Draft Environmental Impact Statement

Stillwater Mining Company's Revised Water Management Plans and Boe Ranch LAD

November 2010



Montana Department of Environmental Quality

Forest Service, U.S. Department of Agriculture

Beartooth Ranger District
Custer National Forest

Yellowstone Ranger District
Gallatin National Forest

Draft Environmental Impact Statement
Stillwater Mining Company's
Revised Water Management Plans and Boe Ranch LAD

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Abstract: This Draft Environmental Impact Statement (EIS) for the Stillwater Mining Company's (SMC) Revised Water Management Plans and Boe Ranch LAD describes the land, people, and resources potentially affected by proposed revisions. The purpose of SMC's proposed revisions are twofold: 1) to develop and implement closure and post-closure water management plans for adit water, tailings impoundments, and storm water for the Stillwater and East Boulder mines; and 2) to construct and operate a pipeline and land application disposal system at SMC's Boe Ranch property, if needed, to dispose of treated adit and tailings waters from the East Boulder Mine during operations and at closure. This Draft EIS analyzes SMC's proposed revisions as well as agency-proposed modifications to the revised water management plans (e.g., reclamation cover requirements, reclamation cap design, use of biological treatment systems for treatment of undiluted tailings water at closure, relocation of tailings slimes as necessary to facilitate capping the tailings impoundments, and post-closure water routing and channel design). The major federal and state actions include the approval of all necessary permits to implement the revised water management plans, including construction and operation. The No Action Alternatives, Proposed Action Alternatives, and Agency-Mitigated Alternatives are analyzed in detail. The Preferred Alternatives are 3A, 3B, and 3C.

Send Comments to: Patrick Pierson (USDA Forest Service) or Emily Corsi (DEQ)

Comments Due: 45 days after the Notice of Availability is published in the *Federal Register*

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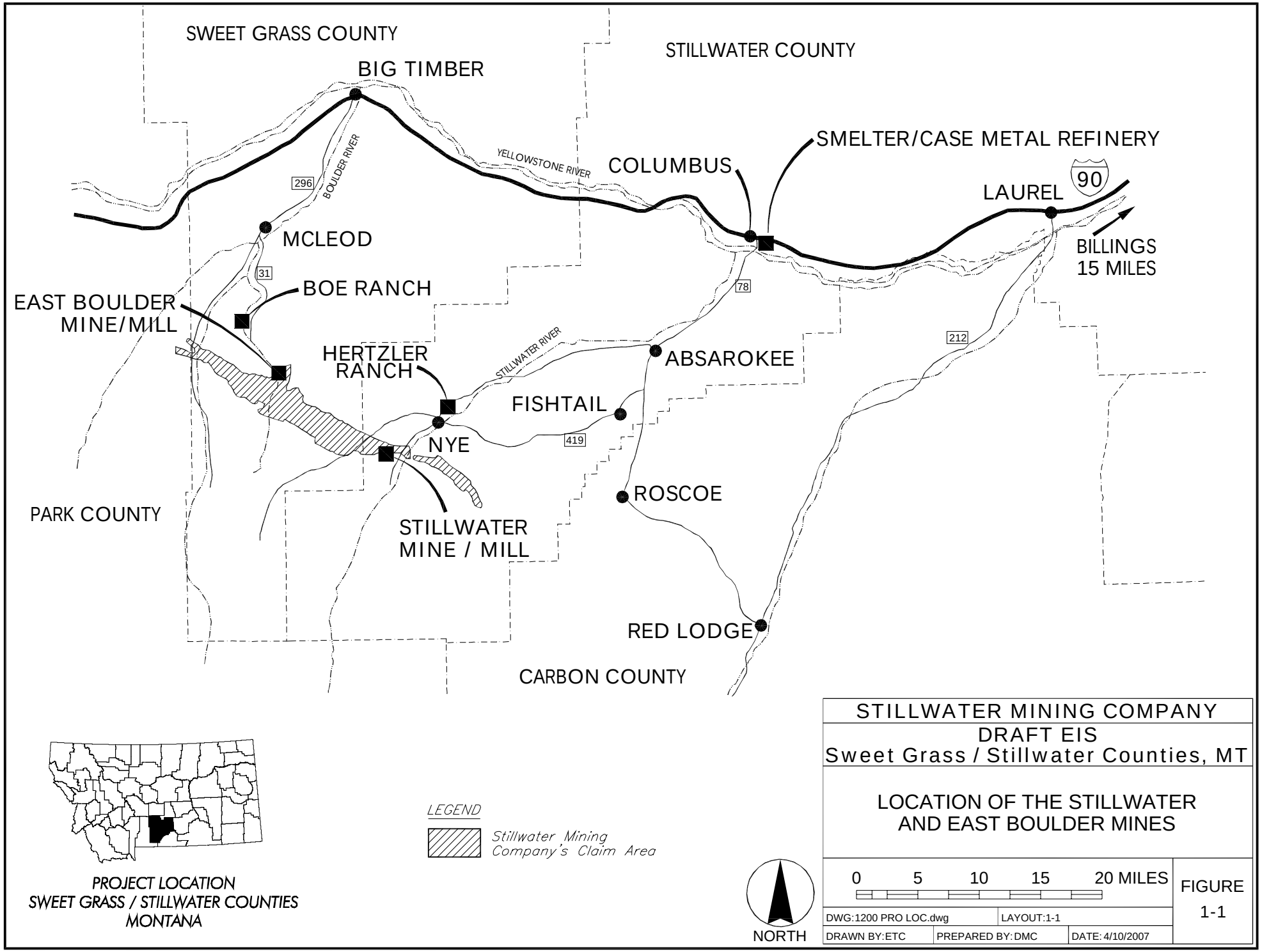
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PROJECT LOCATION
SWEET GRASS / STILLWATER COUNTIES
MONTANA

LEGEND

Stillwater Mining Company's Claim Area

NORTH

STILLWATER MINING COMPANY			
DRAFT EIS Sweet Grass / Stillwater Counties, MT			
LOCATION OF THE STILLWATER AND EAST BOULDER MINES			
0 5 10 15 20 MILES			FIGURE 1-1
DWG:1200 PRO LOC.dwg	LAYOUT:1-1		
DRAWN BY:ETC	PREPARED BY:DMC	DATE: 4/10/2007	

Executive Summary

This executive summary provides an overview of the contents of the Draft Environmental Impact Statement (DEIS) for the Stillwater Mining Company's Closure and Post-Closure Water Management Plans and Boe Ranch LAD. The DEIS discloses potential environmental, cultural, biological, and physical consequences of implementing alternatives related to closure of Stillwater and East Boulder mine facilities sometime in the future. This summary does not provide all of the information contained in the DEIS. If more detailed information is desired, please refer to the DEIS and the referenced reports.

S.1 Introduction

Stillwater Mining Company (SMC) submitted applications in late 2000 to the Montana Department of Environmental Quality (DEQ), the Custer National Forest (CNF), the Gallatin National Forest (GNF), and the Montana Department of Natural Resources and Conservation (DNRC) to amend its operating permits for the Stillwater Mine (Permit #00118) and the East Boulder Mine (Permit #00149). The Stillwater Mine is in Stillwater County near Nye, Montana (MT). The East Boulder Mine is in Sweet Grass County south of Big Timber, MT.

SMC operates two underground mines in Montana that produce platinum group metals. Operations at the Stillwater Mine began in 1985, and ore production is approximately 777,100 tons per year (SMC 2009c). Although permitted in 1993, operations at the East Boulder Mine did not begin until 1998. Ore production at the East Boulder Mine is approximately 407,400 tons per year (SMC 2008c). SMC upgrades the ore at each mine by crushing, grinding, flotation, and filtration to produce a concentrate. This concentrate is shipped by truck to the Stillwater Smelter and Base Metal Refinery (BMR) in Columbus, MT for further upgrading. From the BMR, SMC ships the product to New Jersey for final refining.

For each mine, every 100 tons of ore fed to the mill generates 99 tons of tailings. These tailings are pumped from the mill to underground sand and paste plants where the coarse sand fraction of tailings is separated from the slimes fraction (finest-sized particle). The sand is dewatered, cement is added, and about 58 percent of the total tailings is used to backfill underground workings. The remainder of the tailings are pumped to the respective tailings impoundments at the Hertzler Ranch and the East Boulder Mine. The tailings impoundment at the Stillwater Mine is used to balance water storage.

As of April 2008, the Stillwater Mine had 10 amendments and 49 minor revisions to its Plan of Operations. The East Boulder Mine had one amendment and 20

minor revisions to its Plan of Operations. The ownership of lands at the Stillwater and East Boulder Mines is listed below in Table S-1.

Table S-1 Ownership of Lands at the Stillwater and East Boulder Mines

	Ownership[1]		
Parameter	USFS (acres)	Private (acres)	Total (acres)
Stillwater Mine			
Permit Area	473	2,002	2,475
Total Disturbance Permitted	74.5	638.3	712.8
Disturbance to Date	35.9[2]	401.0	436.9
East Boulder Mine			
Permit Area	397	933	1,330
Total Disturbance Permitted	265.3	0	265.3
Disturbance to Date	199.6	0	199.6

Note:
1. As of April 2008.
2. Roads and adits as of April 2008.
Sources: Weimer 2008a, Wolfe 2008.

SMC's applications include three separate proposals that the agencies analyze in this Draft Environmental Impact Statement (EIS): one proposal involves the Stillwater Mine and two of the proposals involve the East Boulder Mine. SMC requests approval from DEQ, CNF, GNF, and DNRC to:

- Develop and implement closure and post-closure water management plans (WMPs) for adit water, tailings impoundments, and storm water for the Stillwater and East Boulder mines. SMC proposes to discharge water directly to the Stillwater and East Boulder rivers once adit and tailings waters have met Montana state water quality standards or, in the case of nitrogen, have met the Montana Pollution Discharge Elimination System (MPDES) permit nondegradation limits of 100 pounds per day (lbs/day) in the Stillwater River and 30 lbs/day in the East Boulder River; and
- Construct and operate a pipeline and land application disposal (LAD) system at its Boe Ranch property, if needed, to dispose of treated adit and tailings waters from the East Boulder Mine during operations and at closure.

This EIS analyzes the following proposed modifications to the reclamation and Water Management Plans:

- Changing reclamation cover requirements from an average of four to six feet to an average of two feet for all tailings impoundments (cover material is defined as glacial till, waste rock, or a combination of materials);
- Changing the reclamation cap design on all tailings impoundments from a domed or convex configuration to a concave configuration with

positive drainage following the deposited tailings gradient (this includes removal of any requirement for tailings grading prior to cap placement);
- Evaluating the use of Biological Treatment Systems (BTS) for treatment of undiluted tailings waters at closure (test report dated May 2007);
- Evaluating the potential relocation of tailings slimes to alternative locations as necessary to expedite and facilitate the capping process (e.g., to mine workings and lined storage ponds); and
- Evaluating changes in post-closure water routing and channel design.

Descriptions of all alternatives considered in this EIS are contained in Chapter 2 and are summarized in Tables 2-6, 2-7, 2-8, and Appendix C.

S.1.1 General Location and Geographic Setting

The Stillwater Mine is in Stillwater County near Nye, Montana (MT). The East Boulder Mine is in Sweet Grass County south of Big Timber, MT. The Boe Ranch is located northwest of the East Boulder Mine (Figure 1-1).

S.2 Purpose and Need

As described above, the Proposed Actions are the basis for the analyses documented in this EIS. The Proposed Actions encompass several purposes.

First, the purpose and need for closure and post-closure WMPs for the Stillwater and East Boulder mines is to respond to the intent of the regulations for the Montana Metal Mine Reclamation Act (MMRA) 82–4–301 *et seq*. Montana Code Annotated (MCA) and US Forest Service (USFS) regulations (36 Code of Federal Regulations [CFR] 228, Subpart A). These regulations require each mine to have a closure and post-closure WMP to meet water quality standards during and after reclamation.

The agencies concluded that earlier analyses did not address the type and duration of water management and treatment with enough specificity, nor were they detailed enough to use in determining closure and post-closure reclamation bond calculations.

Mine Life Terms

For the purpose of this analysis, the terms "operations," "closure," and "post-closure" will be defined as follows:

Operations: The period when active mining is taking place, tailings are being generated, and active adit water treatment is ongoing.

Closure: The period when mining and milling operations have ceased, tailings impoundments are being dewatered and reclaimed, mine facilities are removed, and adit and tailings impoundment water treatment is ongoing.

Post-Closure: The period when reclamation has been completed, and water treatment is no longer required. Monitoring and maintenance would continue.

Second, the purpose and need of the East Boulder Mine Boe Ranch LAD System Proposed Action is to provide additional operating flexibility, to optimize options for treatment and disposal of adit and tailings waters, and to allow mine waste

waters to be beneficially used in an agricultural setting during the life of the mine and at closure.

SMC's current WMP for the Stillwater Mine was approved on June 28, 1998, for LAD of treated mine waters at the Hertzler Ranch. SMC has proposed the Boe Ranch LAD system as an enhancement of the approved East Boulder Mine LAD system, which would allow for storage of all mine discharge waters during the non-growing season with subsequent LAD of the water during the ensuing growing season. SMC believes that the Boe Ranch location would increase the evaporation potential of the treated mine waters because the area is windier and drier than the mine area. SMC also believes the grassland vegetation would enhance the overall nitrogen removal efficiency of the LAD system. SMC contends the Boe Ranch is better suited for a LAD system than the East Boulder Mine LAD areas because it is not hydrologically connected to the East Boulder River.

S.3 Alternatives

Nine alternatives were considered in this MEPA/NEPA analysis, including the following: three No Action Alternatives, SMC's three Proposed Actions, and three Agency-Mitigated Alternatives. Please see Table S-2 for the naming convention of alternatives. These alternatives are summarized below.

Table S - 2 Alphanumeric Naming Convention of Alternatives

	No Action	Proposed Action	Agency-Mitigated
Stillwater Mine and Hertzler Ranch LAD System	1A	2A	3A
East Boulder Mine	1B	2B	3B
Boe Ranch LAD System	1C	2C	3C

The revised water management plans under consideration address the management of all mine waters generated during operations, closure, and post-closure at both mines. The plans are summarized here. Differences between the alternatives are summarized in Tables S-4, S-5, and S-6, which can be found in Section S.7. For more detailed descriptions of these water management plans by alternative, please refer to Chapter 2.

Adit water:	Ground water intercepted by the mine workings that exits the adits.
Tailings water:	Water deposited in the tailings impoundment.
Storm water:	Rain and snowmelt that must be managed on the mine property.

During operations at both mines, SMC uses water (process water) during production and processing of the ore for milling, concentrating, and controlling dust. Used process water is eventually routed to the tailings impoundment for storage as supernatant water. Supernatant water is drawn from the tailings impoundment as needed and is treated along with adit water in the biological treatment system at the respective mine for reuse as process water, or it is routed to the percolation pond and/or land application system for disposal. Water that is land applied undergoes further treatment for nitrogen. Percolation provides no treatment; it is only a water disposal method.

Sources of Tailings Waters

There are several sources of tailings waters to be managed during closure and post-closure. They have different volume, treatment, and disposal needs.

Supernatant water:	The freestanding water on tailings that needs to be disposed of before reclamation can begin.
Water in the tailings mass:	The water held within the tailings mass that is freed upon tailings consolidation.
Underdrain water:	Tailings water that has infiltrated through the tailings mass and discharged through the underdrain.
Liner leakage:	Tailings water that has infiltrated through the tailings impoundment and leaks through the liner.
Seepage through the cover:	Water that infiltrates through the cover to the tailings interface and discharges laterally to the embankment edge.

At closure, the tailings impoundments at both mines and Hertzler Ranch require capping. Enough of the tailings mass water would need to be removed so that the reclamation cap could be installed. The tailings waters at the mines would be evaporated over the tailings mass or removed to receive biological treatment prior to disposal. The Hertzler Ranch tailings mass water would be evaporated over the tailings mass or land applied. This water would not receive biological treatment prior to land application disposal. Adit water produced during closure would be treated in the biological treatment system at the respective mine then routed to the percolation pond and/or land application system for disposal. The time frames for closure vary from 12 to 36 months, depending on the alternative.

Post-closure, adit water would be treated until it met criteria, then discharged to ground water through percolation ponds and underground workings or to the respective river through a constructed channel. Underdrain water would be collected above the liner at the base of the tailings mass in the Hertzler Ranch and East Boulder tailings impoundments. The Stillwater tailings impoundment does not have an underdrain. Post-closure, the underdrains would be decommissioned and plugged, or the underdrain water would be percolated. Each tailings impoundment is expected to leak at rates less than 1 gpm. Post-closure, storm water and seepage through the reclamation cover would not be treated and would be routed through constructed channels into sedimentation basins and/or to the respective river.

Each alternative has a water monitoring plan for operations and closure, and all but the No Action Alternatives have monitoring plans for post-closure. The descriptions that follow highlight the differences among the alternatives.

S.3.1 Stillwater Mine Closure and Post-Closure Water Management Plan No Action Alternative 1A

Under this alternative, the existing closure and post-closure water management plans are primarily conceptual (Table S-4). The plans have not been adequately analyzed or approved and do not contain sufficient detail to be implemented. Closure of the Stillwater and Hertzler Ranch tailings impoundments would take up to three years to evaporate the tailings waters and would not address the issue of dry tailings blowing from the impoundments.

The thicknesses of the tailings impoundment caps are different based on the availability of salvaged soil. The Stillwater impoundment would be capped by 42 inches of waste rock and/or borrow material and 8 inches of soil. The Hertzler Ranch impoundment would be capped by 48 inches of borrow material and 24 inches of subsoil/soil. Both caps would have a mounded configuration to shed water. Decommissioning of the underground at the Stillwater Mine is not defined under this alternative, nor is there an estimate of the time it would take to flood the workings. The operating and closure monitoring plans for this alternative have been approved by the agencies.

S.3.2 Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2A

A detailed closure and post-closure water management plan has been proposed by SMC (Table S-4). Approximately 35 million gallons (MG) of tailings waters, which include supernatant and waters residing in the tailings mass, would have to be removed from the Stillwater tailings impoundment so that the reclamation cap could be installed. About 45 MG of tailings waters would have to be removed from the Hertzler Ranch tailings impoundment before the reclamation cap could be installed. SMC proposes a 12-month period would be necessary to dewater the impoundments and treat and dispose of adit and tailings waters. By the end of this 12-month period, SMC estimates no further treatment of mine waters would be necessary.

Based on the amount of available salvaged soil, SMC has proposed to cap the Stillwater impoundment with 24 inches of waste rock and/or borrow material and 8 inches of soil. SMC's proposal for the Hertzler Ranch tailings impoundment cap would be 24 inches of borrow material and 24 inches of subsoil/soil. Both caps would have a swale configuration that would focus drainage across the cap to one discharge point. SMC's proposal estimates that decommissioning of the underground workings could be accomplished in six weeks and that the mine would flood in 11 to 38 years, depending on the rate of ground water inflow and total volume of workings at closure. The monitoring plan for this alternative is the existing plan and has been approved by the agencies.

S.3.3 Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 3A

This alternative outlines the agencies' suggested modifications to SMC's proposed closure and post-closure plan water management plan (Table S-4). The agencies concur with SMC's estimates that 35 MG of tailings waters would have to be removed from the Stillwater tailings impoundment and 45 MG from the Hertzler Ranch tailings impoundment prior to installing the respective reclamation caps. The agencies propose a more conservative 18-month period to dewater these impoundments and treat and dispose of adit and tailings waters. The agencies estimate that it could take up to 24 months after closure for the adit water nitrogen concentration to decline sufficiently so that no further treatment would be necessary.

The agencies propose that the Stillwater impoundment be capped by 42 inches of waste rock and/or borrow material and 8 inches of soil. The Hertzler Ranch impoundment would be capped by 48 inches of borrow material and 24 inches of subsoil/soil. Both caps would have a swale configuration that would focus drainage across the cap to one discharge point. The agencies would extend the decommissioning of the underground workings from six to twelve weeks. The agencies would route adit water underground and flood the mine workings in 4 to 11 years, depending on the rate of ground water inflow and total volume of workings at closure. This alternative would increase the scope of the operational monitoring plan to include the volume of supernatant water, the grade and direction of the slope across both tailings impoundments, and the concentrations of dissolved salts in mine waste waters (adit, tailings, and supernatant waters). The agencies would also augment the closure and post-closure monitoring to include mine pool water quality and elevation and maintenance of routing structures for ground water flow out of the off-shaft, storm water drainage, and seepage through the reclamation cover.

S.3.4 East Boulder Mine Closure and Post-Closure Water Management Plan No Action Alternative 1B

Under this alternative, the existing closure and post-closure water management plans are primarily conceptual (Table S-5). The plans have not been adequately analyzed or approved, and do not contain sufficient detail to be implemented. The Boe Ranch LAD system would not be built and all mine waste waters would be managed at the East Boulder Mine percolation pond and LAD areas. Currently, only LAD Area 6 (10.2 acres) has been built; LAD areas 2, 3-Upper, and 4 (36.4 acres) have been approved by the agencies but not constructed by SMC. The East Boulder Mine LAD feed pond has limited storage of 0.7 MG. Closure of the East Boulder tailings impoundment would take up to three years to evaporate the supernatant and tailings mass waters and would not address the issue of dry tailings blowing from the impoundments.

The East Boulder tailings impoundment would be capped by 48 inches of waste rock and/or borrow material (including boulders) and 28 inches of subsoil/soil. The cap would have a mounded configuration to shed water. Decommissioning of the underground at the East Boulder Mine is not defined under this alternative, and the geology and geometry of the workings of this mine are such that it would not flood. The monitoring plan for this alternative has been approved by the agencies.

S.3.5 East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B

A detailed closure and post-closure water management plan has been proposed by SMC (Table S-5). Approximately 40 MG of tailings waters would have to be removed from the East Boulder tailings impoundment before the reclamation cap could be installed. SMC proposes a 12-month period would be necessary to dewater the impoundment and treat and dispose of adit and tailings waters. By the end of this 12-month period, SMC estimates no further treatment of mine waters would be necessary. The Boe Ranch LAD system would not be built unless Alternative 2C or Alternative 3C is also selected and implemented; otherwise, all mine waste waters would be managed at the East Boulder Mine.

SMC has proposed to cap the East Boulder impoundment with 24 inches of waste rock and/or borrow material (including boulders) and 28 inches of subsoil/soil. The cap would have a swale configuration that would focus drainage across the cap to one discharge point. SMC's proposal estimates that decommissioning of the underground workings could be accomplished in six weeks, and the geology and geometry of the workings of this mine are such that it would not flood. The monitoring plan for this alternative is the existing plan and has been approved by the agencies.

S.3.6 East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B

This alternative outlines the agencies' suggested modifications to SMC's proposed closure and post-closure plan water management plan (Table S-5). The agencies concur with SMC's estimate that 40 MG of tailings waters would have to be removed from the East Boulder tailings impoundment prior to installing the reclamation cap. The agencies propose a more conservative 18-month period to dewater the impoundment and treat and dispose of adit and tailings waters. The agencies estimate that it could take up to 24 months after closure for the adit water nitrogen concentration to decline sufficiently so that no further treatment would be necessary. The Boe Ranch LAD system would not be built unless Alternative 2C or Alternative 3C is also selected and implemented; otherwise, all mine waste waters would be managed at the East Boulder Mine.

The agencies propose that the East Boulder tailings impoundment be capped by 48 inches of waste rock and/or borrow material (including boulders) and 28 inches of soil. The Hertzler Ranch impoundment would be capped by 48 inches of subsoil/soil. The cap would have a swale configuration that would focus drainage across the cap to one discharge point. The agencies would extend the decommissioning of the underground workings from six to twelve weeks. The geology and geometry of the workings of this mine are such that it would not flood. This alternative would increase the operational monitoring plan to include the volume of supernatant water, grade and direction of the slope across the tailings impoundment, and the concentrations of dissolved salts in the mine waste waters (adit, tailings, and supernatant waters). The agencies would augment the closure and post-closure monitoring to include maintenance of routing structures for storm water drainage and seepage through the reclamation cover.

