acid-rock drainage (ARD) source from TSF-1 and adding this source (after reprocessing and considerable depyritization) to the Pit. The primary objective of the geochemical evaluation for this Environmental Impact Statement is to assess the extent that the Proposed Action would result in changes to water quality at either facility. Accordingly, the geochemical site conceptual model consists of two primary components:

- Removing the tailings source at TSF-1 and corresponding impacts to underlying ground water systems; and
- Backfilling depyritized tailings to the Pit and impacts to downgradient ground water quality.

Significant solids characterization and water quality data have been collected over the life of the mine and more recently in support of this Application to develop the site conceptual model, establish an understanding of long-term material environmental behavior, and support risk-based predictions of potential water quality impacts associated with ongoing mining activities. The objective of this technical memorandum is to summarize these efforts, assess the sufficiency of existing datasets, evaluate the site conceptual model for the Proposed Action, and describe periodic model recalibration and ongoing characterization work.

2.0 BACKGROUND GEOLOGY AND HYDROLOGY

GSM is located in a breccia-hosted gold deposit with Tertiary breccias (consisting of hydrothermally altered latite and Proterozoic wallrock clasts) hosted by Proterozoic sedimentary rocks. The breccias are part of the Tertiary volcanic system common in upland areas of the southern Bull Mountains. Pyrite is abundant throughout the breccia and, in some cases, matrix-forming. Phyllic (quartz-sericite-pyrite) and argillic alteration have removed most primary breccia silicates, and the rocks have very little remaining alkalinity (although some younger vicinity host rocks have carbonates). Natural (i.e., premining) ARD is common at the site, and mining disturbance is likely to amplify acidity and metals loading.

The ore body at the Pit is a breccia pipe intruded into late Precambrian Belt Supergroup host rocks in the southern Bull Mountains (**Figure 2-1**). The mineralized breccia pipe is generally bounded by faults on the east and west in the host rock. The breccia pipe is mineralized and contains gold-bearing sulfide deposits. The surrounding host rock has been hydrothermally altered and includes pyritic sulfide zones and gold-quartz veins.

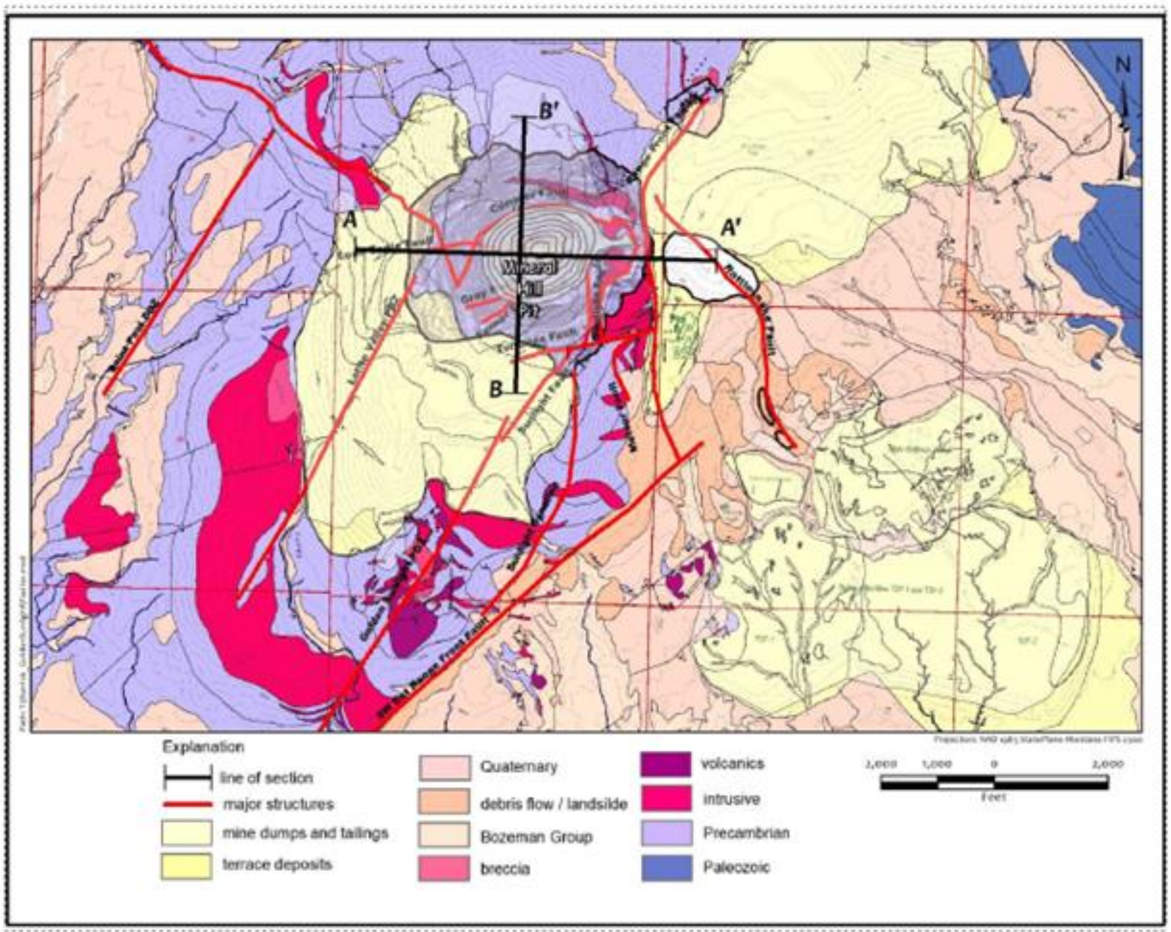


Figure 2-1
Golden Sunlight Mine and Vicinity Geologic Map (John Shomaker & Associates [JSAI] 2020)

Surface water drainage in the mine area generally flows south and southeast toward the Jefferson Slough, which is the northernmost channel of the Jefferson River south of Interstate 90. Ground water occurs in limited quantities in the bedrock and mineralized zone within fractures and faults in the otherwise solid rock and within sedimentary deposits flanking the Bull Mountains. Ground water direction of flow is generally to the south, southwest, and southeast toward the Jefferson Slough.

3.0 CURRENT CONDITIONS AND TAILINGS GEOCHEMISTRY AT TAILINGS STORAGE FACILITY 1

TSF-1 was constructed in 1982, and deposition within the facility continued from 1982 to 1994. The facility covers 190 acres at its base and 130 acres across the top with a depth ranging from 30 to 35 feet (ft) at its northern end to over 170 ft at its southern end. TSF-1 contains approximately 26.2 million tons (Mt) of tailings, was constructed on compacted natural clay without a synthetic liner, and was capped and reclaimed/revegetated in 1998.

Some of the tailings coarse fraction was used in raising the main embankment above the starter dam over the operational years. Tailings were placed to maintain a coarse tailings beach against the dam; as a result, a concentration of slimes and fine-grained tailings exist in the western and central portions of the facility over an estimated 600- to 1,000-ft-wide area.

The tailings have an average 15 weight percent (wt. %) moisture content, a dry density of approximately 93.6 pounds per cubic foot (pcf), and are consolidated in a drained-down steady-state condition. Water seeps from the drains at a rate of less than 0.2 gallon per minute (gpm). Because of its unlined nature, meteoric water infiltrates the facility at approximately 4 gpm and mixes with ground water below the facility to a total flux of approximately 40 gpm, as indicated by the operating volumes of the downgradient pumpback wells.

Tailings from TSF-1 were sampled from 1990 through 2019 and included compiling a bulk sample for metallurgical testing through an extensive drilling campaign in 2018. The tailings properties are generally well understood because several characterization campaigns were completed to support geochemical and hydrogeological modeling, and reprocessing.

The tailings in TSF-1 comprise finely ground rock, including the host sedimentary and volcanic units and ore minerals. Primary minerals within the tailings include potassium feldspar, quartz, and plagioclase, with lesser amounts (1 to 10 percent) of pyrite, illite/muscovite, barite, gypsum, and dolomite (Gallagher 2021). While much of the gold was removed by leaching, residual gold associated with pyrite often remains and predominantly resides in the finer particle-size fractions. Tailings have an average sulfide concentration of 4.0 to 4.5 percent. The tailings have the potential to become acidic when oxidized, as is demonstrated by surficial tailings (less than 6-ft depth) exhibiting acidity in TSF-1. Below 6 ft, the tailings are unoxidized and non-acidic, with pH varying between 5 to 8.5 standard units (s.u.).

The quality of the downgradient pumpback well water confirms that the tailings contain high levels of mobile, soluble constituents of concern, including sulfates, iron, manganese, arsenic, cadmium, copper, and nickel. The pore water in the TSF-1 tailings has moderate total dissolved solids of approximately 2,400 milligrams per liter [mg/L]) and sulfate of 1,300 to 1,400 mg/L (Schafer Limited LLC 2020). Cyanide and nitrate levels in interstitial fluids are low because of the age of the tailings. Geochemistry of TSF-1 tailings, including total metals in raw tailings and soluble metals from Meteoric Water Mobility Procedure (MWMP) tests, are included in **Table 3-1**.

Table 3-1
Geochemistry of the Tailings at the Tailings Storage Facility 1 (Schafer Limited LLC 2020)

Dissolved Constituents (mg/L; unless otherwise specified)	Total Metals in Raw Tailings (mg/kg)	Depyritized Tailings Test 6 Decant Process Solution	Depyritized Rougher Tails Decant Process Solution	TSP-1 Tailings MWMP	Depyritized Tailings Test 6 MWMP	Depyritized Rougher Tails MWMP
Acidity		12	12	12	12	12
Aluminum	3,275	0.1	0.05	0.5	0.1	0.05
Antimony	<5	0.0101	0.0037	0.0068	0.0087	0.0053
Arsenic	52.7	0.0037	0.001	0.003	0.0031	0.0015
Barium	295	0.03	0.009	0.19	0.04	0.03
Bicarbonate as $CaCO_3$		134	110	125	77.6	92.3
Boron	34	0.09	0.03	0.17	0.07	0.05
Cadmium	1.5	0.0001	0.0003	0.0006	0.0001	0.00008
Calcium	2,668	399	396	553	224	123
Chloride		32.2	37	89	55	9.1
Chromium	13.3	0.001	0.001	0.004	0.001	0.0005
Cobalt		0.253	0.194	0.356	0.106	0.0492
Conductivity 25C (DS/m)				3910	1390	1030
Copper	287	0.02	0.01	0.06	0.04	0.01
Cyanide, WAD		0.03	0.006	0.014	0.019	0.003
Fluoride		1.8	1.1	1.8	1.9	1.6
Iron	43,429	0.16	0.03	0.74	0.14	0.03
Lead	82	0.0002	0.0002	0.0014	0.0002	0.0001
Lithium		0.02	0.012	0.05	0.02	0.012
Magnesium	2,792	87.4	87.9	378	45.6	24.3
Manganese	78	1.02	1.01	3	0.35	0.27
Mercury	<1	0.0002	0.0002	0.0006	0.0002	0.0002
Molybdenum		0.17	0.11	0.23	0.16	0.1
Nickel	28	0.02	0.015	0.08	0.02	0.011
Nitrate/Nitrite as N		4.48	0.02	0.42	0.23	0.26
Nitrogen, ammonia				7.77	0.29	1.88
pH (S.U.)				7	7.3	7.3
Phosphorus		0.2	0.1	0.2	0.2	0.1
Potassium	2,383	86.4	64.6	125	63.7	39.5
Selenium	0.01	0.0193	0.0189	0.0559	0.0238	0.0099
Silver		0.02	0.01			
Sodium	451	119	101	387	41.1	23.3
Sulfate		1320	1410	2110	662	408
Thallium	5	0.0002	0.0002	0.0004	0.0002	0.0001
Thiocyanate as SCN		6.6	0.1	15	2.9	0.3
Total Alkalinity		134	110	125	77.6	92.3
Vanadium		0.01	0.005	0.01	0.01	0.005
Zinc	128	0.02	0.01	0.05	0.02	0.01
TDS @180C		2,400	2,460	3,945	1,275	828

4.0 PROPOSED ACTION

The proposed TRP consists of three primary components (1) recover and reprocess tailings currently located in TSF-1; (2) dispose nonreactive, low-sulfidic tailings produced from the Flotation Plant as a thickened slurry into the Pit; and (3) revise the Reclamation Plan for TSF-1 and the Pit.

The current Proposed Action entails excavating approximately 26.2 million tons (Mt) of tailings from the reclaimed TSF-1. Excavation will be conducted using conventional truck and shovel methods, and transporting the tailings to the Re-Pulping Plant located northwest of TSF-1. Recovery of TSF-1 tailings would remove the source of leaching to subsurface aquifers. Over 12 years, the tailings would be reslurried and piped to a Flotation Plant in the existing and retrofitted mill building and processed to produce a fine gold and sulfide concentrate. The tailings would be thickened to approximately 65 percent solids before being gravity-pumped to the bottom of the inactive Pit. Approximately 23.6 Mt of tailings would be placed in the Pit. Reprocessing of tailings is anticipated to reduce sulfide concentrations to an average of 0.5 wt. % before lime amendment and disposal in the Pit. The lime would be added to neutralize acidity from ground water and runoff from mineralization in the Pit, which would affect the pH of the process solution pond that would form on the tailings. The reprocessed tailings would interact with and neutralize acidic water sourced from Pit wall materials and ground water inflow. Lime addition to tailings underflow would continue for several years to offset the expected decline in pH in the overlying process solution pond as a result of flushing residual Pit surface salts.

Implementing the Amendment Application would not require a change in the approved water-management system for the Pit. Continued operation of the Pit dewatering sump would maintain a cone-of-depression at the 4,750-ft elevation (GSM Mine datum) and thus capture ground water inflow and tailings water that encounters ground water in the Pit. GSM would continue to dewater at a rate that results in zero outflow and capture water flowing into the Pit. The rate of pumping would fluctuate to maintain the sump-water level below the 4,750-ft elevation.

To mitigate the potential geochemical reaction of the tailings and process solution with reactive surfaces and acidic waters present in the Pit, lime would be added to the tailings to achieve a pH of 9.0 s.u. in the temporary pond during initial years. After the initial years of placement, the overlying process solution pond would be expected to be accessible for pumping. The excess fluids would be captured, treated with lime as needed to achieve pH 7.6 (s.u.), and then sent back to the mill for reuse in the flotation circuit.

The process solution for flotation tailings that infiltrates into the wall and bottom rock of the Pit would combine with meteoric water and ground water from the bedrock aquifer associated with the Pit. The combined water sources would continue to be managed according to the current approved system (i.e., collecting and pumping water from the underground mine workings and sump). GSM maintains the South Well that pumps water from the underground sump and conveys the water via pipeline to TSF-2. During final closure, GSM would evaluate opportunities to reduce or eliminate the need to actively treat mine-impacted water from the TSF-1 site and the Pit. Future mine-water management may include passive/enforced evaporation or other passive means. Any modification of the currently approved water treatment system would require approval by the Montana Department of Environmental Quality (DEQ) and the Bureau of Land Management (BLM) before implementation.

Following the initial 3 years of tailings placement, water reclaimed from the tailings process solution pond in the Pit would be returned to the thickener tank overflow and Flotation Plant using a new return pipeline system. This water would be used as makeup water in the Flotation Plant. Returning the ponded process solution to the Flotation Plant and thickener tank during the subsequent years of tailings reprocessing would also have the net effect of reducing the amount of water entering into and being pumped from the underground sump. By recirculating this water, the amount of fresh water that is needed from the Jefferson River Slough may also be reduced.

GSM would continue to maintain the cone-of-depression in the ground water table surrounding the Pit by managing the underground sump dewatering system. The existing dewatering system would effectively control seepage water from the tailings into the fractured bedrock comprising the Pit walls and bottom, and ultimately into the underground sump, where sump water would then be pumped to TSF-2 using the South Well. Ground water is currently pumped from the underground sump at an average rate of 57 gpm to prevent a Pit lake from forming.

Current dewatering of the Pit occurs via the South Well, which pumps water from the underground mine workings below the Pit. This well pumps from an elevation of 4,390 ft to maintain a ground water cone-of-depression of approximately 4,488 feet, which is below the bottom of the Pit (4,525 feet). Under the Proposed Action, as the surface of the reprocessed tailings rises, the ground water elevation would be allowed to rise, as long as no outflow from the Pit or formation of a pit lake occurs, until the 4,750-ft elevation is reached (GSM 2021). After the 4,750-ft elevation is reached, the South Well would be used to maintain the phreatic surface at this elevation. Ground water modeling indicates that maintaining the phreatic surface at the 4,750-ft elevation would generate a cone-of-depression sufficient for containing ground water inflow, meteoric water, and tailings water that commingle with ground water in the Pit (i.e., zero outflow). Under this plan, a pit lake would not exist in the long-term (postclosure) conditions.

As the level of tailings rises during placement in the Pit, access to the South Wellhead would be maintained by periodically placing lifts of oxidized waste rock to form an access road to the well site. GSM would place an initial 25-ft lift of waste rock on the South Well bench. The South Well casing would be extended so that the well collar is above the 25-ft lift. As the tailings continue to rise, additional 25-ft lifts would be made to the access road and additional extensions would be added to the South Well casing.

5.0 EXISTING GROUND WATER CONDITIONS

Ground water flow occurs in the mine site area through the fractured and faulted bedrock and mineralized zones. The flanks of the Bull Mountains are overlain by generally fine-grained Tertiary Bozeman Group sediments and sedimentary rocks, which are in turn overlain by coarse younger Tertiary and Quaternary alluvial, fluvial, and debris-flow deposits. These younger sediments can contain ground water recharged from precipitation and higher-elevation fractured flow, generally flowing downgradient toward the Jefferson Slough (see **Figures 5-1** and **5-2**). Preferential flow paths are formed by ancestral channels filled with coarse sediments (e.g., Rattlesnake and Sheep Rock flow paths on **Figure 5-1**).

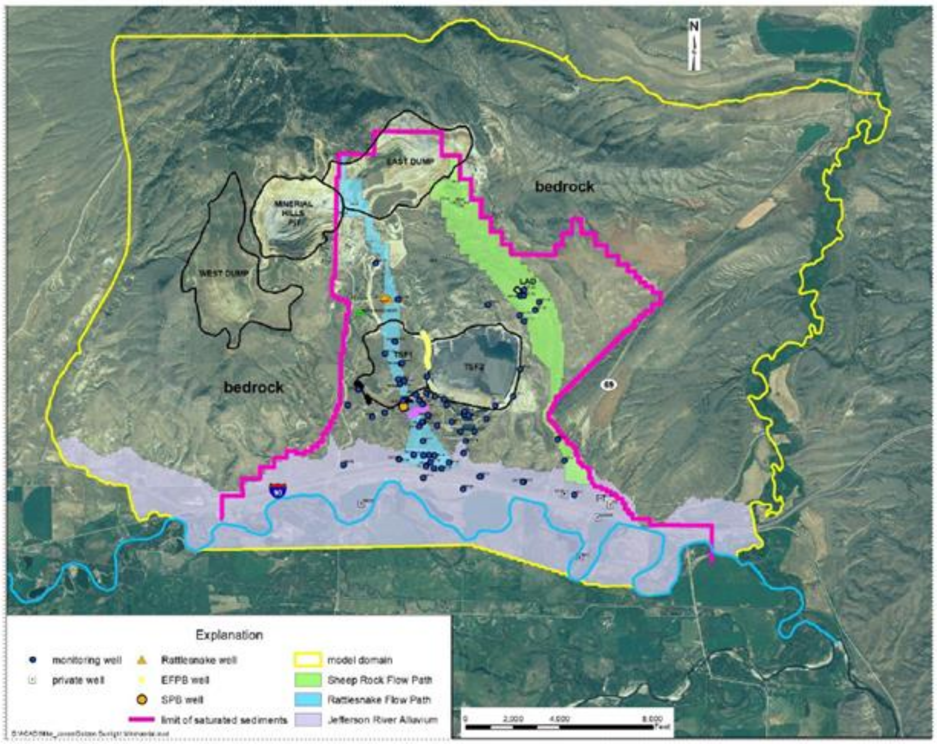


Figure 5-1
Golden Sunlight Hydrogeology (JSAI 2020)

5.1 TAILINGS STORAGE FACILITY 1 AREA

TSF-1 process water released into ground water has been intercepted and recovered through pumpback wells. The facility is considered to be fully drained with net infiltration of about 15 millimeters per year through the cover, which equates to 4 gpm of flux. TSF-1 is not synthetically lined, so meteoric infiltration through the cover and outflow to ground water are virtually equal.

Since 1983, ground water downgradient of TSF-1 has been intercepted because of a failure of a clay slurry wall when mining began at the site. The ground water interception program uses several galleries of wells including the South Pumpback (SPB) and the East Flank Pumpback systems (**Figure 5-3)**. The overall pumping rate has declined from over 350 gpm in 1983 to approximately 40 gpm currently (combined from both pumpback systems).

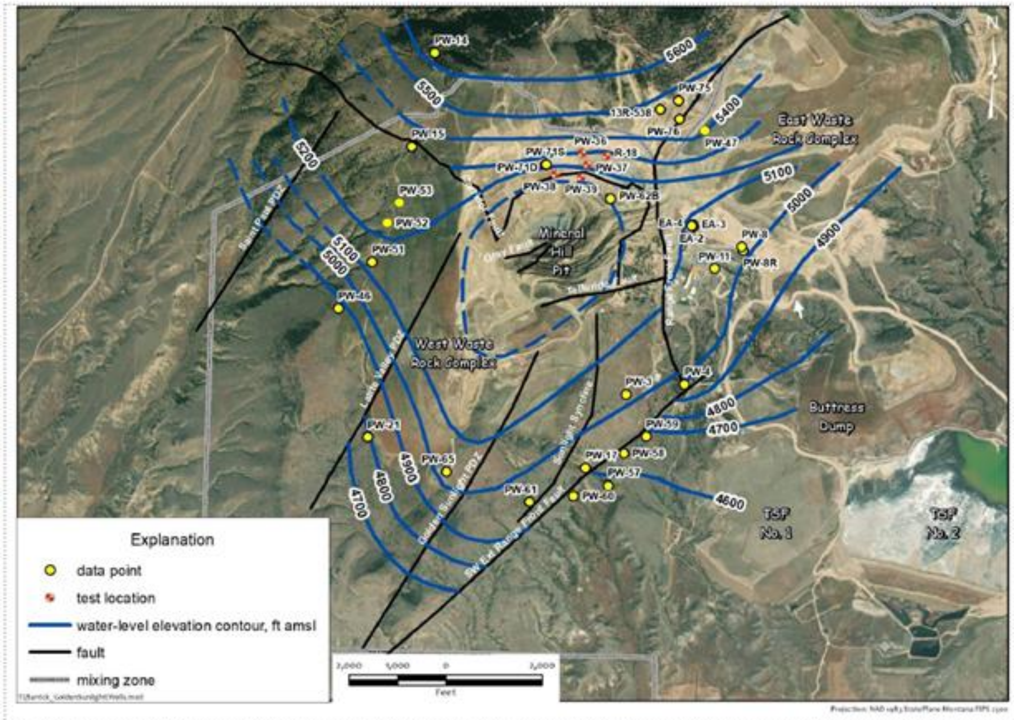


Figure 5-2
Golden Sunlight Area Potentiometric Surface (JSAI 2020)

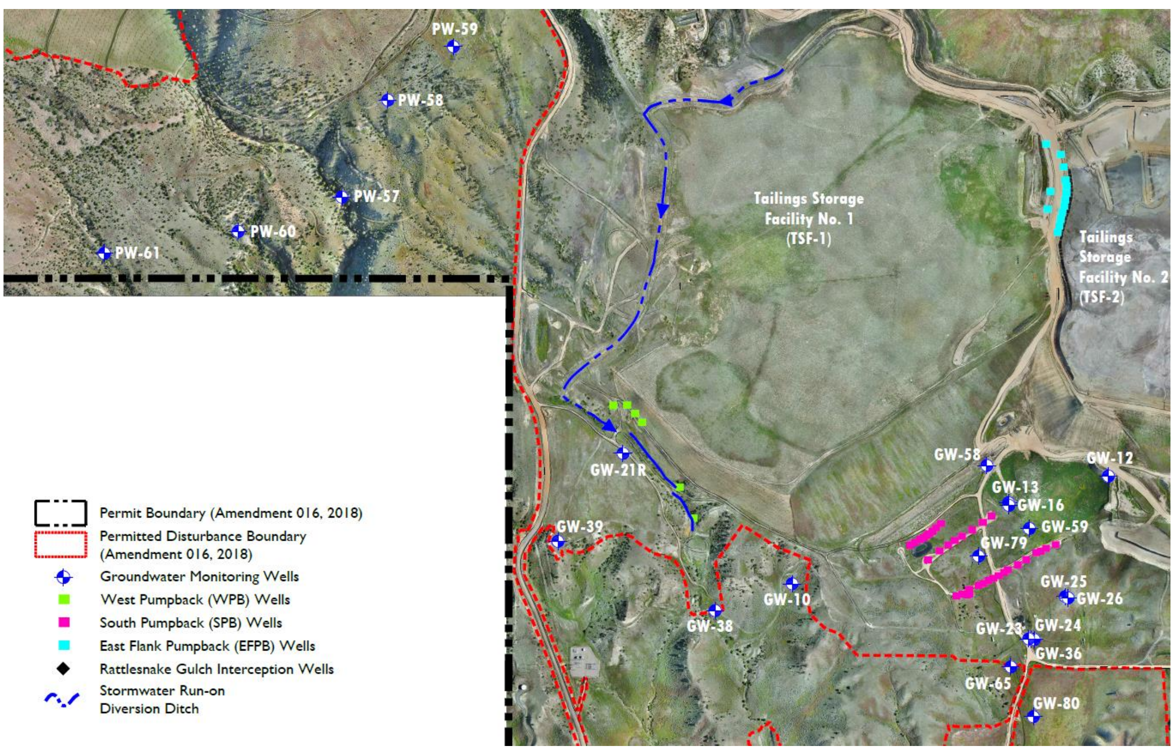


Figure 5-3
Current Facilities Layout and Pumpback Wells at Tailings Storage Facility 1 (GSM 2021)

Water collected around TSF-1 has shown a decline in total cyanide concentration (**Figure 5-4**). Well SPB-18 had the highest observed concentrations of process-related constituents (e.g., total cyanide, thiocyanate, and nitrate) and was used to estimate the composition of process water within TSF-1. Based on trends in SPB-18, total cyanide is expected to become nearly absent at this location after 2026. Other pumpback wells also exhibited lower average cyanide levels but with slower rates of concentration decline. Nitrate in SPB-18 showed modest increases from 3 to over 5 mg/L from 1998 to the present and was likely because of cyanide oxidation.

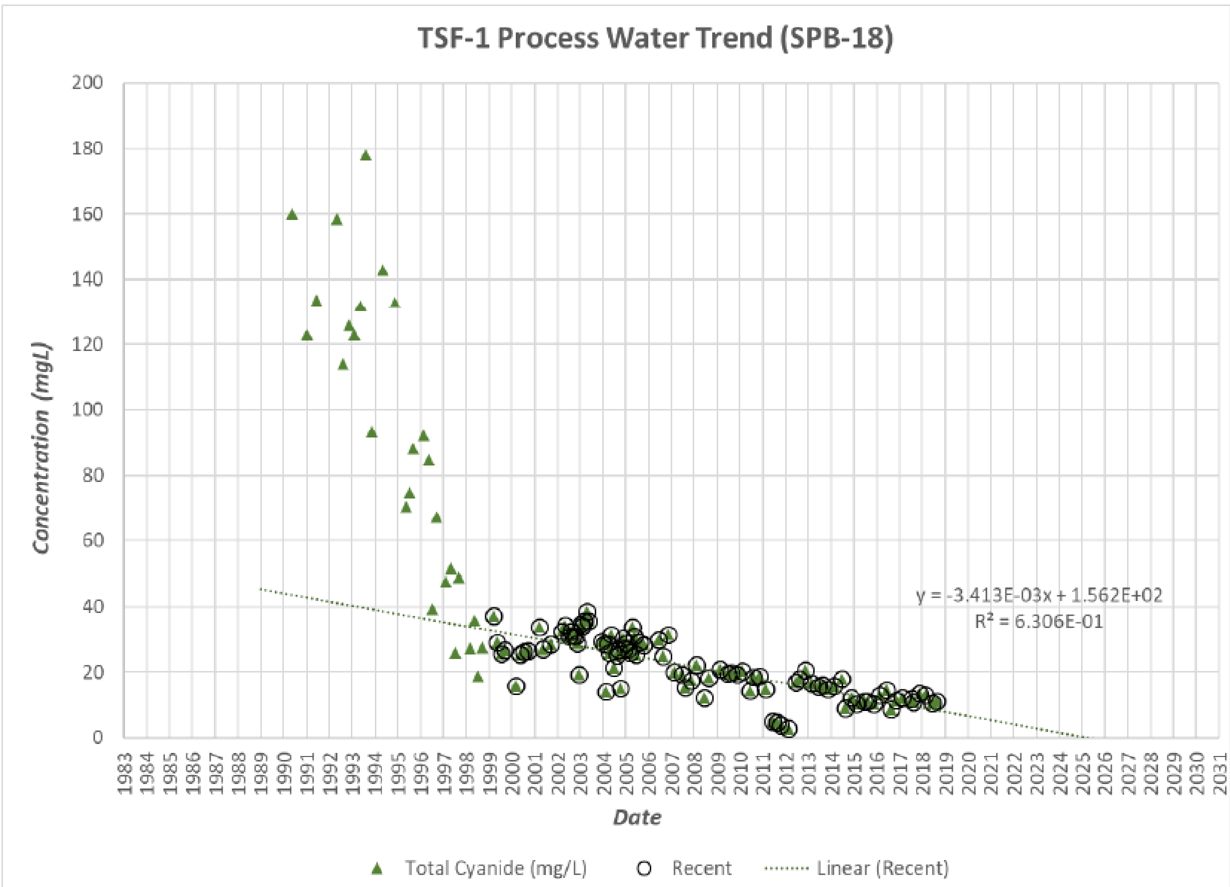


Figure 5-4
Tailings Storage Facility 1 Cyanide Trends (**Schafer Limited LLC 2020**)

Sulfate and sodium in SPB-18 also increased over the period of record (**Figure 5-5**). Although sulfate could be derived from pyrite oxidation in the tailings, sodium is also increasing, which indicates that increases in sulfate may result from gypsum dissolution to satisfy charge neutrality for the increasing sodium. The sodium trend suggests interaction with clays in the native foundation soils or the bentonite clay slurry wall. Gradual migration of sodium in the original process water, as it migrated toward SPB-18, could have been slowed because of ion exchange with the clay minerals releasing calcium and retaining sodium. The earliest measured water sample from SPB-18 had a sodium adsorption ratio (SAR, a measure of sodium abundance) of 4.4 while SAR was approximately 8 in 2018. By comparison, the average SAR of TSF-2 water is 10.

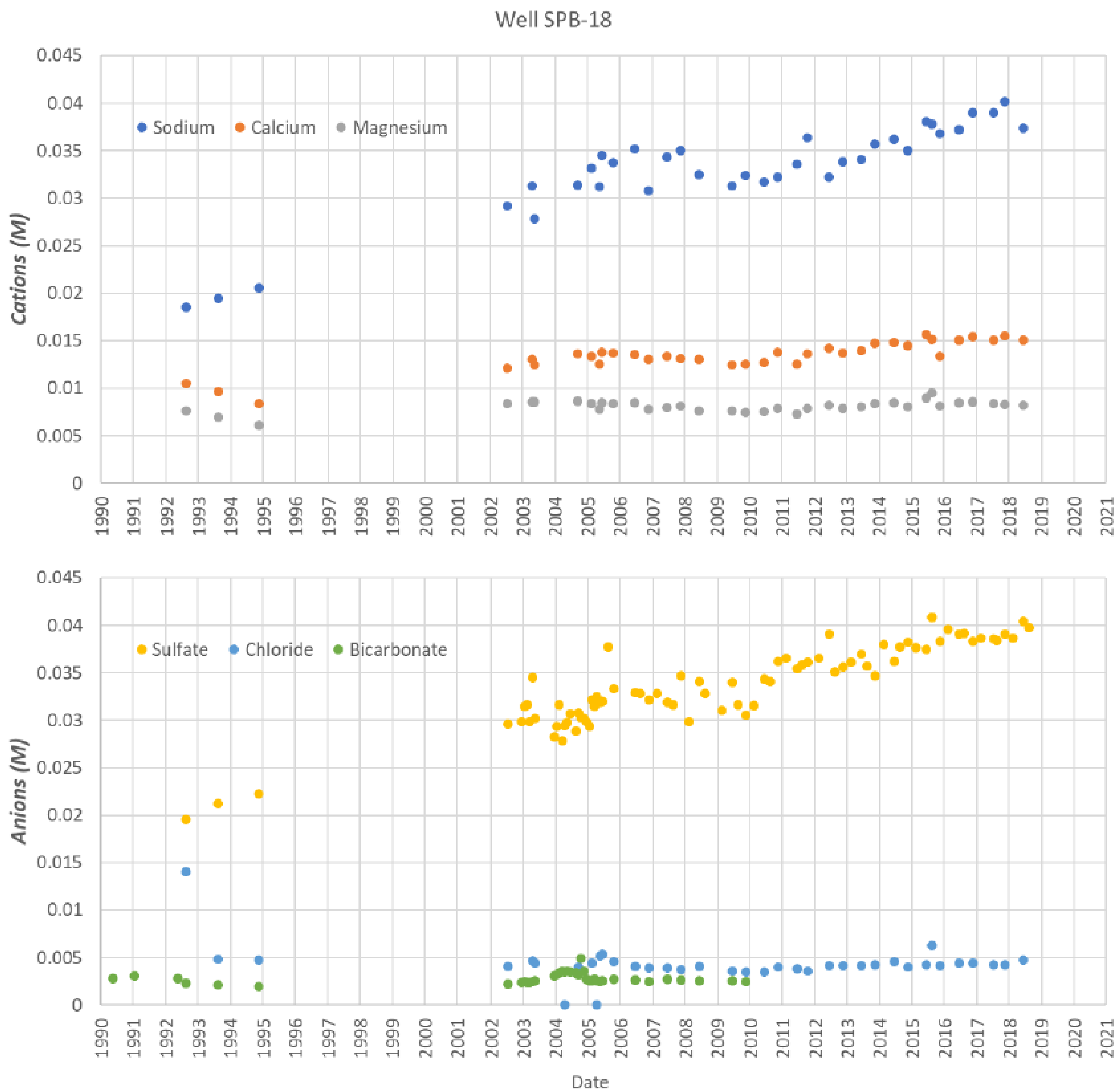


Figure 5-5
Tailings Storage Facility 1 Cation and Anion Trends (Schafer Limited LLC 2020)

5.2 Mineral Hill Pit and Surrounding Bedrock

The ore body at the Pit and surrounding mineralized zone produces natural ARD. Mining of this material has exposed mineralized material that produces additional ARD (Schafer Limited LLC 2020) and some of this water flows into the current Pit. The South Well located in the Pit dewaters the Pit material from below the Pit floor at an average annual rate of 57 gpm to maintain ground water levels below the Pit floor (near the 4,500-ft elevation). This water is discharged and managed at TSF-2.

Historical data on the Pit water levels and dewatering pumping rates is sufficient to characterize the ground water system around the Pit. Estimates of transmissivity of the unfractured bedrock material are low (approximately 10 square feet per day).

6.0 REVIEW AND ANALYSIS OF THE GEOCHEMICAL CHARACTERIZATION PROGRAM

The geochemical characterization program used to develop the geochemical characterization model to support the Proposed Action is summarized in Appendix B of the Amendment Application (Schafer Limited LLC 2020). The geochemical dataset includes waste rock and tailings characterization results as well as site water quality and is summarized as follows:

- Waste rock
  - Static test data (acid-base accounting, net acid generation (NAG), and paste pH) collected by Schafer and Enviromin
  - Short-term leach tests to evaluate soluble surface acidity and metals by the Synthetic Precipitation Leaching Procedure (USEPA 1994) and the MWMP (ASTM 2013)
  - Four humidity cell campaigns (Schafer & Associates 1994, Enviromin, USEPA, and by Barrick)
  - Waste rock facility suction lysimeters
- Tailings
  - Static tests (acid-base accounting, NAG, and paste pH) collected by Schafer & Associates (1994), Telesto Solutions (2003), and Barrick
  - Short-term leach tests (MWMP)
  - Humidity cell tests
  - Leach Environmental Assessment Framework tests (USEPA 2013, 2017, 2019)
- Site water quality (over 10,000 samples):
  - Seeps and springs
  - Ground water, monitoring, and observation wells
  - Pit area
  - TSF-1 and TSF-2 area.

Although the individual characterization programs summarized above were not thoroughly reviewed by RESPEC, the various material types and site areas appear to be well-represented from compositional and volumetric perspectives, and sufficient for evaluating the impacts from the Proposed Action. The staged, phased evaluation of material types is in accordance with established regulatory guidance and industry-accepted best practice standards. The series of tests conducted are sufficient to understand long-term material environmental behavior, namely:

- Acid-base accounting tests provide a screening-level inventory of material acid-generating and acid-neutralizing potential.
- NAG and paste pH provide direct estimates of current and worst-case (i.e., all sulfides oxidize) material acidity.
- Short-term leach tests (e.g., MWMP or Synthetic Precipitation Leaching Procedure) provide an indication of water quality (especially metals loading) associated with initially flushing waste material surfaces after disposal.
- Humidity cells are useful for quantifying long-term material reactivity such as sulfide oxidation, production of acidity and metals, and depletion of acidity by buffering phases. The tests also allow for determining the lag time to acidic conditions, help resolve residual uncertainty from static testing, and provide estimates of water quality (especially for samples that become acid-generating).
- Leaching environmental assessment framework protocol represents a series of tests designed to evaluate the interaction of solid materials (i.e., tailings) with various contact water types to assess acid neutralization and metal attenuation/mobility. Three separate tests evaluate the solubility of various tailings constituents across a broad pH range, assess the neutralization and attenuation capacity of tailings in various water types, and evaluate diffusive constituent release in more coherent tailings (i.e., as found after disposal).

A large (10,000+ samples) water quality database was evaluated by Schafer Limited LLC (2020) to assess the range of acidity and solute loading observed in various areas of the site and to characterize waters into mineralized or background water types based on their water quality characteristics. Mineralized waters are further subdomained based on their inferred acid neutralization pathways. Solute and solid partition coefficients, which are useful for quantifying metal attenuation in ground water flow and mass transport models, were calculated for several constituents (e.g., nitrate, sulfate, and various metals) based on retardation coefficients obtained from column tests conducted in 1994.

7.0 REVIEW AND ANALYSIS OF GROUND WATER MODELS

The Amendment Application and supplemental appendices provide an overview of site ground water and predicted ground water impacts. Numeric ground water modeling was conducted by JSAI (2020) to characterize ground water quantity and quality resulting from the Proposed Action, including removing tailings in TSF-1, reprocessing the tailings, and placing the reprocessed tailings in the Pit.

The JSAI model used MODFLOW (McDonald and Harbaugh 1988), which is a commonly used finite-difference code developed by the U.S. Geological Survey. A five-layer model was constructed to simulate the hydrostratigraphy and geologic structure of the mine area. Aquifer characteristics and boundary conditions for the various materials were assigned to 100-ft × 100-ft grid cells. The model also uses the solute-transport program MT3D (Zheng 1996) to predict chemical constituent concentrations in ground water up to 300 years into the future for both the current mine closure plan (TSF-1 tailings left in place) and the proposed TRP. Sulfate transport is modeled as an example because it is conservative and a constituent of concern in ARD production that is present in high concentrations. The model could theoretically be used to model other parameters; however, nonconservative constituents would result in smaller-extent and lower-concentration plumes caused by adsorption and other mechanisms.

Reported calibration of the model is generally acceptable, as shown on **Figure 7-1**. JSAI explains that because of uncertainty about the accuracy of older water-level data, only recent (2017 and later), well-documented data are used to calibrate the model. However, some of the comparison hydrographs between observed and simulated water levels contained in the model report (Appendix B of JSAI 2020) show poor correlation. Forty-five sites are plotted on **Figure 7-1** but 54 sites are included in Appendix B. A model may calibrate closely in one area of the domain and poorly in another, and typically an area of specific interest is prioritized. The model can be adjusted to achieve good calibration in that area, even if this results in other parts of the domain are less well-calibrated. Evaluating and reporting the distribution of calibration error may help clarify calibration methods. In accordance with the Amendment Application, GSM would periodically recalibrate the model with data collected from ongoing monitoring programs in and around TSF-1 and the Pit. Recalibration will allow the model to be updated and to resolve issues within the model domain.

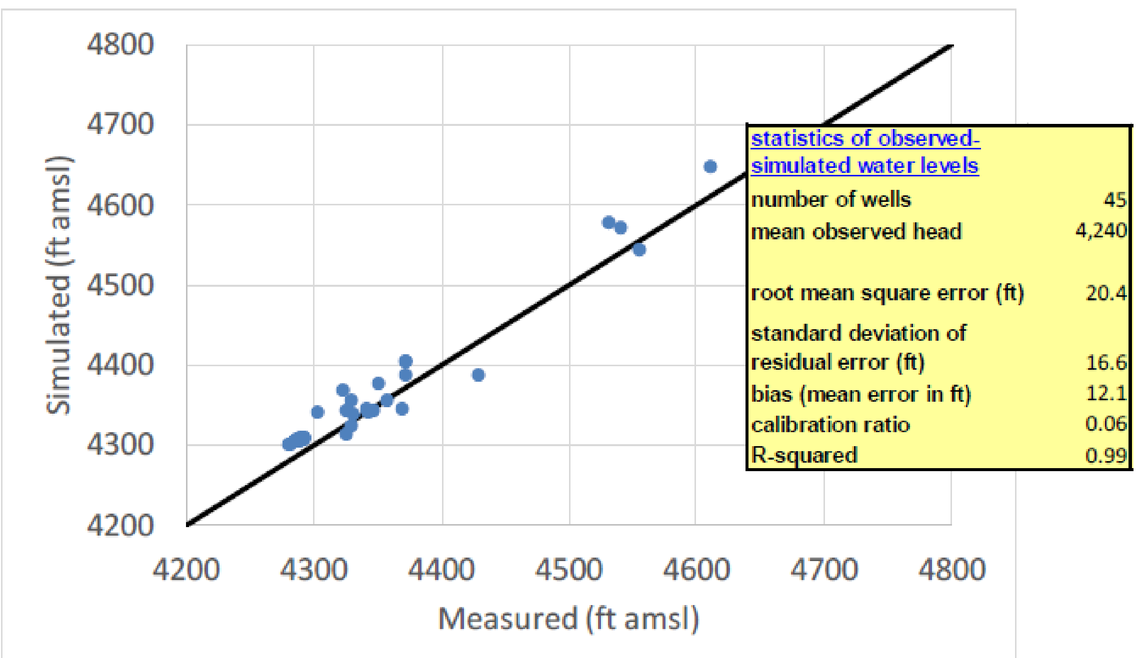


Figure 7-1
MODFLOW Model Calibration Results (JSAI 2020)

7.1 Simulation of Tailings Storage Facility 1 Area

Assumptions used in the TSF-1 ground water and solute-transport model simulations are typical and include the following:

- Continued permanent Rattlesnake wellfield pumping and discharge to the Land Application Disposal Area of 38 gpm.
- Continued pumping from the East Flank Pumpback wells at 25 gpm and the SPB wells at 15 gpm.
- While the historical simulation assumes infiltration mainly into the Rattlesnake drainage, based on observed historical infiltration and model calibrations, the future simulations assume an infiltration breakthrough of 0.6 inch per year throughout the entire TSF-1 footprint.
- Continued dewatering from the underground sump at 57 gpm.

The simulation assumes longitudinal dispersivity of 100 ft and transverse (horizontal and vertical) dispersivity of 10 ft. Boundary conditions and hydraulic properties used in the ground water model are appropriate based on available data.

7.1.1 Water Quality Impacts

Simulated sulfate concentration for the year 2030 (**Figure 7-2**) indicates a residual plume confined to the immediate vicinity of TSF-1. The base case simulation was then modified to simulate an end to the operation of the pumpback system in 2030. The predicted increase in sulfate concentration after 100 and 300 years (assuming an end to pumpback operation in year 12) is shown on **Figures 7-3** and **7-4** and indicates localized effects beneath the footprint of TSF-1. The contours represent increases caused by continued infiltration from TSF-1, with the tailings left in place. Existing background concentrations of sulfate, which are naturally elevated in some areas around the mine site, are not represented. The simulation results of the TRP indicate that removing the contaminant source (finishing in 2030) would result in a more rapid improvement of ground water quality. With regard to surface water, no measurable changes to surface water quality have been observed for decades, which indicates that potential affects from ground water migration are being mitigated by ground water pumpback. The existing pumpback systems will operate until ground water quality has been observed to sufficiently improve to allow for cessation of pumping, following approval from DEQ and BLM.

7.1.2 Flow and Pumping Impacts

Under the Proposed Action, GSM does not propose to alter flow or pumping rates at TSF-1. Water from pumpback recovery wells would continue to be pumped to TSF-2 during the TRP. Following the eventual reclamation of TSF-2, water captured by pumpback wells would be conveyed directly to water treatment. Rattlesnake wells would also continue to pump intercepted water above the tailings facility. After TSF-1 is excavated, removing the tailings source of contamination may allow for reduced pumping rates or eventual elimination of the pumpback well system. GSM is required to maintain the pumpback system until acceptable improvements to water quality are demonstrated. Any modification to the long-term pumpback and water treatment systems would require approval by DEQ and BLM before implementation.

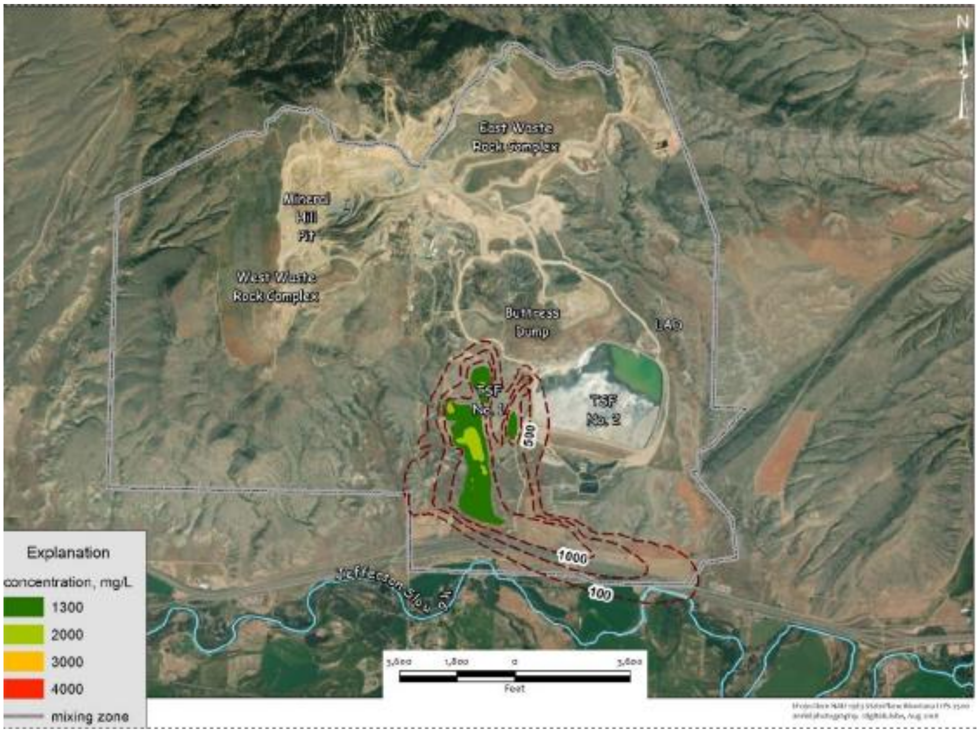


Figure 7-2
Golden Sunlight Current Mine Closure Plan Model Predicted (2030) Sulfate Concentration From Tailings Storage Facility 1 (JSAI 2020)

Figure 7-3
Golden Sunlight Current Mine Closure Plan Model Predicted (2118) Sulfate Concentration From Tailings Storage Facility 1 (JSAI 2020)

Figure 7-4
Golden Sunlight Current Mine Closure Plan Model Predicted (2318) Sulfate Concentration From Tailings Storage Facility 1 (JSAI 2020)

7.2 Simulation of the Mineral Hill Pit

Tailings placement in the Pit was simulated by allowing previously inactive layer 4 cells in the Pit area (removed by mining) to become wet. The bottom of layer 4 for each newly active cell was set at the corresponding Pit wall bottom elevation for that cell. In-Pit tailings were assumed to have a hydraulic conductivity of 0.142 foot per day, vertical anisotropy of 0.1, and a specific yield of 0.2. The tailings surface elevation over time was estimated based on the 12-year schedule of tailings removal from TSF-1 and an analysis of postmining consolidation of the in-pit reprocessed tailings. A combination of specified flow and drain boundary conditions are used to simulate a water level rising over time with the tailings surface.

Dewatering from the underground workings was simulated to control ground water levels. The dewatering rate is assumed to be equal to projected seepage from tailings, plus an additional amount to control ground water outflow. Three cases were simulated, including the base case (continued dewatering to maintain zero ground water discharge from the underground workings) and two alternatives, aiming to show the effects if dewatering were reduced or if dewatering were ended/interrupted. The three cases are as follows:

1. Zero ground water outflow from the underground mine. This model case was constructed to represent a long-term dewatering rate equal to tailings seepage plus

approximately 38 gpm, which would result in zero discharge and completely capture water flowing to the Pit, tailings, and underground mine.

2. Control of ground water outflow. This model case represents a long-term dewatering rate that is equal to tailings seepage plus approximately 15 gpm that would result in minimal (less than 1 gpm) outflow. All water flowing to the Pit or the tailings would drain to the underground mine, from which a small amount of ground water would flow out. The fate and transport of water from the Pit was tracked assuming the following input sulfate concentrations:
   a. TSF-1 infiltration = 4,320 mg/L through the end of tailings removal and zero thereafter.
   b. Ground water discharge from underground mine = 5,790 mg/L.

   The simulation assumes longitudinal dispersivity of 100 ft and transverse (horizontal and vertical) dispersivity of 10 ft.
3. Eventual shut-down or interruption of dewatering. The results of simulating a shut-down of dewatering after year 100 (2118) indicate that ground water outflow from the underground mine would rise from zero to approximately 6 gpm. Water quality effects would be limited to the immediate area of the mine facilities.

Note, the first simulation of the Pit represents the Proposed Action. The other simulations, although informative, would not be permitted without a future permit amendment that has yet to be submitted by GSM. Simulated drainage from tailings and pumping for each dewatering case is shown (**Figure 7-5**). Required pumping peaks near the end of mining and gradually decrease until the tailings become fully drained at about year 100. Projected Pit backfill elevation and simulated water level in the underground mine are shown on **Figure 7-6** for each case.