S.3.7 Boe Ranch LAD System No Action Alternative 1C

Under this alternative, the existing closure and post-closure water management plans are primarily conceptual (Table S-6). The plans have not been adequately analyzed or approved and do not contain sufficient detail to be implemented. The Boe Ranch LAD system would not be built, and all mine waste waters would be managed at the East Boulder Mine percolation pond and LAD areas. Currently, only LAD Area 6 (10.2 acres) has been built; LAD areas 2, 3-Upper, and 4 (36.4 acres) have been approved by the agencies but not constructed by SMC. The East Boulder Mine LAD feed pond has limited storage of 0.7 MG. Closure of the East Boulder tailings impoundment would take up to three years to evaporate the supernatant and tailings mass waters and would not address the issue of dry tailings blowing from the impoundments.

The East Boulder tailings impoundment would be capped by 48 inches of waste rock and/or borrow material (including boulders) and 28 inches of subsoil/soil. The cap would have a mounded configuration to shed water. Decommissioning of the underground at the East Boulder Mine is not defined under this alternative, and the geology and geometry of the workings of this mine are such that it would not flood. The monitoring plan under this alternative is the same as for the East Boulder Mine and has been approved by the agencies.

S.3.8 Boe Ranch LAD System Proposed Action Alternative 2C

A detailed closure and post-closure water management plan for the East Boulder Mine and Boe Ranch LAD system has been proposed by SMC (Table S-6). Approximately 40 MG of tailings waters would have to be removed from the East Boulder tailings impoundment before the reclamation cap could be installed. SMC proposes a 12-month period would be necessary to dewater the impoundment and treat and dispose of adit and tailings waters. By the end of this 12-month period, SMC estimates no further treatment of mine waters would be necessary. SMC would have the option to dispose of treated water at the East Boulder Mine percolation ponds, LAD areas, and if approved and constructed,

the Boe Ranch LAD system (194.1 acres containing ten center pivots and a 108 MG LAD storage pond). The LAD storage pond would have a High-Hazard Dam Classification during operations, closure, and post-closure.

SMC has proposed to cap the East Boulder impoundment with 24 inches of waste rock and/or borrow material (including boulders) and 28 inches of subsoil/soil. The cap would have a swale configuration that would focus drainage across the cap to one discharge point. SMC's proposal estimates that decommissioning of the underground workings could be accomplished in six weeks, and the geology and geometry of the workings of this mine are such that it would not flood. The monitoring plan for this alternative would be the proposed Boe Ranch Operational Plan that is under consideration.

S.3.9 Boe Ranch LAD System Agency-Mitigated Alternative 3C

This alternative outlines the agencies' suggested modifications to SMC's proposed closure and post-closure plan water management plan (Table S-6). The agencies concur with SMC's estimate that 40 MG of tailings waters would have to be removed from the East Boulder tailings impoundment prior to installing the reclamation cap. The agencies propose a more conservative 18-month period to dewater the impoundment and treat and dispose of adit and tailings waters. The agencies estimate that it could take up to 24 months after closure for the adit water nitrogen concentration to decline sufficiently so that no further treatment would be necessary. SMC would have the option to dispose of treated water at the East Boulder Mine percolation ponds, LAD areas, and if approved and constructed, the Boe Ranch LAD system. The agencies would reduce the overall size of the Boe Ranch LAD system due to mass wasting concerns (187 acres containing nine center pivots and a 108 MG LAD storage pond). This alternative would increase the rate of LAD application to facilitate the flushing of salts from the root zone of soil. SMC would be required to monitor the flow rate of the East Boulder River during the irrigation season so that the LAD application rate could be adjusted as needed to prevent nitrogen exceedances in surface water. The LAD storage pond would have a High-Hazard Dam Classification during operations and closure, but the High-Hazard Dam Classification would not continue post-closure.

The agencies propose that the East Boulder tailings impoundment be capped by 48 inches of waste rock and/or borrow material (including boulders) and 28 inches of soil. The cap would have a swale configuration that would focus drainage across the cap to one discharge point. The agencies would extend the decommissioning of the underground workings from six to twelve weeks. The geology and geometry of the workings of this mine are such that it would not flood. This alternative would augment the operational monitoring plan to include the volume of supernatant water, direction and grade of the slope across the tailings impoundment, and the concentrations of dissolved salts in the mine waste waters (adit, tailings, and supernatant waters). The agencies would augment the closure and post-closure monitoring to include maintenance of routing structures for storm water drainage and seepage through the reclamation cover.

S.4 Scope of Decisions To Be Made

S.4.1 Decisions To Be Made

The Director of the DEQ and the Forest Supervisor for the CNF and GNF must make decisions on SMC's requests to amend its permits. These decisions will be documented in a Record of Decision (ROD). The decision-making process will lead to the selection of one of the following possible alternatives for each of the three proposals addressed in this EIS:

- Denial of the proposed amendments (DEQ) or request for revisions (CNF or GNF) (No Action Alternatives 1A, 1B, and 1C);
- Approval of the Proposed Actions amending the existing permits and plans of operations for the Stillwater Mine, East Boulder Mine, and Boe Ranch (Proposed Action Alternatives 2A, 2B, and 2C); or
- Approval of an Agency-Mitigated Alternative to the proposed actions (Mitigated Alternatives 3A, 3B, and 3C); or
- Approval of some combination of the Proposed Action and agency-specified mitigation measures.

DEQ can deny the proposed amendments pursuant to state law. The USFS' authority to deny mining proposals is limited by federal law. The operator then would have the option of revising the plan accordingly or appealing the decision through the courts. Please see Chapter 1 for more details on the agencies' roles, authority, and responsibilities. Table 1-2 lists the permits, licenses, approvals, and consultations potentially required for amendments to SMC's Plans of Operations for the Stillwater and East Boulder mines.

S.4.2 Decisions That Will Not Be Made

This Draft EIS considers only the revisions to the Stillwater Mining Company's water management plans for the Stillwater Mine and Hertzler Ranch LAD and the East Boulder Mine. This analysis is not a reassessment of these mines. The record of decision based upon this analysis would amend the water management plans for closure at these facilities and provide additional operational flexibility for the East Boulder Mine if the Boe Ranch LAD system is approved by the agencies and constructed by SMC.

S.5 Public Participation Summary

S.5.1 Application Review

The agencies received Stillwater Mining Company's (SMC's) proposed amendments to its approved Plan of Operations in December 2000. After reviewing SMC's proposals to ensure the information contained was adequate to complete an environmental analysis, the agencies deemed the proposals complete on July 27, 2001. The agencies issued press releases and published legal notices in local newspapers soliciting public comment on the Proposed Actions. SMC submitted changes to the Proposed Actions and the agencies accepted them in January 2007.

S.5.2 Scoping

Scoping for SMC's three Proposed Actions began in July 2001 with the distribution of a scoping document that informed readers of the agencies' intent to conduct environmental analyses of SMC's Proposed Actions. The agencies mailed approximately 400 copies of the scoping document to individuals, agencies, organizations, and businesses that might be interested in or affected by the Proposed Actions and subsequent decisions. The scoping document solicited comments to assist the agencies in identifying specific issues and concerns to be addressed in the MEPA/NEPA EIS analysis.

The USFS published a notice of intent to prepare an EIS in the *Federal Register* (USFS 2001). DEQ and the USFS held two public scoping meetings (July 18, 2001 in Absarokee, MT and July 19, 2001, in Big Timber, MT) to discuss the Proposed Actions and to receive public comments. A total of 60 participants attended these meetings. Representatives from DEQ and the USFS described the Proposed Actions, and attendees were provided an opportunity to ask questions and submit comments at both meetings.

After public scoping meetings, the agencies and SMC hosted field trips at the Stillwater Mine (August 9, 2001), the East Boulder Mine, and the Boe Ranch LAD area (August 11, 2001) locations. A total of 14 persons attended these field trips.

In addition to attending and commenting at the public scoping meetings and participating in project-related field trips, nine individuals also submitted written comments identifying issues and concerns. Please see Chapter 2 for further details.

S.6 Issue Identification and Issue Statements

The agencies' analysis of comments identified 17 potential issues. Five issues were identified as significant or potentially significant because of the extent of their geographic distribution, the duration of their effects, or the intensity of interest or resource conflict. The agencies are directed by MEPA/NEPA to focus environmental analyses on significant issues and to dismiss nonsignificant issues [Administrative Rules of Montana (ARM) 17.4.615(2)(b) and (c) and 40 Code of Federal Regulations (CFR) 1500.4(b), (c), and (g)].

S.6.1 Significant Issues

The project's purpose and need as well as significant issues govern the range of reasonable alternatives considered in the environmental analysis. Alternatives must meet, at least partially, the project's purpose and need and address one or more of the significant issues. Table S-3 lists the significant issues by the location of alternative components. For more detail on the significant issues, the reader is directed to Chapter 2.

Issue 1: Water Quality and Quantity
Implementation of the Proposed Actions could change the existing quality and quantity of water around the Stillwater Mine, the East Boulder Mine, and/or the East Boulder Mine Boe Ranch LAD area.

Issue 2: Wildlife and Aquatic Resources
Implementation of portions of the Proposed Actions could affect aquatic resources near both mines at closure and post-closure, as well as wildlife (including sensitive and threatened and endangered species) and aquatic resources on and near the Boe Ranch during operations and closure.

Issue 3: Irrigation Practices
Implementation of the Boe Ranch LAD system could affect natural resources (e.g., alterations of natural plant communities, the spread of noxious weeds, and potential for mass wasting) depending on the specific irrigation practices used.

Issue 4: Cultural Resources
Implementation of the Boe Ranch LAD system Proposed Action could adversely affect cultural resources on the property.

Issue 5: Stability of the Boe Ranch LAD Storage Pond
Implementation of Proposed Action 2C would result in construction and long-term operation and closure use of a 32-acre LAD storage pond. Concerns included storage pond embankment stability, potential property and water quality damage in the event of dam failure, and ability of the pond to pass a 100-year storm event.

Table S–3 Issues to be Addressed by Alternatives Relative to Location

	Issues (and Sub-issues)	Stillwater Mine (Closure and Post-Closure Water Management Plan)			East Boulder Mine (Closure and Post-Closure Water Management Plan)			Boe Ranch LAD System		
		No Action 1A	Proposed Action 2A	Agency-Mitigated Alternative 3A	No Action 1B	Proposed Action 2B	Agency-Mitigated Alternative 3B	No Action 1C	Proposed Action 2C	Agency-Mitigated Alternative 3C
1.	Water Quality and Quantity	X	X	X	X	X	X	X	X	X
2.	Wildlife and Aquatic Resources	-	X (Aquatics)	X (Aquatics)	-	X (Aquatics)	X (Aquatics)	-	X	X
3.	Irrigation Practices	-	-	-	-	-	-	-	X	X
4.	Cultural Resources	-	-	-	-	-	-	-	X	X
5.	Stability of LAD Storage Pond	-	-	-	-	-	-	-	X	X

Notes:
1. "X" means the issue is pertinent to the location and the alternative.
2. "-" means the issue is not applicable to or is not addressed by that alternative.

S.6.2 Issues Considered But Dismissed

Twelve preliminary issues identified during project scoping were not relevant to the Proposed Actions since they were beyond the scope of this environmental analysis or have been addressed by federal or state law, regulation, or policy. For more detail on issues considered but dismissed, the reader is directed to Chapter 2.

Issue 6: Bonding (Financial Assurance)
Comments indicated that the MEPA/NEPA analysis should address the reclamation bond needed to cover closure and post-closure treatment and monitoring. Law, regulation, or policy has addressed this issue.

Issue 7: Incorporation of Operational Stipulations/Mitigations
Comments suggested that the ROD for this analysis should require SMC to reevaluate and amend operating plans when new disposal methods for tailings and waste rock are identified. Law, regulation, or policy has addressed this issue.

Issue 8: Potential Water Quality Impacts from Boe Ranch LAD System Mist into the East Boulder River
Comments identified a concern that possible adverse effects could occur to the East Boulder River from mist from the operation of the Boe Ranch LAD center pivots. Experience obtained through monitoring the Hertzler Ranch LAD pivots indicates that mist from the center pivots would not likely travel the mile to the East Boulder River due to evaporation.

Issue 9: Water Quality Effects Caused by Phosphates in Treated Adit and Tailings Waters
Comments suggested that phosphates could be released from the Boe Ranch LAD system and affect water quality. Monitoring data to date indicate that phosphates are not a substantive issue in the East Boulder Mine treated waste waters.

Issue 10: Storm Water Pollution Prevention Plan (SWPPP)
The comments indicated that the SWPPP for the East Boulder Mine should be reviewed and updated to encompass the proposed Boe Ranch LAD system. Review of SMC's SWPPP is a standard part of the Plan of Operations and law, regulation, or policy has addressed this issue.

Issue 11: Wetlands and Riparian Zones
Comments indicated that the MEPA/NEPA analysis should evaluate the potential effects from construction and operation of the Boe Ranch LAD system on wetlands and riparian zones. Neither wetlands nor riparian zones have been identified along the pipeline route to the proposed Boe Ranch LAD facilities. The potential for adverse effects to wetlands appears to be low.

Issue 12: Tailings Impoundment Stability
Comments indicated the tailings impoundments should be evaluated for stability. These analyses have already been performed in previous environmental analyses, and the proposed action under consideration does not include any changes to these tailings impoundments, nor would the water management plans considered affect impoundment stability during operations, closure, and post-closure.

Issue 13: Public Participation
Some scoping participants felt that there should be a higher level of public involvement, particularly with review and comment on preliminary drafts of the EIS. The agencies have met or exceeded all MEPA/NEPA procedural requirements and notification for public involvement. Law, regulation, or policy has addressed this issue.

Issue 14: MEPA/NEPA Process
Several comments were noted that requested that the document comply with the various components of MEPA and NEPA. Law, regulation, or policy has addressed this issue.

Issue 15: Effects of Nitrates and Trace Metal Bioaccumulation on Ruminants
Comments requested that the analysis address the potential for nitrogen and trace metals (mainly cadmium, copper, chromium, lead, and zinc) to accumulate in ruminants through grazing under the Boe Ranch LAD system center pivots. The reader is directed to a detailed discussion of this issue in Chapter 2. In summary, low metals concentrations and the potential for nitrate bioaccumulation in animals through ingestion of vegetation at the Boe Ranch LAD area is not considered an issue to be evaluated in this analysis.

Issue 16: Effects of Nitrates and Trace Metals on Waterfowl
Comments suggested that waterfowl using the Boe Ranch LAD storage pond would be affected by nitrates and trace metals (mainly chromium, lead, and zinc). The East Boulder Mine treated adit water meets or is lower than MPDES permit effluent limits for direct discharge to the East Boulder River. The potential for adverse effects to waterfowl is not considered a significant issue to be evaluated in this analysis.

Issue 17: Effects of Trace Metal Accumulation on Plants and Soils
Comments indicated that trace metal concentrations in adit and tailings waters could pose a risk of accumulation in soil beneath the Boe Ranch LAD center pivots. Trace metal concentrations in adit and tailings waters have been analyzed and range from non-detectable to near detection limits. Metals at these concentrations would not provide an accumulation risk to soils, ground water, or plant tissues, and effects are not reasonably foreseeable, so this issue will not be discussed further.

S.7 Alternatives Considered in Detail

In response to agency and public issues, the following alternatives were developed and analyzed in detail. A general description of each of the alternatives is provided in Section 3 of this summary. Major differences among the alternatives are listed below in tables S-4, S-5, and S-6.

- Stillwater Mine Closure and Post-Closure Water Management Plan No Action Alternative 1A
- Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2A
- Stillwater Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3A
- East Boulder Mine Closure and Post-Closure Water Management Plan No Action Alternative 1B
- East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B
- East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B
- Boe Ranch LAD System No Action Alternative 1C
- Boe Ranch LAD System Proposed Action Alternative 2C
- Boe Ranch LAD System Agency-Mitigated Alternative 3C

The agencies performed extensive analyses to evaluate the effects of each of the alternatives on ground and surface water. The reader wishing to review these analyses, including assumptions made and methodology used, is directed to Chapter 3 and Appendix C.

S.7.1 Preferred Alternatives

Three alternatives must be selected, one for each location. The agencies' preferred alternatives are the following:

- Stillwater Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3A

- East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B

- Boe Ranch LAD System Agency-Mitigated Alternative 3C

Table S-4 Major Differences Among Alternatives - Stillwater Mine and Hertzler Ranch LAD System

	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Closure/Post-Closure Water Management Plan	Inadequate closure and post-closure water management plan (impoundment and underground workings).	Detailed closure and post-closure water management plan.	Agency-modified closure and post-closure water management plan.
Closure Impoundment Timeframe Stillwater: 35 MG Hertzler Ranch: 45 MG	Unspecified, but **up to 3 years** to evaporate over tailings mass.	**12 months** to dewater impoundments, pump, treat, and discharge all mine waters.	**18 months** to dewater impoundments, pump, treat, and discharge all mine waste waters.
Impoundment Cap Thickness	Stillwater: 42" of waste rock/borrow and 8" of soil. Hertzler Ranch: 48" of borrow and 24" of subsoil/soil.	Stillwater: 24" of waste rock/borrow and 8" of soil/borrow. Hertzler Ranch: 24" of borrow and 24" of subsoil/soil.	Stillwater: 42" of waste rock/borrow and 8" of soil. Hertzler Ranch: 48" of borrow and 24" of subsoil/soil.
Impoundment Cap Configuration	Stillwater: Swale. Hertzler Ranch: Mounded.	Stillwater: Swale. Hertzler Ranch: Swale.	Stillwater: Swale. Hertzler Ranch: Swale.
Underground Decommissioning and Mine Flooding	Decommission: **undefined**. Mine Flooding: undefined.	Decommission: **6 weeks.** Mine Flooding: 11 - 38 years (depending on the ground water and workings volumes).	Decommission: **12 weeks.** Mine Flooding: 4 -11 years (depending on the ground water and workings volumes).
Monitoring	Approved Plan.	Approved Plan.	Increased Operations Monitoring: • Supernatant Volume. • Tailings Grade. • Salts Concentrations. Increased Closure/Post-Closure Monitoring: • Mine Pool Levels and water quality (Nitrogen and Salts) of Mine Pool.

Table S-5 Major Differences Among Alternatives - East Boulder Mine

	No Action Alternative 1B	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B
Closure/Post-Closure Water Management Plan	Inadequate closure and post-closure water management plans (impoundment and underground workings).	Detailed closure and post-closure water management plans.	Agency-modified closure and post-closure water management plans.
Closure Impoundment Timeframe 40 MG	Unspecified, but up to **3 years** to evaporate over tailings mass.	**12 months** to dewater impoundment, pump, treat, and discharge all mine waters.	**18 months** to dewater impoundment, pump, treat, and discharge all mine waste waters.
Impoundment Cap Thickness	48" of waste rock/borrow/boulders and 28" of subsoil/soil.	24" of waste rock/borrow/boulders and 28" of subsoil/soil.	48" of waste rock/borrow/boulders and 28" of subsoil/soil.
Impoundment Cap Configuration	Mounded.	Swale.	Swale.
Underground Decommissioning and Mine Flooding	Decommission: **undefined.** Mine Flooding: N/A.	Decommission: **6 weeks.** Mine Flooding: N/A.	Decommission: **12 weeks.** Mine Flooding: N/A.
Monitoring	Approved Plan.	Approved Plan.	Increased Operations Monitoring: • Supernatant Volume. • Tailings Grade. • Salts Concentrations. Increased Closure/Post-Closure Monitoring: • Water quality. • Function of Water Management Facilities.

Table S-6 Major Differences Among Alternatives - Boe Ranch LAD System

	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Operations, Closure/Post-Closure Water Management Plan	All mine waste waters managed at mine site (Same as 1B).	Detailed operational and closure WMP at Boe Ranch and post-closure water management plan at mine site.	Agency-modified operational and closure WMP at Boe Ranch and post-closure water management plan at mine site.
Water Management Facilities	Water treatment at mine site Mine Site: LAD Areas 6: **10.2 acres.** LAD Areas 2, 3, 4: **36.4 acres.** LAD feed pond: **0.7 MG.**	Water treatment at mine site Mine Site: LAD Areas 6: **10.2 acres.** LAD Areas 2, 3, 4: **36.4 acres.** LAD feed pond: **0.7 MG**	Water treatment at mine site Mine Site: LAD Areas 6: **10.2 acres.** LAD Areas 2, 3, 4: **36.4 acres.** LAD feed pond: **0.7 MG**
		Boe Ranch: Boe Ranch LAD Area: **194.1 acres.** Pivots: **10.** Application: agronomic rate LAD Storage Pond: **108 MG.**	Boe Ranch: Boe Ranch LAD Area: **186.9 (166 for modeling purposes) acres.** Pivots: **9 (7 for modeling purposes).** Application: greater than agronomic rate as needed to manage water and soil resource LAD Storage Pond: **108 MG.**
Closure Timeframe (40 MG)	Unspecified, but **up to 3 years** to evaporate over tailings mass at mine site.	**12 months** to dewater impoundment, pump, treat, and discharge all mine waste waters, preferentially at Boe Ranch.	**18 months** to dewater impoundment, pump, treat, and discharge all mine waste waters, preferentially at Boe Ranch.
LAD Storage Pond High-Hazard Classification	N/A	Operations: high-hazard. Closure: high-hazard. Post-Closure: high-hazard.	Operations: high-hazard. Closure: high-hazard. Post-Closure: **not high-hazard.**
Monitoring	N/A	Proposed Boe Ranch Operational Plan.	Increased Operations Monitoring: • Salts Concentrations. • Streamflow Increased Closure Monitoring: • Water Quality. • Function of Water Management Facilities • Streamflow

S.8 Alternatives Considered But Dropped From Detailed Analysis

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives may have been outside the scope of this analyis, duplicative of the alternatives considered in detail, incorporated into alternatives considered in detail, determined to be components that would cause unnecessary environmental harm, or are already addressed by law, regulation or policy. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for the reasons summarized below. The reader is referred to Chapter 2 for a detailed discussion of these alternatives.

- **Plugging the Adits to Prevent Discharge of Water**
  This suggestion for an alternative would reduce the amount of adit water ultimately discharged to the surface environment. The agencies concluded that plugging the adits with tailings, waste rock, or cement would not prevent adit water discharge. Water pressure would increase and could result in uncontrolled discharges through fractures in the rock. The ability to treat water discharged from fractures would be limited if the adits were plugged. The plugging options reviewed would not adequately address the purpose and need and could violate the MT Water Quality Act in the short term.

- **Closure and Post-Closure Water Treatment Evaluations**
  This suggestion for an alternative indicated that changes to SMC's closure and post-closure water management plans at the two mine sites should not be included in this analysis. This suggestion was based on the expectation that closure for these mines would be far in the future and that new non-nitrate explosives might be developed. The Proposed Action was developed in response to state and federal regulations, and the agencies cannot eliminate consideration of SMC's closure and post-closure water treatment methodology.

- **Long-term Treatment of Adit Water and Runoff from the Tailings Impoundments before Discharging**
  This suggestion for an alternative would not allow SMC to discharge adit water and runoff from the tailings impoundment at the Stillwater and East Boulder mines directly to rivers even if the water meets non-degradation standards for water quality. Instead, the water should be discharged through percolation ponds or wetlands constructed specifically for this purpose. The MPDES permit effluent limits for both mines are based on nondegradation standards, and water that meets these limits may be directly discharged to the respective rivers without affecting their quality. If the discharges from the mines meet permit effluent limits by the end of the closure period, the agencies could not

require SMC to construct wetlands or percolation ponds to dispose of mine waters.

- **Alternative Waste Rock and Tailings Disposal Methods**
  This suggestion for an alternative would require evaluation of alternate methods of reclaiming waste rock piles and disposing of tailings. Use of alternate methods may require different closure and post-closure water management plans. SMC currently places up to 60 percent of waste rock and tailings underground. The agencies have directed SMC to explore the use of tailings paste technology, which SMC has done. If SMC should choose to paste tailings, a MEPA/NEPA analysis would be required at that time.

- **Boe Ranch LAD System Montana Pollutant Discharge Elimination System (MPDES) Permit Alternative**
  This suggests that the Boe Ranch LAD system should be covered with an MPDES Permit. Both mines currently have MPDES permits for mine water discharges. An alternative need not be developed to evaluate the need for an MPDES permit at the Boe Ranch LAD system. The agencies have the option of requiring a Montana Ground Water Pollution Control System (MGWPCS) which addresses discharges to ground water.

- **Alternative Locations for the Proposed LAD System**
  This suggestion indicated that the MEPA/NEPA analysis should consider alternate locations for the proposed LAD facilities, such as additional sites on the Gallatin National Forest and other state and private lands. The use of the Boe Ranch meets the purpose and need. No alternative sites were identified with physical or climatological advantages over the Boe Ranch, which is owned by SMC. The agencies cannot require SMC to purchase other private lands. The analyses disclosed in this document conclude that the use of the Boe Ranch would meet all state and federal water quality standards.

S.9 Comparison of Effects

The following tables and figures provide a summary of the effects of implementing each alternative. Information is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives. Detailed effects analysis for each Alternative is found in Chapter 4 of the EIS.

S.9.1 Stillwater Mine Closure and Post-Closure Water Management Plan Alternatives 1A, 2A, and 3A Closure Effects

- Table S-7 Closure and Post-Closure Effects Comparison Among Alternatives

- Water Quality Figures for Alternatives 1A, 2A, and 3A
  - Figure S-1 Projected Nitrogen Load to the Stillwater River by Alternative and Adit Flow Rate
  - Figure S-2 Projected Nitrogen Concentration in Ground Water by Alternative and Adit Flow Rate
  - Figure S-3 Projected Nitrogen Concentration in the Stillwater River by Alternative and Adit Flow Rate
  - Figure S-4 Projected Salts Concentration in Ground Water by Alternative and Adit Flow Rate
  - Figure S-5 Projected Salts Concentration in the Stillwater River by Alternative and Adit Flow Rate

S.9.2 East Boulder Mine Closure and Post-Closure Water Management Plan Alternatives 1B, 2B, and 3B Closure Effects

- Table S-8 Closure and Post-Closure Effects Comparison Among Alternatives
- Water Quality Figures for Alternatives 1B, 2B, and 3B
  - Figure S-6 Projected Nitrogen Load to the East Boulder River Figure S-7 Projected Nitrogen Concentration in Ground Water
  - Figure S-8 Projected Nitrogen Concentration in the East Boulder River
  - Figure S-9 Projected Salts Concentration in Ground Water Figure S-10 Projected Salts Concentration in the East Boulder River

S.9.3 Proposed Boe Ranch LAD System Alternatives 1C, 2C, and 3C Operational and Closure Effects

- Table S-9 Operational, Closure, and Post-Closure Effects Comparison Among Alternatives
- Water Quality Figures for Alternatives 1C, 2C, and 3C
  - Figure S-11 Projected Operational Nitrogen Load to the East Boulder River
  - Figure S-12 Projected Operational Nitrogen Concentration in Ground Water
  - Figure S-13 Projected Operational Nitrogen Concentration in the East Boulder River
  - Figure S-14 Projected Operational Salts Concentration in Ground Water
  - Figure S-15 Projected Operational Salts Concentration in the East Boulder River
  - Figure S-16 Projected Closure Nitrogen Load to the East Boulder River
  - Figure S-17 Projected Closure Nitrogen Concentration in Ground Water
  - Figure S-18 Projected Closure Nitrogen Concentration in the East Boulder River

- Figure S-19 Projected Closure Salts Concentration in Ground Water
- Figure S-20 Projected Closure Salts Concentration in the East Boulder River

Table S-7 Effects Comparison Among Alternatives - Stillwater Mine and Hertzler Ranch LAD System

	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Water Quality and Quantity – 20+ years operational data at Stillwater Mine and 10+ years at operational data at Hertzler Ranch			
Closure	Nitrogen and Salts: @ 650 gpm – 2,020 gpm adit water and 80 MG tailings waters disposal- **In compliance** with surface and ground water standards/recommendations at the Stillwater Mine and Hertzler Ranch.	Nitrogen and Salts: @ 650 gpm – 2,020 gpm adit water and 80 MG tailings waters disposal- **In compliance** with surface and ground water standards/recommendations at the Stillwater Mine and Hertzler Ranch. *Summary:* Analysis shows disposal of mine waters at a rate of 650 gpm to 2,020 gpm at the Stillwater Mine and Hertzler Ranch during closure (12 months) **would comply** with nitrogen and salts water quality standards/ recommendations*. *Unforeseen circumstances during closure could jeopardize compliance within a 12-month period and produce **short-term exceedances.**	Nitrogen and Salts: @ 650 gpm – 2,020 gpm adit water and 80 MG tailings waters disposal at closure - **In compliance** with surface and ground water standards/recommendations at the Stillwater Mine and Hertzler Ranch. *Summary:* Analysis shows disposal of mine waters at closure (18 months) would comply with water quality standards/recommendations.
	Surface Water Quantity: No effects	Surface Water Quantity: No effects	Surface Water Quantity: No effects
Post-Closure	Nitrogen and Salts: @ 650 gpm – 2,020 gpm adit water and 80 MG tailings waters disposal - **Not in compliance** with surface and ground water standards/recommendations at the Stillwater Mine and Hertzler Ranch.		
	Surface Water Quantity: No effects	Surface Water Quantity: No effects	Surface Water Quantity: No effects
Wildlife and Aquatic Resources (Aquatics Only) – 20+ years of operational water quality and biomonitoring data			
Closure and Post-Closure	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.

Figure S-1. Stillwater Mine Closure
Projected Nitrogen Load to the Stillwater River
by Alternative and Adit Flow Rate

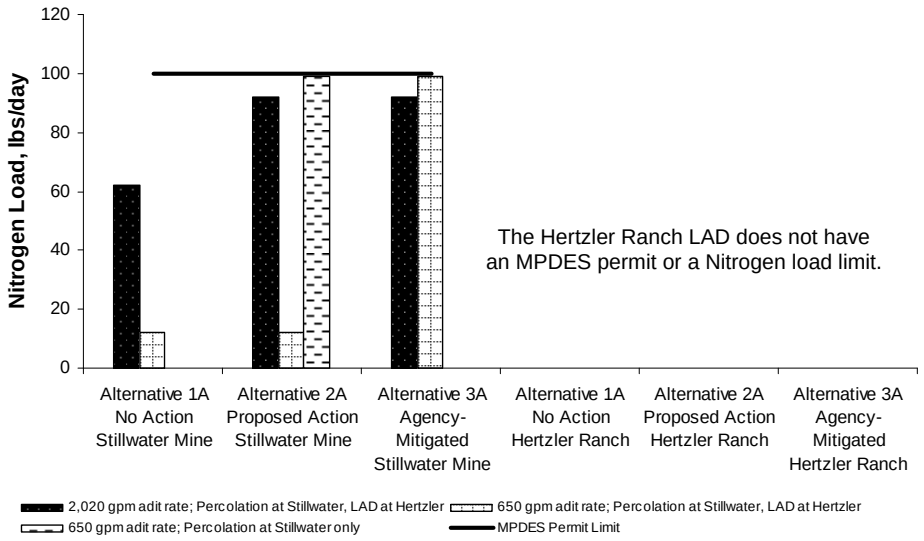


Figure S-2. Stillwater Mine and Hertzler Ranch LAD Closure
Projected Nitrogen Concentrations in Ground Water
by Alternative and Adit Flow Rate

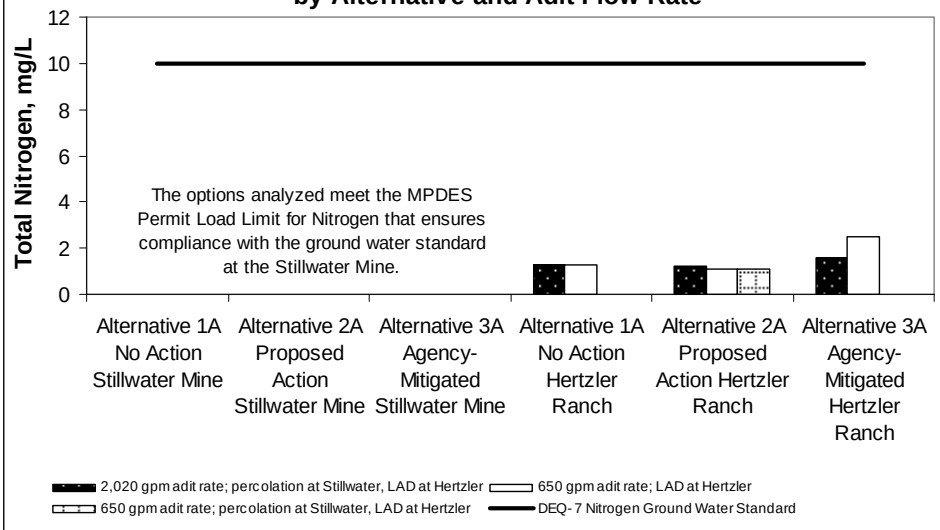


Figure S-3. Stillwater Mine and Hertzler Ranch LAD Closure Projected Nitrogen Concentrations in the Stillwater River by Alternative and Adit Flow Rate

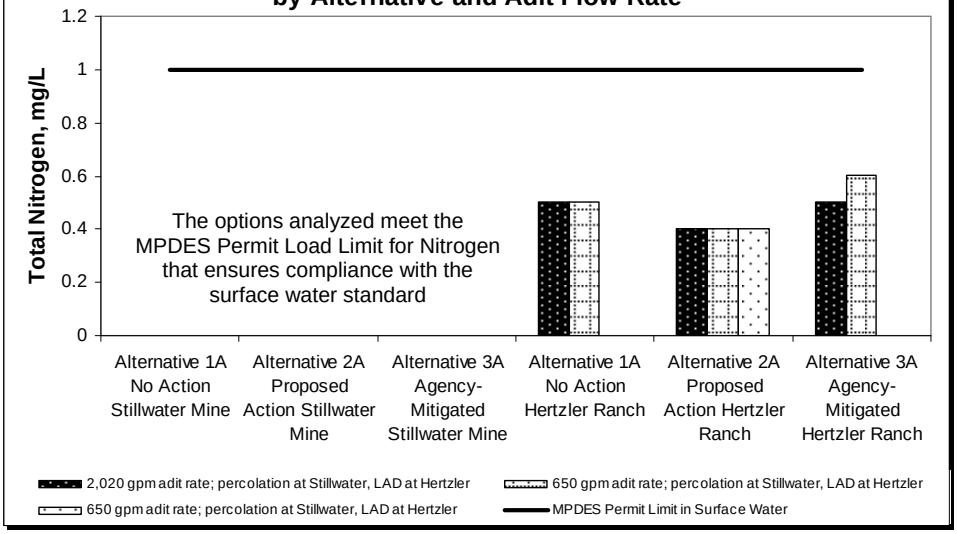


Figure S-4. Stillwater Mine and Hertzler Ranch LAD Closure Projected Salts Concentration in Ground Water by Alternative and Adit Flow Rate

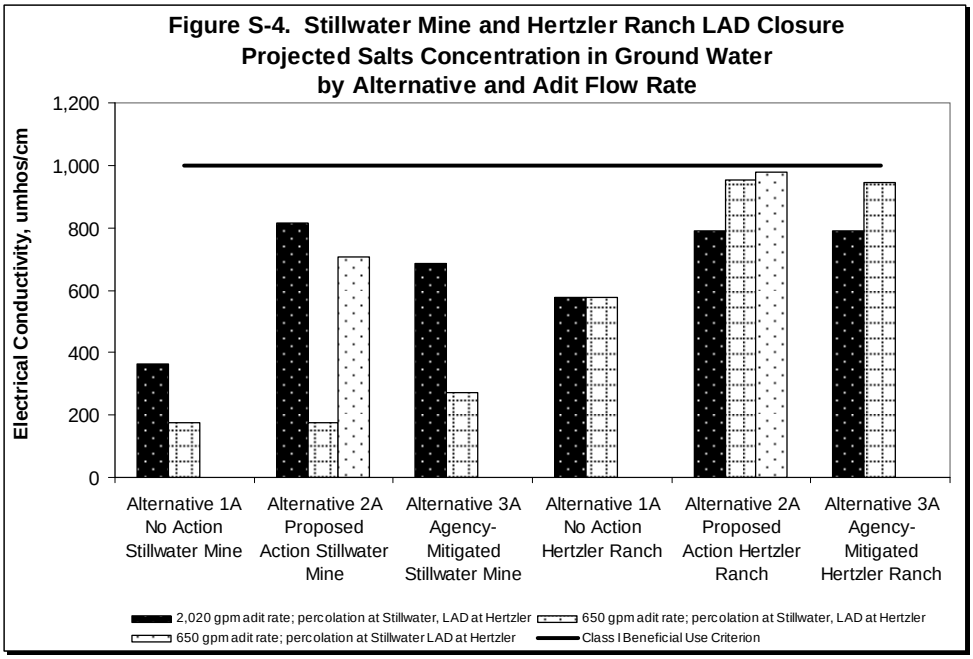


Figure S-5. Stillwater Mine and Hertzler Ranch LAD Closure Projected Salts Concentration in the Stillwater River by Alternative and Adit Flow Rate

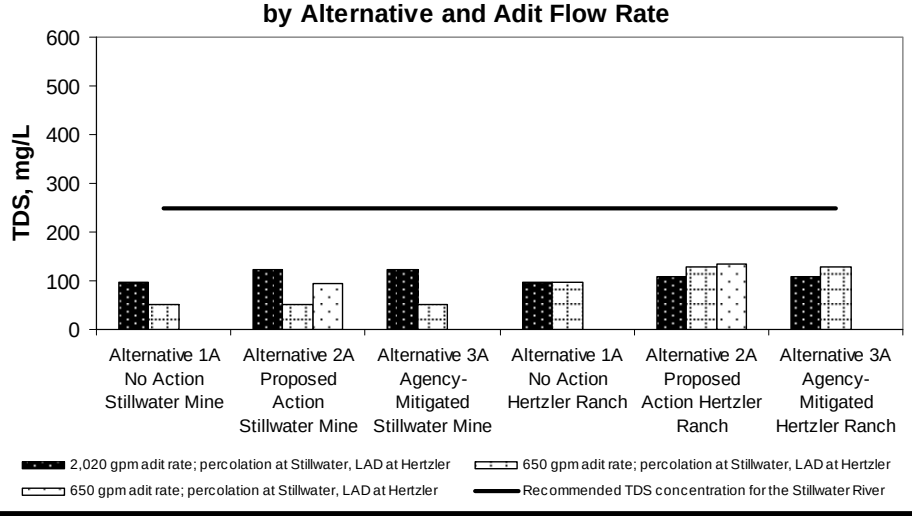
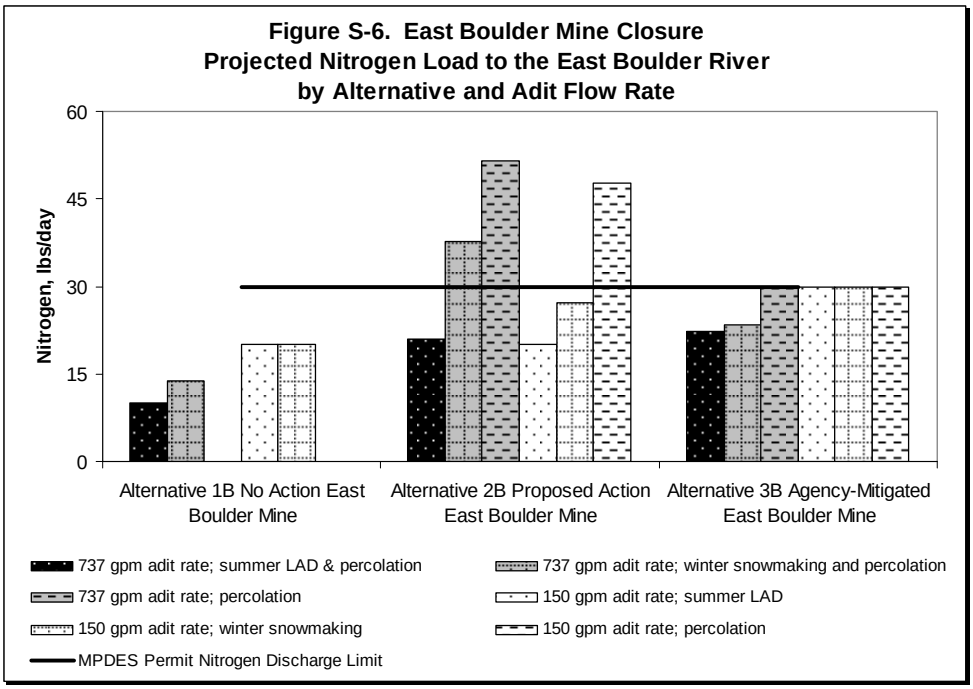


Table S-8 Effects Comparison Among Alternatives - East Boulder Mine

	No Action Alternative 1B	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B
Water Quality and Quantity – 10 years operational data at East Boulder			
Closure	Nitrogen and Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal - **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine.	Nitrogen: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal when closure commences in **summer** using LAD - **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine. Nitrogen: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal when closure commences in **winter** using snowmaking or snowmaking plus percolation – **Not in compliance** with ground water standards at East Boulder Mine. Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal - **In compliance** with surface water recommendation at East Boulder Mine. Analysis shows disposal of mine waters at closure commencing in summer (12 months) would comply with water quality standards.* *Unforeseen circumstances could jeopardize compliance within a 12-month period.	Nitrogen: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal - **In compliance** with surface and ground water standards at the East Boulder Mine. Analysis shows disposal of mine waters at closure (18 months) would comply with water quality standards. Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal – **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine. Analysis shows disposal of mine waters at closure (18 months) would comply with water quality recommendations.
	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.
Post-Closure	Nitrogen and Salts: @ 150 gpm – 737 gpm adit water disposal- **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine .	Nitrogen and Salts: @ 150 gpm – 737 gpm adit water disposal- **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine .	Nitrogen and Salts: @ 150 gpm – 737 gpm adit water disposal- **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine.
	Surface Water Quantity: a 737 gpm adit water discharge rate **would be in compliance** with the East Boulder Mine MPDES permit limits.	Surface Water Quantity: a 737 gpm adit water discharge rate **would be in compliance** with the East Boulder Mine MPDES permit limits.	Surface Water Quantity: a 737 gpm adit water discharge rate **would be in compliance** with the East Boulder Mine MPDES permit limits.
Wildlife and Aquatic Resources (Aquatics Only) – 10 years of operational water quality and biomonitoring data			
Closure	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	At 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal Nitrogen and Salts loads **may have short-term adverse impact** on aquatic communities if the state standard of 1 mg/L Nitrogen is violated or an exceedance of 250 mg/L TDS recommendation occurs.	Extension of closure timeline (18 months) would **reduce the possibility of a short-term adverse impact** on aquatic communities.
Post-Closure	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.


Figure S-6. East Boulder Mine Closure
Projected Nitrogen Load to the East Boulder River
by Alternative and Adit Flow Rate
Nitrogen, lbs/day
60
45
30
15
0
Alternative 1B No Action East Boulder Mine
Alternative 2B Proposed Action East Boulder Mine
Alternative 3B Agency-Mitigated East Boulder Mine
737 gpm adit rate; summer LAD & percolation
737 gpm adit rate; winter snowmaking and percolation
737 gpm adit rate; percolation
150 gpm adit rate; summer LAD
150 gpm adit rate; winter snowmaking
150 gpm adit rate; percolation
MPDES Permit Nitrogen Discharge Limit

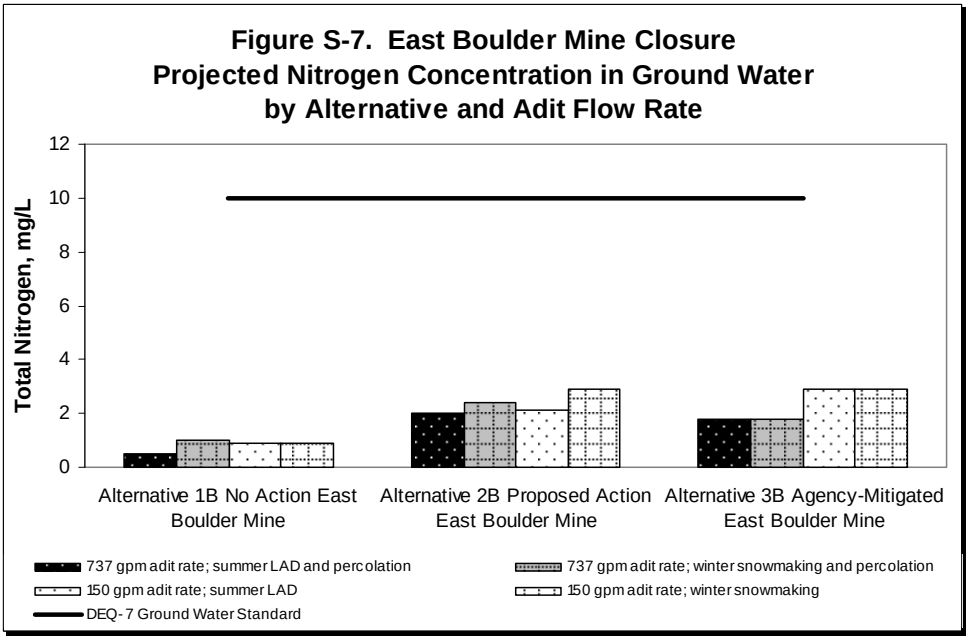

Figure S-7. East Boulder Mine Closure
Projected Nitrogen Concentration in Ground Water
by Alternative and Adit Flow Rate
Total Nitrogen, mg/L
12
10
8
6
4
2
0
Alternative 1B No Action East Boulder Mine
Alternative 2B Proposed Action East Boulder Mine
Alternative 3B Agency-Mitigated East Boulder Mine
737 gpm adit rate; summer LAD and percolation
737 gpm adit rate; winter snowmaking and percolation
150 gpm adit rate; summer LAD
150 gpm adit rate; winter snowmaking
DEQ-7 Ground Water Standard

Figure S-8. East Boulder Mine Closure
Projected Nitrogen Concentration in the East Boulder River
by Alternative and Flow Rate

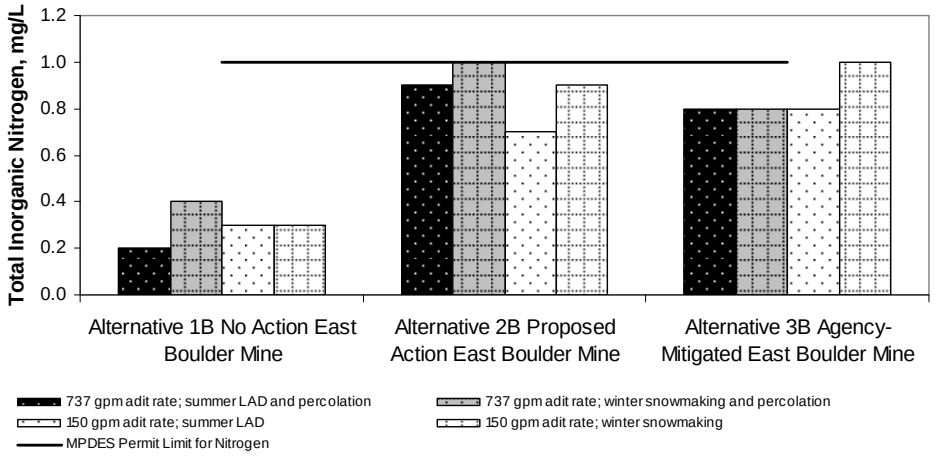


Figure S-9. East Boulder Mine Closure
Projected Salts Concentration in Ground Water
by Alternative and Adit Flow Rate

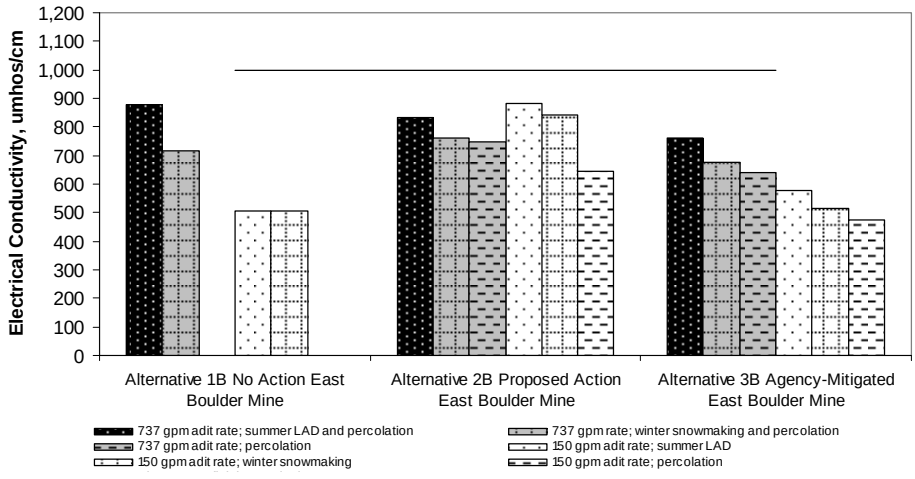


Figure S-10. East Boulder Mine Closure
Projected Salts Concentration in the East Boulder River
by Alternative and Adit Flow Rate