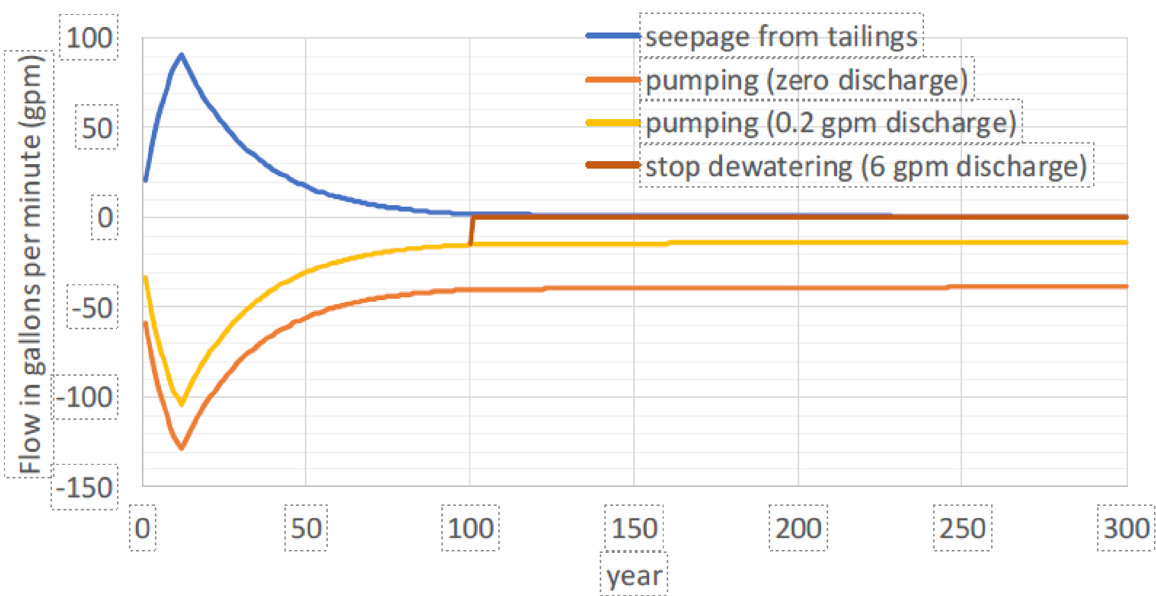


Figure 7-5
Predicted Pit Flows to Underground Mine Workings (JSAI 2020)

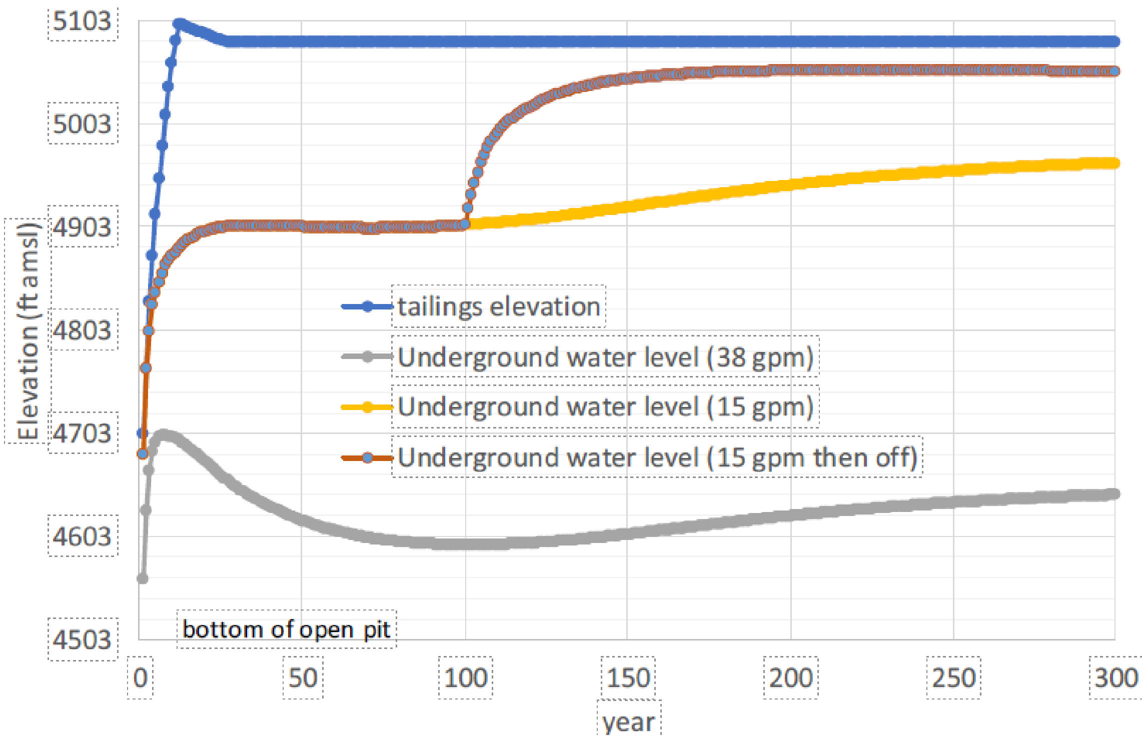


Figure 7-6
Tailings Backfill and Predicted Pit Ground Water Elevations (JSAI 2020)

7.2.1 Water Quality Impacts

The model-predicted impacts to ground water quality for each previously described Pit simulation are summarized as follows:

1. Zero outflow: Removing tailings from TSF-1 while maintaining a complete sink around the open Pit by dewatering at a rate equal to the seepage from tailings plus 38 gpm results in no predicted effects to ground water quality. The concentration of metals or other constituents from reprocessed tailings entering the system from backfill is pumped out and removed from the system, which results in no contamination increase to the ground water flow system.
2. Control of discharge: The fate and transport of water from the Pit was tracked assuming 15 gpm dewatering. The simulated increase in sulfate concentration after 100 years is illustrated on **Figure 7-7** and shows a small residual effect downgradient of the Pit. An increase in sulfate concentration after 300 years is shown on **Figure 7-8** and indicates only localized effects at the downstream toe of the underground mine.
3. Eventual shut-down or interruption of dewatering: The effect of shutting down dewatering entirely after 100 years, instead of continued pumping at 15 gpm, was also simulated. The increase in sulfate concentration after 300 years is shown on **Figure 7-9** and indicates a larger, but still localized, affected area extending downgradient of the Pit and underground mine.

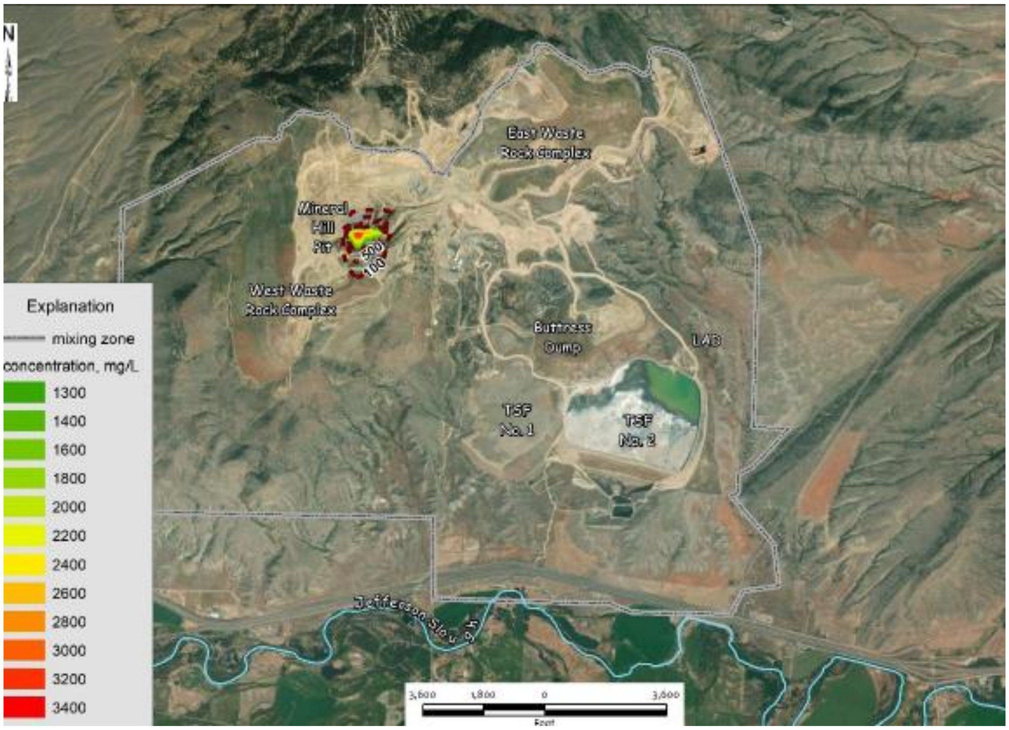


Figure 7-7
Predicted Sulfate Concentration Increase With 15 Gallons per Minute Dewatering in 2118 (JSAI 2020)

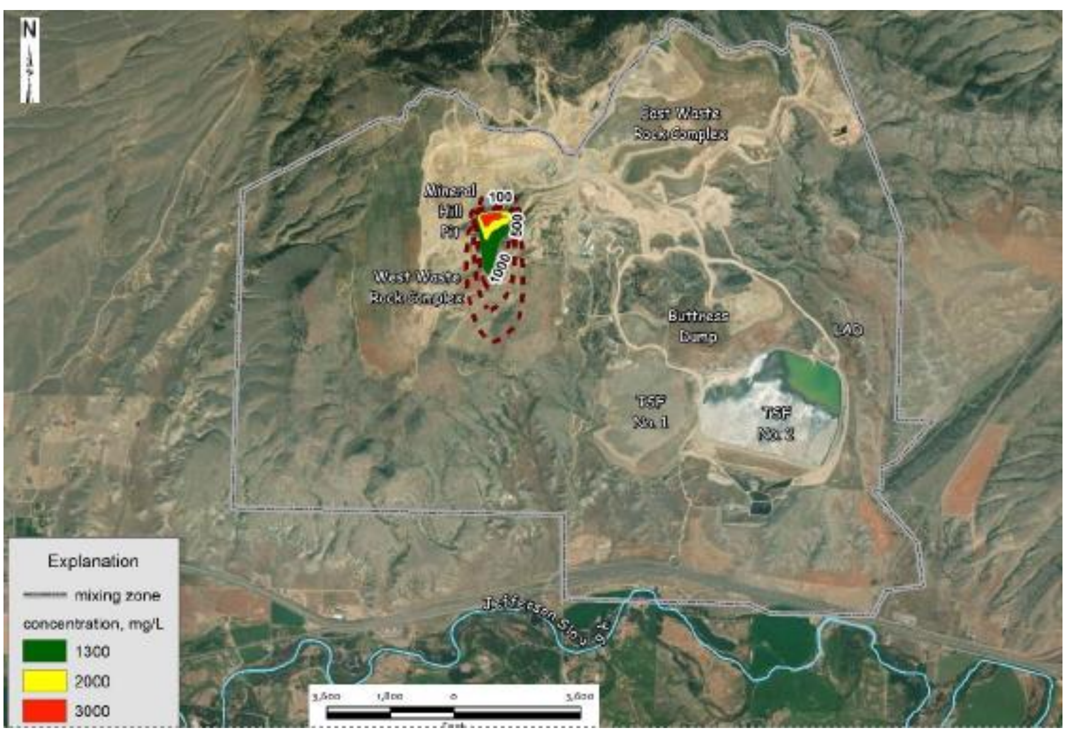


Figure 7-8
Predicted Sulfate Concentration Increase in 2318 With 15 Gallons per Minute Dewatering (JSAI 2020)

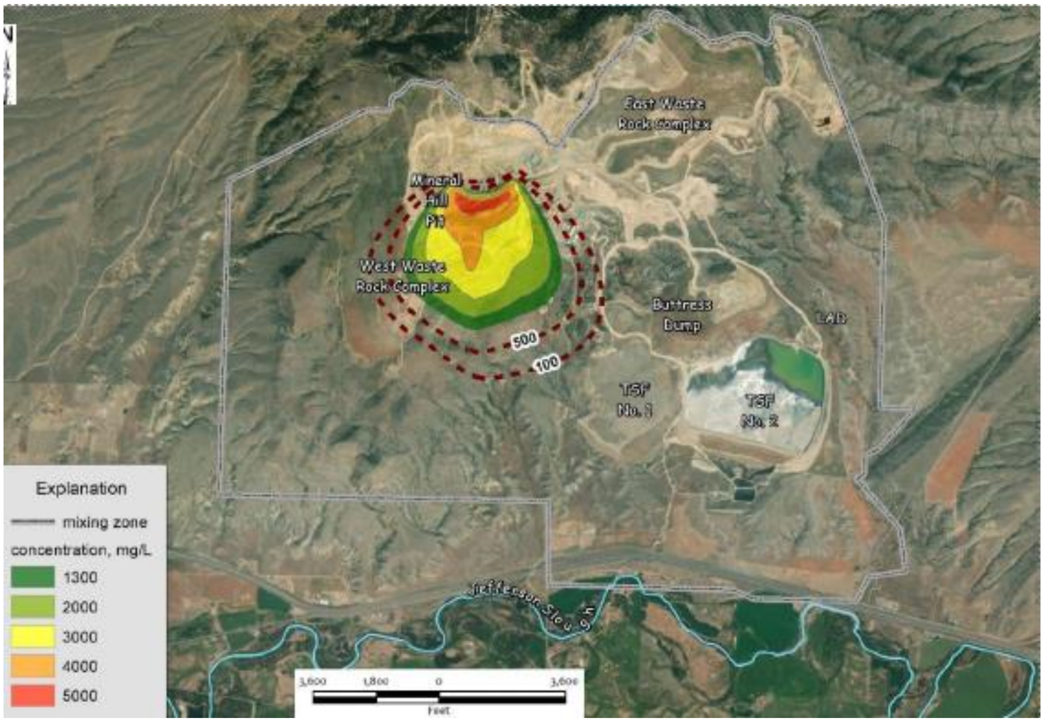


Figure 7-9
Predicted Sulfate Concentration Increase in 2318 After Shut-Down of 15 Gallons per Minute Dewatering (JSAI 2020)

7.2.2 Analysis of Pit Dewatering Strategy

Based on a review of the modeling results, Pit dewatering rates appear reasonable. Sufficient monitoring is in place around the Pit to detect if the dewatering rates should be adjusted to maintain a cone-of-depression.

Continued dewatering of the Pit at a rate of 57 gpm from the underground mine is projected to result in a dry Pit and complete capture of ground water around the open Pit and the underground mine. Under the TRP, dewatering rates are projected to peak near the end of tailings reprocessing, then gradually decrease over 100 years as the tailings drain down. The model results indicate no effects to ground water quality with 38 gpm of long-term dewatering from the underground mine; all ground water flowing to the Pit or tailings seepage would be captured, with zero outflow to the ground water system.

With 15 gpm of long-term dewatering, ground water quality effects (from a minimal discharge to ground water) would be restricted to the immediate vicinity of the Pit. All ground water flowing to the Pit or tailings would drain to the underground mine, and less than 1 gpm of the flow would discharge to the ground water system.

If dewatering were shut down at year 100, the effects on ground water quality would extend further from the open Pit but would still be restricted to the mine area. All ground water flowing to the Pit or tailings would drain to the underground mine. Approximately 6 gpm of outflow from the underground mine would mix with the natural ground water.

8.0 REVIEW AND ANALYSIS OF REPROCESSED TAILINGS

8.1 GEOCHEMISTRY OF REPROCESSED TAILINGS

The current results indicate variability with respect to achieving the desired residual sulfide content in the final tailings; therefore, RESPEC recognizes that the 0.5 percent sulfide content may not be consistently attainable, and even small differences can change the tailings from being net neutralizing to net acid-generating. A bulk TSF-1 tailings sample was obtained in 2018 for many tests (i.e., subsamples) to be run for characterization of raw tailings, which complemented the field characterization done over numerous years. A small number of subsamples taken from the TSF-1 2018 bulk sample, as well as one periodic grab sample, have been processed in flotation cells for testing the depyritization of the tailings and to characterize the reprocessed tailings. Static characterization tests (in particular, acid-base accounting) performed on a large number of samples from TSF-1 indicate that the tailings are heterogeneous; compositional representativeness is critical in selecting subsequent samples for advanced testing.

Humidity cell testing indicates that the potential and timing for tailings to acidify over time is dependent on the sulfide content in the final tailings given their relatively low acid-neutralizing potential. The neutralization potential ranged from 7.3 to 17 kilogram per ton (kg/t) as $CaCO_3$ for raw and depyritized tailings samples, respectively. Based on limited static testing, the depyritized rougher tailings were net neutralizing and other samples were net acid-generating. A comparison of total percent nonsulfate sulfur (total sulfur minus sulfate) to net neutralizing potential is shown on **Figure 8-1**. Based on this information, the tailings have a net neutralizing potential of 0.0 kg/t as $CaCO_3$ (i.e., acidity equals alkalinity) when total nonsulfate sulfur equals 0.56 percent. In the absence of additional sources of alkalinity (e.g., lime in thickened tailings process solution), the reprocessed tailings themselves have limited alkalinity and would not completely offset the acid-generating potential inherent to the tailings when total nonsulfate sulfur exceeds 0.56 percent. Neutralization potential within the tailings would also be subject to reaction or consumption by the infiltration of acidic waters. This emphasizes the need to monitor the flotation system to yield total sulfur in residual tailings below 0.5 percent and to add sufficient lime maintain alkaline conditions within the process solution in the Pit (see Section 4.0, Proposed Action).

The depyritized tailings Test 6, which represents the worst-case/higher-residual sulfide tailings sample (containing 1.21 percent nonsulfate sulfur), becomes acid-generating after 43 weeks in the humidity cell as indicated by an abrupt decline to pH 3 s.u. and an increase in sulfate release. Notably, this decline in pH is a similar fate to the raw feed tailings samples; the primary difference is that the time frame is longer for Test 6 to become acidic (43 weeks) than the preprocess tailings samples (4–15 weeks). The depyritized, rougher tailings sample (containing

0.38 percent nonsulfate sulfur) demonstrates a much lower potential to acidify and has remained neutral over a longer period, with the humidity cells now running for over 55 weeks while effluent pH remains neutral (Schafer *et al.* 2021). As can be seen on **Figure 8-2**, the depyritized rougher tailings sample has not started generating acid, and seepage remains at neutral pH and low sulfate concentration (Schafer *et al.* 2021). Testing will continue through 70 weeks.

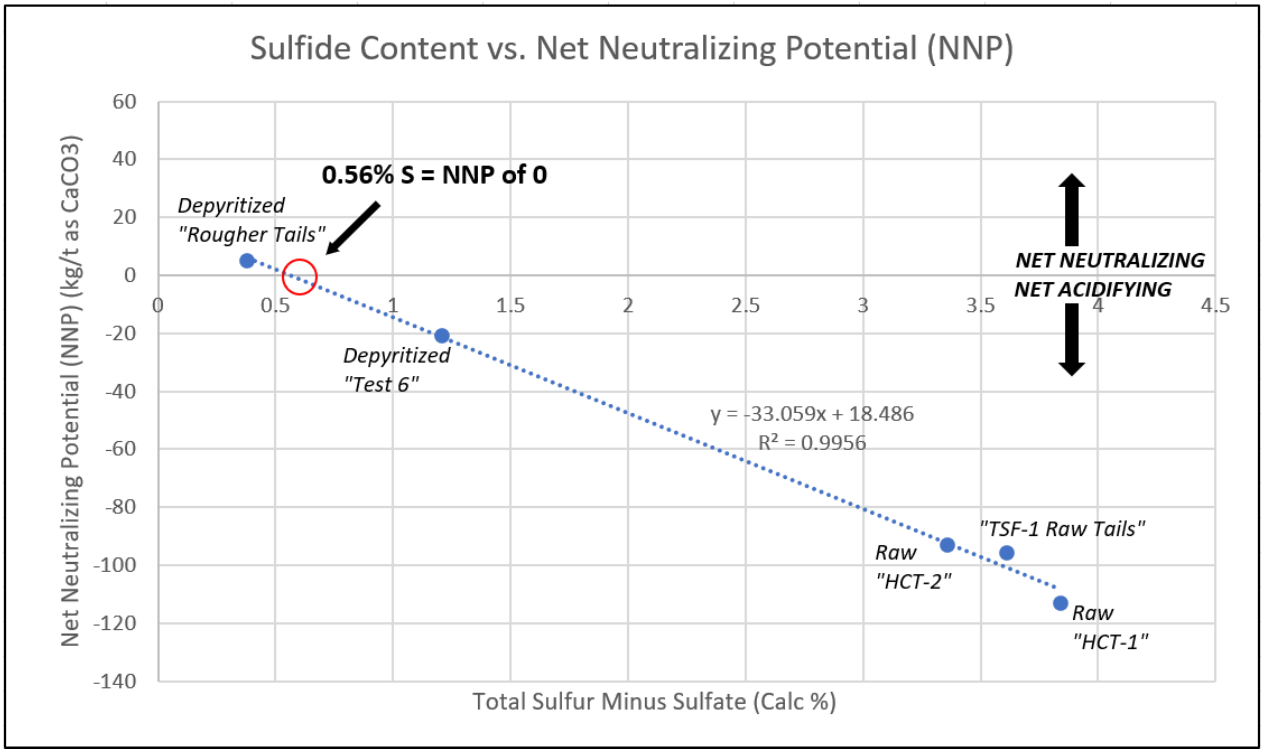
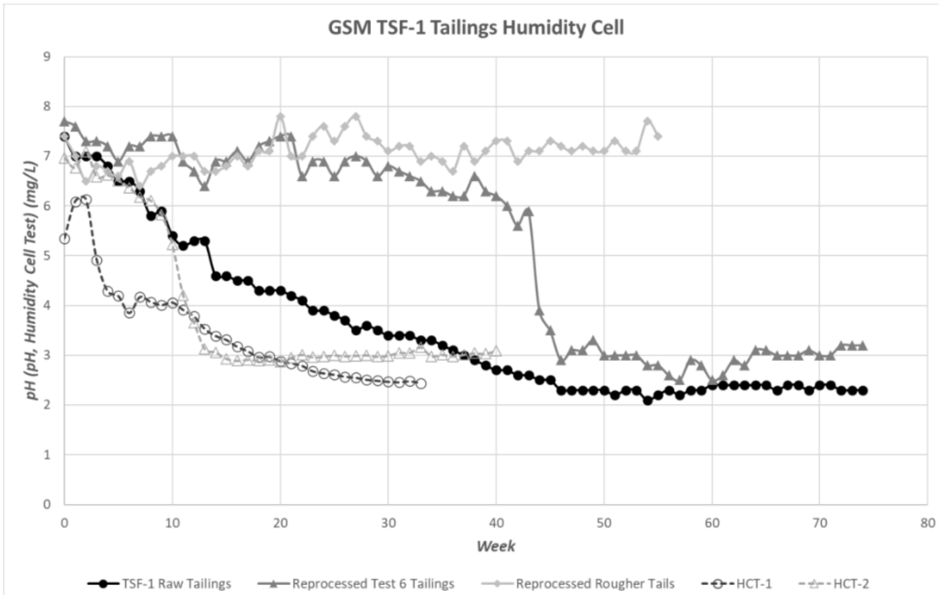


Figure 8-1
Comparison of Tailings Sulfide Content to Net Neutralizing Potential (Data From Schafer Limited LLC 2020)

However, note that even if a humidity cell test sample does not become acidic for the test duration, that material may yet do so in the field under other timeframes, if the potential alkalinity is depleted or unavailable to react completely with the acidity produced. The field lag time to produce acidity could be considerably reduced if reprocessed tailings were rinsed with oxygenated, acidic water (depleting any residual neutralization potential).

A primary objective of the Proposed Action remains to achieve a low-sulfide content within the flotation tailings to reduce the potential for further acidification in the Pit over the long term. Also, the proposed lime-amended tailings were not directly represented by kinetic tests, but the neutralization potential of the tailings would assumingly increase because of the co-deposition of lime. Potential acidification of the tailings mass does not drastically change the assessment of environmental impacts because the Pit dewatering system would be required to maintain hydrologic containment and meet compliance with statutes regarding protecting nearby water resources, regardless of the tailings mass pH. Acidic tailings seepage could result in additional metals and acidity loading to the underground sump that would require water treatment.



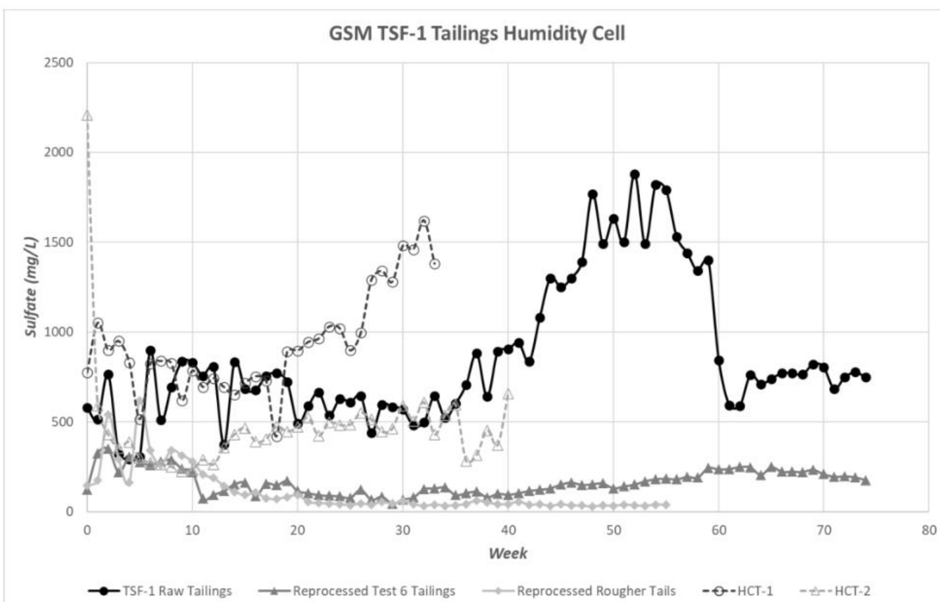


Figure 8-2
TSF-1 Humidity Cell Tests (Schafer *et al.* 2021)

8.2 TAILINGS AND PIT WATER QUALITY

The extent and rate of sulfide oxidation within the lower portions of the Pit highwalls may be greatly reduced after being covered by 23.6 Mt of low-permeability tailings to a depth of more than 600 ft. Oxygen flux is likely the limiting factor for sulfide oxidation in mineralized rock in the Pit highwalls and underground voids. As the depth of sulfide oxidation increases, oxygen flux and the extent of weathered/reacted minerals decrease because of the longer oxygen diffusion pathway. After tailings are placed, the oxidation within the highwalls covered by tailings would greatly decrease, particularly in saturated zones because oxygen diffusion through water is 0.01 percent the rate that occurs in air. Similarly, the oxidation rate in the underground workings would decrease after ventilation ceases, openings are sealed, and the highwalls in the vicinity of the underground mine voids are covered by tailings. Based on an assumed weathered highwall thickness of approximately 6.5 ft, the mass of weathered rock covered by tailings would reach about 1,532,000 tons assuming a saturated area of 2,220,000 square feet by year 12 (Schafer 2020b).

After tailings placement, the primary sources of potential acid generation and metal loading are the reaction products that remain in the weathered highwall zones. Potential acidity and metal loading also exist in the underground workings, but these sources are less significant because of the much smaller surface area of the mine voids compared to the Pit highwalls. During tailings placement and for many following years, the primary source of fluid flux in the Pit would be tailings draindown. Much of the acidity and metals that may have accumulated in the weathered Pit highwalls would be displaced into surrounding bedrock by the draining pore solution and would be collected by the underground dewatering system.

Modeling for the water quality of the process solution pond was conducted for scenarios with and without lime addition to the tailings; details are provided in the Amendment Application, Appendix F (Schafer 2020b). The lime addition case is representative of the tailings management under the Proposed Action, and the no-lime case is shown to reflect worst-case conditions if no pH control was used in the mill. During early years of tailings deposition, process water would tend to flow outward from the tailings and overlying pond into fractured rock surrounding the Pit and then into the underground mine void space and local bedrock porosity adjacent to the Pit.

The proportion of acidity and sulfate that would be rinsed from the highwall by tailings draindown was estimated. Using the ground water model results (JSAI 2020), approximately 1.5 million tons of water would drain from the tailings by year 12 and 5.6 million tons by year 100. The mass of tailings draindown solution that would leach through the weathered rock zone would equal the weathered rock mass by year 12 and 3.6 times the rock mass by year 100. The chemical mass should be substantially depleted in the weathered rock zone caused by tailings draindown (Schafer 2020b).

A mass balance was developed for the highwall to compare the acidity in the highwall to the alkalinity in the backfilled tailings, with the variables defined in Schafer (2020b). Assuming

2 percent pyritic sulfur in the weathered rock mass (1,532,000 tons), the fully oxidized weathered rock could generate acidity of approximately 6 percent of the rock mass, or about 96,000 tons as $CaCO_3$. This amount may be an overestimate because complete oxidation is unlikely to occur on the highwall surfaces buried by the tailings mass. The 23.6 Mt of tailings have an average neutralization potential of 17 kg/t as $CaCO_3$ (1.7 percent $CaCO_3$ equivalent), for a total alkalinity of 400,000 tons as $CaCO_3$, or about 4.2 times the mass of acidity in the highwall. This model estimate does not include the alkalinity provided by the lime amendment, which would be added to the thickened tailings in the Proposed Action. Pit ground water that contacts tailings is expected to be neutralized as long as the mass ratio of cumulative ground water flux to tailings mass remains below about 2. This is based on EPA 1314 column test results (Schafer 2020a) and related geochemical testing. The cumulative input of acidic highwall runoff plus influent ground water to the tailings fill zone would be approximately 6.4 million tons through year 100, which reaches a mass ratio of about 0.5 (Schafer 2020b).

Long-term neutralization of ground water would require that the interior of the tailings mass have contact with ground water inflow, which is reasonable given the higher horizontal hydraulic conductivity within the tailings ($K = 5 \times 10^{-5}$ cm/s) when compared to the bedrock hydraulic conductivity ($K = 7.1 \times 10^{-7}$ to 3.5×10^{-6} cm/s). However, not all of the interior alkalinity of the tailings mass may be available for ground water contact. The tailings nearest to and within zones of ground water flux would likely be depleted of alkalinity more quickly than in other portions of the tailings mass that may not encounter ground water as frequently (heterogeneous neutralization). Despite the likely neutralization of ground water inflow by the tailings mass, the ground water transport simulation and the water quality at the Pit dewatering sump were assumed to remain unchanged from the values shown in the postclosure evaluation (pH 4.2; 595 mg/L acidity; 5,790 mg/L sulfate (Schafer 2020b).

If the reprocessed tailings were to start producing acid, the additional impact on the Pit sump-water quality is not clearly understood because this scenario was not modeled in the Amendment Application; however, the resulting ground water quality from the Pit ground water contacting potential acidic water in tailings could be similar to the historical Pit sump water used in the GSM model.

8.3 Tailings Hydraulic Conductivity and Moisture Retention

For consolidation and seepage analyses, tailings were characterized through a variety of tests to determine specific gravity, particle-size distribution, saturated hydraulic conductivity, and water retention capacity. To determine the hydraulic conductivity of the tailings, three densities were tested: loose pack (92.4 pcf), low bulk density (106.1 pcf), and high bulk density (111 pcf). The resulting conductivity tests indicate that the loose pack tailings would have an approximate saturated hydraulic conductivity (k_s) of 0.11 foot per day (ft/day), while the low-density and high-density tailings would result in $k_s = 7.9 \times 10^{-3}$ ft/day and $k_s = 1.5 \times 10^{-3}$ ft/day, respectively.

For determining moisture retention capability within the tailings, the tailings were tested at a low bulk density (104 pcf) and high bulk density (115 pcf). Seepage from the tailings was estimated based on the low-density test results. While the characteristics of the placed tailings are likely to vary because of segregation across the final deposit, using the low bulk density as opposed to the loose pack density measured above, may result in underestimating the rate of seepage from the tailings during and after deposition. On the same basis, the rate of consolidation has been conservatively underestimated.

8.4 Analysis of Tailings Thickening

Within the Amendment Application, a tailings thickener was introduced to the tailings processing circuit. Based on testing performed by SGS (2010), the thickener is designed to achieve 65 percent solids before discharging into the Pit. This testing was carried out on tailings samples destined for TSF-2 from the then-operational processing circuit or dredged from TSF-2 to represent tailings materials that were previously proposed for reprocessing.

Rheological testing was performed on representative homogeneous test-sample aliquots that were flocculated with CIBA Magnafloc at "optimum" dosage, as determined by settling-thickening testing. The density test results generally align with tailings characteristics established through other geotechnical testing, whereby at solids density of 65.8 wt. %, density is 106.6 pcf, and at the critical solids density of 71–72 wt. %, density is 113.9 pcf. Two observations can be made and are described as follows:

- Recall that the lowest density tested is similar to the low bulk density used for testing saturated hydraulic conductivity and assumed to conservatively project seepage and consolidation rates. Because the proposed discharge solids density is 65 wt. %, and is associated with low bulk density, the parameters used in consolidation seem appropriate.
- Given that the critical solids density is 71–72 wt. %, targeting a discharge solids density of 65 wt. % is achievable and manageable. Because of the low strength of the thickened materials at this density, the deposition strategy within the Pit should not be challenging. A 0.5 to 1 percent slope angle is assumed to set up in the Pit upon discharge of the thickened materials as they discharge excess pore fluids. This assumption is common for discharging thickened tailings materials and seems appropriate given the low strengths of this low-density material.

SGS (2019) concluded their testing report with the note that "the static settling-thickening tests results and subsequent design criteria do not incorporate any safety or scale-up factor. Depending on factors such as throughput, cost, and risk tolerance, the equipment suppliers may require additional data, including continuous thickener testing or additional rheology study to establish the final design criteria." In addition, testing should be complete to confirm that the tailings samples tested thus far are representative of the range of tailings properties that may be encountered in TSF-1.

If the desired solids content cannot be achieved for any reason, the deposition of the tailings could potentially be impacted. Impacts include final slope angles, segregation of fines from the slurry across the discharge beach, effects to the rate of interstitial fluids release and consolidation, and the duration of time upon which access to and reclamation of the tailings surface can be performed. Consideration should be given to evaluating the amount of segregation that might occur at this discharge density as well as considering multipoint discharge strategies in the event that the tailings do not form the desired final slope angles to help segregate the process solution pond and ultimately support the proposed closure drainage scenarios.

8.5 ANALYSIS OF CONSOLIDATION MODELING

For the modeling of consolidating the reprocessed tailings in the Pit, a deposition rate of 8,740 tons per day over 8 years was applied rather than the proposed 6,400 tons per day over 12 years. The modeling assumed an impermeable base (to be conservative) and an initial density of 80 pcf. At the projected rate of rise in the Pit, the tailings quickly settle to a density of 83.5 pcf and continue to increase in density to 85.1 pcf at the end of year 8, which is when the deposition is complete. The tailings continue to settle until year 24 when consolidation slows significantly, and the tailings have reached a density of 91.5 pcf. While this rate of placement is accelerated in comparison to the proposed processing rate, the results would likely be similar with the obvious extension to the amount of time for final densities to be achieved. The loose pack density tested previously (92.4 pcf) corresponds with the modeled final deposition density, and the associated saturated hydraulic conductivity (3.9×10^{-5} cm/s) is used for modeling the rate of long-term ground water flux through the final tailings deposit.

While one-dimensional, finite strain consolidation modeling is commonly used for a wide variety of fine-grained materials, GSM noted that the results are based on the properties of unsegregated (mixed) tailings. The results “do not imply that the in-pit tailings will behave exactly as modeled; deposition sequencing (location and duration of perimeter tailings spigot operation), overall filling rates, segregation, flocculent breakdown, and tailings composition changes will affect these results. In addition, these results are based on the lab test parameters and on a one-dimensional model which can not exactly represent field conditions” (GSM 2021).

Segregation alone can create significant variations to hydraulic conductivity, rates of seepage, and consolidation within the deposit. The center of the Pit would likely experience more consolidation than the edges, and the discharge side of the deposit would likely experience heavier loading rates, drain more quickly, and increase to greater density when compared to the north side of the Pit simply because of the likeliness of segregation across the deposit.

Based on current test results and modeling, the final densities would likely fall somewhere between the loose pack and low-density samples, with the higher measured hydraulic conductivities dominating the long-term characteristics of the tailings deposit unless the tailings characteristics are altered or changes are made to the depositional strategy.

9.0 CONCLUSION AND RECOMMENDATIONS

The geochemical tests and modeling chosen to evaluate potential impacts associated with the Proposed Action is sufficient and represents a robust characterization program. Overall, RESPEC agrees with the broad conclusions drawn in Appendices A and B of the Amendment Application. Reprocessing of potentially acid-generating tailings from TSF-1 would result in sulfide fraction reduction and thereby reduce the acid-generating and metals loading potential of the tailings. Furthermore, most leach tests, including those conducted with acidic ground water, suggest that the tailings have some residual buffering capacity and that, in the short term, the interaction between contact water and tailings does not result in significantly more impacted ground water. These conclusions are strictly related to the results of the characterization program; extending the results to the field scale to assess whether or not the Proposed Action would result in measurably different water quality at the reclaimed TSF-1 site or in the partially backfilled Pit is considerably more complicated; however, continued operation of the Pit sump and pumpback systems would provide management of changes in water quality that may result. Related issues stemming from extending laboratory characterization data to field-scale data are discussed within this technical memorandum.

Numerical ground water flow and solute-transport models (using MODFLOW and MT3D) of the vicinity of the Golden Sunlight Mine were constructed to evaluate the current mine closure plan (TSF-1 tailings left in place) and the TRP. The produced models use accepted methods, reasonable assumptions, and considerable existing data to predict future ground water conditions in the mine area and these results appear reasonable. Simulation results indicate that removing tailings from TSF-1 would improve water quality compared to the No Action Alternative, as a result of removing the source of contamination from TSF-1. Placing tailings in the Pit would not result in a permanent Pit pool, and a reduced dewatering rate could be sufficient to control ground water outflow from the Pit. The proposed low-sulfide, acid-neutralizing tailings could also improve the chemical quality of water pumped from the underground mine. The simulation results further indicate that any ground water quality effects would be confined to the immediate vicinity of the Pit.

Modeling by JSAI (2020) indicates that recovering tailings from TSF-1 would result in a long-term, positive effect on downgradient water quality. RESPEC agrees that removing partially saturated, acid-generating tailings and residual, steady-state porewater eliminates the primary source of acidity and metals loading currently captured by pumpback systems. However, uncertainty remains as to the extent that stored acidity and metals (from TSF-1 seepage over time) exist in underlying alluvial soils, and whether those metals might be remobilized as hydrogeologic conditions change after excavation. Any remobilization of contaminants would require continued use of the TSF-1 pumpback well system as long as necessary to prevent degradation of downgradient water, which is the requirement under the current permit.

The Amendment Application states that the risk of acidification is small for placed reprocessed tailings, although quantitative support for this statement is somewhat limited. The primary mechanisms that control Pit water quality are understood but not precisely modeled or quantified in the Amendment Application, such as the heterogeneous depletion of tailings neutralization potential (gradually increasing their acid-generation potential) by infiltrating acidic ground water, the rinsing and neutralization of weathered highwall surfaces by volumes of lime-amended tailings process solution and pore water, the additional neutralization potential contained within the tailings mass from lime amendment, and the reduction in the oxidation of sulfide minerals in portions of the Pit highwalls underneath the tailings mass.

Modeling did not fully assess the potential for ARD to develop if the neutralization potential of the tailings is entirely depleted by acidic seepage from the Pit walls and/or infiltrating acidic ground water, considering that seepage may contain sulfide oxidation catalysts (e.g., high iron, and/or acidophilic bacteria). Despite the substantial amount of alkalinity that would exist in the tailings mass, the long-term closure model assumed no change in the sulfate or acidity of water pumped back from the Pit through the closure period.

The sulfur fraction threshold for the potential for ARD to develop in reprocessed tailings is also not completely defined, although limited static test data suggest that the threshold is around 0.56 percent nonsulfate sulfur. Only two tests show a difference in ARD potential for depyritized tailings samples: one test at 1.21 percent nonsulfate sulfur (acid-generating), and the other test at 0.38 percent nonsulfate sulfur (currently non-acid-generating, based on humidity cell test results).

Based on information in the Amendment Application, it is difficult to determine if the slurry pH amendment would act as sufficient neutralization for the acidic ground water until the risk of ARD within the tailings is also mitigated through depyritization. Flotation tests show a significant reduction in sulfur fraction in final processed tailings and GSM states that the design criteria would be “less than 0.5 percent,” but considerable uncertainty exists in estimating the likely sulfur fraction in the tailings placed in the Pit. Reprocessed tailings may become acidic or not depending on the final sulfur fraction and the amount of lime amendment added to the thickened tailings, so it is recommended as a permit stipulation that GSM develops and employs a tailings sampling and analysis program to ensure that the residual sulfide content of the flotation tailings is meeting the design criteria (i.e., <0.5 percent sulfide) (see Section 2.4, DEQ’s Permit Stipulations). It is also recommended that GSM develop a response protocol or automated lime injection mechanism that adjusts the pH of the flotation tailings such that excess neutralization potential is established, dependent on its sulfide content. Considering the level of uncertainty that is inherent in any modeling exercise to predict water chemistry with the existing sources of acidic water reporting to the Pit sump, the Proposed Action is not anticipated to create a unique condition not already evident in current sump-water quality. The dewatering operations from the sump would continue to manage water levels and water that reports to the sump would be routed for reuse or treatment; regardless of quality.

Additional explanation by GSM of the water-level data used in calibrating the ground water model may be useful. For example, details of the distribution of error (residuals) could show where the model is most predictively accurate and also point to areas where more data would improve the model. Numeric models, without exception, provide non-unique solutions to ground water flow problems and alternative models may also be reasonable. In the future, recalibration of the ground water model would be conducted; including new long-term water-level data collection to test the model's predictive capabilities. If ground water conditions differ substantially from the current understanding of the aquifer system, updating the model with new monitoring data can improve the representation of these conditions, which should involve updated ground water monitoring data from the TSF-1 and Pit areas.

10.0 REFERENCES

ASTM International. 2013. Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure. ASTM International. West Conshohocken, PA.

Gallagher, K. 2021. Technical Memorandum: Results of Quantitative Phase Analysis of 14 Powder Samples Using the Rietveld Method and X-Ray Powder Diffraction Data. Prepared by Kathy Gallagher, GHI, to Golden Sunlight Mines, Inc., Whitehall, Montana. March 30, 2021.

GSM (Golden Sunlight Mines, Inc.). 2021. Modification to Application for Amendment 017 to Operating Permit No. 00065 and Plan of Operations No. MTM-82855 for Golden Sunlight Mine, Montana. Montana Department of Environmental Quality. Helena, Montana.

JSAI (John Shomaker & Associates, Inc.). 2020. Golden Sunlight Mine Groundwater Flow Model, Appendix A. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

McDonald, M.G. and W.W. Harbaugh. 1988. A Modular Three-Dimensional Finite-Difference Groundwater Flow Model. Techniques of Water Resources Investigations, Book 6, Chapter A1. U.S. Geological Survey, Reston, Virginia.

Schafer, B., M. Jones, and J. Zhan. 2021. Memorandum: GSM Geochemical Characterization Report Addendum. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Schafer & Associates. 1994. Draft Final Report for Golden Sunlight Mine Foundation Materials Acid Rock Drainage Attenuation Column Study. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Schafer Limited LLC (Schafer). 2020a. Golden Sunlight Mine, Geochemical Characterization Report A Compendium of Historic and On-Going Geochemical Tests and Water Quality Data. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______ 2020b. Golden Sunlight Mine Closure Option Evaluation. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

SGS. 2010. An Investigation into the Solid-Liquid Separation and Rheology of Golden Sunlight Mine Flotation Test Products. Prepared for Barrick Gold Corporation. Toronto, Canada.

______ 2019. An Investigation Into Flotation Testwork on a Tailings Pond Sample Taken From the Golden Sunlight Mine. Barrick Gold Corporation. Whitehall, Montana.

Telesto Solutions, Inc. 2003. Memorandum: Pit Backfill Geochemistry. Prepared by Telesto Solutions, Inc. Loveland, Colorado, to Golden Sunlight Mines, Inc., Whitehall, Montana. October 9, 2003.

USEPA (US Environmental Protection Agency). 1994. Synthetic Precipitation Leaching Procedure. Method 132. US Environmental Protection Agency. Washington DC.

______2013. Liquid-Solid Partitioning as a Function of Liquid-Solid Ratio for Constituents in Solid Materials Using an Up-Flow Percolation Column Procedure. SW-846. US Environmental Protection Agency. Washington DC.

______ 2017. Liquid-Solid Partitioning as a Function of Extract pH Using a Parallel Batch Extraction Procedure. SW-846. US Environmental Protection Agency. Washington DC.

______ 2019. Method 1315 - Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure. SW-846. U.S. Environmental Protection Agency. Washington DC.

Zheng, C. 1996. MT3D: A Modular Groundwater Transport Program User Manual, 1996.

APPENDIX B: TECHNICAL MEMORANDUM 2—GROUND-MOVEMENT MODEL ASSESSMENT

Technical Memorandum 2

To:	Montana Department of Environmental Quality 1520 E. 6th Avenue Helena, MT 59601
From:	RESPEC Company, LLC P.O. Box 725 Rapid City, SD 57709
Date:	June 7, 2021
Subject:	Golden Sunlight Mine Tailings Reprocessing Project – Ground-Movement Model Assessment

1.0 INTRODUCTION

This technical memorandum presents an assessment of the geotechnical implications of the Proposed Action presented by Barrick Golden Sunlight Mines, Inc. (GSM) to the Montana Department of Environmental Quality in its Application for Amendment 017 to Operating Permit No. 00065 and Plan of Operations No. MTM-82855, Golden Sunlight Mine, Montana. The application was originally submitted in March 2020, and in February 2021, a Modified Application for Amendment 017 (herein referred to as Amendment Application) was submitted.

2.0 BACKGROUND

Amendment 017 is intended to provide accommodation for GSM's Tailings Reprocessing Project (TRP). As part of the proposed TRP, GSM would excavate and reprocess sulfide tailings stored in Tailings Storage Facility 1 (TSF-1). Reprocessed tailings would be deposited in the existing Mineral Hill Pit (Pit). The TRP raises six primary geotechnical concerns:

1. Stability of the shared berm separating TSF-1 and Tailings Storage Facility 2 (TSF-2) during and after excavation of tailings;
2. Stability of the Pit walls during and after deposition of reprocessed tailings;
3. Stability of crown pillars above stopes in the underground workings during and after deposition of reprocessed tailings;
4. Geotechnical suitability of the most recently proposed Re-Pulping Plant location;
5. Stability of the Earth Blocks uphill of TSF-1; and
6. Ground-movement monitoring during and after the TRP is complete.

3.0 PROPOSED ACTION

TSF-1 will be excavated in stages using mechanical methods (e.g., excavators and dozers). Each stage will be a narrow northwest-southeast swath of ground beginning on the upgradient (northwest) side of TSF-1. Reclamation and final grading and slope configurations will be developed progressively as the excavation of each stage is completed. As proposed, the TRP will require altering the shared embankment forming the eastern edge of TSF-1 and western edge of TSF-2, which is also known as the West Wing Dike (**Figure 3-1**). The embankment would need to be altered or buttressed so that it remains stable during and after the TSF-1 excavation. GSM is proposing to use non-acid-generating borrow material to buttress the embankment. The existing tailings embankment would be cut back at a 2.5H:1V angle during excavation and the buttressing material would be emplaced on the bottom half of the slope.

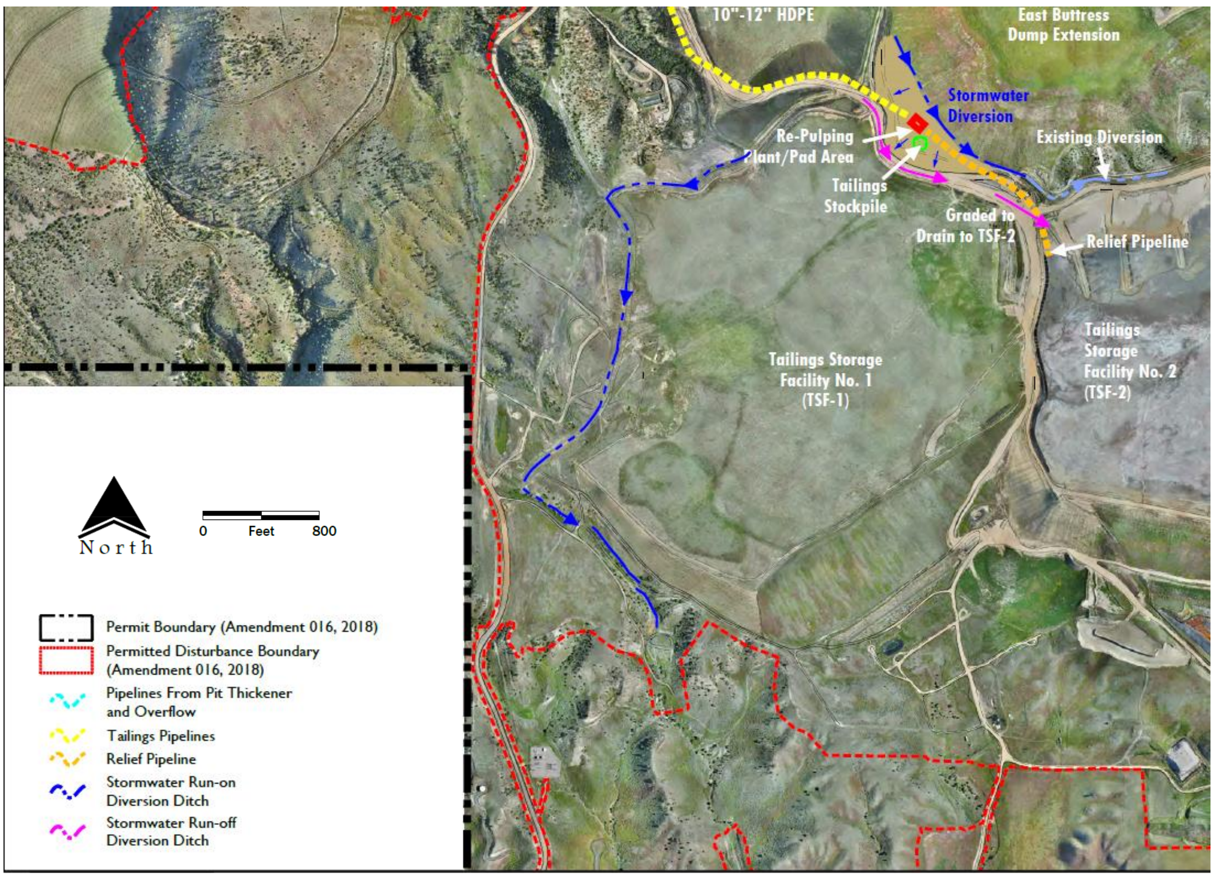


Figure 3-1
Facilities Map Showing Locations of Tailings Storage Facility 1 and Tailings Storage Facility 1 (Adapted From Figure 3-1 in GSM's Application for Amendment)

After reprocessing, the TSF-1 tailings would be deposited in the Pit as a thickened slurry via a spigot located on the southwest side of the Pit. In terms of geotechnical risk, GSM expects rockfall conditions and stability of the Pit's west wall to be improved by emplacing tailings. The Pit would be filled to a final elevation of approximately 5,173 feet (ft) after the tailings have consolidated (**Figure 3-2**).