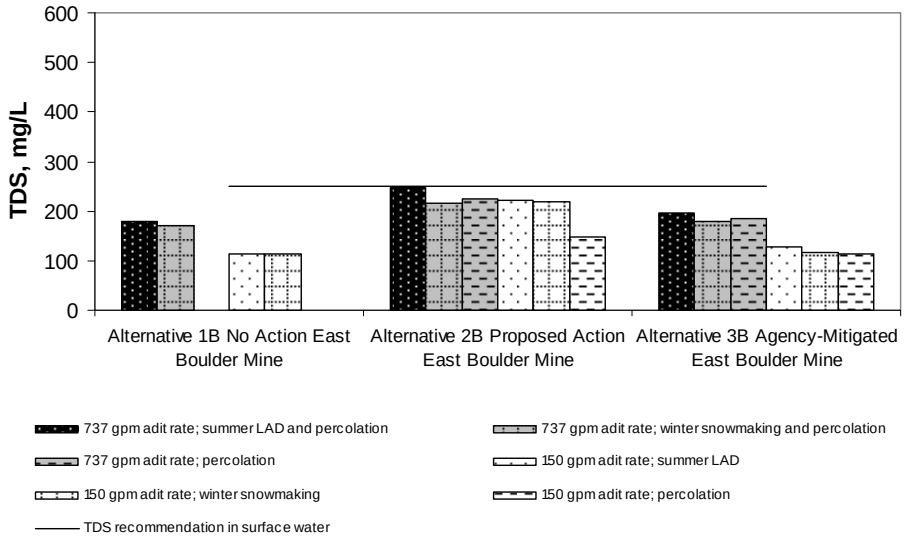


Table S-9 Effects Comparison Among Alternatives - Boe Ranch LAD System

	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Water Quality and Quantity			
Operations	N/A. The Boe Ranch LAD System would not be built.	Nitrogen: @ 150 gpm – 737 gpm - **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine and the Boe Ranch. Salts: @ 150 gpm – 737 gpm - **In compliance** with surface water TDS recommendations at the East Boulder Mine. Background TDS concentration exceeds the surface water recommendation at the Boe Ranch.	Nitrogen and Salts: @ 150 gpm – 737 gpm - **In compliance** with surface and ground water standards/recommendations at the East Boulder Mine and the Boe Ranch
	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.
Closure	N/A.	Nitrogen: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal – **In compliance** with surface and ground water standards at the East Boulder Mine. **Not in compliance** for 150 gpm at the Boe Ranch. Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal- **In compliance** with surface water TDS recommendations at the East Boulder Mine. Background TDS concentration exceeds the surface water recommendation at the Boe Ranch.	Nitrogen and Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal- **In compliance** with surface and ground water standards/recommendations at East Boulder Mine and the Boe Ranch. The agencies would monitor the streamflow in the East Boulder River: if streamflow is less than 3 cfs, the volume of water disposed by LAD would be reduced to meet criterion. Background TDS concentration exceeds the surface water recommendation at the Boe Ranch.
		Summary: Analysis shows disposal of all mine waters at a rate of 737 gpm at the Boe Ranch during closure (12 months) **would comply** with nitrogen standards but the background TDS concentration at the Boe Ranch exceeds the surface water recommendation. Disposal of all mine waters at a rate of 150 gpm at the Boe Ranch during closure (12 months) **would not comply** with nitrogen surface water quality standards.* *Unforeseen circumstances could jeopardize compliance within a 12-month period.	Analysis shows disposal of mine waters at closure (18 months) would comply with water quality standards/recommendations.
		Surface Water Quantity: N/A.	Surface Water Quantity: N/A.
Post-Closure	N/A.	**No additional mine-related effects**.	**No additional mine-related effects.**
Wildlife and Aquatic Resources			
Operations	N/A.	**TDS < 250 mg/L in East Boulder River No effects** to wildlife/aquatic communities.	**TDS < 250 mg/L in East Boulder River No effects** to wildlife/aquatic communities.

	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Closure	N/A.	**No effects** to wildlife communities.	**No effects** to wildlife communities.
		Aquatic communities: If all mine waters are disposed at Boe Ranch (150 gpm – 737 gpm adit water and 40 MG tailings waters), salt loads **may have short-term adverse impacts** on aquatic communities if an exceedance of 250 mg/L TDS occurs.	Aquatic communities: Extension of closure timeline (18 months) **would reduce the possibility of a short-term adverse impact** on aquatic communities.
Post-Closure	N/A.	**TDS <250 mg/L No effects** to wildlife/aquatic communities.	**TDS < 250 mg/L No effects** to wildlife/aquatic communities.
Irrigation Practices			
Operations	N/A.	At 150 gpm – 737 gpm adit water disposal long-term changes in plant composition and noxious weed populations would occur.	Same as Alternative 2C
		At 150 gpm – 737 gpm adit water disposal there is increased potential for mass wasting at center pivots 4, 9, and 10.	The agencies would eliminate center pivot 10. Center pivots 4 and 9 would be operated with increased monitoring to reduce the potential for mass wasting.
		At 150 gpm – 737 gpm adit water disposal there are increased nitrogen and salts loads in soils: soil productivity may not be maintained due to annual flushing.	At 150 gpm – 737 gpm adit water disposal would increase the nitrogen and salt loads in soils: soil productivity would be maintained due to annual flushing.
Closure	N/A.	At 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal long-term changes in plant composition and noxious weed populations.	Same as Alternative 2C
		At 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal there is increased potential for mass wasting at center pivots 4, 9, and 10 due to additional 40 MG of tailings water disposal during 12-month closure period.	The agencies would eliminate center pivot 10. Center pivots 4 and 9 would be operated with increased monitoring to reduce the potential for mass wasting, and the water would be applied over an 18-month closure period.
		At 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal there are increased nitrogen and salt loads in soils: soil productivity may not be maintained due to annual flushing.	At 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal would increase the nitrogen and salt loads in soils: soil productivity would be maintained due to annual flushing.
Post-Closure	N/A.	**No Additional Mine-Related Effects.**	**No Additional Mine-Related Effects.**
Cultural Resources			
Operations, Closure, and Post-Closure	N/A.	Direct adverse effects to the Boe Ranch drive-line site.	Direct adverse effects to the Boe Ranch drive-line site.

	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Stability of Boe Ranch LAD Storage Pond			
Operations and Closure	N/A.	Meets engineering standards for high-hazard dam: No effects projected to property, water quality, or stability.	Meets engineering standards for high-hazard dam: No effects projected to property, water quality, or stability. The DEQ would require an Operations, Maintenance, and Emergency Preparedness Plan that meets DNRC high-hazard dam requirements, reducing potential effects to property, water quality, and stability.
Post-closure	N/A.	Meets engineering standards for high-hazard dam: No effects projected to property, water quality, or stability.	Reduced potential for effects to property, water quality, and stability due to **elimination of high-hazard dam**. LAD storage pond volume would be reduced to less than 50 acre feet.

Figure S-11. East Boulder Mine and Boe Ranch LAD Operations Projected Nitrogen Load by Alternative and Adit Flow Rate

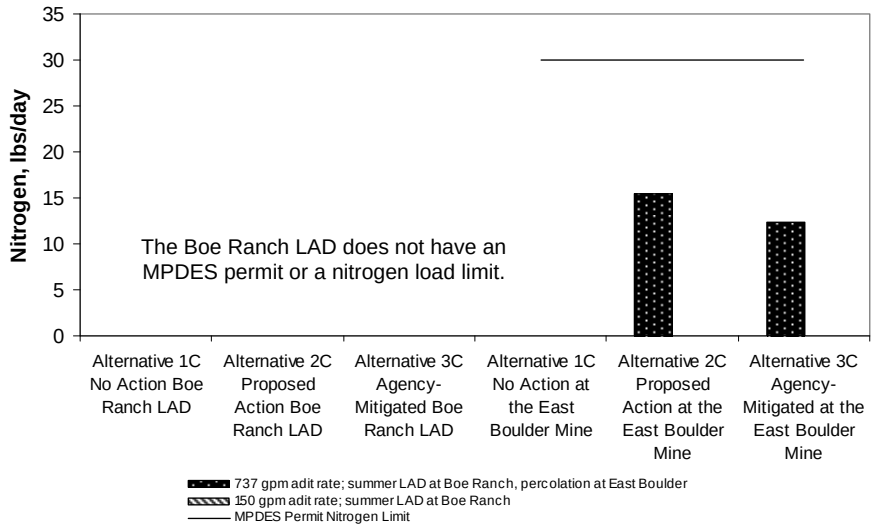
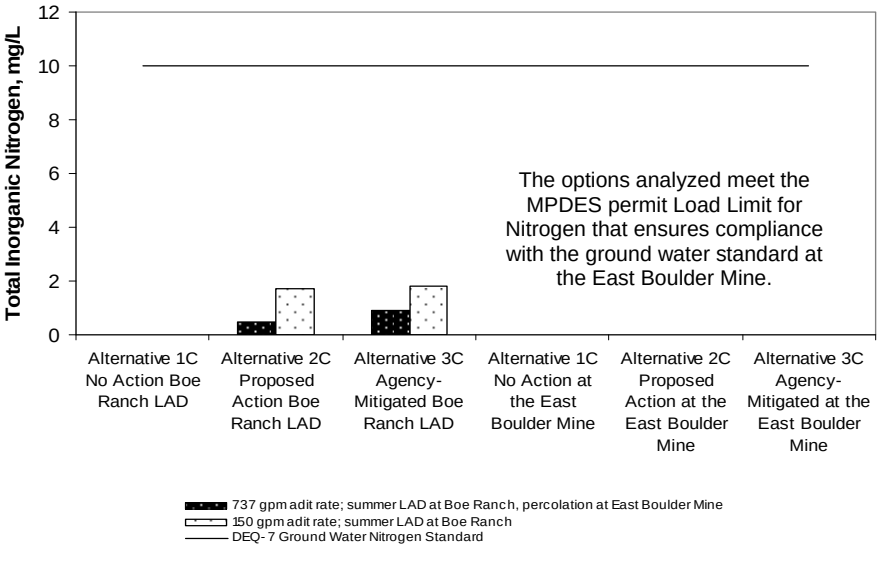


Figure S-12. East Boulder Mine and Boe Ranch LAD Operations Projected Nitrogen Concentration in Ground Water by Alternative and Adit Flow Rate



Note: This nitrogen criterion is met for all alternatives if the streamflow in the East Boulder River is 3.0 cfs or greater. The concentrations listed on this figure are for post-irrigation withdrawal losses in the East Boulder River if streamflow is 2 cfs. The Agency-Mitigated Alternative would adjust LAD rates if streamflow was 3 cfs or less to meet the nitrogen criterion.

Figure S-13. East Boulder Mine and Boe Ranch LAD Operations Projected Nitrogen Concentration in the East Boulder River by Alternative and Adit Flow Rate

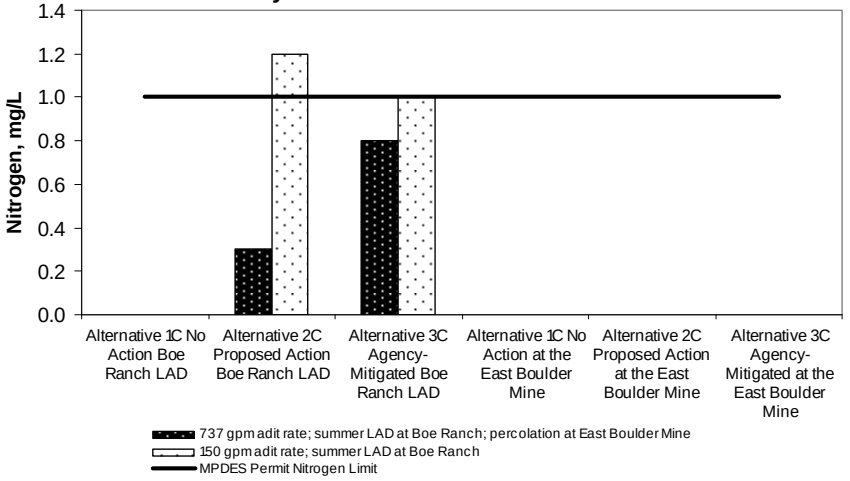


Figure S-14. East Boulder Mine and Boe Ranch LAD Operations Projected Salts Concentration in Ground Water by Alternative and Adit Flow Rate

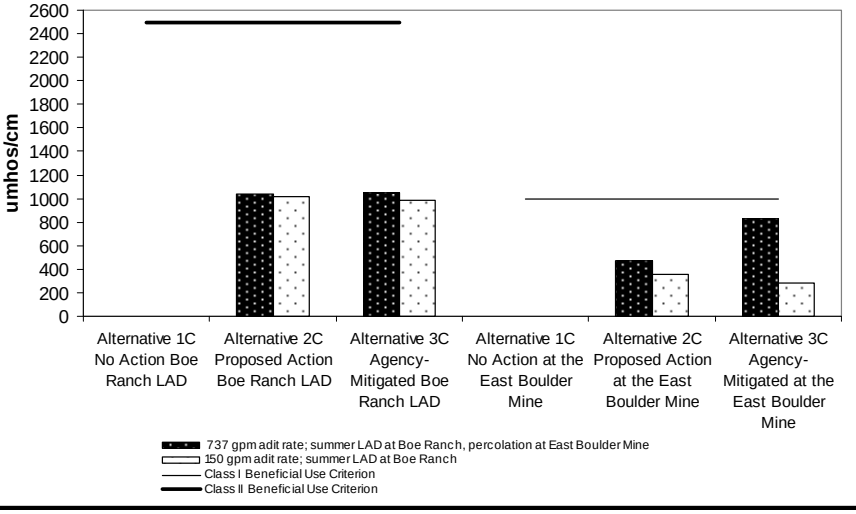


Figure S-15. East Boulder Mine and Boe Ranch LAD Operations Projected Salts Concentration in the East Boulder River by Alternative and Adit Flow Rate

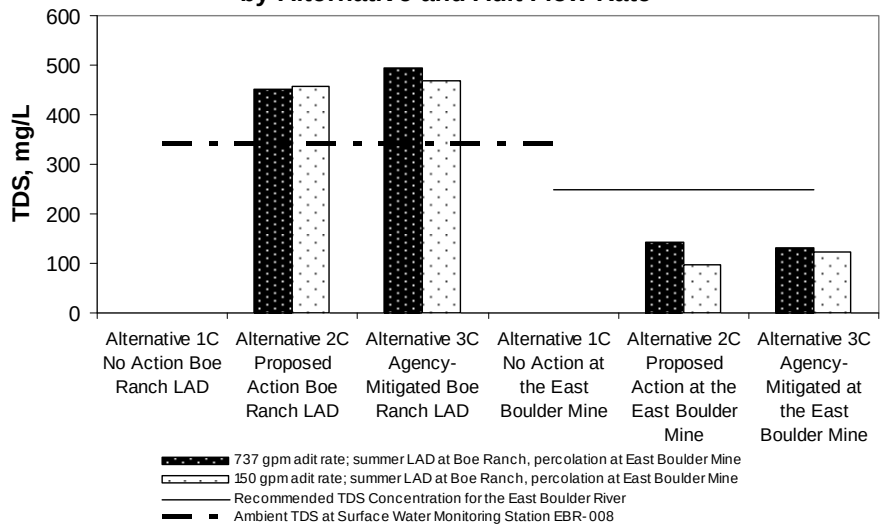


Figure S-16. East Boulder Mine and Boe Ranch LAD Closure Projected Nitrogen Loading by Alternative and Adit Flow Rate

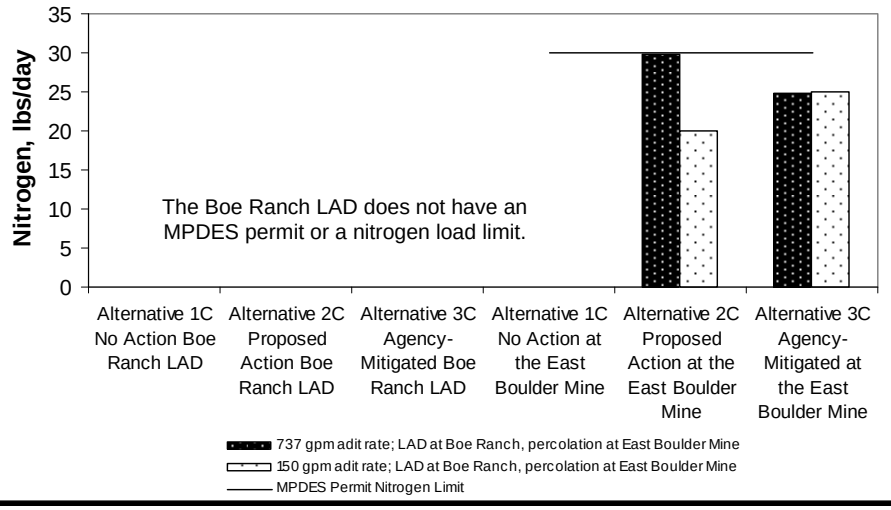


Figure S-17. East Boulder Mine and Boe Ranch LAD Closure Projected Nitrogen Concentration in Ground Water by Alternative and Adit Flow Rate

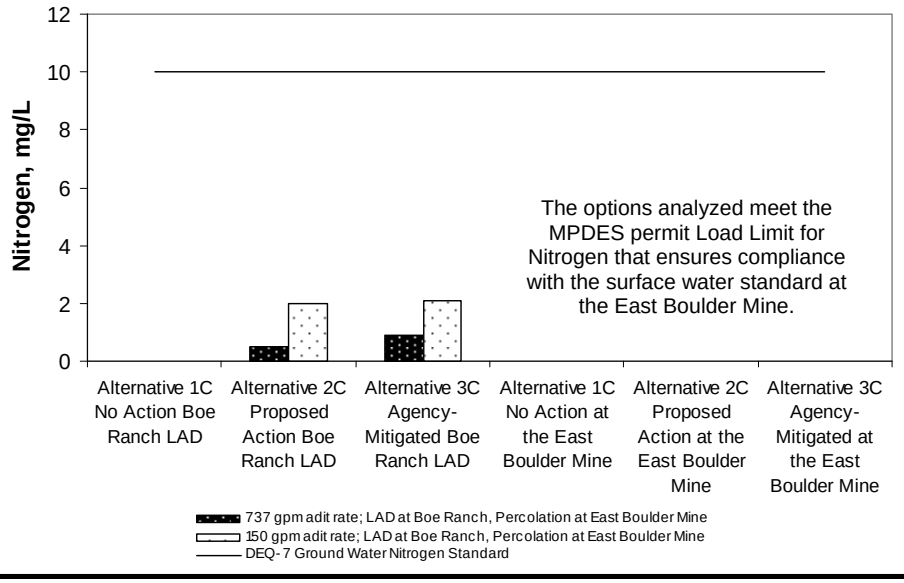


Figure S-18. East Boulder Mine and Boe Ranch LAD Closure Projected Nitrogen Concentration in the East Boulder River by Alternative and Adit Flow Rate

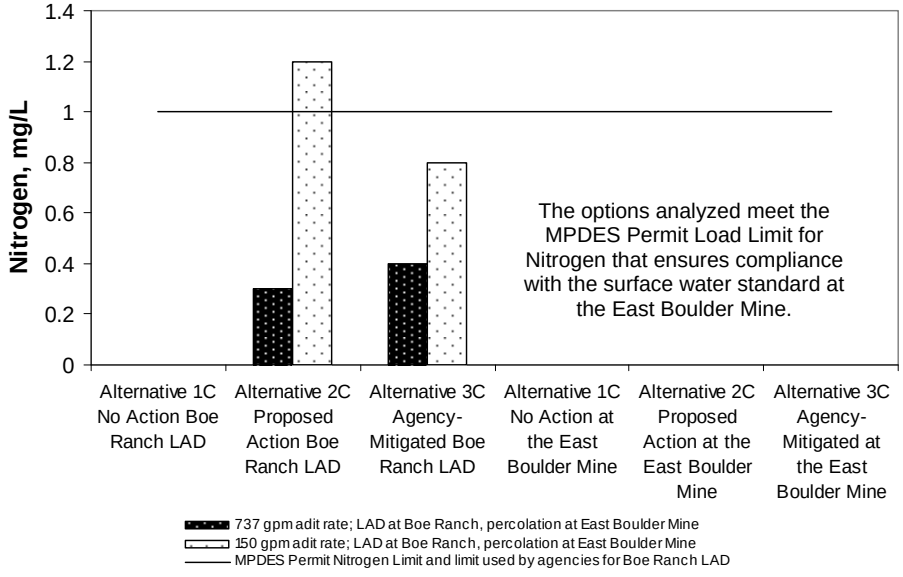


Figure S-19. East Boulder Mine and Boe Ranch LAD Closure Projected Salts Concentration in Ground Water by Alternative and Adit Flow Rate

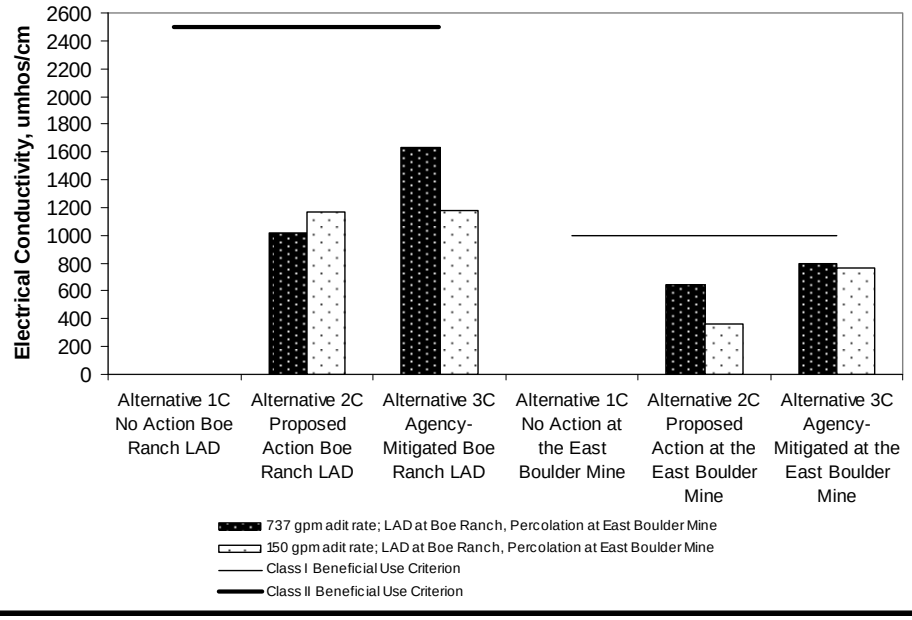
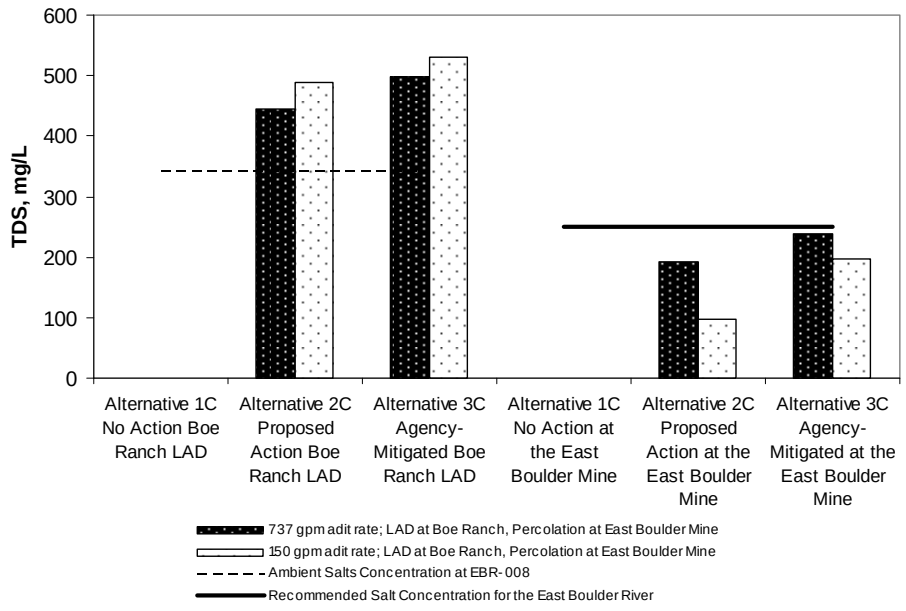


Figure S-20. East Boulder Mine and Boe Ranch LAD Closure Projected Salts Concentration in the East Boulder River by Alternative and Adit Flow Rate



Chapter 1 — Purpose and Need

Stillwater Mining Company (SMC) submitted applications in late 2000 to the Montana Department of Environmental Quality (DEQ), the Custer National Forest (CNF), the Gallatin National Forest (GNF), and the Montana Department of Natural Resources and Conservation (DNRC) to amend its operating permits for the Stillwater Mine (Permit #00118) and the East Boulder Mine (Permit #00149). The Stillwater Mine is in Stillwater County near Nye, Montana (MT). The East Boulder Mine is in Sweet Grass County south of Big Timber, MT (Figure 1-1).