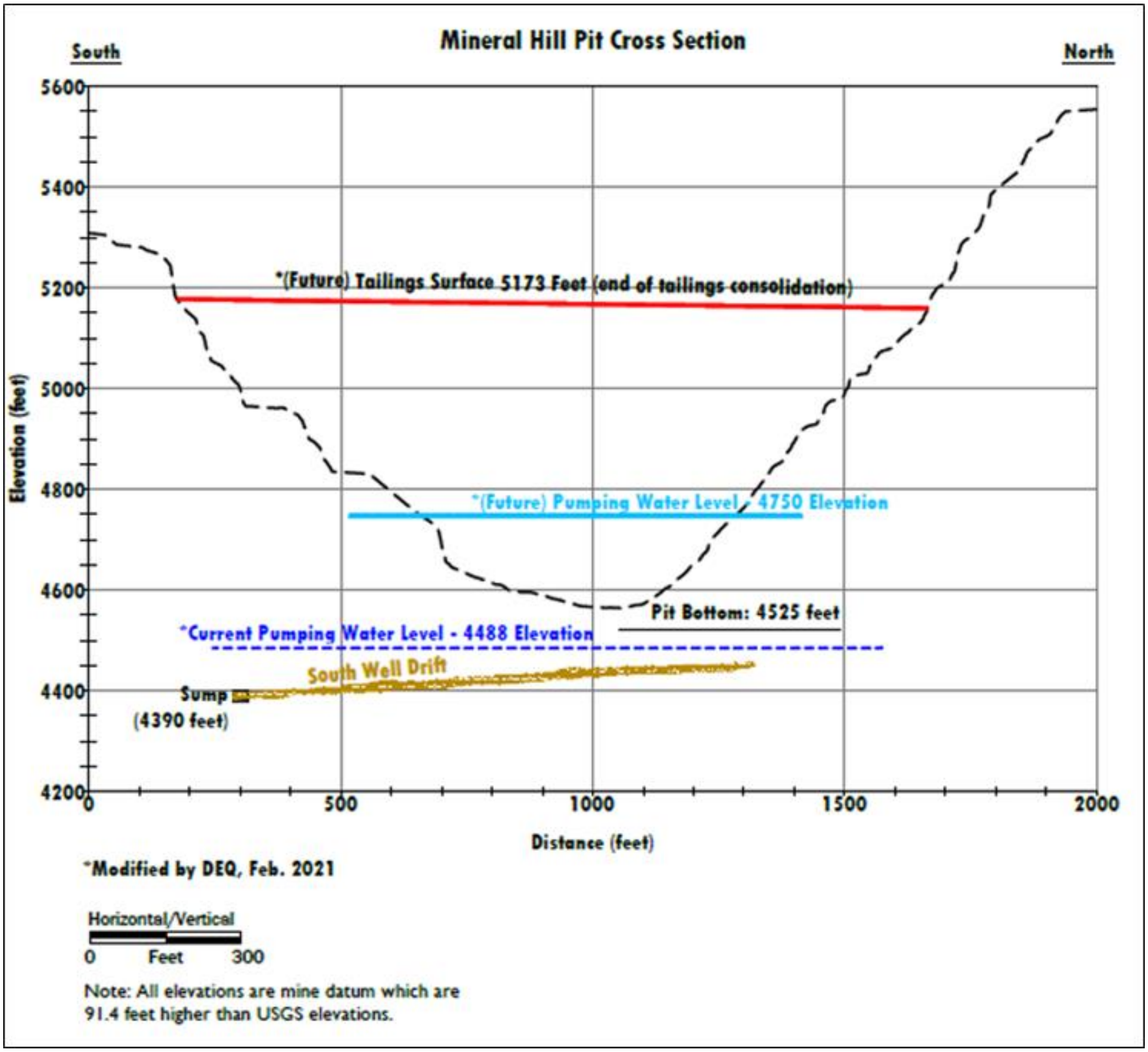


Figure 3-2
Schematic of Expected Final Tailings Configuration in the Mineral Hill Pit (Image Was Extracted From Figure 3-3 in Golden Sunlight Mine's Application for Amendment, Modified by DEQ to Depict Future Conditions)

Depositing tailings in the Pit could overstress the crown pillars above stopes in the underground workings beneath. Collapses in the underground workings could potentially damage or disable the sump, pump, and/or well that is used to dewater the Pit and underground workings.

Removing tailings from TSF-1 during the TRP is a geotechnical concern because doing so could potentially destabilize the Rattlesnake and/or Sunlight Earth Blocks and result in earth movement upslope of TSF-1 and TSF-2 (**Figure 3-3**). The Earth Blocks are part of a large (400 million tons) historical landslide complex that is thought to have been reactivated by constructing waste rock dumps and other mining activity that changed the loading conditions on the blocks. Movement of the Earth Blocks has slowed significantly in recent years but given the loading-controlled nature of the failures, de-buttressing the toes of either of the blocks may cause unwanted ground movement.

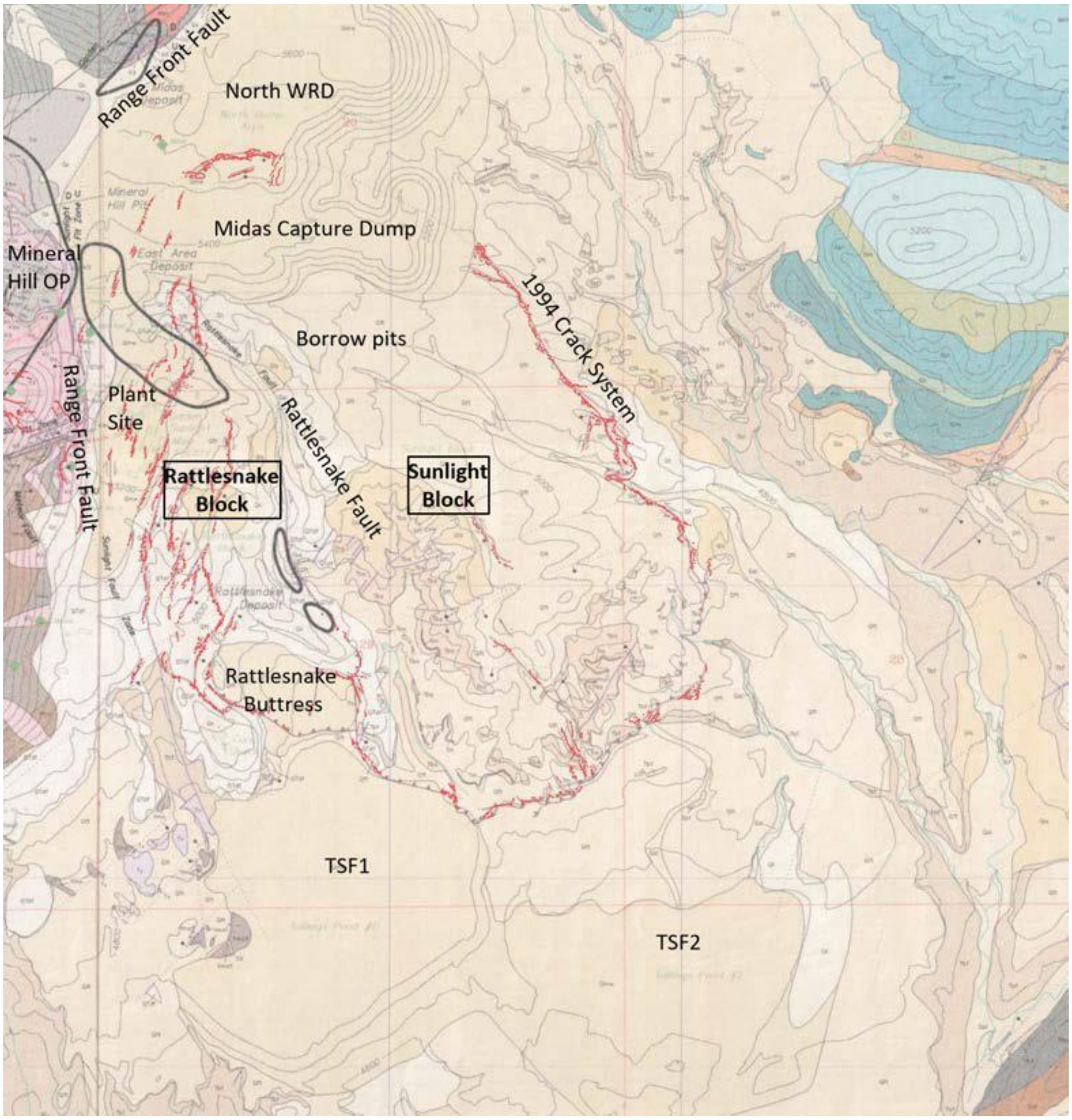


Figure 3-3
Map Showing the Rattlesnake (West) and Sunlight (East) Earth Blocks That Comprise the Reactivated Historical Landslide North of Tailings Storage Facility 1 and Tailings Storage Facility 2 (Adapted From Figure 1 of Subterra LLC [2020a])

4.0 ANALYSIS OF GROUND STABILITY AT TAILINGS STORAGE FACILITY 1

The east flank of TSF-1 is a shared embankment with the adjacent “TSF-2” facility, known as the West Wing Dike for TSF-2. The primary ground-stability concern in the TSF-1 area is the alteration of the West Wing Dike that separates TSF-1 from TSF-2 during the TRP. Unlike TSF-1, TSF-2 meets the definition of a tailings storage facility provided in 82-4-303(34)(a), Montana Code Annotated (MCA), and an Engineer of Record (EOR) has been designated in accordance with 82-4-375(1), MCA for TSF-2. The proposed TRP amendment would involve excavating and removing the tailings and embankments of TSF-1, although the shared embankment with TSF-2 would remain in place.

The actions associated with the TRP do not constitute the construction of a new TSF nor expanding of the TSF-2 facility, as defined by Section 82-4-303(11), MCA. Therefore, a design document is not required for Amendment 017 under 82-4-376, MCA. However, the EOR is required to review, certify, and seal designs or other documents pertaining to tailings storage facilities submitted to Department of Environmental Quality and to annually inspectTSF-1 under (82-4-375(3)(b) and (c), MCA). For the TRP amendment, a stability analysis was completed regarding removing tailings along the shared embankment, and the analysis report was certified by the EOR (Appendix D of Amendment 017 application, GSM 2021).

According to the stability analysis performed by NewFields (2020), the reworked dike is expected to be stable under static (i.e., nonseismic) loading conditions with either a 3H:1V layback configuration extending from native ground elevation to the west side of the crest of the dike (**Figure 4-1**) or a 2.5H:1V configuration with a “30-foot-wide by 50-foot-high common fill” berm constructed on the lower half of the slope (**Figure 4-2**). The minimum factors of safety used in the analysis for temporary static, long-term static, and pseudo-static conditions were 1.3, 1.5, and 1.0, respectively.

The Mohr-Coulomb material properties used by NewFields (2020) for the Common Fill were estimates. The unit weight of the material is most important because the berm’s weight is mostly responsible for increased slope stability. The material for the berm was identified by NewFields (2020) as “alluvium/colluvium sourced from onsite borrow areas” and the analysis assumed that the material would be “compacted fill similar to the material used in the TSF-2 embankment construction.” Strength and unit-weight properties used for TSF-1, TSF-2, Embankment Fill, and Bozeman Group Foundation materials appear appropriate and were developed based on previous engineering analyses. NewFields (2020) assumed unsaturated strength properties for tailings in TSF-1 according to Telesto Solutions Inc.(2008) that encountered higher water content only in the lower regions of the basin. The Embankment Fill and Common Fill materials in the models were modeled in a drained state, which is consistent with a higher hydraulic conductivity of low plasticity alluvial silty sand and gravel soil and the hydraulic containment provided by the liner in the interior face of TSF-2. Because of the influence of pore pressures on slope stability, the extent and integrity of the liner could heavily influence the validity of this assumption.

Because the original construction method of the West Wing Dike is uncertain, centerline and upstream embankment construction methods were considered in the NewFields (2020) models. As expected, the centerline-method models had higher factors of safety than the upstream-method models. Upstream methods are generally considered the least-stable type of tailings dam construction and, in the absence of any other information, should be used as the baseline for stability assessments of the type that NewFields (2020) conducted on behalf of GSM. Whether or not the slope cross section used in NewFields' (2020) stability models is representative of the largest section of embankment is unclear. Larger embankments may be present closer to the toe of TSF-1.

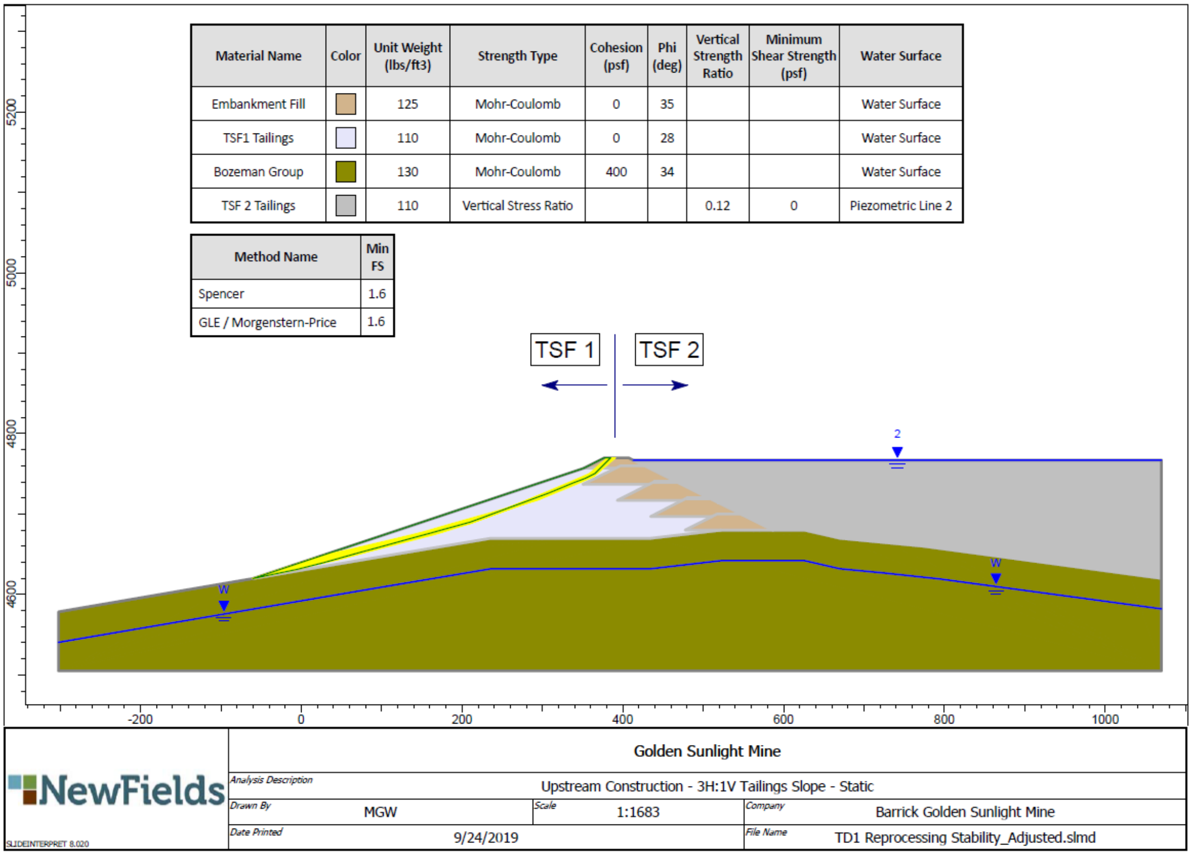


Figure 4-1
Cross Section Showing the Results of Limit-Equilibrium Stability Model of the 3H:1V Final Slope Configuration of the West Wing Dike Built With Upstream Methods and Under Static Loads (Adapted From Attachment 2 of NewFields [2020])

NewFields (2020) also modeled the slope stability of the short-term West Wing Dike configuration during the TSF-1 tailings excavation. During the excavation, the west side of the dike will have a 2.5H:1V profile without a buttress (**Figure 4-3**). The upstream design version of the short-term slope only just met the critical factor of safety threshold (1.3) under static loads. Because the assumed friction angle for the TSF-1 tailings was relatively low (28 degrees), NewFields (2020) conducted a sensitivity study to evaluate whether or not the short-term excavation slopes can be steepened if it can be proven that the friction angle estimate used by NewFields was conservative. NewFields found that to achieve the minimum short-term factor of safety, friction angles of 32 and 39 degrees would be required for slopes with 2H:1V and 1.5H:1V profiles, respectively. Measured friction angles from TSF-1 have shown friction angles as high as 39 degrees, and although this is probably not a reasonable estimate for fine-grained tailings, NewFields argued that “there is an opportunity for the temporary cut slopes to be steepened if it can be demonstrated that the tailings” have a friction angle greater than 28 degrees.

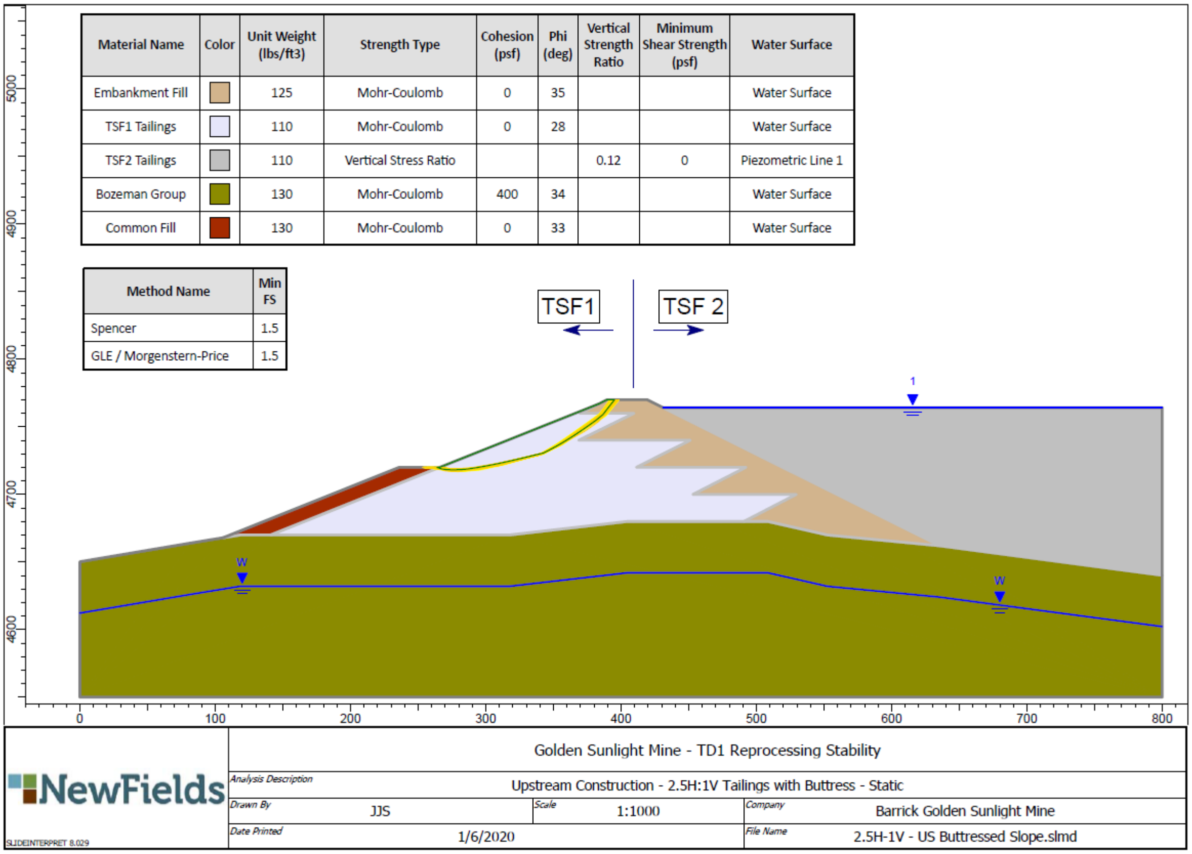


Figure 4-2
Cross Section Showing the Results of Limit-Equilibrium Stability Model of the Bermed 2.5H:1V Final Slope Configuration of the West Wing Dike Built With Upstream Methods and Under Static Loads (Adapted From Attachment 2 of NewFields [2020])

Under pseudo-static (i.e., seismic) loads, none of the modeled slope configurations met the minimum factor of safety. Following standard practice, NewFields (2020) performed a seismic deformation analysis and found that slope movement displacements generated by a 10,000-year seismic event would be “less than 12-inches for both the 3H:1V cut slope and the 2.5H:1V buttressed cut slope” and “and would not result in a loss of containment or compromise the overall stability of TSF 2.”

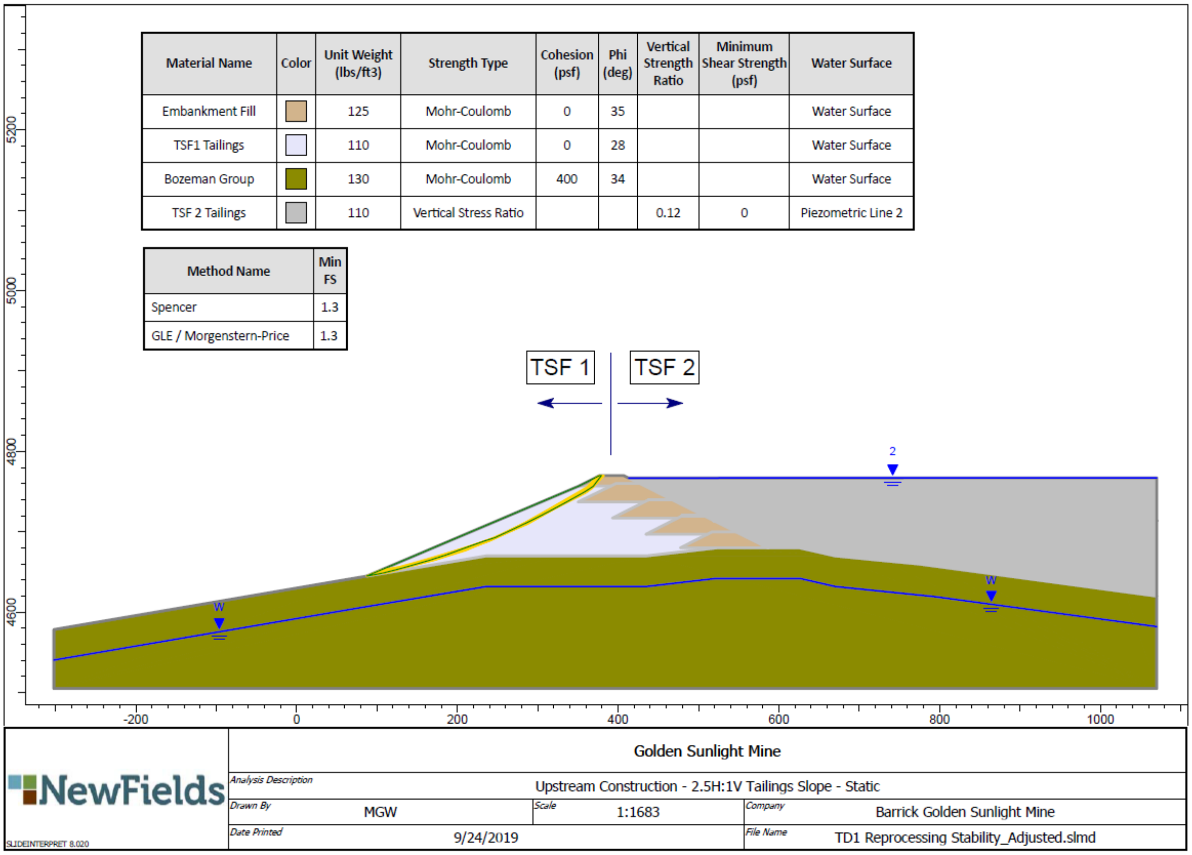


Figure 4-3
Cross Section Showing the Results of Limit-Equilibrium Stability Model of the Unbermed 2.5H:1V Temporary Slope of the West Wing Dike Built With Upstream Methods and Under Static Loads (Adapted From Attachment 2 of NewFields [2020])

5.0 ANALYSIS OF GROUND STABILITY AT THE MINERAL HILL PIT

Two primary geotechnical concerns at the Pit are (1) the effects of redeposited tailings on the stability of the large slope failure on the west wall of the Pit and (2) the potential collapse of the crown pillars above stopes beneath the Pit. Four relevant geotechnical studies (included as Appendix G to the Amendment Application) were performed before GSM's Amendment Application was submitted. Three of the studies were performed by GSM personnel (Barrick 2020a) (Barrick 2020b) (Barrick 2020c) and one was performed by a consulting engineering company (Subterra LLC, 2020b). In addition to discussions of the primary geotechnical concerns of the TRP at the Pit, RESPEC also reviewed rockfall risk in the Pit.