The applications include three separate proposals that the agencies analyze in this Draft Environmental Impact Statement (EIS): two of the proposals involve the East Boulder Mine and one proposal involves the Stillwater Mine. SMC requests approval from DEQ, CNF, GNF, and DNRC to:

- Develop and implement closure and post-closure water management plans (WMPs) for adits, tailings impoundments, and storm water for the Stillwater and East Boulder mines. SMC proposes to discharge water directly to the rivers once adit and tailings waters have met Montana (MT) state water quality standards or, in the case of nitrogen, have met the grandfathered nondegradation limit of 100 pounds per day (lbs/day) in the Stillwater River and 30 lbs/day in the East Boulder River; and
- Construct and operate a pipeline and land application disposal (LAD) system at its Boe Ranch property, if needed, to dispose of treated adit and tailings waters from the East Boulder Mine during operations and at closure.

In 2007, the agencies initiated negotiations with SMC regarding the five-year bond review process. While the bond review itself is outside the scope of this environmental analysis, the negotiation process resulted in SMC submitting changes to the reclamation and water management plans (WMP) for each mine (SMC 2007a).

This EIS analyzes the following reclamation and WMP proposed modifications:

- Changing reclamation cover requirements from an average of four to six feet to an average of two feet for all tailings impoundments (cover material is defined as glacial till, waste rock, or a combination of materials);
- Changing the reclamation cap design on all tailings impoundments from a domed or convex configuration to a concave configuration with positive drainage following the deposited tailings gradient (this includes removal of any requirement for tailings grading prior to cap placement);
- Evaluating the use of Biological Treatment Systems (BTS) for treatment of undiluted tailings waters at closure (test report dated May 2007);

- Evaluating the potential relocation of tailings slimes to alternative locations as necessary to expedite and facilitate the capping process (e.g., mine underground, lined storage ponds); and
- Evaluating changes in post-closure water routing and channel design.

Descriptions of all alternatives considered in this EIS are contained in Chapter 2 and are summarized in Tables 2-6, 2-7, and 2-8 and Appendix C.

1.1 Purpose and Need

As described above, the Proposed Actions are the basis for the analysis documented in this EIS. Two of the proposals involve the East Boulder Mine and one proposal involves the Stillwater Mine. The Proposed Actions encompass several purposes.

First, for the two closure and post-closure WMPs for the Stillwater and East Boulder mines, the purpose and need is to respond to the intent of the regulations for the Montana Metal Mine Reclamation Act (MMRA) 82–4–301 *et seq*. Montana Code Annotated (MCA) and US Forest Service (USFS) regulations (36 Code of Federal Regulations [CFR] 228, Subpart A). These regulations require each mine to have a closure and post-closure WMP to meet water quality standards during reclamation. The agencies concluded that earlier analyses did not address the type and duration of water management and treatment with enough specificity, nor were they detailed enough to use in determining closure and post-closure bond calculations.

Mine Life Terms

For the purpose of this analysis, the terms "operations," "closure," and "post-closure" will be defined as follows:

Operations: The period when active mining is taking place, tailings are being generated, and active adit water treatment is ongoing.

Closure: The period when operations have ceased, tailings impoundments are dewatered and reclaimed, mine facilities are removed, and adit and impoundment water treatment is ongoing.

Post-Closure: The period when reclamation has been completed, and water treatment is no longer required. Monitoring and maintenance would continue.

Second, the purpose and need of the East Boulder Mine Boe Ranch LAD System Proposed Action is to provide additional operating flexibility, to optimize options for treatment and disposal of adit water, and to allow adit water to be beneficially used in an agricultural setting during the life of the mine and at closure. SMC's current WMP was approved on June 28, 1998, for LAD of treated mine waters on National Forest System (NFS) lands. SMC has proposed the Boe Ranch LAD system as an enhancement of the approved mine site LAD system, which will allow for storage of all mine discharge water during the non-growing season with subsequent LAD of the water during the ensuing growing season. SMC believes

that the Boe Ranch location would increase the evaporation potential of the treated mine water because the area is windier and drier. SMC also believes the grassland vegetation would enhance the overall efficiency of the LAD system. SMC contends the Boe Ranch is better suited for a LAD system because it is not hydrologically connected to the East Boulder River.

1.2 Supply and Demand for Platinum/Palladium

Platinum Group Metals (PGM) are important to industrial and defense technologies. Platinum is used primarily for jewelry and as a catalyst in pollution-control devices, such as catalytic converters. Palladium is used primarily as a catalyst in pollution-control devices, electronics micro-circuitry, jewelry, and dental alloys.

South Africa and Russia continue to produce more than 90 percent of the world's platinum and palladium (Jollie 2006). The J-M Reef, which is the primary source of PGM ore at the Stillwater and East Boulder mines, holds one of the few sources of PGM outside South Africa and Russia. Other sources include North American Palladium and Raglan in Canada and the proposed North Met Project in northern Minnesota. SMC's mining claims extend for more than 28 miles along the J-M Reef, which is one of the highest grade PGM ore bodies in the world (Figure 1-1). As of December 31, 2007, the indicated ore reserves of 2.8 million tons at Stillwater Mine and 2.0 million tons at East Boulder Mine represent approximately 41 months of ore production (at 2,200 tons per day [tpd]) and 47 months of ore production (at 1,400 tpd), respectively. The long-term ore reserve targets are approximately 3.4 million tons at Stillwater Mine and 2.4 million tons at East Boulder Mine, which reflect about 40 months of production at full capacity of each facility (SMC 2007a).

1.3 History of the Stillwater and East Boulder Mines

SMC operates two underground PGM mines in Montana. Operations at the Stillwater Mine began in 1985. The DEQ and US Forest Service (USFS) approved the East Boulder Mine in 1993, but operations at the East Boulder Mine did not begin until 1998. The histories of both mines are described below.

1.3.1 Stillwater Mine

Ore production at the Stillwater Mine is approximately 777,100 tons per year (tpy) or 2,129 tpd with spikes up to 2,500 tpd (SMC 2009c). SMC's air quality permit currently authorizes up to 5,000 tpd (1,825,000 tpy) to be processed through the mill. SMC's mill capacity is currently limited to 3,000 tpd without an upgrade and expansion of current milling operations and facilities. At the mill, SMC upgrades the ore by crushing, grinding, floating, and filtration to a concentrate. This concentrate is then shipped by truck to the smelter and base

metal refinery (BMR) in Columbus, MT, for further upgrading (Figure 1-1). From the BMR, SMC ships the product to New Jersey for final refining.

Every 100 tons of ore fed to the mill generates 99 tons of tailings. These tailings are pumped from the mill to the paste plant and then to the underground sand plant where the sand component is separated from the slimes (the smallest sized tailings particles). The coarse fraction is utilized as sand backfill in the underground mine workings. SMC has constructed and is operating a paste plant at the Stillwater Mine that utilizes whole tailings as paste backfill. Tailings are dewatered and cement added prior to placing this paste mixture underground. By utilizing both methods of backfill, SMC is capable of placing up to 58 percent of the tailings back into the mined-out stopes, depending on the mining cycles. The slimes and sands that cannot be used as backfill are pumped to the tailings impoundments.

SMC's original Plan of Operations was approved in 1985 after a final EIS was completed (Montana Department of State Lands [DSL] and USFS 1985). The current proposal, if approved, would be the 11th amendment to the original Plan of Operations and permit. The previous amendments are:

001 — Approved and permitted June 30, 1986. This amendment relocated mine and mill facilities. No increase in permit area or disturbed area resulted.

002 — Approved and permitted September 8, 1986. This amendment allowed excavation of a sand borrow area in the existing permit area. The disturbed area has been reclaimed.

003 — Approved and permitted January 8, 1987. This amendment allowed excavation of a second sand borrow area within the permit area. The disturbance has been reclaimed.

004 — Approved and permitted February 24, 1987. This amendment relocated the southern portion of the tailings impoundment toe dike to higher ground along Mountain View Creek on previously disturbed land within the permit area.

005 — Approved and permitted March 2, 1989. This was the first major amendment to the original permit. It increased the permit area to 1,158 acres and permitted mining on the east side of the Stillwater River. The total allowable disturbance increased by 72 acres.

006 — Approved and permitted July 21, 1989. This amendment allowed construction of a temporary sand slurry pipeline to connect the east and west sides of the mine area. No increase in permit area or disturbed area resulted.

007 — Approved and permitted November 15, 1990. This amendment allowed construction of the four Stillwater Valley Ranch percolation ponds and five monitoring wells. The permit area was increased by 27 acres. The total allowable disturbance was increased by 7 acres.

008 — Approved and permitted on September 23, 1992. This amendment allowed production to increase from 1,000 to 2,000 tpd (DSL et al. 1992a). It also approved some expansion of support facilities, such as waste dumps, the mill, and the tailings impoundment.

009 — Approved and permitted February 28, 1996. This amendment allowed construction of an underground connection between the east and west sides of the Stillwater River mining areas (DEQ 1996). No increase in permit area or disturbance area resulted.

010 — Approved and permitted November 12, 1998. This amendment allowed the construction of the Hertzler tailings impoundment, Hertzler LADs, the Stratton Ranch LADs, and the slurry and water pipelines to connect these facilities with the mine. This amendment also removed the 2,000 tpd production cap.

In addition, 49 minor revisions have been made as of April 2008 (Weimer 2005a). The operating permit area is 2,475 acres, and 712.8 acres of these are permitted for disturbance (Weimer 2008a). As of April 2008, 436.9 acres have been disturbed by mining and exploration. Some of the permitted and disturbed areas are on NFS lands (Table 1-1).

Table 1–1 Ownership of Lands at the Stillwater and East Boulder Mines

	Ownership		
Parameter	USFS (acres)	Private (acres)	Total (acres)
Stillwater Mine			
Permit Area	473	2,002	2,475
Total Disturbance Permitted	74.5	638.3	712.8
Disturbance to Date	35.9[1]	401.0	436.9
East Boulder Mine			
Permit Area	397	933	1,330
Total Disturbance Permitted	265.3	0	265.3
Disturbance to Date	199.6	0	199.6

Note:
1. Roads and adits.
Sources: Weimer 2008a, Wolfe 2008.

1.3.2 East Boulder Mine

Although SMC's original Plan of Operations for the East Boulder Mine was approved in 1993 after a final EIS was completed in 1992 (DSL et al. 1992b), SMC did not begin construction until 1998. Surface and underground construction was completed in November of 2001, and SMC brought the mine into commercial production during the first quarter of 2002. The mining rate for the first full year of commercial production averaged 1,000 tpd or approximately 365,000 tpy (SMC 2003a). Current production is 1,116 tpd or 407,400 tpy (SMC 2008c).

The two current proposals for the East Boulder Mine, if approved, would represent the second and third amendments to the original Plan of Operations and permit. The previous amendment is:

001 — Approved and permitted on May 20, 1999. This amendment allowed use of USFS lands for spray irrigation, snowmaking LAD areas, and percolation ponds for disposal of water that contains total inorganic nitrogen (TIN). It also

allowed the construction of structures for water treatment by biological denitrification. The amendment expanded the permit boundary by 136 acres and increased the total allowable disturbance area by 5.7 acres.

In addition, 20 minor revisions also have been approved. The permit area is 1,330 acres, and 265.3 acres of these are permitted for disturbance (Wolfe 2008). Only 199.6 acres have been disturbed by mining and exploration as of April 2008. Some of the permitted and disturbance areas are on NFS lands (Table 1-1).

1.4 Decisions to be Made

The Directors of the DEQ and DNRC and the Forest Supervisor for the CNF and GNF must make decisions on SMC's requests to amend its permits. These decisions will be documented in a Record of Decision (ROD). The decision-making process will lead to the selection of one of the following possible alternatives for each of the three proposals addressed in this EIS:

- Denial of the proposed amendment (DEQ) or request for revision (CNF or GNF) (No Action Alternatives 1A, 1B, and 1C);

- Approval of the Proposed Action amending the existing permits and plans of operations for the Stillwater and East Boulder mines (Proposed Action Alternatives 2A, 2B, and 2C); or

- Approval of an Agency-Mitigated Alternative to the proposed amendments (Mitigated Alternatives 3A, 3B, and 3C), or some combination of the Proposed Action and agency-specified mitigation measures.

DEQ can deny the proposed amendments. The authority for denial originates from the MMRA and Montana's water quality and air quality statutes. From 1986 to 2001, DEQ and the Montana First Judicial District Court interpreted the Montana Environmental Policy Act (MEPA) as supplementing the basis to condition a denial of an operating permit under MMRA. This interpretation meant that DEQ could deny or modify a hard rock operating permit under MMRA to avoid or mitigate an impact that would significantly degrade the environment. The operator then would have the option of revising the plan accordingly or appealing the decision through the courts. With enactment of House Bill 473, though, the 2001 state legislature removed MEPA as a means for conditioning (in this case, requiring implementation of mitigation measures for impacts not specifically covered by state law or regulation) or denying a state permit. All changes to a proposed permit or denial of a permit now must be linked directly to a specific state law or regulation. The permittee may request that the additional mitigation measures be incorporated into its exploration license or operating permit. Those mitigation measures then would become enforceable conditions of the permit (75–1–201(5) (b), MCA).

The USFS' authority to deny mining proposals is limited by federal law. The 1872 Mining Law, as amended, and its regulations at 36 CFR 228A; the 1897 Organic Administration Act; and the 1955 Multiple Use Mining Act allow the USFS to reasonably regulate mining to minimize adverse environmental impacts

on NFS surface resources and to ensure compliance with applicable environmental laws and regulations. The latter include, but are not limited to, the 36 CFR 228 Locatable Regulations, Subpart A; the 1972 Clean Water Act (CWA); and the 1973 Endangered Species Act.

Several court decisions have made clear that while the USFS can reasonably regulate mining, it cannot prohibit or unreasonably restrict operations that are otherwise in compliance with law. If analysis done under the National Environmental Policy Act (NEPA) and other analyses show that a mining proposal can be approved in a manner that will comply with the applicable environmental laws, the USFS has no authority to prohibit or to deny the proposal on NFS lands subject to the 1872 Mining Law. The proposals or agency alternatives, if approved, must comply with all applicable federal and state air and water quality laws and regulations.

DNRC has no authority to regulate mining, but would have to reach a decision regarding leases and land use permits for the access road and pipeline crossing state land. DNRC would have to make decisions regarding the final hazard classification of the Hertzler Ranch and Boe Ranch LAD storage pond dams and would need to determine if any changes are needed regarding water rights.

1.5 Agencies' Roles and Responsibilities

The DEQ and USFS (as represented by the GNF and CNF) are the lead agencies for this EIS. The DNRC is a participating agency. A December 11, 1989 Memorandum of Understanding between the State of Montana and the USFS provides for preparation of joint environmental analyses and sharing of information, personnel, and funds.

The DEQ and the USFS are also responsible for establishing reclamation bonds. Reclamation bonds are set by the agencies and are held jointly. The USFS may require additional bond if it decides the joint bond is insufficient. The bond is jointly determined by computing costs to the state and USFS for reclaiming a site should the operator default. The joint bond can be used by either agency per their regulations. Each agency's role and responsibilities are described below.

1.5.1 Montana Department of Environmental Quality

DEQ oversees mining within the State of Montana. DEQ's responsibilities originate from several acts and their implementing regulations. They are the MMRA, MEPA, the Public Water Supply Act, the Clean Air Act of Montana, and Montana Water Quality Act (WQA).

1.5.1.1 Montana Metal Mine Reclamation Act

DEQ administers the MMRA, under which SMC has applied for amendments and revisions to its two operating permits (#00118 and #00149). The MMRA's purpose is to ensure that the usefulness, productivity, and scenic values of all lands and surface waters affected by mining and exploration receive the greatest

reasonable degree of protection and that the lands are reclaimed to beneficial uses. Other purposes of the act are to allow mining as an activity beneficial to the economy of Montana and to allow the production of minerals to meet the needs of society and the economic demands of the marketplace (82.4.302(b) and (c), MCA). The act and its rules define the steps to be taken in issuing an operating permit or revising an approved operating plan for reclamation of an applicant's proposed or modified mine operation.

A finding that the mining or reclamation plan would violate laws administered by DEQ would be grounds to deny a permit or amendment (82–4–351, MCA). A permit or amendment also may be denied if a person independently or as a principal or controlling member of any firm or business association has forfeited a bond (82–4–335 (9)(a) and 82–4–360 (1), MCA); failed to reclaim an operation within the time allowed (not less than 2 years as provided in 82–4–336 (3) MCA) or within the time allowed by the agencies in the formal approval of the reclamation plan for the site, pursuant to 82–4–341(2), MCA. Additionally, an operating permit may not be issued if the applicant has not posted a bond, has failed to pay a penalty, or has failed to comply with an abatement order issued pursuant to MMRA or the air and water quality acts (82–4–335 (9), MCA).

DEQ also sets reclamation bonding under MMRA. The agency is required to review the bond amount for all active and permitted mines annually and comprehensively every five years. If a bond is determined to be insufficient, the company is required to submit the additional amount. SMC's current bonds are $19.5 million ($8.9 million is obligated) for the Stillwater Mine and $13.5 million ($12.2 million is obligated) for the East Boulder Mine.

If these amendments are approved, additional bonds would be calculated using the specifications and stipulations of the approved amendments. The bonds would include costs such as long-term maintenance of water management facilities (e.g., percolation ponds and diversion ditches); demolition of buildings and other structures; regrading and soil replacement; seedbed preparation; and revegetation. Bonds must be submitted and accepted before the proposed amendments could be permitted by DEQ or an authorization to proceed could be granted by the USFS.

A newly approved hardrock operating permit or amendment to an approved permit cannot be implemented unless and until other associated permits and plans have been approved. These include any new or revised water discharge or air quality permits regulated by DEQ and other permits or approvals required by other state or federal agencies, such as a Section 404 dredge and fill permit under the Clean Water Act from the U.S. Army Corps of Engineers (Corps).

1.5.1.2 Water Quality Statutes

DEQ is responsible for administering several water quality statutes, including the Public Water Supply Act and the WQA. DEQ also administers several sections of the federal CWA pursuant to an agreement between the State of Montana and the U.S. Environmental Protection Agency. The State of Montana, through DEQ, has been delegated authority for administering nonpoint source pollution prevention programs, the National Pollutant Discharge Elimination System pro-

gram, and Water Quality Standards. The WQA provides a regulatory framework for protecting, maintaining, and improving the quality of water for beneficial uses. Pursuant to the WQA, DEQ has developed water quality classifications and standards, as well as 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. SMC currently holds four Montana Pollutant Discharge Elimination System (MPDES) permits. They include:

- MT–0024716 for the discharge of excess adit water from the Stillwater Mine into the Stillwater River. This permit expired April 30, 2003; but SMC submitted a renewal application in a timely manner. The permit was reissued in September 2008 (effective November 1, 2008) and will be valid until October 31, 2013.
- MTR–300017 for the discharge of storm water from the Stillwater Mine site to the Stillwater River.
- MT–0026808 for the discharge of excess adit water from the East Boulder Mine into the East Boulder River. This permit expired July 31, 2005; but SMC submitted a renewal application in a timely manner, and DEQ administratively extended the permit until the application can be reviewed and reissued.
- MTR–300226 for the discharge of storm water from the East Boulder Mine site to the East Boulder River.

MPDES permits normally expire every five years and by law must be either renewed or terminated at expiration. Application for renewal must be made 180 days prior to permit expiration. While applications are in the review process, existing permits are administratively extended and all permit requirements remain in force. In any event, permit expiration does not end the permittee's obligations. Only after the adit water meets all applicable nondegradation limits and water quality standards can the permit be terminated at the permittee's request, pursuant to Administrative Rules of Montana (ARM) 17.30.1365.

DEQ may also authorize short-term exemptions from Montana's surface water quality turbidity standards for construction projects that affect water bodies. This authorization must be obtained before the applicant may begin the construction activity.

1.5.1.3 Clean Air Act

DEQ administers the Clean Air Act of Montana. A facility must obtain an air quality permit before construction or a change in operation, unless a permit is not required under ARM 17.8.705. The owner or operator of a new or altered source that requires an air quality permit must utilize Best Available Control Technology in designing pollution control systems. The applicant also must demonstrate that the project would not violate Montana or National Ambient Air Quality Standards.

SMC operates the Stillwater and East Boulder mines under air quality permits. The State of Montana issued the latest amended air quality pre-construction permit for the Stillwater Mine (Air Quality Permit #2459–13) on January 15, 2003

and the Title V Air Quality Operating OP2459-03 on November 29, 2003. These permits limit SMC's mining and ore processing to 1,825,000 tpy and a maximum of 5,000 tpd.

The State of Montana also issued an updated air quality permit for the East Boulder Mine (Air Quality Permit #2653–05) on October 26, 2006. This permit limits SMC's mining and ore processing at this mine to 730,000 tpy. In addition, waste rock production and handling, as well as ore processed in the surface crushing system, is limited to 730,000 tpy. This permit also limits the crushing of borrow material to 132,000 tpy.

1.5.1.4 Montana Environmental Policy Act (MEPA)

Procedures that govern state decision-making processes on state, federal, and private lands in Montana are defined in the administrative rules that implement the MEPA. Under this law and implementing regulations, an EIS must be prepared whenever any action taken by a state agency "significantly affects the quality of the human environment." The DEQ has determined that an EIS is appropriate for this project. This EIS has several purposes:

- It ensures that the agency uses the natural and social sciences and environmental design arts in planning and decision making;
- It assists in evaluating reasonable alternatives and developing conditions, stipulations, or modifications to be made part of a Proposed Action. MEPA no longer allows state agencies to use the analysis to require supplemental stipulations to a permit unless they can be required by a specific state law or regulation. The permitee may request that these stipulations be added to its permit;
- It ensures the fullest appropriate opportunity for public review and comment on Proposed Actions, including alternatives and planned mitigation; and
- It examines and documents the effects of a Proposed Action on the quality of the human environment and provides the basis for public review and comment.

1.5.2 Montana Department of Natural Resources and Conservation

DNRC administers several acts that apply to mining development in Montana. DNRC must approve easements across state lands for access roads and pipelines. A portion of the proposed access road and pipeline to Boe Ranch from the East Boulder Mine would cross state land in Section 16, Township 3 South, Range 13 East, Montana Principal Meridian (MPM). As a result, SMC has obtained a right-of-way for the pipeline and road across the state section from DNRC.

If a mining operation proposes construction of a dam that exceeds a certain height or length, it would be classified as a high-hazard dam and subject to design review and approval before construction from the DNRC's Dam Safety Bureau. When a dam has an impoundment capacity of 50 acre-feet or more, DNRC classifies the hazard of that dam by the potential loss of life downstream if the

dam fails. Construction and operation of such a dam would be regulated under MMRA, rather than a DNRC dam safety permit, during mine operation and closure until reclamation bond release. After the reclamation bond is released, such a structure would be subject to DNRC oversight and regulation.

1.5.3 USDA Forest Service, Custer and Gallatin National Forests

SMC's patented claim block extends some 28 miles and is bordered by portions of both forests (CNF and GNF). The current surface expression of the Stillwater Mine is surrounded by the CNF, while the surface expression of the East Boulder Mine is surrounded by the GNF. This discussion addresses the management direction for both forests.

1.5.3.1 Custer National Forest Land and Resource Management Plan

According to its 1986 Land and Resource Management Plan (CNF Forest Plan), the CNF must consider how other resources and impacts from mining would be mitigated to the extent possible through standard operating procedures. Additionally, the CNF can prescribe mitigation measures to the Plan of Operations, as necessary, to manage key surface resources. Mineral development can not be precluded by these resource concerns within legal constraints. Efforts must be made to avoid or mitigate resource conflicts. If the responsible official determines that conflicts cannot be adequately mitigated, the conflict will be resolved in accordance with the management goal, and, if necessary, in consultation with affected parties (USFS 1986).

The area under consideration for SMC's Stillwater Mine proposal falls within Management Area E, which emphasizes exploration, development, and production of mineral resources (USFS 1986). The CNF Forest Plan did not analyze site-specific actions, such as SMC's current proposal. As an integrated management plan, it evaluated various alternatives for managing the Forest as a whole for a 10- to 15-year period. The ROD for the CNF Forest Plan clearly states that a site-specific project, such as SMC's current proposal, must undergo additional analysis under NEPA. This EIS documents the required analysis.

1.5.3.2 Gallatin National Forest Land and Resource Management Plan

According to its 1987 Land and Resource Management Plan (GNF Forest Plan) and the final EIS that accompanied it, USFS's responsibilities for minerals management include the following: to make available mineral resources from the forest and to administer their exploration and development. A thorough environmental analysis must be completed for each proposed mineral activity before it is approved (USFS 1987a).

The East Boulder Mine permit area falls within Management Area 8, which emphasizes production of timber (USFS 1987b). The GNF Forest Plan did not analyze site-specific actions, such as SMC's East Boulder Mine. As an integrated

management plan, it evaluated various alternatives for managing the forest as a whole for a 10- to 15-year period. The ROD for the GNF Forest Plan clearly states that a site-specific project, such as SMC's current proposal, must undergo additional analysis under NEPA. This EIS documents the analysis.

1.5.3.3 Organic Administration Act of 1897

In 1891, Congress granted the President the authority to establish forest reserves (national forests) from the existing public domain lands. In the Organic Administration Act of 1897, Congress outlined the purposes for the establishment of national forests and provided for their protection and management. These purposes were to improve and protect the forest within the reserves, to secure favorable water flows, and to furnish a continuous supply of timber for the use and needs of the citizens of the U.S. It was not the purpose or intent of these provisions to authorize the inclusion of lands more valuable for their minerals or for agriculture than for forest purposes (16 United States Code § 475). The Organic Administration Act does not allow the GNF or CNF to unreasonably circumscribe or prohibit reasonably necessary activities under the Mining Law of 1872 that are otherwise lawful.

1.5.3.4 Mining Law of 1872

The Mining Law of 1872 was enacted by Congress to stimulate exploration for and development of minerals on federal lands. The act accomplishes these objectives by giving claim holders statutory rights to develop mineral resources. Claims for viable ore bodies can be patented, and ownership of the ore body can pass into private hands. The act contains provisions for mining claims and for mill site claims to allow surface occupancy for ore body development.

1.5.3.5 Locatable Minerals — 36 CFR 228, Subpart A

These regulations, 36 CFR 228, Subpart A (228 regulations), set forth the rules and procedures that enable use of the surface of NFS lands in connection with operations authorized by mining laws. These laws confer a statutory right to enter public lands to search for minerals. The USFS developed its regulations for locatable minerals to ensure mining-related activities are conducted in a manner that minimizes adverse environmental impacts on NFS surface resources.

The 228 regulations specifically authorize the USFS to calculate and hold a reclamation bond for approved mining operations on NFS lands. The USFS is working with the DEQ to estimate reclamation costs for the Stillwater and East Boulder mining operations and would hold the reclamation bonds jointly.

1.5.3.6 Executive Order 13007 and the National Historic Preservation Act

Executive Order 13007 requires that agencies contact Indian tribes regarding effects, and the National Historic Preservation Act's Section 106 regulations require consultation with Indian tribes to identify and resolve adverse effects to historic properties. The Memorandum for the Heads of Executive Departments and Agencies entitled *Government-to-Government Relations with Native American Tribal Governments,* signed by President Clinton on April 29, 1994, outlines

principles that federal agencies must follow when interacting with federally-recognized Native American tribes in deference to Native Americans' rights to self-governance. Specifically, federal agencies are directed to consult with tribal governments prior to taking actions that affect federally recognized tribes and to ensure that Native American concerns receive consideration during the development of federal projects and programs.

1.5.3.7 National Environmental Policy Act (NEPA)

The NEPA declares a national environmental policy and promotes consideration of environmental concerns by federal agencies in decision-making. Procedures and regulations issued by the Council on Environmental Quality (CEQ), as authorized under NEPA, direct implementation of NEPA by federal agencies. The CEQ's regulations are promulgated at 40 CFR Parts 1500–1508. Also, the USFS direction pertaining to implementation of NEPA and CEQ's regulations is contained in Chapter 20 of USFS Handbook 1909.15 (Environmental Policy and Procedures). To meet the requirements under NEPA and their forest plans, the GNF and CNF have prepared this EIS in cooperation with DEQ and DNRC.

1.5.4 Permits, Approvals, and Coordination Required from Other Agencies

In addition to approvals from the DEQ, USFS, and DNRC, several additional permits, approvals, and consultations with other federal, state, and local agencies may be required before SMC could implement the Proposed Actions. These additional permits, approvals, and consultations are identified and described on Table 1-2.

Table 1–2 Permits, Licenses, Approvals, and Consultations Potentially Required for SMC Amendments to the Plans of Operations for the Stillwater and East Boulder Mines

Permit, License, or Approval	Purpose
U.S. Fish and Wildlife Service (USFWS)	
Biological Opinion (Endangered Species Act 50 CFR 402)	To ensure actions taken by federal agencies would not jeopardize the continued existence of threatened or endangered species (TES) or result in the destruction or modification of critical habitat. The CNF and GNF must consult with the USFWS, which issues its Biological Opinion following review of a Biological Assessment submitted by the CNF and GNF. Since no new disturbances would occur on federal lands, a Biological Opinion is not required and the USFS has not entered into formal consultation with the USFWS.
USFS	
Biological Assessment	To ensure actions taken by USFS would not jeopardize the continued existence of TES or result in the destruction or modification of critical habitat. Since no new disturbances would occur on federal lands, a Biological Assessment is not required.
Plan of Operations	To ensure design, operation, closure, monitoring, and bonding of mining operations result in adequate reclamation for post-mining land uses. Coordinate with DEQ and other appropriate agencies.
Executive Order (E.O.) 13007 and Government to Government Relations with Native American Tribal Governments — Memorandum for the Heads of Executive Department and Agencies (signed by President Clinton on April 29, 1994)	E.O. 13007 requires that agencies contact Indian tribes regarding effects and the Section 106 regulations require consultation with Indian tribes to identify and resolve adverse effects to historic properties. The Memorandum outlines principles that federal agencies must follow when interacting with federally recognized Native American tribes in deference to Native Americans' rights to self-governance. Specifically, federal agencies are directed to consult with tribal governments prior to taking actions that affect federally recognized tribes and to ensure that Native American concerns receive consideration during the development of Federal projects and programs. Since no new disturbances would occur on federal lands, consultation with Tribal Governments can be conducted at the discretion of SMC or DNRC. The USFS has not entered into formal consultation with the Tribal Governments.
U.S. Army Corps of Engineers	
Section 404 Nationwide Permit (Clean Water Act)	To control the discharge of dredged or fill material into waters of the U.S., including wetlands.
DEQ	
401 Certification (Clean Water Act)	To certify that any activity requiring a federal license or permit that may result in any discharge into State waters would not cause or contribute to a violation of State surface water quality standards.
MPDES Permit	To authorize SMC to discharge water from the Stillwater Mine's adits to the Stillwater River and ground water adjacent to the Stillwater River and from the East Boulder

Table 1–2 Permits, Licenses, Approvals, and Consultations Potentially Required for SMC Amendments to the Plans of Operations for the Stillwater and East Boulder Mines

Permit, License, or Approval	Purpose
	Mine's adits to the East Boulder River and ground water adjacent to the East Boulder River.
DEQ (continued)	
MMRA Operating Permit	To ensure design, operation, closure, monitoring, and bonding of mining operations result in adequate reclamation for post-mining use. Coordinate with the CNF, GNF, and other appropriate agencies.
Storm Water Pollution Prevention Plan	To prevent the degradation of state waters from pollutants, such as sediment, industrial chemicals or materials, heavy metals, and petroleum products.
Short-term Water Quality Standard for Turbidity Related to Construction Activity (318 Authorization)	To allow for short-term increases in surface water turbidity during construction. Montana Fish, Wildlife, and Parks (FWP) are consulted on this authorization.
DNRC	
Land Use Licenses	To permit the construction of the access road and pipeline across State of Montana lands to the Boe Ranch LAD area.
Dam Safety Permit	To permit continued operation of the Hertzler Ranch and Boe Ranch LAD storage ponds after closure of the Stillwater and East Boulder Mines. Montana's Dam Safety Law requires a dam safety permit for all high-hazard dams. DNRC classifies a high-hazard dam with an impoundment capacity of 50 acre-feet or more based on the potential loss of life downstream if the dam fails.
State Historic Preservation Office (SHPO)	
Historic Resources Consultation (National Historic Preservation Act)	To obtain joint approval by land-managing agencies and concurrence by the SHPO before agency approval; reviewed by the Advisory Council on Historic Preservation. Since no new disturbances would occur on federal lands, consultation with MT SHPO can be conducted at the discretion of SMC or DNRC. The DNRC and/or USFS have not entered into formal consultation with the MT SHPO.
Sweet Grass County Conservation District	
310 Permit (Montana Natural Streambed and Land Preservation Act)	To protect and preserve streams and rivers in their natural or existing state. Application processed in consultation with Montana Department of Fish, Wildlife, and Parks.
Sweet Grass County Road Department	
Application to Perform Construction Work in a Right-of-Way	To permit construction of the pipeline along Sweet Grass County Road 31.

Note: More information on the permits, licenses, approvals, and consultations identified on this table is contained in previous permitting documents, including the 1985, 1992, 1996 final EISs and the 1989 EA (see Appendix A for additional descriptions of these documents).

1.5.5 MEPA/NEPA Process, Including Tiering

MEPA and NEPA are state and federal laws that direct the DEQ and USFS, respectively, to disclose the effects of proposed activities on state, private, and federal lands to the public and to officials who must make decisions concerning the proposals. The MEPA/NEPA process began when SMC proposed to amend its current operating permits and plans of operations. The agencies sought public input to help identify environmental issues and concerns through the process called "scoping."

The regulations that implement MEPA and NEPA encourage tiering EISs. Tiering is the process of referencing information presented in previously prepared MEPA/NEPA documents, such as EISs, to minimize repetition. This EIS is specifically tiered to the documents identified in the following section.

1.5.6 Related Environmental Documents

Several environmental analyses have been prepared for the Stillwater and East Boulder mines. They include the EISs prepared for the original operating permits and plans of operations, and environmental assessments (EAs) prepared in support of amendments to those permits/plans of operations. This EIS is specifically tiered to the following environmental documents (Appendix A contains a synopsis of each of these documents).

1.5.6.1 Stillwater Mine

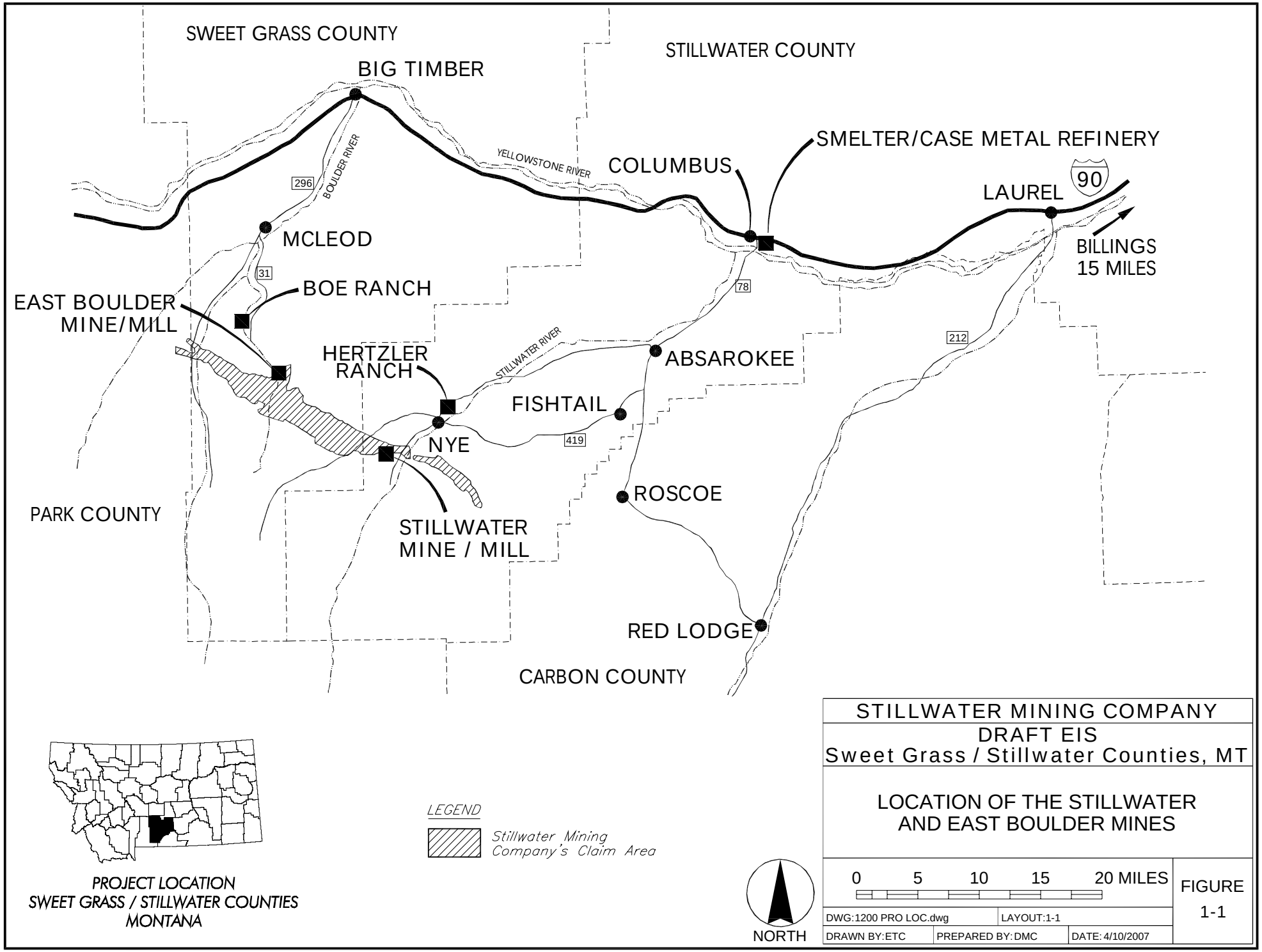
- Final EIS, Stillwater Project, Stillwater County, Montana, prepared by the DSL and USFS in 1985.
- Preliminary Environmental Review/EA, Stillwater Project East Side Adit Development, prepared by the DSL and USFS in 1989.
- Final EIS, Stillwater Mine Expansion 2000 TPD, Application to Amend Plan of Operations and Permit No. 00118, prepared by the DSL, DHES, and USFS in 1992.
- Final EIS for the Stillwater Mining Company Underground Valley Crossing and Mine Plan. Application to Amend Plan of Operations, Permit No. 00118, prepared by the DEQ in 1996.
- Final EIS, Stillwater Mine Revised Waste Management Plan and Hertzler Ranch Tailings Impoundment, prepared by the DEQ and USFS in 1998.

1.5.6.2 East Boulder Mine

- East Boulder Final EIS prepared by the DSL, USFS, and DHES in 1992.
- Section 18 NEPA Review for the East Boulder Water Management Plan conducted in 1998 by the USFS (decision documented in Garber 1998).

All the documents are available for review at DEQ's offices in Helena. The documents for the Stillwater Mine are available for review in the CNF Supervi-

sor's Office in Billings. The documents for the East Boulder Mine are available for review at the GNF Big Timber Ranger District office in Big Timber.



PROJECT LOCATION
SWEET GRASS / STILLWATER COUNTIES
MONTANA

LEGEND

Stillwater Mining Company's Claim Area

NORTH

STILLWATER MINING COMPANY			
DRAFT EIS Sweet Grass / Stillwater Counties, MT			
LOCATION OF THE STILLWATER AND EAST BOULDER MINES			
0 5 10 15 20 MILES			FIGURE 1-1
DWG:1200 PRO LOC.dwg	LAYOUT:1-1		
DRAWN BY:ETC	PREPARED BY:DMC	DATE: 4/10/2007	

Chapter 2 — Public Participation, Issue Identification, and Alternatives Development

This chapter identifies issues and concerns based on public and agency input. It describes in detail the development of alternatives considered in this analysis, including the Proposed Actions and alternatives to the Proposed Actions. It also identifies and briefly describes alternatives dismissed from further consideration and rationale for dismissal. It summarizes and compares components and environmental effects of the alternatives analyzed in detail in Chapter 4, and finally, this chapter identifies the agencies' preferred alternatives.

2.1 Public Participation

2.1.1 Application Review

The agencies received Stillwater Mining Company's (SMC's) proposed amendments to its approved Plan of Operations in December 2000. After reviewing SMC's proposals to ensure the information contained was adequate to complete an environmental analysis, the agencies deemed the proposals complete on July 27, 2001. The agencies issued press releases and published legal notices in local newspapers soliciting public comment on the Proposed Actions. SMC submitted changes to the Proposed Actions and the agencies accepted them in January 2007.

2.1.2 Scoping

Scoping for SMC's three Proposed Actions began in July 2001 with the distribution of a scoping document that informed readers of the agencies' intent to conduct an environmental analysis of SMC's Proposed Actions. The agencies mailed approximately 400 copies of the scoping document to individuals, agencies, organizations, and businesses that might be interested in or affected by the Proposed Actions and subsequent decisions. The scoping document solicited comments to assist the agencies in identifying specific issues and concerns to be addressed in the Montana Environmental Policy Act (MEPA)/National Environmental Policy Act (NEPA) environmental impact statement (EIS) analysis.

The US Forest Service (USFS), specifically the Custer National Forest (CNF) and the Gallatin National Forest (GNF), published a notice of intent to prepare an EIS in the *Federal Register* (USFS 2001). The DEQ and the USFS published public scoping notices in newspapers in the affected area, including the *Stillwater County News*, *Carbon County News*, *Billings Gazette*, *Big Timber Pioneer*, *Bozeman Chronicle*, and *Helena Independent Record*.

The Montana Department of Environmental Quality (DEQ) and the USFS held two public scoping meetings to discuss the Proposed Actions and to receive public comments. The first meeting was held on July 18, 2001, in Absarokee, MT, and 13 participants attended. The second meeting was held on July 19, 2001, in Big Timber, MT, and 47 participants attended. Representatives from the DEQ and the USFS described the Proposed Actions, and attendees were provided an opportunity to ask questions and submit comments at both meetings.

At the scoping meetings, the agencies committed to make a Chapter 2 draft available to the public when it was completed. After public scoping meetings, the agencies and SMC hosted field trips at the Stillwater Mine, the East Boulder Mine, and Boe Ranch LAD area locations. Only one member of the public attended the Stillwater Mine field trip, held on August 9, 2001, and 13 people attended the East Boulder Mine and Boe Ranch LAD area field trip held on August 11, 2001.

2.2 Issue Identification and Issue Statements

In addition to attending and commenting at the public scoping meetings and participating in project-related field trips, nine individuals also submitted written comments identifying issues and concerns.

Specific comments were arranged into groups of common concerns. A primary topic and issue statement was prepared for each comment group and evaluated for applicability to the MEPA/NEPA analysis. The analysis of comments identified 17 potential issues. Five issues were identified as significant or potentially significant because of the extent of their geographic distribution, the duration of their effects, or the intensity of interest or resource conflict. MEPA and NEPA direct agencies to focus environmental analyses on significant issues and to dismiss nonsignificant issues [ARM 17.4.615(2)(b) and (c) and 40 CFR 1500.4(b), (c), and (g)]. An issue's significance is different than and separate from any determination of significance of an environmental consequence evaluated in subsequent MEPA/NEPA environmental impact analyses.

2.2.1 Significant Issues

Significant issues form the basis of the MEPA/NEPA analysis, thereby defining the analysis scope. Once the scope has been defined, the project purpose, need, and significant issues govern the range of reasonable alternatives considered in the environmental analysis. Alternatives must meet, at least partially, the project purpose and need and address one or more of the significant issues. Significant issues vary with the location of alternative components (Table 2-1).

The following sections present significant issues identified for each of the three Proposed Actions. These issues will define the scope of the MEPA/NEPA analysis and alternatives considered.

Table 2–1 Issues to be Addressed by Alternatives Relative to Location

Issues (and Sub-issues)	Stillwater Mine (Closure and Post-Closure Water Management Plan)			East Boulder Mine (Closure and Post-Closure Water Management Plan)			Boe Ranch LAD System		
	No Action 1A	Proposed Action 2A	Agency-Mitigated Alternative 3A	No Action 1B	Proposed Action 2B	Agency-Mitigated Alternative 3B	No Action 1C	Proposed Action 2C	Agency-Mitigated Alternative 3C
1. Water Quality and Quantity	X	X	X	X	X	X	X	X	X
2. Wildlife and Aquatic Resources	-	X (Aquatics)	X (Aquatics)	-	X (Aquatics)	X (Aquatics)	-	X	X
3. Irrigation Practices	-	-	-	-	-	-	-	X	X
4. Cultural Resources	-	-	-	-	-	-	-	X	X
5. Stability of LAD Storage Pond	-	-	-	-	-	-	-	X	X

Notes:

1. "X" means the issue is pertinent to the location and the alternative.

2. "-" means the issue is not applicable to or is not addressed by that alternative.

Issue 1: Water Quality and Quantity

Project scoping identified concerns that implementation of the Proposed Actions might change the existing quality and quantity of water around the Stillwater Mine, the East Boulder Mine, and/or the East Boulder Boe Ranch LAD area. These changes could result from:

- Discharges of waters containing total inorganic nitrogen (TIN), heavy metals, or sediment from mine adits or storm water discharge during closure and post-closure;
- Discharges of tailings waters associated with impoundment dewatering during closure, which could vary in quality and quantity with low TIN concentrations. Water quality and quantity differences could result from treatment and disposal of tailings waters and/or open or plugged underdrains at closure and post-closure. Tailings waters consist of the following: supernatant water, tailings mass water, liner leakage, and seepage through the reclamation cover;
- Inadequate treatment of TIN during snowmaking at Boe Ranch LAD area during operations and closure;
- Uncontrolled discharges of adit water containing elevated TIN levels resulting from a ruptured pipeline feeding the Boe Ranch LAD system from the East Boulder Mine during operations and closure;
- Discharges of mine adit and tailings waters that contain low concentrations of TIN or other contaminants to ground and surface waters. This discharge could result from Boe Ranch LAD facilities if inappropriate application rates are used during operations and closure; and
- Post-closure discharges of adit water, tailings waters, and storm water runoff discharged directly to ground and surface waters.

The remaining environmental issues identified during scoping were estimated through analysis of potential water chemistry changes, operational experience at both mines, results of monitoring conducted since operations began at each mine, and professional interpretation of site-specific data and conditions. Water balances at both mines were evaluated to identify all sources of water at each mine. Mine water volume estimates, ground water flow rates, and mine waste water quality were used to evaluate the volume and quality of water discharged during operations, closure, and post-closure. Mine waste water treatment periods were evaluated. Changes to the monitoring programs at both mines were considered.

Issue 2: Wildlife and Aquatic Resources

Project scoping indicated that implementation of portions of the Proposed Actions might affect aquatic resources near both mines at closure and post-closure, as well as wildlife and aquatic resources on

and near the Boe Ranch during operations and closure. Effects could include:

- Adverse impacts to aquatic resources in the East Boulder and/or Stillwater Rivers from post-closure discharges to those rivers;
- Increases in the numbers of deer and elk that winter on the Boe Ranch and surrounding lands as a result of increases in forage values and carrying capacity due to the application of mine waters; and
- Adverse consequences to threatened or endangered species (TES); high-interest species; species of concern and sensitive species; and management indicator species that occur or potentially occur in the Boe Ranch LAD area.