5.1 Stability of the West Wall

According to Subterra LLC (2020b), a large, complex, wedge-type slope failure began developing in early 2011. The 2011 slide mass was located on the west highwall of the Pit and was bracketed by faults on either side (the Fenner and Gray faults). The slide began when mining had reached the 5,400-ft elevation. Step-outs and buttresses were used to control the progression of the failure. The failure continued to progress up until September 2012 as mining reached the 4,875-ft elevation. By that time, tension cracks behind the Pit crest (and through some waste rock) had developed and dilation of another fault—the Lone Eagle Fault—indicated that the slope had become globally unstable. Mining continued to advance using step-outs and buttressing to limit ground movement.

Because of the heavy deterioration of the west highwall and rockfall concerns, mining in the Pit ceased in April 2015 at the 4,525-ft elevation. The west highwall failure is controlled by unfavorable fault orientations, as Subterra LLC (2020b) describes in the excerpt below:

> *"The West Shear Fault is a 45 degree, in-pit dipping geological feature that sub parallels the west highwall. The West Shear Fault, in combination with the NNE striking, high-angle set of faults that include the Lone Eagle, the Gray, the Fenner and others, act as lateral release features that provided enhanced mobility and the conditions for the global instability … By September 2012 when 5BOP was at the 4875 ft. elevation, the West Shear Fault was approximately 80 ft. below the west highwall of 5BOP."*

An annotated photograph of the west wall slope failure in the Pit is shown on **Figure 5-1**. The West Shear Fault that forms the primary sliding plane at depth is hidden from view because it nearly parallels the orientation of the west highwall. Slope deformation slowed after mining reached more competent materials below the failure and again after surface mining ended. When underground mining began in May 2015 (1 month after surface mining ended), the failure reaccelerated, and the most rapid accelerations were directly correlated to underground blasts. When underground mining ceased in 2019, ground-movement rates again began to slow. As of early 2020, total deformations in some areas of the failure were as much as 75 ft.

Subterra LLC (2020b) reconstructed the sequencing of the west wall slope failure from slope-monitoring data provided by GSM. Based on the reconstructed sequence of events, a series of three-dimensional (3D) finite element models of the slide were built, first to calibrate the model to known behavior and then to predict the slide's behavior at various stages of tailings backfilling. While the model could not capture blasting-induced "stick-slip" failure mechanism that resulted in isolated rapid accelerations and decelerations of movement, simulated prism data concurrent with active surface mining match well with actual prism data. General deformation patterns also matched field observations, and the patterns of movement were measured with a slope-monitoring radar unit.

The findings of Subterra LLC (2020b) indicate that the "stability of the west highwall will increase over time" blasting will no longer be occurring, creep will allow for stress relaxation, and reprocessed tailings will buttress the failure. However, because of the complexity of the failure mechanism and associated difficulties accurately predicting ground movement, Subterra LLC (2020b) recommended that "the current monitoring systems, procedures, and ground control management plan will be kept in place to ensure that the highwall does not pose a threat to mine personnel and infrastructure."

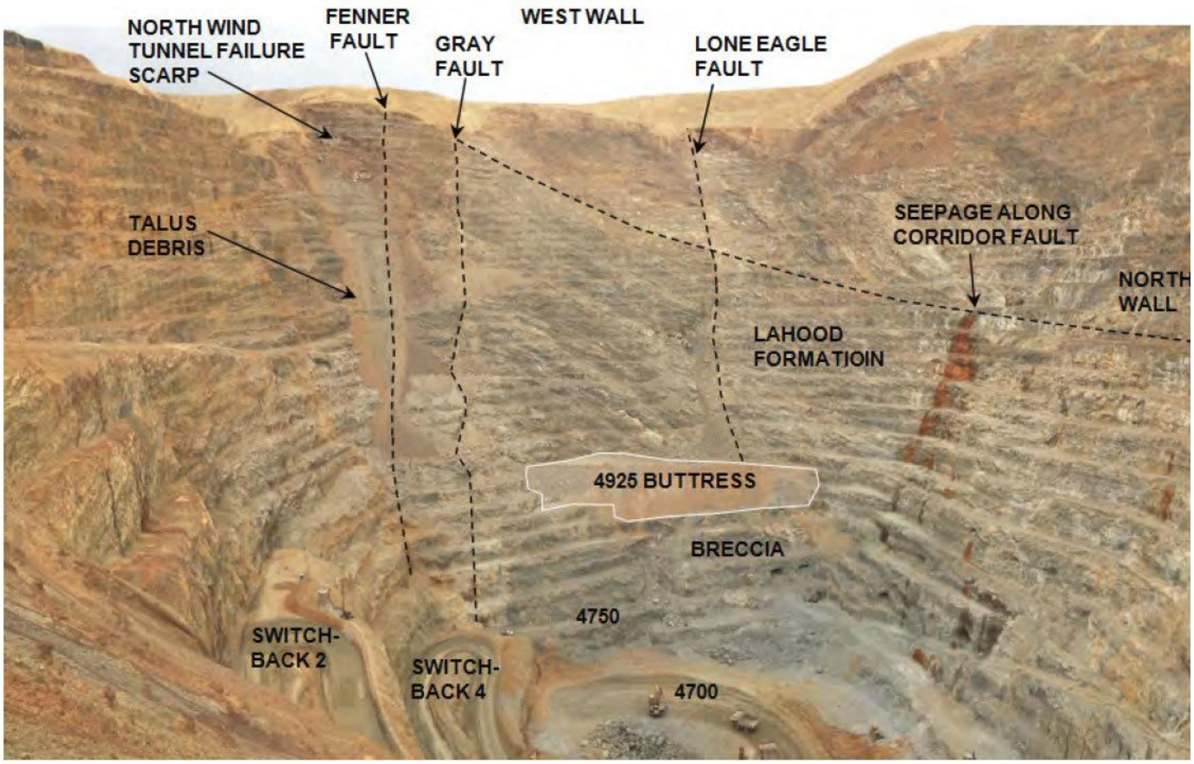


Figure 5-1
Annotated Photograph of the West Highwall of the Mineral Hill Pit (From Subterra LLC [2020b])

The methods that were used to evaluate the stability of the Pit's west wall are reasonable and generally consistent with standard engineering practice. Previous work indicated that the ground water elevation could be modeled as 4,750 ft in the Pit, which is well below the ultimate elevation of the post-consolidation tailings surface of 5,173 ft. In contrast, the Barrick (2020b) study indicates that water in the redeposition slurry will continually saturate the tailings pile and ponded water is expected to remain atop the reprocessed tailings during redeposition. Water seeping from the tailings into the surrounding rock will rapidly flow and merge with the local water table. Pore pressures are not anticipated to build up within the backfilled tailings as surrounding jointed bedrock has sufficient hydraulic conductivity to dissipate pore pressure.

Subterra LLC's (2020b) findings indicate that placing reprocessed tailings in the Pit will increase the stability of the west wall failure. As the tailings material rises in the Pit during the filling period, the tailings would eventually provide enough confinement to inhibit movement of the highwall. Based on stability modeling (Subterra LLC 2020b), the highwall should be stable once the reprocessed tailings reach a thickness of approximately 240 ft or an elevation of 4,950 ft. However, continued ground-movement monitoring in the Pit is still needed.

The failure of the west wall would be an immediate threat to personnel and infrastructure at the mine. A catastrophic failure could also damage the tailings deposition lines and/or the surface components of the dewatering system.

5.2 STABILITY OF UNDERGROUND WORKINGS

The depths of underground workings below the Pit range from tens to hundreds of feet. The crown pillars of some formerly open stopes have caved and collapsed portions of the Pit. For this reason, and because the dewatering system for the reprocessed tailings depends on the underground workings, there is a risk that a collapse of the crown pillars of currently open stopes may damage or disable the dewatering system. GSM commissioned an internal study (Barrick, 2020c) to evaluate the stability of underground workings under excess loads and pore pressures caused by the deposition of reprocessed tailings in the Pit and whether or not stope collapses pose a risk to the dewatering system.

Barrick's (2020c) study included empirical, kinematic, and finite element modeling analyses of the 5 open stopes and 15 caved stopes beneath the Pit during the TRP and 8 and 16 years after backfilling was completed. Similar to Subterra LLC's (2020b) analysis of the stability of the west wall failure, a phreatic water-surface elevation of 4,750 ft was used in the finite element models. According to the study, this elevation represents the "hydrogeologic modeling and plans for post-tailings reprocessing dewatering in the Mineral Hill Pit." Importantly, in their finite element models, Barrick (2020c) did account for anisotropic strengths of the sedimentary rock units by adding geologic structures as they have been observed. Breccia, the other main rock unit at the site, was assumed to have homogeneous strength. In addition to the finite element models, probabilistic kinematic analyses and empirical scaled-span methods were also used to evaluate the stability of the stopes.

Finite element and empirical methods indicated that the NEV stope's crown pillar would collapse during backfilling. NEV (25-ft-thick, 40-ft-long crown pillar) is the closest to the surface of any of the existing open stopes and, as expected, is most prone to collapse. Kinematic methods indicated that wedge failures that could lead to crown pillar collapse were unlikely. The other open stopes are anticipated to remain open during and after the TRP. **Figure 5-2** shows the location of the NEV stope, the expected crown pillar failure region, and the configuration of other workings beneath the Pit.

Barrick's (2020c) analysis showed that a failure of the southwestern portion of the NEV crown pillar will result in the collapse of crown pillar rock, waste rock, and reprocessed tailings into the stope. They expect that the material that falls into the stope will "choke off draw points and drifts," resulting in a limited amount of tailings or other materials reaching other parts of the underground workings. Barrick (2020c) also notes that the exit points of the NEV stope are at a lower elevation than the South Well Drift where the dewatering well sump will be. Given these factors, Barrick (2020c) does not expect the failure of the NEV crown pillar to damage the dewatering system.

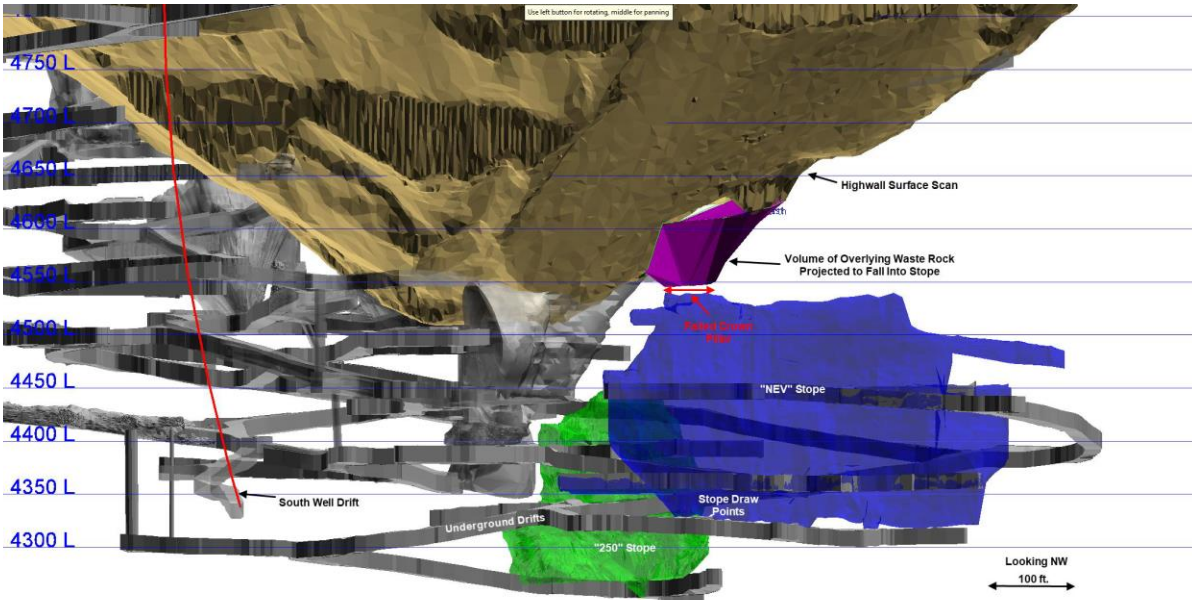


Figure 5-2
Isometric View of the Mineral Hill Pit (Brown) and Underground Workings Showing the Location of the South Well Drift and Dewatering Well Where Water Will Be Pumped for Processing (Red Line on the Left), and the Failure Area (Red Arrows) in the NEV Stope (Blue) (From Barrick [2020c])

Some uncertainties are associated with the modeling and stability analysis methods used by Barrick (2020c), and those uncertainties are acknowledged in the report. For this reason, they recommend developing a monitoring plan to include looking for “signs of failure” of the NEV crown pillar, monitoring for signs of suspended tailings in pumped water, and monitoring the transducer controlling the dewatering pump for abnormal operation.

The findings and recommendations presented by Barrick (2020c), including the empirical and modeling methods used, are consistent with standard engineering practice. Their judgment that the collapse of stopes other than NEV is unlikely is sound, and their argument that the dewatering system is unlikely to be negatively impacted by the collapse of the NEV crown pillar is logical. We also agree with Barrick (2020c) that monitoring is necessary to understand if, when, and how impactful the collapse of the NEV stope will be on the TRP and environment. Additional discussion of the monitoring plan is included later in this memorandum.

5.3 ROCKFALL

Rockfall risk was not specifically addressed in GSM’s Amendment Application. Backfilling the Pit will likely reduce rockfall by stabilizing the west highwall and lowering the exposed height of the highwalls. Bounce heights and runout distances will also likely be reduced by the presence of the tailings because they are softer and more energy absorbent than the existing rock slopes. Personnel and equipment will also be excluded from entering the tailings deposition area before consolidation; thus, rockfall poses little safety risk during the TRP and is not an environmental hazard. However, rockfall could affect the tailings deposition system and/or dewatering wellhead.

6.0 ANALYSIS OF GROUND STABILITY AT THE RE-PULPING PLANT

The Re-Pulping Plant would be constructed on a pad located in an area near the northern end of the TSF-1 site and the toe of the East Buttress Dump Extension. The planned location was updated from the original Amendment Application, and as shown on **Figure 3-1**, is further east and occupies the westernmost corner of the East Buttress Dump Extension. According to NewFields (2021), the Re-Pulping Plant would be constructed on a graded pad over in-place soil cover overlying buttress fill and overburden soil overlying Bozeman Group materials. These materials are generally well-suited for construction and are low-plasticity, silts, sands, and gravels. Newfields' (2021) geotechnical assessment of foundation and fill materials and recommendations for suitable materials to be used in constructing the fill pad are consistent with standards of engineering practice.

The updated Re-Pulping Plant location is more favorable than the previous location for two reasons. First, the new location is closer to an existing haul road that will require less ground disturbance. Second, and more importantly from a geotechnical perspective, the new location is outside the area of the Earth Block that is most likely to move if TSF-1 tailings are excavated (for more details, refer to Chapter 7.0, Analysis of Ground Stability of Earth Blocks). The new location has similar subsurface materials to the original proposed location but is less likely to experience ground instability. Construction of the Re-Pulping Plant according to NewFields' (2021) recommendations is also unlikely to create ground instability.

7.0 ANALYSIS OF GROUND STABILITY OF EARTH BLOCKS

Dumping, stockpiling, and borrowing activities at the site have caused instability in two large Earth Blocks that are immediately uphill of TSF-1 and TSF-2. According to Subterra LLC (2020a), block movement (**Figure 3-3**) accelerated in June 1994 because portions of a larger, inactive landslide were head-loaded with waste rock. The largest displacement measured was 4.6 ft, and the movement of the blocks caused "undesirable settlement" at the plant site. The toe of the western block (i.e., the Rattlesnake Block) was buttressed that summer, and by October 1994, movement rates had receded. Whether or not ground movement occurred before 1994 is unclear, but Subterra LLC (2020a) appears to have reviewed movement data from as early as 1983. Conversely, in its Amendment Application, GSM states that the Earth Blocks have been "subject to instability since June 1994," without indicating any previous movement.

A waste rock buttress was constructed at the toe of the Rattlesnake Block beginning in August 1994. By February 1995, the movement of the Rattlesnake Block was nearly halted. In 2007, however, alternating periods of increased movement occurred in the Rattlesnake and Sunlight (eastern) Blocks because of "a series of dumping, stockpiling, and borrowing activities." As recently as 2016, Subterra LLC (2020a) reported that “[no] cohesive overall block movement” exists in the Sunlight Block and that the Rattlesnake Block continues to move slowly as a single cohesive slide mass. Movement in the Sunlight Block is evident in the upper (north) section and the toe of the Sunlight waste rock buttress that was constructed between 2011 and 2012. In 2012, tailings deposition in the northern portion of TSF-2 was ceased out of caution. **Figure 7-1** shows the patterns of Earth Block movement as reported in 2016.

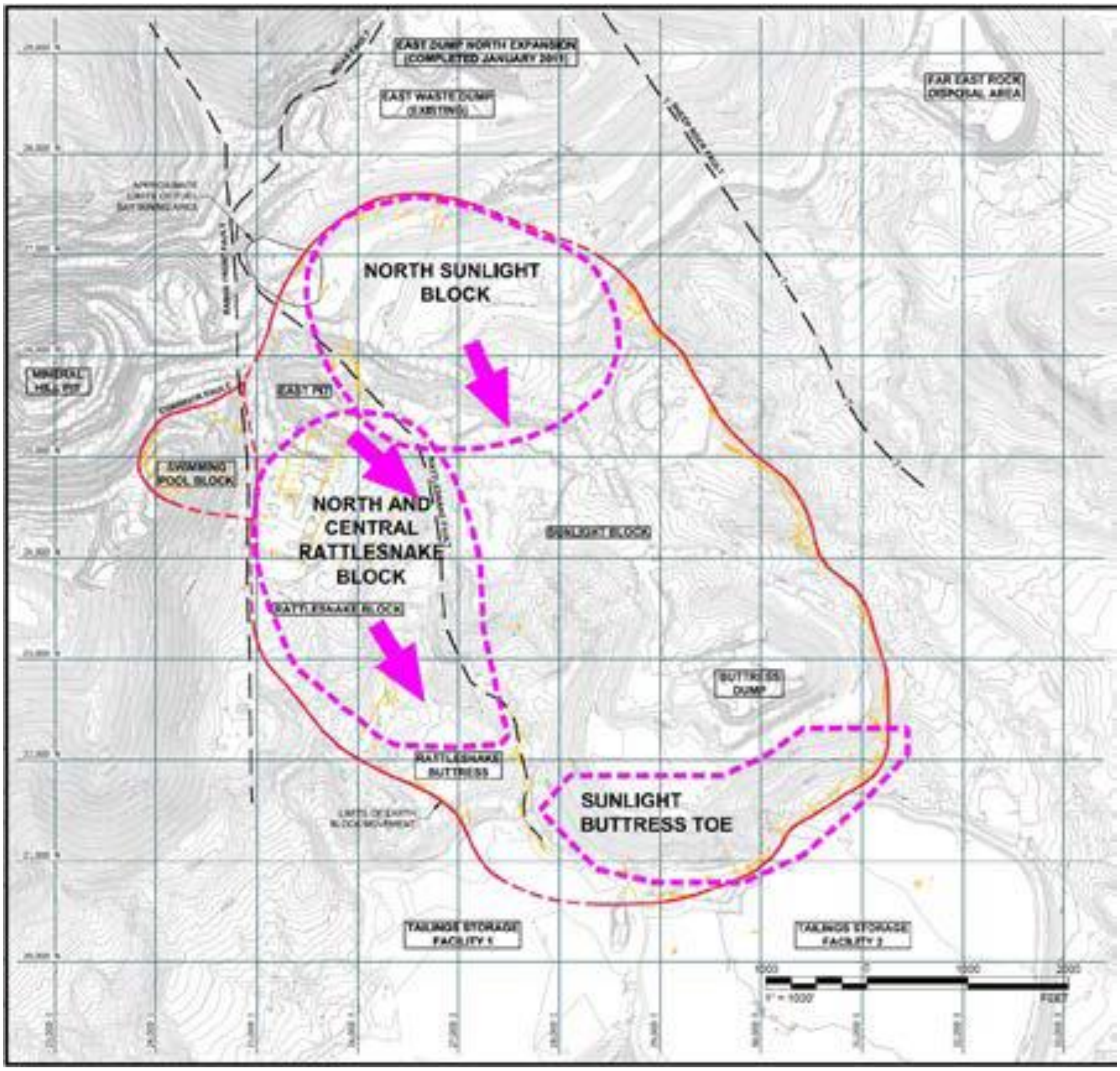


Figure 7-1
Map Showing Zones of Movement in the Earth Blocks as of 2016 (From Subterra LLC [2020a])

Based on previously reported information provided by GSM, Subterra LLC (2020a) built and ran a 3D finite element slope stability model that included eight “stages” in which a sequence of events and measured movements were simulated. The model was calibrated using ground-movement measurements between 1993 and 2014, and the eighth and final stage was used to predict earth movement after removing the TSF-1 tailings. The model simplifies highly heterogenic geological and hydrogeological units that resulted in less than optimal results. The movement magnitudes for reference monitoring points were only moderately correlated with actual data, although generally replicated observed patterns, and the spatial pattern of displacements showed significant movements outside the known region of movement bracketed by tension cracks and lateral-slip shears.

Subterra LLC (2020a) correctly indicated that a model of this size lacks the granularity to account for the complex 3D nature of slip surface and Earth Block interactions, and it is encouraging that known behaviors such as basal uplift in the upper portion of the Sunlight Block were evident in the model.

Subterra LLC (2020a) concluded that removing the TSF-1 tailings would not "convey additional movement to the Sunlight or Rattlesnake blocks." Because "instability of the Rattlesnake Block is more complex and subjected to more uncertainty compared to the Sunlight Block" and the Rattlesnake Block is more likely than the Sunlight Block to be destabilized by TRP activities, monitoring ground movement is critical in this area.

8.0 EXISTING GROUND-MOVEMENT MONITORING PROGRAM

GSM has a well-developed ground-movement monitoring program and includes the following systems:

1. **TSF-1 Area:** satellite-based Interferometric Synthetic Aperture Radar (InSAR);
2. **Mineral Hill Pit:** a real-time Movement and Surveying Radar, InSAR, a robotic total station and associated reflective prisms, and a global positioning system (GPS) array that couples 3D displacement measurements with the InSAR data; and
3. **Earth Blocks:** survey monuments, inclinometers, piezometers, ShapeAccelArray sensors, GPS devices, and InSAR.

InSAR monitoring covers GSM's entire site but special emphasis has been placed on the Pit's west wall failure. InSAR satellites pass over the site every 7 to 10 days and interpretative reports are provided quarterly. The InSAR data provide excellent line-of-sight ground-movement data that can be further analyzed to create pseudo-3D displacement measurements using time-series or GPS-coupled, on-ground devices. InSAR monitoring will be critically important for the TSF-1 area and the Rattlesnake buttress above it because no other currently established ground-movement monitoring systems occupy those locations.

The monitoring system design, as well as the functional capability of the in-place instruments that are planned to be used during and after the TRP, are appropriate and reliable indicators of ground movement.

9.0 RECOMMENDATIONS

In general, GSM has performed thorough and appropriate analyses of the impacts on ground stability if the Proposed Action is implemented. The documentation provided with GSM's Amendment Application clearly and accurately describes the expected outcomes and geotechnical effects of the Proposed Action. Our conclusions and recommendations are explained in more detail in the following subsections. Some of these recommendations may be addressed through clarifications provided by GSM during the Environmental Impact Statement process or may be incorporated into a geotechnical stability permit stipulation.

9.1 TAILINGS STORAGE FACILITY 1 AREA

It is recommended that GSM use the unbuttressed 3H:1V long-term and 2.5H:1V short-term cut slope designs evaluated by NewFields (2020), which are included in the Proposed Action. These designs meet geotechnical standards of practice and have been shown to be stable under the assumptions of NewFields (2020) analysis. If GMS would like to use steeper slope designs, additional modeling should be performed to demonstrate whether or not steeper short-term slopes can be safely achieved.

9.2 MINERAL HILL PIT AREA

Modeling assessments support the increased stability of the west wall failure and the stability of underground workings during the TRP. This highest-risk scenario is seepage from saturated tailings emigrating into the west wall of the Pit; increased pore pressures in the slope could cause the west wall failure to accelerate. Such a scenario is unlikely, however, because the rock materials in the Pit are highly fractured, expected to have high hydraulic conductivity, and drained by underground workings and the existing dewatering sump. If the ground water rises above 4,750-foot elevation assumed by Barrick (2020c) and Subterra LLC (2020b), increased head pressures in the underground workings are expected to act as a stabilizing force.

Continuous monitoring of the west wall failure is critically important (refer to Section 9.5, Ground Movement Monitoring). If the west wall failure appears to be accelerating rather than decelerating, tailings deposition should be ceased until a root-cause analysis has been performed and a mitigation plan has been developed. As included in the Proposed Action, the existing Ground Control Management Plan should be revised to include appropriate measures for protecting in-pit infrastructure from rockfall impacts during and after the TRP.

9.3 RE-PULPING PLANT

The proposed Re-Pulping Plant location is geotechnically suitable and is less geotechnically hazardous than the originally proposed location. NewFields' (2021) findings are reasonable and GSM should follow the recommendations therein.

9.4 EARTH BLOCKS

Subterra LLC's (2020a) analysis indicates that removing tailings in TSF-1 is unlikely to initiate accelerated movement rates of the Rattlesnake or Sunlight Earth Blocks. We acknowledge, however, that the failure mass comprising the two Earth Blocks is complex and difficult to predict. Thus, the most crucial step that GSM can take to protect the environment, personnel, and infrastructure from the hazards posed by the Earth Blocks is to monitor ground movements in and around the Earth Blocks and the upper portion of TSF-1. Because the flotation plant is located at the existing plant site and Earth Block movement caused substantial settlement at the plant site in the past, we also recommend continuous and rigorous monitoring be performed at the plant site.