Impacts to aquatic resources from adit, tailings, and storm waters discharges to the Stillwater and East Boulder rivers during operations, closure, and post-closure were estimated through professional interpretation of water quality and biomonitoring data.

Effects wildlife on and adjacent to Boe Ranch and the access road were estimated through professional interpretation of Montana Fish, Wildlife and Parks (FWP) data, including migratory patterns, local winter range use by deer and elk, hunting pressure, and predicted vegetation effects.

The US Fish and Wildlife Service (USFWS) were consulted on potential effects to listed or proposed TES on and adjacent to Boe Ranch and the access road. Impacts to TES at the Stillwater and East Boulder mines have been addressed in past environmental analyses.

Issue 3: Irrigation Practices

Concerns were identified related to implementation of the Boe Ranch LAD system, which could affect natural resources. Depending on the specific irrigation practices used, operation of the Boe Ranch LAD facilities could result in the following:

- Alterations in plant community composition under the LAD system in response to the increase in water and nutrients available to the plants during operation, as well as when the water is turned off;
- The spread of noxious weeds during operations, closure, and post-closure;
- Instability and increased potential for mass wasting beneath and downgradient of the irrigation center pivots; and
- Impacts to soils from nitrates, salts, and heavy metal accumulation.

Effects on plant communities and soils at Boe Ranch were predicted based on proposed irrigation practices, monitoring results for SMC's Hertzler Ranch LAD, and professional interpretation of site-specific

conditions of existing vegetation, soils, and water quality and quantity.

Effects on Boe Ranch LAD area mass wasting were predicted based on existing surface geology, soils characteristics, and proposed irrigation practices.

Issue 4: Cultural Resources

Public and agency comments indicated that implementation of the Boe Ranch LAD system Proposed Action might adversely affect cultural resources on the property. Effects to cultural resources were evaluated based on locations, types, and extent of disturbances associated with construction and operation of the Boe Ranch LAD system.

Issue 5: Stability of Boe Ranch LAD Storage Pond

Implementation of the Proposed Action (2C) would result in construction and long-term operation and closure use of a 32-acre LAD storage pond. SMC would construct the embankment using materials excavated from the pond site. The pond would be lined with a high-density polyethylene (HDPE) liner. SMC proposes to leave the pond in place during post-closure for ranching operations.

Public scoping revealed concerns associated with the construction and long-term use of the Boe Ranch LAD storage pond. Most of the comments questioned the stability of the pond embankment. Specific concerns include the following:

- The pond embankment stability based on site geologic and seismic conditions;
- The pond embankment stability should the geo-membrane lining fail;
- The ability of the pond to contain or pass a 100-year storm event and the effect of such an event on the drainage below the pond; and
- Damage to property and effects on water quality and quantity in the East Boulder River if the pond fails during operations, closure, or post-closure.

The following elements were evaluated:

- The Boe Ranch LAD storage pond proposed design criteria;
- Site-specific engineering studies and field data;
- Embankment construction material;
- Risk of failure based on known geologic conditions, anticipated seismic activity, and potential for flooding;
- Potential damage to property and effects on water quality and quantity in the East Boulder River.

2.2.2 Issues Considered But Dismissed

Several preliminary issues identified during project scoping were not relevant to the Proposed Actions. Additional potential issues were identified that were beyond the scope of this environmental analysis or that have been addressed by federal or state law, regulation, or policy. As discussed in Section 2.2, MEPA/NEPA analyses are intended to focus on potentially significant issues. The issues that appear below were identified during public scoping and were considered but dismissed from further analysis because they are not relevant to the three Proposed Actions.

Issue 6: Bonding

The MEPA/NEPA analysis should address the reclamation bond needed to cover closure and post-closure treatment and monitoring. The public indicated that the EIS should present options for providing financial assurance based on the full cost of feasible controls to maintain compliance with water quality standards and nitrogen non-degradation limits. Project scoping also identified that financial contingencies to deal with incorrect assumptions or control failures should be considered.

The Montana Metal Mine Reclamation Act (MMRA) requires DEQ to calculate the costs to the state and USFS for reclaiming a site should SMC default on its reclamation responsibilities (MCA 82–4–338). The state is required to review the bond at least every five years. Furthermore, the law dictates the methods that DEQ must use to compute the reclamation bond. The USFS has established bonding requirements under 36 CFR 228.13. A Memorandum of Understanding between the USFS and DEQ allows for joint bonding and eliminates duplicate bonds. Because these laws require a reclamation bond, funding for closure and post-closure monitoring and treatment is not an issue for this MEPA/NEPA analysis. The bond amount would be calculated according to the requirements of the selected alternative. Law, regulation, or policy has addressed this issue.

Issue 7: Incorporation of Operational Stipulations/Mitigations

Comments received suggested that the Record of Decision (ROD) for this analysis should include stipulations and mitigation measures that require SMC to reevaluate and amend operating plans when new disposal methods for tailings and waste rock are identified. It was suggested that SMC should be required to review best management practices (BMPs) and new technologies every five years and incorporate them into its Plans of Operations and reclamation plans.

Stipulations and mitigation measures identified from past environmental reviews are currently in place. The MMRA requires the agencies to evaluate and approve any changes to any approved Plan of Operations before implementation. MEPA and NEPA would require supplemental analysis of any new operational methods. In the

event that this or any further analyses indicated the need for permit stipulations or mitigations, they could be required and bonds would be adjusted at that time. Law, regulation, or policy has addressed this issue.

Issue 8: Potential Water Quality Impacts from Boe Ranch LAD System Mist into the East Boulder River

Comments received on the Proposed Actions identified a concern related to operation of the Boe Ranch LAD system and possible adverse effects to the East Boulder River from mist blowing from the LAD center pivots into the river.

Proposed center pivots are less than one mile from the East Boulder River. Experience obtained through monitoring SMC's Hertzler Ranch LAD system, which is about one mile from the Stillwater River, indicates that mist from the Boe Ranch LAD pivots would be unlikely to reach the East Boulder River due to distance and evaporation. This issue is beyond the scope of this analysis.

Issue 9: Water Quality Effects Caused by Phosphates in Treated Adit and Tailings Waters

Comments suggested that implementation of the Boe Ranch LAD system may result in adverse water quality effects through release of phosphates. SMC adds phosphoric acid to treated mine waters to increase the TIN removal efficiency of the biological treatment system (BTS). These comments indicated that, if soils under the LAD system contain insufficient calcium to bind phosphates, they may leach to ground water.

Data from water quality monitoring samples collected at both the Stillwater and East Boulder mines' LAD facilities have not identified elevated levels of phosphates in treated mine waters, in monitoring wells and lysimeters associated with existing LAD center pivots, or in percolation ponds. Phosphate levels were addressed in the Montana Pollutant Discharge Elimination System (MPDES) permits for each mine. Monitoring data to-date indicates phosphates would not be a substantive issue at the Boe Ranch LAD area. If the MEPA/NEPA analysis concludes that discharges of phosphates or other water quality parameters may pose a problem, they would be addressed under the *Water Quality and Quantity,* Section 4.1 in Chapter 4.

Issue 10: Storm Water Pollution Prevention Plan (SWPPP)

Project scoping comments indicated that the storm water pollution prevention plan (SWPPP) for the East Boulder Mine should be reviewed and updated to address the proposed Boe Ranch LAD site, pipeline, and new roads. The EIS should discuss or summarize and reference the SWPPP or BMPs that would be employed.

A review of SMC's SWPPP is a standard part of the MEPA/NEPA analysis. There is no need to include this review as a specific issue in the analysis. Law, regulation, or policy has addressed this issue.

Issue 11: Wetlands and Riparian Zones

Scoping comments indicated that the MEPA/NEPA analysis should evaluate the potential effects from construction and operation of the Boe Ranch LAD system on wetlands and riparian zones. Data collected to date indicate that neither wetlands nor riparian zones exist along the pipeline route near the proposed Boe Ranch LAD facilities. There are downslope riparian zones and wetlands approximately one mile northeast in Section 9, Township 3 South, Range 13 East. The Mason Ditch on the Boe Ranch leaks and appears to be a possible source of water for the riparian zones and wetlands. Other wetland resources are located along the East Boulder River. If possible, SMC must apply treated mine waters at Boe Ranch and comply with the 10 milligrams per liter (mg/L) TIN ground water standard. The potential for adverse effects to wetlands appears to be low. Impacts to wetlands and riparian zones will not be a substantive issue for the MEPA/NEPA analysis. If analysis of impacts to surface and ground water indicate a potential impact to riparian zones and wetlands, then those impacts would be addressed under Issue 3, *Irrigation Practices* in Chapter 4, Section 4.3.. This potential issue is beyond the scope of the analysis.

Issue 12: Tailings Impoundment Stability

Some comments indicated that the MEPA/NEPA analysis should evaluate long-term stability of the tailings impoundments. This evaluation should examine saturated conditions and consider stability during disasters such as floods and seismic events.

The long-term stability of existing tailings impoundments was evaluated as part of previous approval analyses for the tailings impoundment facilities. The analyses of these impoundments are contained in the final EISs for the Stillwater and East Boulder mines and the Hertzler Ranch tailings impoundment. The evaluations documented in those final EISs considered the engineering plans for closing the tailings impoundments. Changes to those approved designs are not part of the Proposed Actions and are not subject to this MEPA/NEPA analysis. Changes to the proposed water management plans being evaluated in this EIS would not affect tailings impoundment stability during operations, closure, and post-closure. This potential issue is beyond the scope of this analysis.

Issue 13: Public Participation

Some scoping participants felt that the MEPA/NEPA analysis process must provide for a higher level of public involvement.

- Concerns were identified about the perceived short notice for the public scoping meetings and the methods used to notify the public of the meetings.

- A few respondents indicated that the scoping document provided too little information on SMC's Proposed Actions. Responses received from the Northern Plains Resource Council and affiliates indicated that participants in the Good Neighbor Agreement with SMC believed that they should be allowed to review and comment on preliminary versions of the draft EIS. The environmental organizations believe that including these participants at this stage of the document's development would be within the spirit of the agreement and could help avoid potentially costly litigation later in the process.

The agencies have met or exceeded all procedural requirements and notification for public involvement embodied within the MEPA/NEPA regulations. As stated at the public meetings held in Big Timber and Absarokee, MT, public scoping comments were accepted beyond the August 20, 2001, date indicated in the scoping document.

The Good Neighbor Agreement is a working contract between SMC and private parties. USFS guidelines and legal requirements preclude selective public involvement. The Federal Advisory Committee Act is intended to provide an equal and open opportunity for public participation in federal decision-making processes. In other words, all non-governmental entities must be afforded the same opportunities to be involved in the MEPA/NEPA process. These opportunities are defined in the USFS regulations as the scoping process and review of the draft EIS. This issue is beyond the scope of this analysis and has been previously addressed by law, regulation, and policy.

Issue 14: MEPA/NEPA Process

Several comments requested that the document comply with various components of MEPA and NEPA.

- The MEPA/NEPA analysis should rigorously explore and objectively evaluate all reasonable alternatives that meet the purpose and need for the three Proposed Actions. It should include no-action alternatives and identify the agencies' preferred alternatives.
- The EIS should fully disclose the results of the impact analysis. The discussion should address direct, indirect, and cumulative effects. The analysis should discuss unavoidable adverse environmental effects, short-term and long-term environmental considerations, and irreversible or irretrievable commitments of resources that are involved in the implementation of each alternative.
- The EIS should include a comprehensive discussion of appropriate mitigation for direct, indirect, and cumulative effects. If possible, the EIS should provide a quantitative or a qualitative de-

scription of the site-specific effectiveness of mitigation measures.

The rigorous and objective analysis of reasonable alternatives; the full disclosure of direct, indirect, and cumulative effects, unavoidable adverse environmental effects, and irreversible or irretrievable commitments of resources; and a comprehensive discussion of appropriate mitigation measures for direct, indirect, and cumulative effects are all standard requirements for MEPA/NEPA analyses (ARM 17.4.617 and 40 CFR 1508). This issue has been addressed by state and federal law, regulation, or policy.

Issue 15: Effects of Nitrates and Trace Metal Bioaccumulation on Ruminants

Comments requested that the document address:

- The potential of nitrogen and trace metals (mainly cadmium, chromium, copper, lead, and zinc) accumulation through grazing under the Boe Ranch LAD area center pivots.

Nitrogen can accumulate in vegetation and within animals, including cattle, elk, deer, and pronghorn. In ruminants, the digestion process converts nitrates to nitrite and in turn to ammonia. Bacteria in the rumen then convert ammonia to protein. If ruminants rapidly ingest large quantities of plants that contain high levels of nitrate, nitrite will accumulate in the rumen. Nitrite is absorbed into red blood cells and combines with hemoglobin to form methemoglobin. Methemoglobin cannot transport oxygen as efficiently as hemoglobin and the animal would eventually suffocate.

Research involving livestock suggests that conditions resulting in elevated levels of nitrates in plants are unlikely to occur at the Boe Ranch LAD facility. Nitrates accumulate in plants under stressful conditions when growth of plants slows considerably, such as under drought conditions (Stoltenow and Lardy 1998; Undersander et al. 2001). Levels of nitrates in plants that could be toxic for ruminants are listed in Table 2-2. Application of treated mine waters with concentrations of nitrates equal to or lower than 10 mg/L are unlikely to result in the concentrations identified in Table 2-2 as potentially toxic. For example, during the 2005 growing season, SMC applied about 145,000,000 gallons of water to 265 acres through the Hertzler Ranch LAD system (SMC 2006c). With an average TIN concentration of less than 5 mg/L, SMC applied about 23 pounds of nitrogen per acre of treatment.

Guidelines for applying nitrogen to low alfalfa grass fields in MT range from 20 to 120 pounds per acre (lbs/ac) per season (Jacobsen et al. 2005), depending on the yield desired (1 to 6 tons per acre). SMC's application of nitrogen at the Hertzler Ranch LAD system is at the low end of the scale compared with common practices for agricultural hayfields in MT, where animals are exposed to considerably higher concentrations without adverse effects. Potential nitrate

bioaccumulation in animals through ingestion of vegetation at the Boe Ranch LAD area is not considered an issue to be evaluated in the MEPA/NEPA analysis.

Water quality analyses conducted for treated mine waters indicate that trace heavy metals can be found at or below analytical detection limits. Sediment may also contain low concentrations of heavy metals that are present in the mineralized rocks. These metals, such as cadmium, chromium, copper, lead, and zinc, which do occur in mine waters, are found at levels much lower than limits recommended for livestock drinking water (Table 2-3). Additionally, several of the trace metals, such as chromium and zinc, are essential, non-toxic elements at low concentrations. Animals' bodies control the concentrations of these metals. The combination of low concentrations that are below livestock and human health safety limits and the limited potential for bioaccumulation in animals through ingestion of vegetation at the Boe Ranch LAD area suggests that the application of trace metals via land application is not an issue to be evaluated in the MEPA/NEPA analysis.

Table 2–2 Levels of Nitrates Considered Safe or Potentially Toxic for Livestock

Level of Nitrate (mg/L[a])			Effects on livestock
KNO_3[b]	NO_3-N[c]	NO_3[d]	
0–10,000	0–1,500	0–6,500	Generally considered safe for livestock.
10,000–30,000	1,500–4,000	6,500–20,000	Problems have occurred at these levels.
> 30,000	> 4,000	> 20,000	Potentially toxic

Notes:
a. mg/L (milligrams per liter)
b. KNO_3 (potassium nitrate)
c. NO_3-N (nitrate-nitrogen)
d. NO_3 (nitrate)
Sources: Stoltenow and Lardy 1998; Undersander et al. 2001.

If analysis indicates that nitrates would accumulate in vegetation at levels that could cause problems in ruminants, or if trace metals are found to occur at levels that may be toxic, then this issue would be addressed under *Irrigation Practices*, Issue 3 in Chapter 4, section 4.3.

Table 2–3 Comparison of Metals Concentrations in Mine Water and Livestock and Human Health Water Quality Standards

	Cadmium		Chromium		Copper		Lead		Zinc	
	Min (µg/L)	Max (µg/L)	Min (µg/L)	Max (µg/L)	Min (µg/L)	Max (µg/L)	Min (µg/L)	Max (µg/L)	Min (µg/L)	Max (µg/L)
Adit Water	<0.1	0.3	<1	11	<1	3	<3	<3	<10	30
Tailings Waters	<0.1	0.4	<1	2	2	3	<3	<3	<10	40
East Boulder River	<0.1	0.6	<1	4	<1	8	<3	<3	<10	30

Livestock Standards	50	1,000	500	50	24,000
Human Health Standards for Surface Water	5	100	1,300	15	2,000

Sources: MT State University 1998; SMC and Hydrometrics, Inc. 2005; DEQ 2006; (µg/L) = micrograms per liter

Issue 16: Effects of Nitrates and Trace Metals on Waterfowl

Comments requested that the document address:

- Potential effects of nitrates and trace metals (mainly chromium, nickel, and zinc) on waterfowl that would use the Boe Ranch LAD storage pond.

Nitrate concentrations in untreated adit water exceed water quality standards for direct discharge to the East Boulder River. Treated adit water meets MPDES permit effluent limits for direct discharge to the East Boulder River (SMC and Hydrometrics, Inc. 2005). Nitrates concentrations are projected to be 10 mg/L in the Boe Ranch LAD storage pond. Tailings impoundments that contain nitrogen concentrations, which are five times higher, have not proven toxic to waterfowl. The potential for adverse effects to waterfowl using the LAD storage pond is not considered a significant issue to be evaluated in the MEPA/NEPA analysis. If analysis indicates that nitrates and trace metals may cause problems in waterfowl, then this issue would be addressed under *Wildlife and Aquatic Resources*, Issue 2 in Chapter 4, Section 4.2.1.

Issue 17: Effects of Trace Metal Accumulation on Plants and Soils

Trace metal concentrations in adit water and tailings waters have been tested and range from non-detectable to near detection limits (SMC 2007a). Trace metals can be essential micronutrients for plant growth but can accumulate in soil and plant tissue to the point that threatens plant and animal health. Concentrations of dissolved metals in the adit and tailings waters are less than EPA recommended guidelines for maximum peak and long-term (> 20 years) land application for all tested metals (EPA 1992).

Soil testing results from the Hertzler Ranch LAD area for spring 2005 through fall 2006 indicate no consistent discernible accumulation of heavy metals in soils for two years. Comparison to background soil samples indicates no differences that would indicate that metals are accumulating in soils. Ground water samples also show no discernible increase in heavy metals at the Hertzler Ranch LAD site or the East Boulder Mine site (SMC 2007a and SMC 2007b).

To evaluate heavy metal accumulation risk, the total mass load of metals from all East Boulder Mine water sources at maximum permitted design flows for 23 years was evaluated (CES 2008). Heavy metal loading for all sources of mine waters to the Boe Ranch LAD area is two to five orders of magnitude (.01 to .0001 percent) less than the EPA recommended maximums. With the low concentrations of metals in mine waters, metals loading does not present a risk of accumulation in soils, ground water, or plant tissues. Based on the above information, effects of heavy metal accumulations in LAD soils and plants are not reasonably foreseeable and will not be discussed further in this analysis.

2.3 Process Used to Develop Alternatives

Section 102 of NEPA and Part 2 of MEPA require agencies to consider alternatives to the Proposed Action (42 USC § 4332 and MCA 75-1-201(1)(b)(iv)(C), respectively). The process of developing alternatives to SMC's Proposed Actions involved four steps. First, DEQ and the USFS (GNF and CNF) conducted project scoping as described above. Significant issues were identified to help the agencies establish the scope and provide the basis for identifying changes (alternatives and mitigations) that would be needed to avoid, eliminate, reduce, or minimize impacts. The scoping process involved both agency and public concerns. It also considered environmental and project design elements.

The second step consisted of formulating alternatives that address one or more of the significant issues. A range of alternatives must be considered (40 CFR 1508.25) and must provide a clear basis for choice among the alternatives for decision-makers and the public (40 CFR 1508.14).

The third step was to screen the preliminary alternatives for reasonableness, as required by the MEPA/NEPA process. The Council on Environmental Quality's (CEQ) *40 Most Asked Questions about NEPA* (Question 2a) states, in part, "reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense…" (CEQ 1981). MEPA regulations require state agencies "to consider only alternatives that are realistic, technologically available, and represent a course of action that bears a logical relationship to the proposal being evaluated" (ARM 17.4.603(2)(b)).

Finally, based on this direction, the agencies screened alternatives to ensure that they met the project purpose and need and addressed technical, environmental, and economic considerations. Each reasonable alternative must meet, at least partially, the purpose of and need for the project. Technical considerations include the feasibility of facilities construction and operation. Environmental considerations include potential for significant impacts and the feasibility of successfully mitigating them. Economic considerations include potential costs and benefits.

Unreasonable alternatives were dropped from detailed consideration. If an alternative did not pass the technical, environmental, and economic screening for feasibility or did not at least partially address the project's purpose and need, it was

not considered further in the analysis. Section 2.4.5 summarizes and identifies any preliminary alternatives that were not evaluated in detail and explains why they were not considered further.

2.4 Descriptions of Alternatives

Nine alternatives were considered in this MEPA/NEPA analysis, including the following: three No Action Alternatives, SMC's three Proposed Actions, and three Agency-Mitigated Alternatives. These alternatives are described below.

Table 2- 4 Alphanumeric Naming Convention of Alternatives

	No Action	Proposed Action	Agency-Mitigated
Stillwater Mine and Hertzler Ranch LAD System	1A	2A	3A
East Boulder Mine	1B	2B	3B
Boe Ranch LAD System	1C	2C	3C

All significant issues are addressed, and results of the analysis are disclosed in Chapter 4. Five significant issues drove alternative development and represented discrete differences in environmental consequences, thereby providing a clear choice for decision-makers, as directed by 40 CFR 1502.14 and MEPA. These driving issues are water quality and quantity, wildlife and aquatic resources, irrigation practices, cultural resources, and stability of the LAD storage pond. Tables 2-6, 2-7, and 2-8 summarize how the MEPA/NEPA analysis addressed the significant issues by location and alternative.

Mine Life Terms

For the purpose of the alternatives in this EIS, the terms "operations", "closure", and "post-closure" are defined as follows:

Operations: The period when active mining is taking place, tailings are being generated, and active adit water treatment is ongoing.

Closure: The period when operations have ceased, tailings impoundments are dewatered and reclaimed, mine facilities are removed, and adit and tailings waters treatment is ongoing.

Post-Closure: The period after reclamation has been completed and active water treatment is no longer required. Monitoring and maintenance would continue.

2.4.1 Stillwater Mine Closure and Post-Closure Water Management Plan No Action Alternative 1A

Previous environmental studies for SMC's Stillwater Mine have analyzed the operational Water Management Plan (WMP) (see Appendix A). At closure, SMC would continue to handle adit water, the Stillwater and Hertzler Ranch tailings waters, and storm water.

Water Management Plan Components

The WMP addresses the management of all mine waters generated during operations, closure, and post-closure. These include:

Adit water:	Ground water intercepted by the mine workings that exits the adits.
Tailings water:	Water deposited in the tailings impoundment.
Storm water:	Rain and snowmelt that must be managed on the mine property.

2.4.1.1 Adit Water

The Stillwater Mine's underground workings intercept and would continue to intercept ground water. Inflows of ground water would increase with development of the mine until an area is dewatered. SMC grouts to reduce ground water inflows.

The Stillwater Mine discharges up to 650 gallons per minute (gpm) of adit water (Weimer 2009pc). The maximum discharge rate permitted from the two adits under the Plan of Operations is 2,020 gpm (DEQ and USFS 1998b) (Figure 2-1). MPDES Permit Number MT0024716 allows for an instantaneous maximum of 2,000 gpm (DEQ 2008).

Adit water picks up sediment and nitrogen compounds as it moves through the underground mine workings. Blasting compound residue is the source of the nitrogen compounds.

2.4.1.1.1 Operational Adit Water Management

During operations, SMC treats the adit water using process clarifiers. Within the clarifiers, sediment is settled out of solution before the water is directed to the BTS or recycled back to the underground operational water system. Within the BTS, any remaining sediment is removed, and the treated water is discharged to the Hertzler Ranch LAD system.