9.5 GROUND MOVEMENT MONITORING

GSM's ground-movement monitoring program is reasonable and well-designed. The monitoring focuses on the west wall of the Pit, Earth Blocks, and Tailings Dams. Monitoring will continue to be important during and after the TRP; however, we believe that the highest-risk and most critical monitoring area will be the Rattlesnake Earth Block immediately upslope of TSF-1. InSAR and other instruments should be monitored closely as the excavation of TSF-1 progresses. The existing comprehensive Ground Control Management Plan for the site should be updated for the TRP. The plan should include physical and remotely sensed observations of the tailings and Pit area. As mentioned previously, if acceleration of the west wall failure is observed, tailings deposition in the Pit should be ceased until a root-cause analysis has been performed and a mitigation plan has been developed.

10.0 CONCLUSION

The Proposed Action has manageable and reasonable geotechnical risks. With appropriate ground-movement monitoring procedures in place and, pending the evaluation of any additional modeling that may be required, the TRP is expected to reduce the risk of slope failures and rockfall in the Pit. The geotechnical risks associated with excavating TSF-1, altering the West Wing Dike, and reactivating the Earth Blocks are manageable if project development follows the recommendations that resulted from modeling and appropriate geotechnical monitoring is performed.

11.0 REFERENCES

Barrick. 2020a. Memorandum: GSM Reprocessing Tailings Consolidation. Prepared by Johnny Zhan, Ph.D. January 27, 2020.

_______2020b. Memorandum: GSM Reprocessing Tailings Draindown. Prepared by Johnny Zhan, Ph.D. January 27, 2020.

______ 2020c. Memorandum: Mineral Hill Pit Stopes Subsidence Modeling Review, Golden Sunlight Mine. Prepared by Ryan Turner, Geotechnical Engineer. February 4, 2020.

GSM (Golden Sunlight Mines, Inc.). 2021. Modification to Application for Amendment 017 to Operating Permit No. 00065 and Plan of Operations No. MTM-82855 for Golden Sunlight Mine, Montana. Montana Department of Environmental Quality. Helena, Montana.

NewFields. 2020. Technical Memorandum: Review of TSF No. 2 Stability During TSF No.1 Reprocessing. Prepared by NewFields Helena, Montana, to Golden Sunlight Mines, Inc., Whitehall, Montana. January 7, 2020.

______ 2021. Geotechnical Recommendations for Tailings Repulper Facility – Revision 1 Tailings Reprocessing Project, Golden Sunlight Mine, Jefferson County, Montana. Prepared by NewFields Helena, Montana, to Golden Sunlight Mines, Inc., Whitehall, Montana. February 4, 2021.

Subterra LLC. 2020a. Earth Block Movement – Numerical Modeling. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______ 2020b. 5BOP West Highwall – Numerical Model of Interaction of Highwall with Deposited Tailings Material. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Telesto Solutions Inc. 2008. Geotechnical Testing Summary of Tailings Impoundment 1, #270105, Draft, August 6. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

APPENDIX C: TECHNICAL MEMORANDUM 3—RECLAMATION ALTERNATIVES EVALUATION

Technical Memorandum 3

To:	Montana Department of Environmental Quality 1520 E. 6th Avenue Helena, MT 59601
From:	RESPEC Company, LLC P.O. Box 725 Rapid City, SD 57709
Date:	June 7, 2021
Subject:	Golden Sunlight Mine Tailings Reprocessing Project – Reclamation Alternatives Evaluation

1.0 INTRODUCTION

The basis for this technical memorandum is the application for Amendment 017 to Operating Permit No. 00065 (Barrick Golden Sunlight Mines, Inc.) that was originally submitted to Montana Department of Environmental Quality (DEQ) in March 2020. In February 2021, a Modified Application for Amendment 017 (herein referred to as Amendment Application) was submitted.

This document describes and compares the alternatives considered for the reclamation plan of the Tailings Storage Facility 1 (TSF-1) and Mineral Hill Pit (Pit) for the Golden Sunlight Mine. The objective of this memorandum is to provide sufficient information to address the environmental impacts of the Proposed Action and other alternatives. The reclamation activities presented in the Amendment Application are described in Section 3.0, Proposed Action – Reclamation Plan. Alternative reclamation methods are also presented, evaluated, and compared to the Proposed Action to define differences between the alternatives and provide recommendations.

2.0 BACKGROUND AND EXISTING CONDITIONS

The Golden Sunlight Mine is located 5 miles northeast of Whitehall in Jefferson County, Montana. The mine is operated by Golden Sunlight Mines, Inc. (GSM), which is a wholly owned subsidiary of Barrick Gold U.S. Inc. (a California corporation). GSM's Operating Permit (No. 00065) was issued by the Montana Department of State Lands (now DEQ) on June 27, 1975. Various major permit amendments and several minor revisions to Operating Permit No. 00065 have been approved by DEQ. These minor revisions authorize a variety of activities such as road building, well construction, and water-management activities. The Amendment

Application would not result in any additional disturbance beyond the existing permitted disturbance area. An overview of the existing conditions at TSF-1 and the Pit is discussed in the following sections.

2.1 Tailings Storage Facility 1

TSF-1 is a 190-acre facility (including embankments) that contains approximately 26.2 million tons (Mt) of tailings and was constructed in 1982 and operated until 1994. The facility has a relatively flat surface area and was constructed on a compacted, natural-clay surface of the Bozeman Group Formation. Approximately 1.0 million cubic yards (yd^3) of capping material was placed on the surface of TSF-1 during reclamation, which is equivalent to an average capping thickness of approximately 4 feet (ft) over its 190-acre area.

The tailings deposit includes a concentration of “slimes” or finer-grained tailings within the western and central portions of TSF-1 where the surface pond was located during operations. This zone of finer tailings material is expected to have a southeast to northwest orientation with an estimated width ranging between 600 to 1,000 ft. The perimeter of the deposit consists of coarse-grained tailings materials (sand) that settled quickly and formed the tailings beach against the embankment.

A bentonite slurry cutoff wall was constructed downgradient (south) of TSF-1 to prevent off-site effects to ground water from tailings seepage during operations and closure. In 1983, a synthetic-lined seepage collection pond (Old Seepage Basin) was also installed south of the impoundment to collect water from underdrains that were constructed beneath the TSF-1 embankment.

Seepage from TSF-1 mixes with ground water beneath and downgradient of the facility; this water is currently controlled by two main galleries of pumpback wells: South Pumpback and East Flank Pumpback. A third pumpback well system (West Pumpback) was installed in 1993 along the southwest side of TSF-1. All ground water impacted by TSF-1 is effectively being captured by these pumpback well systems. The pumpback wells create a cone-of-depression in the ground water table so the ground water gradient flows toward the wells and thus prevents the impacted ground water from traveling farther south toward the Jefferson River Slough.

Soil or growth media cover was also placed over the TSF-1 embankment slopes. The main embankment was originally constructed using cyclone sand from the tailings stream, and the dam height was progressively increased above the Stage 1 starter embankment through the life of this area. Throughout the operating life of TSF-1, a process of rotational deposition of the tailings from multiple spigot points was used to maintain a coarse tailings beach that acts as a talus slope against the embankment. Based on the current reclamation status, bond levels were reduced to 187 acres.

Final seedbed preparation at TSF-1 was conducted before seeding activities began. TSF-1 reached final reclamation in 2001 and has not been active since. A self-sustaining vegetation cover has been established on the facility that consists of crested wheatgrass, intermediate wheatgrass, and Russian wildrye; native perennial grasses including slender wheatgrass, thickspike wheatgrass, and western wheatgrass; and native shrubs including fourwing saltbush.

2.2 Mineral Hill Pit

The Pit covers an area of 258 acres. Mining in the Pit and underground workings was suspended in November 2015 and April 2019, respectively. Seeding has not occurred in the Pit or on the highwalls, and little to no vegetation has been established on these areas. Based on a site visit, safe access to any mined benches off of the haul road is very limited.

The approved Operations and Reclamation Plan (GSM 2014) for the Pit includes the following primary components:

- Overall highwall design configuration incorporates benches to provide for limited raveling of slope and maintain overall competency of the slope.
- Ground water flow and precipitation directly running into the Pit are managed by the dewatering well (South Well) located at Switchback #2.
- Abrupt Pit perimeters are bermed and/or fenced.
- Berms and storm water run-on diversions constructed around the Pit perimeter are designed to handle a 100-year, 1-hour storm event.
- Warning signs are placed around the Pit perimeter.
- Major benches, which are not likely to become buried with rubble from the Pit highwall over time, have sufficient width to allow machinery access, and Pit haul roads will be capped with a 3-ft-thick soil cover and revegetated.
- The Pit haul road will be maintained for access; however, the access road from Switchback #2 to the bottom of the Pit (sump area) will be reclaimed because underground access will not be necessary.
- Rock raveling and sloughing from the highwall that escapes the safety benches and berms are removed from the Pit haul road, as safe access allows.
- Oxidized benches containing enough fine material to support plant life will be seeded and/or planted with shrubs where safety allows.

The Pit highwalls currently provide ten or more nesting sites on each highwall for raptors, bats, and other avian species, and these sites are mostly concentrated in the upper one-third of the Pit highwalls. No active raptor nesting sites have been observed in the Pit, although hundreds of rock dove and numerous cliff swallows are active at the Pit. Rock dove are prey for golden eagles and mine personnel report seeing golden eagle activity. Insufficient data have been collected to determine the presence or absence of bats at the Pit (NewFields 2015).

3.0 PROPOSED ACTION – RECLAMATION PLAN

GSM proposes modifying the currently permitted Operations and Reclamation Plan (GSM 2014) under Operating Permit No. 00065 and Plan of Operations No. MTM-82855. The Proposed Action would allow GSM to excavate and reprocess 23.6 Mt (20.8 million yd^3) of tailings from the previously reclaimed TSF-1, construct a new Re-Pulping Plant, reprocess the tailings to separate sulfur and gold, and dispose the remaining tailings by partially backfilling the Pit over a 12-year span.

The tailings would take approximately 5 years to sufficiently densify for low-compaction equipment to prepare the final reclamation surface; the Pit would then be returned to wildlife habitat. At closure, the basal area of the Pit would be approximately 50 acres and no permanent ponding is anticipated. Additional disturbance outside of the currently permitted disturbance boundary would not occur (GSM 2021). Modifications to the existing permit would occur primarily on privately held land and approximately 1.4 acres of Bureau of Land Management (BLM) lands on the west Pit highwall. Post closure land use would remain as livestock grazing and wildlife habitat at TSF-1 and wildlife habitat in the Pit.

A more detailed description of the Proposed Action, including operations and reclamation, at TSF-1 and the Pit are discussed in Section 3.1, Tailings Storage Facility 1 and Section 3.2, Mineral Hill Pit.

3.1 TAILINGS STORAGE FACILITY 1

Tailings would be recovered and transported from TSF-1 over a period of approximately 12 years by using conventional excavation, loading, and haulage equipment (i.e., dozers, excavators, front-end loaders, and haul trucks). The 26.2 Mt (20.8 million yd^3) of tailings at TSF-1 encompass an area of approximately 190 acres (including embankments) and have a dry density of approximately 93.6 pounds per cubic foot.

Before tailings are removed from the first cut, the north end of the TSF-1 site would be stripped of vegetation, growth media, and capping material from the previous reclamation. This growth media and capping material would be placed in separate, temporary stockpiles within the northern portion of TSF-1, as shown on **Figure 3-1**, and used for reclamation of the exposed native ground after the first cut is completed.

Ongoing excavation of the growth medium and capping materials would be limited to the areas directly above the tailings to be excavated to limit dust and water runoff from exposed tailings. The upper 2 ft of growth media would be salvaged from each active excavation area and stockpiled in an area where tailings have already been removed, and the underlying capping material would be salvaged and placed in a separate stockpile.

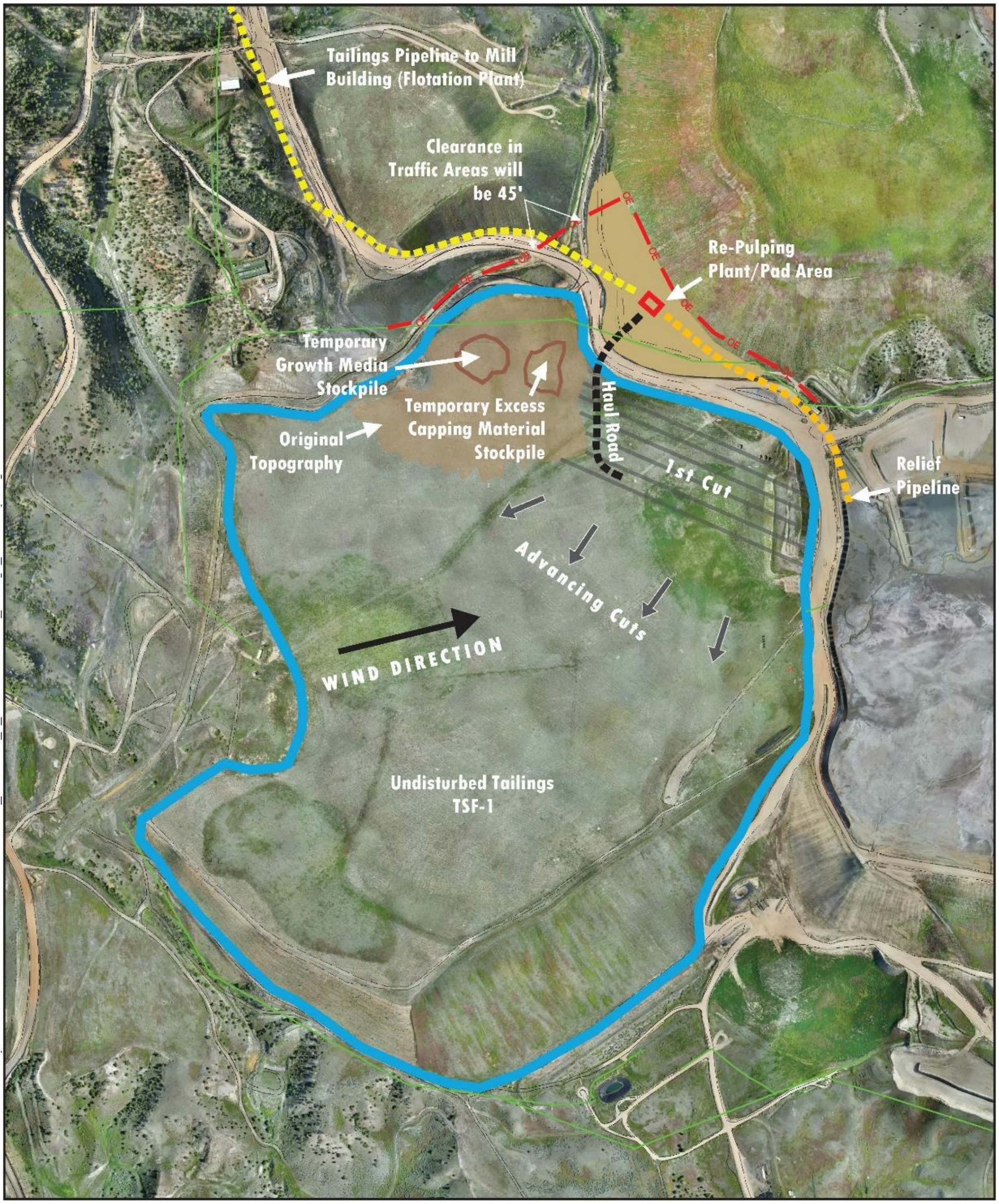


Figure 3-1
Tailings Storage Facility 1 Proposed Action Layout (GSM 2021)

The growth media and capping material would be salvaged from progressive cuts of TSF-1 and used to concurrently reclaim areas where tailings have been removed, and the original ground surface has been prepared for reclamation and can receive the capping material followed by placing the growth media. After placing the previously salvaged capping material (approximately 2 ft thick) and the previously salvaged 2 ft of alluvium/growth media, the TSF-1 flat areas and the east-, west-, and south-facing sloped areas would be seeded as specified in Appendix H Reclamation Seed List of the Amendment Application. Seedbed preparation would be conducted based on slope angle; for slopes that are less than 3H:1V, the seedbed would be prepared along the contour using a chisel-plow, disc, or harrow. On slopes steeper than 3H:1V, or areas too narrow to operate equipment, the surface may be left in a roughened condition. During concurrent reclamation of TSF-1, the current seed mix for flat (0 to 5 percent) will be used for the majority of surfaces; however, surfaces that are steeper than 5 percent, such as the common embankment between TSF-1 and TSF-2, would use existing recommended seed mixes for east-, south-, and west-facing slopes. The Proposed Action would continue to monitor seedling emergence, measure point-intercept transects, take photo-points, and analyze soils on problematic areas to support revegetation efforts on reclamation areas.

During the TSF-1 recovery process, tailings excavated to the original ground surface would be loaded and hauled to the Re-Pulping Plant. The excavation of tailings would be developed in benches with cut faces oriented northeast to southwest to minimize exposure to the prevailing wind direction, and excavation would proceed in a southwestern direction. A general schematic of the facility is shown on **Figure 3-2**.

Any encountered coarse waste rock (e.g., cobbles and boulders) that was used as fill while constructing TSF-1 would be separated from the tailings at the Re-Pulping Plant and trucked to an existing waste rock disposal area or, if determined to be oxide waste rock, placed as capping material in the TSF-1 site reclamation. Depending on conditions observed during tailings removal, the upper 1 to 2 ft of foundation material (e.g., original ground surface) located immediately below the tailings could be removed to ensure that the tailings are fully recovered. Any removed foundation material, which consists of sediment of the Bozeman Formation, would be separated at the Re-Pulping Plant and placed in a waste rock disposal area. Based on this description from the Amendment Application, it is clear that the underlying ground surface would not remain entirely intact.

The final reclaimed surface, as shown on **Figure 3-3,** mimics the original topography of the TSF-1 area before tailings placement. Disturbed areas would be reclaimed to comparable stability and ecologic function as that of adjacent areas, as specified in the 2014 Operations and Reclamation Plan (GSM 2014). The interface of tailings and original ground are assumed to be identified based on visual observation, similar to the method to differentiate the salvaged capping material from the tailings. The Amendment Application states that capping material and growth media would be hauled and placed on areas of TSF-1 that are devoid of tailings and prepared for reclamation. Specific aspects of being “prepared for reclamation,” such as controls for maintaining the original topography, grading designs, thickness, or stabilization practices, are not detailed in the Amendment Application.

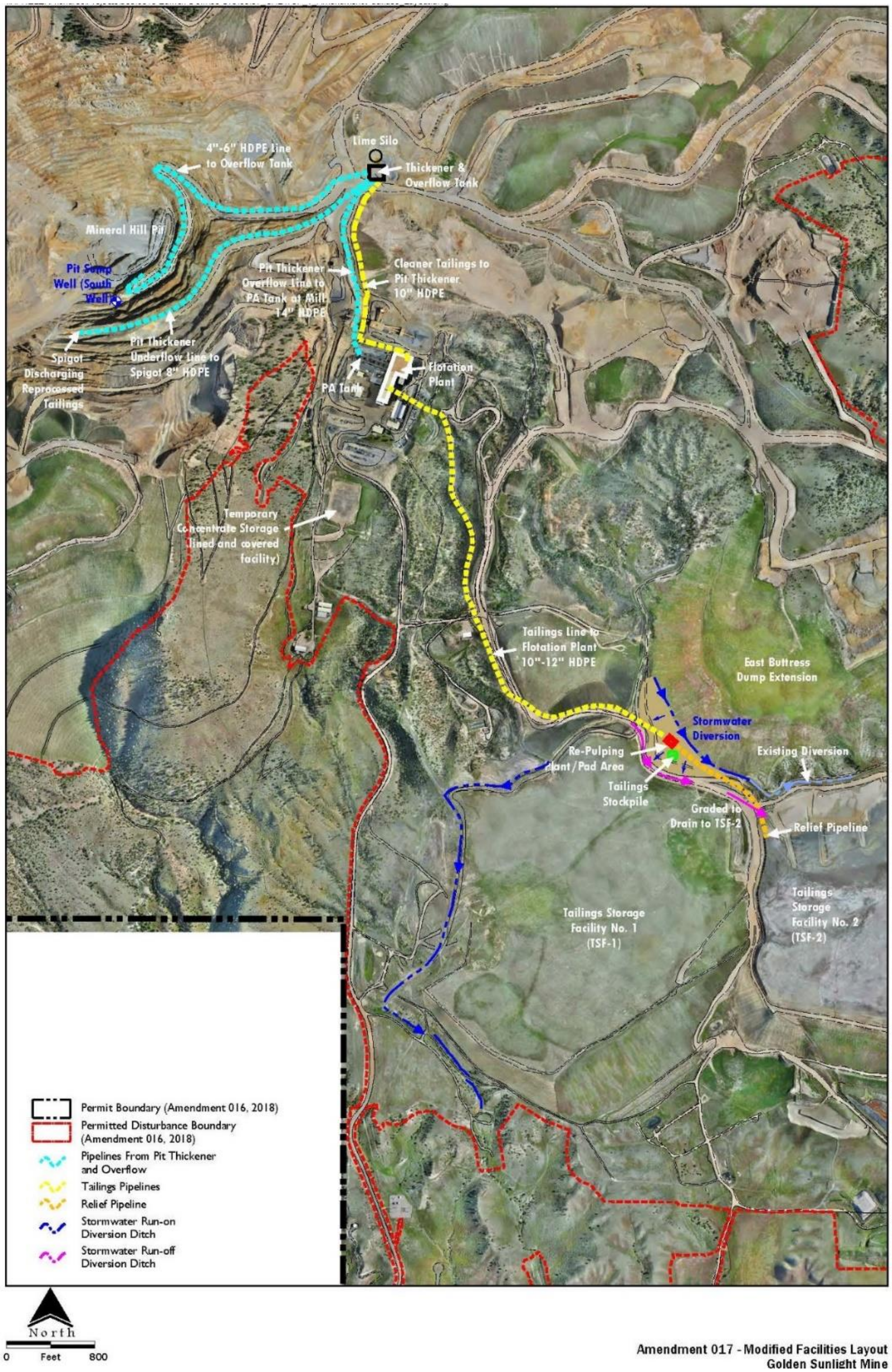


Figure 3-2
Tailings Storage Facility 1 Proposed Action Layout (GSM 2021)

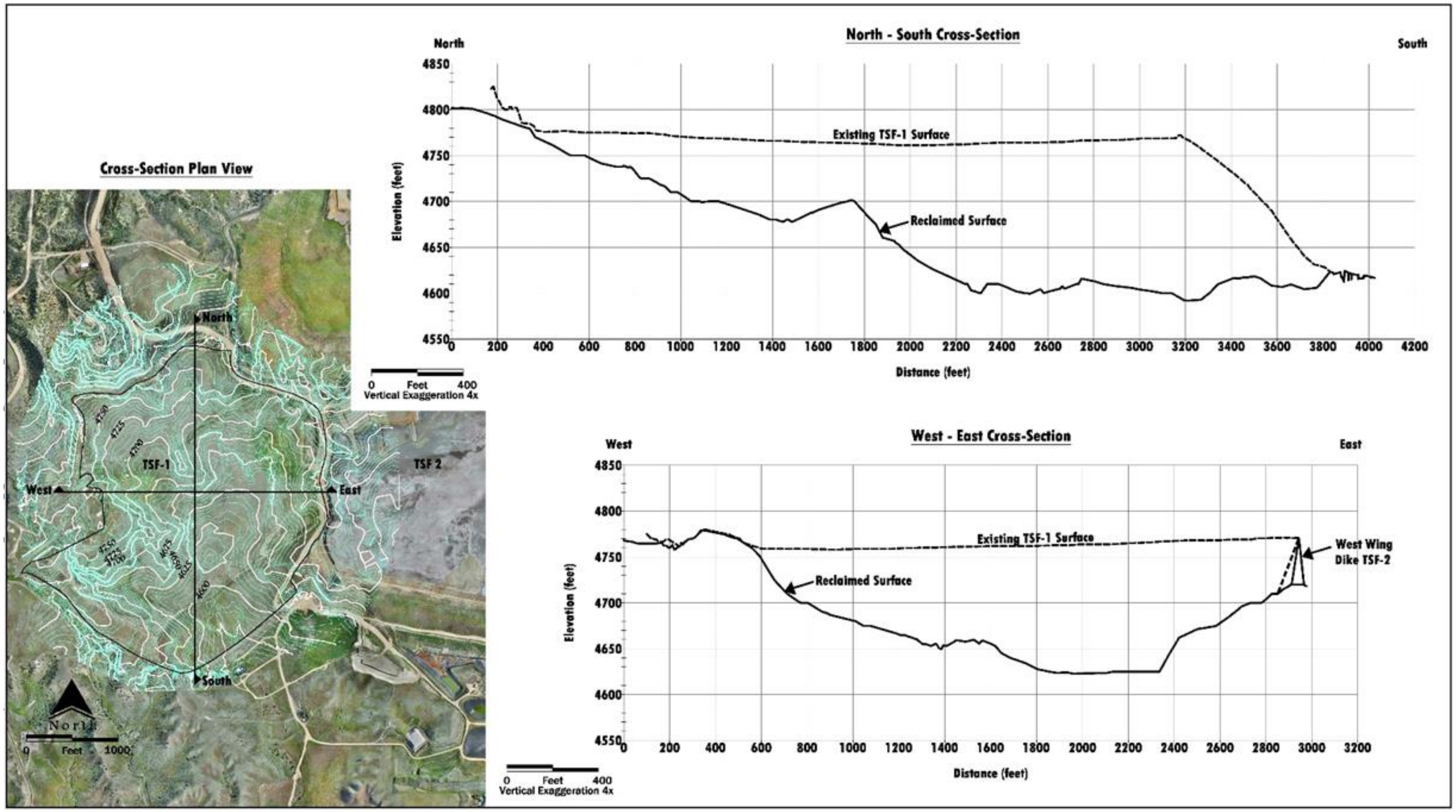


Figure 3-3
Final Grading Plan for Tailings Storage Facility 1 (GSM 2021)

3.2 Mineral Hill Pit

Tailings from the Flotation Plant would be pumped to a thickener tank located near the Pit to thicken the tailings slurry to approximately 65 percent solids. Lime would be added as needed to raise the final tailings slurry pH. The thickened tailings slurry would then be pumped to the Pit for final placement.

The thickened tailings would be conveyed through a pipeline to a spigot system located in the Pit. Spigot operations would be managed to distribute tailings into the Pit from one or more discharge points along the south side of the Pit to create a pond comprising process solution in the eastern portion of the Pit. Flotation tailings would initially reach an elevation of approximately 5,191 ft (mine datum) and then settle to an elevation of approximately 5,173 ft (mine datum) after consolidation. The tailings would have an approximate grade of 1 percent to the northeast at the end of the reprocessing period, and the Pit would have a surface area of approximately 50 acres. After the processing of tailings processing is completed, the final surface would cover approximately 1.4 acres of land managed by the BLM on the west highwall, which is the only BLM-managed land affected by the Amendment Application.

Water that infiltrates the reprocessed tailings material in the Pit and bedrock beneath the Pit would be captured by the existing underground dewatering system. As tailings materials rise in the Pit during placement, the tailings should eventually provide enough confinement to inhibit movement of the highwall. Until placement of tailings is complete, GSM will maintain its current standard of monitoring and managing the highwall deformation.

Process water in the tailings slurry would collect in a pond on the eastern side of the tailings surface in the Pit. This process water would be pumped through a pipeline at approximately 50 gallons per minute to the thickener tank overflow and then to the PA Tank for distribution to the Flotation Plant and/or Re-Pulping Plant for reuse. After tailings disposal ceases in the Pit, the surface pond is expected to become nonexistent because of net evaporation and infiltration, with possible short-term, seasonal ponding of precipitation in the low point on the eastern side of the tailings surface.

After tailings disposal in the Pit is complete, 4 ft of capping material (comprising 2 ft of oxidized overburden and limestone and 2 ft of growth media) sourced from the East Pit Borrow site would be placed over the final tailings surface to reduce the net infiltration of precipitation and influx of oxygen into tailings material as well as support the establishment of vegetation. Stope accesses and haul ramps leading to excavations below the Pit floor would be filled with waste rock before tailings deposition, to prevent tailings from migrating into open stopes. After placing the capping and growth material, the reclaimed tailings surface would be seeded as specified in Appendix H Reclamation Seed List (for north-facing slopes) within the Amendment Application.

4.0 EVALUATION OF ALTERNATIVE RECLAMATION METHODS

Proposed alternative reclamation methods of TSF-1 and the Pit were evaluated as part of the Environmental Impact Statement for GSM's Operating Permit No. 00065 Amendment 017. Alternatives for grading configuration, capping thickness and quality, habitat, vegetation, and seed mixes were analyzed for TSF-1 reclamation. Grading configuration, perimeter ditch, capping thickness and quality, habitat, vegetation, and seed mix alternatives were investigated to provide reclamation options for the Pit. The technical feasibility and environmental consequences of all alternatives are discussed in the following sections.

4.1 ALTERNATIVE RECLAMATION OF TAILINGS STORAGE FACILITY 1

The proposed reclamation design for TSF-1 is described in the Amendment Application Section 4.2. The current reclamation of the TSF-1 area is almost exclusively grasses and forbs. The Proposed Action consists of returning the land to its predisturbance topography, but specific grading techniques are not detailed. Without specifying success criteria and grading methodology, the resultant final grade may fill in drainages and eliminate swell/swale features to produce a more regular and smooth grading. Where infilling of micro-topography occurs, common erosion-control features employed elsewhere at GSM may then be required to stabilize the reclaimed surfaces. Upon reviewing the Proposed Action and preliminary environmental impacts, the final reclamation design of TSF-1 could be improved to reduce visual and environmental impacts and increase vegetation diversity and wildlife habitat.

Under this proposed alternative, TSF-1 reclamation would be modified to ensure that landform variation is created that would support an increase in vegetation type and thereby improve the quantity and quality of wildlife habitat. Actions such as modifying the existing seed mixes, controlling the grading configuration, preparing the native topography before placing capping material, and using suitable salvaged growth media and native ground can improve the quality of wildlife habitat and reduce visual impacts.

4.1.1 Micro-Topography and Mosaic Vegetation

The alternative geomorphic design (micro-topography and mosaic vegetation) would create a final grade to better approximate native topography regarding drainage density and length as well as the number of swales and swells present in the reclaimed area. Swell, swale, and drainage density criteria would be measured based on predisturbance imagery and topography for TSF-1 or a suitable undisturbed control area using AutoCAD or similar software; these characteristics would provide measurable criteria for determining reclamation grading success and would not hinder concurrent reclamation. For operators to accurately create these features, a Global Positioning System unit can be used in the equipment to identify the cut or fill required for a given area to meet the reference topography. As under the Proposed Action, concurrent tailings excavation and reclamation would occur under this alternative.

Controlling these landscape features would increase the diversity and quality of wildlife habitat by matching the original topography compared to the Proposed Action, which may grade over many of the swells, swales, and drainages. Under this alternative, using the predisturbance topography to calculate the total footage of primary and secondary drainage and the number of swells and swales for each cut is recommended. These features should be maintained on the reclaimed topography.

The elevation, proposed contours, and size of TSF-1 would remain as shown in the Proposed Action. The alternative geomorphic design would ensure that the original micro-topography (i.e., small topographic changes) of the native ground surface is honored, thus creating sufficient drainage density to restore a stable hydrologic balance. The density and location of these features would be measured in the predisturbance imagery and topography and used as criteria to confirm that the approximate original contour is restored as concurrent reclamation advances. The design would also better blend TSF-1 into the existing topography in the area. This alternative design would measure and compare the distribution and density of swells, swales, and drainages against the original topography as a measure of success. The resulting post-reclamation landscape would be superior in terms of appearance and performance. Construction of micro-topography could be aided by Global Positioning System machine guidance.

The technical considerations for grading swells and swales with independent primary and secondary drainages require different best management practices for equipment operators. Specifically, the density of drainage, swells, and swales present in the original topography should be maintained to avoid long, even slopes. Creating these landforms is standard industry practice on many sites, and these technical considerations would not hinder the final grading during the proposed concurrent reclamation. Depending on current practices, modifying seeding equipment to low compaction or light machinery may be needed to ensure that the designed topography is not adversely impacted during seeding.

The environmental benefits from varying landforms at TSF-1 would create mosaic grass, forb, and shrub vegetation patterns and microclimates that support multiple habitats for vegetation and wildlife. The microenvironments would encourage the growth of specific plant species and promote greater biodiversity within the Proposed Action seed mixtures. Vegetation diversity would be enhanced by the variations in sunlight, water infiltration, and topsoil thickness that would provide favorable sites for volunteer and seeded species. In addition to varied species of grasses and forbs, shrubs, which require more water, would be more likely to grow and thrive within swales and drainages. Vegetation diversity would positively impact wildlife diversity.

Successful tree and shrub establishment on the GSM site has been challenging. In 2017 and 2018, GSM partnered with faculty and students from Montana Technological University to plant more than 200 trees and shrubs on four plots on reclamation areas to evaluate species and planting techniques for use on larger-scale efforts. The results indicated that initial plant survival appeared good; however, the following winter survival was poor for all species, and no additional seedlings were transplanted during 2019. This challenge is partially caused by competing aggressive grasses, forbs, and invasive species; smooth and level reclaimed slopes; and depth of growth media. The Historic Climax Plant Community (HCPC) or Reference State on the GSM site consisted of grass and shrub plant communities with no tree species, which is another factor for poor tree and shrub establishment. The only tree species for this area include Rocky Mountain juniper and Douglas fir, which occur in an “Invaded State” plant community that consists of introduced species such as cheatgrass, knapweed, field brome, or yellow toadflax. Therefore, this alternative would not include tree planting and would focus more on establishing grass, forb, and shrub species of the HCPC or Reference State for the site.

Under this alternative, the concurrent grading design would be revised to create a drainage density and pattern that could form stable land features with long-term erosion control. The design would allow the landform to convey storm water in a nonerosive, natural manner. The alternative design surface would be a stable, natural-acting, and generally maintenance-free surface that behaves more like a native surface in flood events and thus reducing erosion of reclaimed topsoil.

The final grading and reclamation could eliminate the need for more defined channels around the upper edge of TSF-1 and other erosion-control measures that could be needed under the Proposed Action. The reclaimed TSF-1 runoff water quality would be comparable to surrounding undisturbed lands.

When a representative population of vegetation is successfully established, the visual impact of the reclaimed area would be eliminated if the original topography is mimicked sufficiently. The proposed natural grading would also lead to the overall reclamation success and bond release.

4.1.2 Suitability Testing of Capping Material

As outlined in the Amendment Application, the Proposed Action would involve removing the 4 ft of cover material at TSF-1, which would be separated into two piles (growth media and underlying capping material). The growth media has proven to support vegetation. However, under the Proposed Action, mixing between the tailings and the capping materials may occur during salvage, which could degrade the quality of the capping material and reduce its capacity to support plant life after replacement, particularly for shrubs and plants with roots that may extend below the upper 2 ft of growth media. The boundary between the capping material and the tailings may have elevated levels of contamination from decades of vadose zone activity and upward migration of elements to this boundary.

As part of this reclamation alternative, the suitability of the capping material would be evaluated to confirm that contaminants have not migrated into the capping material and ensure its capacity to support grass, forb, and shrub seeding and plantings on reclaimed areas. The tailings/capping material boundary would be tested during mining advancement to confirm or deny the toxicity of that material and identify potential effects of upward contaminant migration and reduce the likelihood of inadvertent mixing of the two. Adequate material characterization would also be performed on the stockpiled capping material before replacement for reclamation.

Unsuitable and poor-quality material would hinder the successful establishment of vegetation on the TSF-1 reclamation area; as a result, the quality of wildlife habitat would be reduced. The visual impacts of inferior capping and/or growth media would be a noticeable reduction in vegetation cover and potentially areas devoid of vegetation. **Table 4-1** lists the suitability criteria that would be used to ensure that the appropriate material is used for improving vegetation on reclaimed areas (as provided by GSM consultant Cedar Creek Associates Inc.).

Table 4-1
Growth Media Evaluation Suitability Criteria (Cedar Creek Associates Inc. 2020)

Parameter	Method	Acceptable Average Values	Units
pH (paste)	ASTM D4972 – 13	6–8.3	N/A
Electrical Conductivity	4F1a1a1	< 6	mmhos/cm
Organic Matter	Walkley-Black	< 4	% of Total Soil
NO3-N	4D6 [a]	0.1 ± 15	ppm
Phosphorus (P)	4D6 [a]	1 ± 25	ppm
Potassium (K)	4D6 [a]	100 ± 250	ppm
Zinc (Zn)	4D6 [a]	> 0.25+	ppm
Iron (Fe)	4D6 [a]	> 1.0+	ppm
Manganese (Mn)	4D6 [a]	> 0.1+	ppm
Copper (Cu)	4D6 [a]	> 0.1+	ppm
Calcium (Ca)	EPA Method 3050B	Addressed as SAR	ppm
Magnesium (Mg)	EPA Method 3050B	Addressed as SAR	ppm
Sodium (Na)	EPA Method 3050B	Addressed as SAR	ppm
Texture by Hydrometer	ASTM D422-63(2007)e2	Textural Extremes	% Size Fraction
Sodium Adsorption Ratio	EPA Method 3050B	< 15	N/A

ppm = parts per million.
mmhos/cm = millimhos/centimeter.

4.1.3 Habitat/Vegetation/Seed Mix

The Proposed Action provides for continued use of the currently approved seed mix that has a heavy component of aggressive rhizomatous grasses for rapid stabilization. This seed mix has the effect of limiting the successful establishment of shrub species with minor impacts of reducing grass and forb diversity. Although the seed mix was modified in 2019 to increase species diversity, data to support the performance of this revised seed mix are not yet available. This alternative proposes that either multiple seed mixes or a modified version of the current seed mix could be used for direct seeding during the fall-winter season to improve shrub establishment by significantly increasing the shrub component and replacing some of the rhizomatous grasses with bunch grasses. In addition to the shrub direct seeding, this alternative would also include using bareroot and container shrub species to establish shrub stands or shrub islands on smaller areas near swells, swales, and drainages to develop manageable plots, site-specific planting procedures, and potential local seed sources. This approach is also useful when establishing shrubs into existing grass and forb vegetation cover.

A single, modified seed mix could be used across the TSF-1 area to improve shrub establishment and forb diversity. Reducing the grass Pure Live Seed (PLS)/ft^2 by one-half and replacing some of the rhizomatous grasses with bunch grasses while significantly increasing the shrub PLS/ft^2 is proposed. Overseeding the shrub component relative to grasses and forbs will encourage increased shrub and forb establishment; however, the increased shrub component would not be expected to outcompete or hinder grass establishment. Increasing the shrub seed component may facilitate successful shrub establishment where it would otherwise fail.

Two seed mixes are proposed to greatly improve the chance of successful shrub establishment. The currently approved seed mix detailed in the Operations and Reclamation Plan could be used as one seed mix. A second mix with heavier shrub and forb components, as well as a greatly reduced grass component of only bunch grasses, could be planted in drainage and swale areas where a shrub mosaic is preferred. The second seed mix would concentrate the shrub population in the drainages and swells, which matches their native undisturbed distribution.

No additional technical considerations are needed for the single seed mix modification. Technical considerations for the multiple seed mixes would include hopper cleaning if a single seeder is used and seeding each mix within its own defined areas. The different seed mixes should not be mixed, and if a single seeder is used to apply both seed mixes, the hopper boxes should be thoroughly cleaned before switching seed mixes. If multiple seeders are used, this technical consideration is not relevant. Specific areas of application would need to be defined for each mix, and seeding between these areas should not overlap. If seed mix distributions overlapped, shrub establishment would likely be significantly reduced or potentially eliminated. Seed storage conditions including temperature and humidity levels for sagebrush species should be considered to ensure seed viability. Equipment Global Positioning System tracking or physical ground demarcations of separate seeding areas would allow equipment operators to identify the separate areas. When broadcast seeding, care would need to be taken to ensure that broadcasting did not occur across areas.

The environmental benefit of the modified, single seed mix would be improved vegetation type and species diversity. Reducing the competition from aggressive rhizomatous grasses should improve the establishment of shrubs and diversity of grasses and forbs, which will improve the wildlife habitat and speed the development of an HCPC or Reference State.

The environmental benefit of the modified multiple seed mixes would be similar to the modified, single seed mix except that the modified multiple seed mixes could significantly improve the establishment of shrub communities in the drains and swales of the topography and better reflect the native undisturbed reference areas. Densely packed shrub islands have beneficial impacts on wildlife habitat as well as improving soil health by capturing windblown silt and snow, which would greatly improve the development speed of an HCPC or Reference State.

The visual impacts of this alternative's seeding mixes and planting methods would improve blending the disturbed area with the surrounding land. The proposed multiple seed mixes and methods would add a visual impact benefit by more accurately mimicking the types of native vegetation communities associated with different landforms (e.g., swells, swales, and drains).

GSM has had a limited grazing partnership with a local rancher on the TSF-1 facility for summer cattle grazing, and regrowth appears to be good in the spring but no grazing was scheduled for 2020. This alternative's postclosure land use would allow for livestock grazing and wildlife habitat at TSF-1 but would include a prescribed grazing plan that defines the frequency and intensity of scheduled grazing activities to achieve the HCPC or Reference State and improve wildlife habitat of the reclaimed areas. The availability of livestock and wildlife water sources would also be assessed to determine if additional water developments are needed within the reclaimed areas.

4.2 ALTERNATIVE RECLAMATION OF THE MINERAL HILL PIT

4.2.1 Grading Configuration

Under the Proposed Action, the backfilled Pit bottom would be graded to a relatively flat surface grading 1 degree to the northeast. Tailings would consolidate and the low point may gradually form toward the center of the Pit; however, finer-grained tailings to the northeast side of the Pit may experience more consolidation. Consolidation would continue approximately 16 years after the end of tailings disposal.

To ensure that an appropriate grade is maintained for adequate drainage after final placement consolidation of tailings material, long-term monitoring of the final grade is recommended. If unequal settling occurs after seedbed preparation and seeding such that water ponding is present and plant life is submerged for an extended period, recontouring of the surface to obtain an even grade may be required. Extended periods of submersion would likely kill seeded species; if this occurs, the surface would need to be prepared and seeded again. Monitoring should continue for the 16 years that it is expected settling would continue after final tailings placement in the Pit and should be conducted on a similar frequency to other on-site reclamation monitoring.

4.2.2 Perimeter Ditch

A proposed (but dismissed) alternative to the Proposed Action grading of the Pit would be to include a perimeter ditch around the edge of the backfilled tailings within the Pit bottom. This technical memorandum did not evaluate the specific design of a perimeter ditch but rather the general concept and benefits.

The primary purpose of the perimeter ditch would be to collect rocks from rockfalls and raveling as well as fine materials transported down the Pit walls. Collecting this material could help protect the revegetated floor from acid-generating highwall materials. The biggest concern for geotechnical stability of the Pit is in the southwest corner; however, a geotechnical analysis (Subterra LLC 2020) indicates global slope stability after the Pit is backfilled with tailings, so only smaller rockfall events would likely occur in the future.

The perimeter ditch should catch minor rockfall and slough material to protect the revegetation from smaller boulders or debris flow. Regardless of the final perimeter ditch design and location of the rockfall, the perimeter ditch may not contain all of the potential falling rocks; large boulders or debris flows could still be transported onto the graded and reclaimed surface. Defining how much rockfall onto the reclaimed Pit floor is too much or too large and whether or not boulders pose a risk to degrade the quality of the reclaimed surface is difficult. The perimeter ditch would also reduce the total acreage of reclamation, although not significantly. This alternative includes a stipulation that maintenance be conducted to remove large boulders or debris flows from the floor, as access allows.

Data presented in the Amendment Application indicate that the reclaimed and revegetated surface is not expected to result in ponded water; therefore, the ditch is not needed to aid drainage. This alternative would not likely significantly impact ground water quality because all water would likely still mix sufficiently within and around the Pit before dewatering. Constructing a perimeter ditch would likely be feasible after tailings consolidation, but the effectiveness would likely be limited and not provide sufficient environmental benefit to justify increasing the site reclamation time, fuel usage, and additional mining or purchase of nonreactive rock to create the ditch. This alternative was dismissed from further consideration.

4.2.3 Capping Thickness and Quality

The Proposed Action calls for the tailings in the Pit to be covered with 2 ft of capping material (e.g., oxidized overburden/limestone) and 2 ft of growth media. Testing the capping material for toxicity levels and/or general suitability is not included in the Proposal Action. Similar to Section 4.1.2, Capping Thickness and Quality, the suitability of the capping material for the Pit could be evaluated to ensure the quality of the soil and its capacity as growth media to support grass, forb, and shrub seeding and plantings on reclaimed areas. Unsuitable and poor-quality material would hinder the successful establishment of vegetation at the Pit reclamation area; as a result, the quality of wildlife habitat would be reduced.

However, the capping material for the Pit would be sourced from the East Pit Borrow area, which has been used for reclamation cover around the mine site for many years. This material has not been exposed to potential mixing or contaminant migration from tailings, unlike the capping material on TSF-1 that would be rehandled before placement during reclamation.

Although GSM has indicated no changes to the use of soil amendments described in the Operations and Reclamation Plan (GSM 2014), they indicate that they may use organic matter and/or fertilizer to condition growth media to support revegetation as needed. This alternative for preemptive testing of the Pit capping material could confirm the suitability of the borrow material source, but there is less concern about the contaminant exposure for the borrow material. Preemptive testing of capping material for the Pit is not considered to be as important as characterizing the capping material on TSF-1.

4.2.4 Habitat/Vegetation/Seed Mix

Single Modified Seed Mix

The Proposed Action uses a grass-heavy seed mix with aggressive rhizomatous species selected for rapid erosion control. A modified, single seed mix could be used in the Pit area to improve shrub establishment and forb diversity. It is proposed to cut the grass PLS/ft^2 by one-half and replace some of the rhizomatous grasses with bunch grasses while also significantly increasing the shrub PLS/ft^2. Overseeding the shrub component relative to grasses and forbs will encourage their establishment, and the increased shrub component would not likely outcompete or hinder the establishment of grasses. Increasing the shrub seed component may facilitate successful establishment. Successful establishment of shrubs and improved grass species diversity would increase the vegetation diversity and improve wildlife habitat.

Improved Habitat Creation

The Proposed Action does not include the placement of improved habitat features such as boulders, mosaic rock features with overhangs and shelters, or mature dead trees. These and other habitat features provide shelter from predators, wind, and rain and facilitate animal borrows, hollows, and other areas for habitation in and around them. Placing these features close together allows for increased sheltered movement of prey animals and would increase the diversity of small mammals and reptiles that could use the reclaimed Pit as long-term suitable habitat. Habitat features increase hibernation and hibernacula sites, and dead-tree litter provides a long-term source of soil nutrients.

Habitat features would need to be placed after seeding on the reclaimed surface by low-compaction equipment. The features should be placed in a configuration and with sufficient quantity to facilitate rapid movement between features by wildlife. Vegetation could not establish under boulders and would have limited establishment under mosaic rock features. Large dead trees create micro-variation in sunlight, snow capture, and drainage to increase the diversity of available sites for vegetation establishment. Intentionally placing rock and boulder features comprising limestone or other non-acid-generating material is recommended. Placing these features would not likely impact overall drainage or ponding in the Pit.

Because the Pit has limited egress that significantly limits the number and type of wildlife that might take advantage of created habitat features, environmental benefits of this option are likely minimal and limited. This alternative was dismissed from further consideration.

5.0 CONCLUSION AND RECOMMENDATIONS

The Amendment Application to Operating Permit No. 00065 for the Golden Sunlight Mine was reviewed to assess the environmental impacts of the Proposed Action and offer alternatives that may reduce these impacts or improve postmining land-use goals.

The following recommendations are provided for the TSF-1 area:

- Use original topography or reference location information to assess grading success criteria for concurrent reclamation and confirm that the land surface is sufficiently restored beneath the tailings. Without more details about the grading design in the Proposed Action, it is not clear whether drainages, swells, and swales may be graded over, which would reduce the stability of the landform and may require installing standard erosion-control features.
- Modify the seed mix to include fewer total grasses and a reduced number of rhizomatous grasses along with an increase in the shrub seed or include a second seed mix for establishing shrub mosaics in the drainages and swales.
- Evaluate the toxicity of the tailings and capping material interface to address concerns about potential upward migration of contaminants and/or mixing of these two materials during capping material removal.

The following recommendation is provided for the Pit:

- Use a modified seed mix to reduce grass PLS/ft^2quantity and replace rhizomatous grasses with bunch grasses while increasing the shrub PLS/ft^2.

It is not recommended to carry forward the perimeter ditch and improved habitat creation options for the Pit.

6.0 REFERENCES

Cedar Creek Associates, Inc. 2018. Golden Sunlight Mine Revegetation/Soil Monitoring – 2018 Buttress WRD Extension, Northeast Dump, Cheatgrass Study Area, & South Intra-Dump. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______ 2019. Golden Sunlight Mine Revegetation/Soil Monitoring – 2018 Buttress Wrd Extension, Northeast Wrd, Cheatgrass Study Area, Tailings Dam Sw Corner Northeast Wrd. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

______. 2020. Golden Sunlight Mine Revegetation Monitoring – 2019 Buttress Wrd Extension, Northeast Wrd, Tailings Dam #2 Sw Corner & Far East Wrd. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

Golden Sunlight Mines, Inc. 2021. Modification to Application for Amendment 017 to Operating Permit No. 00065 and Plan of Operations No. MTM-82855 for Golden Sunlight Mine, Montana. Montana Department of Environmental Quality. Helena, Montana.

______. 2014. 2014 Operations and Reclamation Plan; Golden Sunlight Mine. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

NewFields. 2015. Bat and Raptor Habitat Plan. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.

EDIT (Ecosystem Dynamics Interpretive Tool). 2021. Ecological site descriptions. Accessed: March 01, 2021. Retrieved from https://edit.jornada.nmsu.edu/catalogs/esd

NRCS (Natural Resources Conservation Service). 2018. Web Soil Survey. Accessed: March 01, 2021. Retrieved from http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Schafer Limited LLC & John Shomaker & Associates. 2020. Golden Sunlight Mine, Closure Option Evaluation. Barrick Golden Sunlight Mines, Inc. Whitehall, MT.

Schafer Limited LLC & John Shomaker & Associates. 2020. Golden Sunlight Mine Closure Option Evaluation (Appendix F in Amendment Application 017). Golden Sunlight Mine, Montana. Montana Department of Environmental Quality. Helena, Montana.

Schafer. 2020. Golden Sunlight Mine Geochemical Characterization Report. Compendium of Historic and On-Going Geochemical Tests and Water Quality Data. Barrick Golden Sunlight Mines, Inc., Whitehall, MT.

Subterra LLC. 2020. 5BOP West Highwall – Numerical Model of Interaction of Highwall with Deposited Tailings Material. Barrick Golden Sunlight Mines, Inc. Whitehall, Montana.