The primary purpose of the BTS is to remove nitrates from the adit water, thereby reducing TIN concentrations, prior to land application or percolation. Denitrification is a biologically enhanced process that converts nitrates to nitrogen gas. At the Stillwater Mine, SMC has documented reductions of TIN concentrations in adit water from approximately 15 – 30 mg/L to 1 – 3 mg/L. This is a 70 to 90 percent reduction (SMC 2006b). Operational BTS water treatment at the Stillwater Mine was authorized through the MPDES permit.

Under both the Plan of Operations and the MPDES permit, water from above 5,000 feet on the east-side exits the 5000E (east) adit during operations and is routed to the east-side clarifier, then to the east-side percolation ponds or Stillwater Valley Ranch percolation ponds (Figure 2-1, Figure 2-2, and Figure 2-3). SMC can reroute waters for operational purposes without going to treatment as long as it meets MPDES permit requirements.

Under the current MPDES permit, SMC routes the 5000W (west) adit water and water from below the 5,000-foot elevation on the east-side to the west-side clarifier during operations. From there, adit water is routed to the lined west-side BTS feed ponds 1 and 2. From the BTS feed ponds, the water is recycled underground, used in the milling circuit, or routed through the BTS plant and to the lined west-side LAD feed pond 3. SMC then routes the water to the Hertzler Ranch LAD storage pond, the east-side percolation ponds, or the Stillwater Valley Ranch percolation ponds (Figure 2-1). Although the MPDES permit allows direct discharge to the Stillwater River if TIN concentrations do not exceed 100 pounds (lbs) per day from all sources (DEQ 2008), SMC has never done so.

The Stillwater Mine percolation ponds and LAD areas were used for disposal of adit water through 2003. Since 2003, all Stillwater Mine west-side treated adit water has been routed for further treatment and disposal at the Hertzler Ranch LAD area. During the growing season, SMC avoids water balance problems by disposing of all water stored over the winter in the 100 million gallons (MG) Hertzler Ranch LAD storage pond with the excess operational adit water that is not recycled. There is no requirement at the Hertzler Ranch to LAD at agronomic rates. SMC's LAD system is operated to maximize evaporation and evaporates 30 percent of the water that enters the central pivot irrigation system. Only 70 percent of the water that enters the central pivot irrigation system reaches the soil.

2.4.1.1.2 Closure Adit Water Management

The current Plan of Operations does not specify methods or a time frame for adit water management during closure. Total discharge would be required to meet the nondegradation limit of 100 lbs TIN/day or MPDES permit limits in place at that time for other water quality parameters. The BTS can treat more than 1,000 gpm. SMC historically treats up to 650 gpm of adit water at up to 40 mg/L nitrogen concentrations. MPDES permit renewal is required every five years, although a permit can be administratively extended should its issuance be delayed.

West-side: Above 5,000 feet & Below 5,000 Feet

At closure, under the current Plan of Operations, water from the 5000W adit would be routed to the new west-side percolation ponds relocated downgradient of the 5000W mine portal (SMC 1994a). As shown in Figure 2-4, once MPDES permit limits are met, the west-side percolation ponds would be reclaimed, and adit water would be routed directly to the Stillwater River (SMC 1994b).

Routing of west-side water below the 5,000-foot level was not defined in the Plan of Operations, but would be routed to the underground at closure.

East-side: Above 5,000 feet & Below 5,000 Feet

East-side water above 5,000 feet would not be routed to the BTS at closure but would be disposed of in either set of east-side percolation ponds (DEQ and USFS 1998a).

Mixing of adit water with tailings waters and disposal at the Hertzler Ranch tailings impoundment was included in the final design documents for the Hertzler Ranch tailings impoundment (Knight Piésold 2005).

2.4.1.1.3 Post-closure Adit Water Management

During post-closure, 5000W and 5000E adit water would be discharged through percolation ponds to the Stillwater River via new channels. The design for the drainage channels would be submitted 12 months before closure (DSL and CNF 1992). Adit water from below the 5,000-foot elevation for the entire mine would not be discharged but would flood the mine workings (Figure 2-5)

2.4.1.2 Tailings Impoundment Waters

2.4.1.2.1 Stillwater Tailings Impoundment

The Stillwater tailings impoundment would be used throughout the life of the mine and would be reclaimed during mine closure, according to approved plans (Section 2.4.1.4).

Operational Tailings Waters Management

Supernatant water management. No volume was specified in the original Plan of Operations. Currently, water in the Stillwater tailings impoundment includes supernatant water and water contained in the tailings mass. SMC maintains about two feet of supernatant water in the Stillwater tailings impoundment, which equals up to 30 million gallons. This is the optimum volume of process water SMC needs for milling, concentrating, and controlling dust (Gilbert 2003). To maintain six feet of freeboard above the supernatant water level, SMC would use snowmakers and sprinklers as evaporators on the Stillwater tailings impoundment as well as pumping the supernatant water to the Hertzler Ranch tailings impoundment.

Sources of Tailings Waters

There are several sources of tailings waters to be managed during closure and post-closure. They have different volume, treatment, and disposal needs.

Supernatant water:	The freestanding water on tailings that needs to be disposed of before reclamation can begin.
Water in the tailings mass:	The water held within the tailings mass that is freed upon tailings consolidation.
Underdrain water:	Tailings water that has infiltrated through the tailings mass and discharged through the underdrain.
Liner leakage:	Tailings water that has infiltrated through the tailings impoundment and leaks through the liner.
Seepage through the cover:	Water that infiltrates through the cover to the tailings interface and discharges laterally to the embankment edge.

During operations, tailings waters are continuously recycled and used in the milling process and for dust control within the tailings impoundment. Tailings waters have never been routed through the BTS or to the LAD system, except during recent tests conducted by SMC (Gilbert 2004a; Weimer 2006c; Weimer 2006d).

Tailings mass dewatering and consolidation. The approved plans do not contain an estimate of the additional water volume contained in the tailings mass during operations or the volume that would be removed during closure dewatering and consolidation. SMC is dredging tailings during operations in order to consolidate tailings.

Underdrains. The Stillwater tailings impoundment does not have an underdrain to assist in dewatering the tailings.

Liner leakage. The Stillwater tailings impoundment was built with a 100-millimeter liner. Liner leakage is estimated to be less than 1 gpm (DSL and USFS 1985; Knight Piésold 2000b).

Closure Tailings Waters Management

Supernatant water management. Up to 30 million gallons of supernatant water would be treated and disposed of during closure. Tailings consolidation and dewatering would take about two years (DSL and CNF 1992).

The existing Plan of Operations specifies dewatering of the Stillwater tailings impoundment by pumping and evaporating the supernatant water over the tailings mass (SMC 1994b).

SMC may use sprinklers to irrigate revegetated areas, such as the dam face or surface of the tailings, as a contingency to dispose of supernatant water. SMC could install an enlarged spray evaporation system over the tailings to dispose of excess water (SMC 1994b).

Tailings mass dewatering and consolidation. The Plan of Operations does not contain an estimate of the water volume contained within the tailings mass to be removed, treated, and disposed of during closure. Consolidation is estimated to take two years (DSL and CNF 1992).

Tailings mass dewatering and consolidation through pumping and evaporation would continue until the tailings surface could support heavy equipment. Where the tailings surface remains too soft to support construction equipment, subgrade stabilization fabrics, waste rock, or a combination of the two, may be used to bridge soft areas (SMC 1994b). The current reclamation bond calculation assumes that 25 percent of the tailings surface would need stabilization fabric.

SMC proposed a combination of contingencies to facilitate dewatering and consolidation of the tailings mass (SMC 1994b). These methods included the use of horizontal drains, trenching, and sumps. No specific plans are approved. The Plan of Operations does not include contingencies for differential settling of the tailings surface. The tailings final grade after consolidation was not specified.

Rock mulch, sprinklers, or a chemical binder may be used to control dust while the tailings are being dewatered, if necessary (SMC 1994b). SMC made no commitments to any specific method or duration of tailings dust control.

Underdrains. There are no underdrains in the Stillwater tailings impoundment.

Liner leakage. Liner leakage would be the same as during operations.

Seepage through the cover. Seepage during closure would infiltrate through the cover and move laterally along the tailings surface. No flow rate was specified, as seepage through the cover was not anticipated. No means of collecting, routing, or discharging this seepage through the cover have been approved.

Post-Closure Tailings Waters Management

Supernatant water management. There would be no supernatant water to be managed during post-closure.

Tailings mass dewatering and consolidation. Tailings would have been dewatered and consolidated during closure, and tailings mass water would not need to be considered during post-closure.

Underdrains. There are no underdrains in the Stillwater tailings impoundment.

Liner leakage. Liner leakage would be the same as during operations.

Seepage through the cover. No flow rate was specified, as seepage through the cover was not anticipated. No means of collecting, routing, or discharging this seepage through the cover have been approved.

2.4.1.2.2 Hertzler Ranch Tailings Impoundment

At closure, SMC would reclaim the Hertzler Ranch tailings impoundment following plans approved by the agencies (DEQ and USFS 199a; DEQ and USFS 1998b).

Operational Tailings Waters Management

Supernatant water management. No volume was specified in the original Plan of Operations. Currently, SMC maintains about two feet of supernatant water on the Hertzler Ranch tailings impoundment, which equals up to 40 million gallons (Weimer 2006b). SMC maintains a freeboard of six feet above the supernatant water level.

During operations, the supernatant water is recycled back to the Stillwater impoundment and used in the milling process. It is also used for dust control within the Hertzler Ranch tailings impoundment. Hertzler Ranch tailings waters never have been routed through the BTS or to the LAD system, except during recent tests conducted by SMC (Gilbert 2004a; Weimer 2006c; Weimer 2006d). In 2008, the agencies approved a minor revision to dispose of excess supernatant water via the BTS system and Hertzler Ranch LAD system.

Tailings mass dewatering and consolidation. The approved plans do not contain an estimate of the additional water volume contained in the tailings mass during operations or the volume that would be removed during dewatering and consolidation. Dredging is not included in the approved Hertzler Ranch tailings impoundment operations and reclamation plan. SMC controls tailings deposition by using variable spigotting locations (SMC 1996).

Underdrains. The Hertzler Ranch tailings impoundment was permitted and constructed with an underdrain (DEQ and USFS 1998b). An underdrain improves tailings consolidation and dewatering during operations. The Stage 1 underdrain is open and discharges water at a rate of 30 gpm as of December 2007 (Weimer 2008b). The Stage 2 underdrain would discharge between 150 and 200 gpm initially but would decrease to a rate of approximately 50 gpm after 2 to 3 years.

Liner leakage. The Hertzler Ranch tailings impoundment is lined with a 60-millimeter-thick HDPE liner. Leakage through the liner is projected to be less than 0.1 gpm (SMC 1996).

Closure Tailing Water Management

Supernatant water management. At closure, the volume of supernatant water in the Hertzler Ranch tailings impoundment would be up to 40 million gallons, the same as during operation (Weimer 2006b). The quality of tailings supernatant water is discussed in Section 3.1.2. Mixing of untreated tailings waters with treated adit water and Stillwater tailings waters for disposal in the Hertzler Ranch LAD area was included in the final design (Knight Piésold 1999b).

Tailings consolidation, including dewatering, is anticipated to take two years. Dewatering of the Hertzler Ranch tailings impoundment would be accomplished by pumping and evaporating the water over the tailings mass (Knight Piésold 1999a; Knight Piésold 199b). SMC could also use a sprinkler irrigation system to irrigate revegetated areas, such as the dam face or the surface of the tailings, or to dispose of supernatant water and/or seepage collected in the underdrain system.

Rock mulch, sprinklers, or a chemical binder may be used to control dust while supernatant water is being removed and the tailings are being dewatered, if necessary. SMC made no commitments to any specific method or duration of dust control.

Tailings mass dewatering and consolidation. The volume of water contained within the tailings mass to be removed, treated, and disposed of during closure has not been estimated. Drying, settling, and consolidation of the tailings are expected to require two years (SMC 1996).

The water level within the tailings would be lowered to a point that would enable operation of heavy equipment on the tailings. Where the tailings surface remains too soft to support construction equipment, subgrade stabilization fabrics, borrow material, or a combination may be employed to bridge the soft areas.

Underdrains. The underdrain system would facilitate dewatering and consolidation of the Hertzler Ranch tailings impoundment by collecting water above the impoundment liner. Underdrain seepage would be collected in a pond outside of the impoundment embankment and routed back into the impoundment during operations and closure (Figure 2-1). Underdrains would be decommissioned when seepage is negligible. SMC anticipates negligible seepage after reclamation cover construction is completed (Knight Piésold 2000b). The underdrain would be grouted, the sump pump would be removed, and collection ponds would be reclaimed (Wolfe 2001).

Liner leakage. Liner leakage would be the same as during operations.

Seepage through the cover. Seepage through the cover was originally anticipated to infiltrate and percolate through the tailings, collect above the liner, and report as liner leakage. No flow rate was specified. No means of collecting, routing, treating, or disposing of this seepage through the cover has been approved.

Post-Closure Tailings Waters Management

Supernatant water management. There would be no supernatant water to be managed during post-closure.

Tailings mass dewatering and consolidation. Tailings would be dewatered and consolidated during closure, and tailings mass water would not need to be considered during post-closure.

Underdrains. The underdrains would be plugged during closure, and there would be no seepage from the underdrains to be managed during post-closure.

Liner leakage. Liner leakage would be the same as during operations.

Seepage through the cover. Management would be the same as during closure.

2.4.1.3 Storm Water Management

2.4.1.3.1 Stillwater Tailings Impoundment

Operational Storm Water Management

Storm water falling on the inner slopes of the tailings impoundment is not an issue during operations because all runoff is contained within the impoundment. Runoff from the outer slopes of the impoundment is managed according to SMC's approved SWPPP (SMC2007b).

Final design of the Stillwater tailings impoundment increased the west-side embankment height and routed upgradient storm water to percolation ponds or through diversion ditches to Mountain View Creek.

Closure Storm Water Management

Reclamation Cover Design and Construction

After the tailings have been dewatered during closure, SMC would construct a tailings reclamation cover by placing 335,600 cubic yards (cy) of waste rock and/or burrow material on the impoundment surface. This volume would provide a cover averaging 42 inches thick (SMC1994b). SMC would then cover the waste rock with soil or soil substitutes as approved by the agencies. The Reclamation Plan specifies eight inches of soil or approved soil substitutes (SMC 1994b).

SMC would conduct field tests before closure of the tailings impoundment. These tests would determine tailings consolidation (SMC 1994b). SMC would use the information acquired from this testing, subject to the agencies' approval, to finalize the depths and volumes of reclamation cover material required to achieve necessary post-settlement gradients.

The final surface of the reclamation cover would be graded at one percent away from the embankments to the northwest corner, creating a gentle swale down the center of the tailings impoundment (Figure 2-6). The reclamation cover would be revegetated with grasses and forbs. An existing berm along the west side of the tailings impoundment would preclude any storm water from running onto the reclaimed tailings impoundment. This berm and flow path would route water to the south and into Mountain View Creek. The reclamation cover would need routine maintenance during post-closure.

During closure, storm water runoff would flow to the drainage channel on the impoundment surface and exit the northwest corner of the impoundment (Figure 2-6). The Reclamation Plan provides conceptual routing only and states that suitable locations for the drainage channel would be evaluated and discussed with the agencies before the mine closes (SMC 1994b). The storm water flow rate from the reclamation cover was never specified.

Storm water would be routed into west-side percolation or sediment retention ponds. No drainage channel design or routing to those ponds has been specified. The 2007 SWPPP describes mine site operational storm water routes that would be in place at the start of closure (SMC 2007b). Storm water from the impoundment would need to connect to those channels.

Post-closure Storm Water Management

During post-closure, SMC may use one of two options to route storm water once it leaves the impoundment. One option would be to connect the drainage channel to a new storm water channel down the road west of the impoundment towards Mountain View Creek. The historic storm water channel to Mountain View Creek is closed at a culvert at the mill site. There are no approved plans for routing water to Mountain View Creek should SMC select that option. The second option would route storm water to the adit water channel from the 5000W portal to the Stillwater River. SMC would submit a plan 12 months prior to closure. The percolation ponds used for storm water discharge during closure would be reclaimed when the impoundment surface was revegetated (SMC 1994b).

2.4.1.3.2 Hertzler Ranch Tailings Impoundment

Operational Storm Water Management

Storm water falling on the inner slopes of the tailings impoundment during operations would be contained within the impoundment. Runoff from the outer reclaimed slopes of the impoundment would percolate into the ground at the base of the embankment. There is no SWPPP at the Hertzler Ranch tailings impoundment because storm water does not discharge to surface water.

Closure Storm Water Management

The one percent mounded reclamation cover slope would prevent storm water from ponding on the cover's surface. Storm water either would infiltrate the cover or would flow across the cover and over the edges of the impoundment as runoff before percolating into the ground (Knight Piésold 2000a). A channel would not be needed to handle runoff during post-closure because there would be no preferential flow paths. The storm water flow rate was never specified.

Reclamation Cover Design and Construction

SMC would test tailings consolidation before closure to finalize the depths and volume of cover materials needed to achieve post-settlement gradients. A detailed cover design would not be provided until final reclamation.

After the tailings are sufficiently dewatered, SMC would construct and revegetate the tailings reclamation cover (Figure 2-7). SMC would cover the surface of the tailings with an average of 48 inches of borrow material that was stockpiled during construction of the impoundment. If necessary for stabilization, up to 25 percent of the tailings surface may be covered with geo-fabric. The borrow material would then be covered with a total of 24 inches of subsoil and soil. There would be a minimum of 12 inches of soil. The resulting reclamation cover would be revegetated with grasses and forbs. The reclamation cover would be completed during closure.

Post-Closure Storm Water Management

Post-closure storm water handling would be the same as storm water handling during closure. The reclamation cover would need routine maintenance.

2.4.1.3.3 General Stillwater Mine Site

SMC has an operational SWPPP for the mine site (SMC 2007b). The storm water control facilities required by the SWPPP would be in place at closure. It does not address requirements, facilities, and management of storm water at closure or post-closure.

2.4.1.4 Reclamation

The following approved practices would be implemented at closure:

- The 5000W and 5000E adits would be secured with heavy mesh steel doors to retain future access and to facilitate water management (SMC 1988).

- Water would discharge from these adits into channels to the Stillwater River. All other adits would be backfilled with waste rock.
- A new west-side percolation pond would be constructed downgradient of the 5000W portal at closure. The pond would be reclaimed when adit water meets MPDES effluent limits without treatment. A new channel would connect the reclaimed percolation pond with the Stillwater River (SMC 1994b).
- The east-side percolation ponds and channels would remain in place (SMC 1994b). A channel would be constructed from the new percolation pond to the Stillwater River (DEQ and USFS 1998a).
- The Hertzler Ranch LAD storage pond and the LAD infrastructure would be left in place for the future landowner's use.
- Decommissioning of the BTS plant is not addressed in the MPDES permit. Reclamation of the pipelines between the mill site and the Hertzler Ranch LAD storage pond was covered in the 1998 EIS.
- Ventilation raises and breakouts would be plugged and capped.

2.4.1.5 Monitoring and Maintenance Plans

2.4.1.5.1 Monitoring Plans

Operational and/or closure monitoring plans include the following items:

- Adit water would be monitored until it meets MPDES effluent limits and TIN nondegradation load limits of 100 lbs/day, meets all legal requirements without treatment at closure, and the permit is terminated.
- Discharges of storm water to surface waters would be sampled as required by the MPDES permit. Sampling would occur according to the SWPPP (SMC 2007b).
- The ambient quality of surface water and ground water would be monitored according to the approved water monitoring plan (Hydrometrics, Inc. 1999).
- Reclamation covers would be monitored for settlement and consolidation during the closure period (DSL, USFS, and MDHES 1992b).
- Water seeping out of the underdrains at the Hertzler Ranch tailings impoundment would be sampled until the underdrains were plugged.
- There are no monitoring requirements for quantity and quality of supernatant water, seepage through the cover, liner leakage, percolation ponds, or discharge channel function contained in the 1996 Plan of Operations.

No post-closure monitoring plans were approved.

2.4.1.5.2 Maintenance Plans

Closure and post-closure maintenance plans for water management facilities are limited. The Plan of Operations does not include managing and maintaining the BTS plant and associated facilities during closure. SMC would bear the responsibility for maintenance of all ponds as specified in its MPDES permit and

SWPPP. SMC has prepared a 5-year maintenance plan for the sedimentation basins, percolation ponds, and/or lined west-side feed ponds 1, 2, and 3 during closure (SMC 1994a). SMC would reclaim sedimentation basins at the end of closure. After the MPDES permit expires, SMC would be responsible for any necessary maintenance or reclamation (SMC 1994a). All facilities discussed above, except the east-side percolation ponds and channels, would have been de-commissioned and reclaimed by the end of closure (SMC 1994b).

No plans exist for maintaining any water management facilities during post-closure.

2.4.2 Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2A

Under this alternative, SMC proposes to modify its WMP for the Stillwater Mine (Knight Piésold 2000b). SMC would implement a closure and post-closure WMP after operations cease at the Stillwater Mine. This plan would involve constructing, maintaining, and operating facilities that would collect, treat, and discharge adit, tailings, and storm water during operations and at closure. During post-closure, when adit water no longer requires treatment, SMC would discharge the water directly into the Stillwater River.

2.4.2.1 Adit Water

As with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, described in Section 2.4.1, adits at the Stillwater Mine would continue to intercept ground water.

2.4.2.1.1 Operational Adit Water Management

Operational adit water management would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A (Figure 2-1). The BTS water treatment system would be used during mine operation. The Hertzler Ranch LAD would be used during mine operation. Adit water would be treated through the BTS prior to disposal to meet the MPDES 100-lbs TIN/day limit.

2.4.2.1.2 Closure Adit Water Management

All adit water would be pumped out of the Stillwater Mine for six weeks while the underground workings are decommissioned, which would include removing or draining all fluids from equipment (Knight Piésold 2007). SMC would not route any treated, mixed adit/tailings waters directly to the Stillwater River, although, it is a disposal option under the MPDES permit.

West-side: Above 5,000 feet

At closure, west-side adit water above 5,000 feet would be mixed with Stillwater tailings waters for up to six months and treated through the clarifier and BTS. After six months, the west-side clarifier would be decommissioned. From six months to one year, water above the 5,000-foot level would be routed directly to the BTS, if needed, for mixing with tailings waters. The BTS would be available for a maximum of one year. Treated adit water or mixed adit/tailings waters would be routed to the Hertzler Ranch LAD System for disposal for up to one year (Knight Piésold 2007). At some time between six months and one year, west-side adit water above the 5,000 foot level would be routed to the underground workings.

West-side: Below 5,000 feet

At closure, west-side adit water below 5,000 feet would be mixed with Stillwater tailings waters for up to six months and treated through the clarifier and BTS.

After six months, the west-side clarifier would be removed. From six months to one year, water below the 5,000-foot level would be routed directly to the BTS, if needed, for mixing with tailings waters. The BTS would be available for a maximum of one year. Treated adit water or mixed adit/tailings waters would be routed to the Hertzler Ranch LAD System for disposal for up to one year (Knight Piésold 2007). At some time between six months and one year, west adit water below the 5,000-foot level would be routed to the underground workings.

East-side: Above 5,000 feet

East-side adit water above 5,000 feet would be routed to the east-side clarifier for three months and then routed to the east-side percolation ponds (Figure 2-6) (Knight Piésold 2007). After the east-side clarifier is decommissioned, the water would be routed directly to the east-side percolation ponds.

East-side: Below 5,000 feet

At closure, east-side adit water below 5,000 feet would be mixed with Stillwater tailings waters for up to six months and treated through the east-side clarifier and BTS. After six months, the east-side clarifier would be removed. From six months to one year, water below the 5,000-foot level would be routed directly to the BTS with tailings waters. For the first year, the mixed, treated adit and tailings waters would go to the Hertzler Ranch LAD system, the east-side percolation ponds, or the Stillwater Valley Ranch percolation ponds. At some time between six months and one year, east adit water below the 5,000-foot level would be routed to the underground workings.

2.4.2.1.3 Post-Closure Adit Water Management

After the BTS plant is decommissioned, west-side water from above the 5000W adit would discharge from the adit through the percolation pond to a newly constructed channel to the Stillwater River (Figure 2-9)(Knight Piésold 2000B). East-side water from above the 5000E adit would be routed through a reclaimed percolation pond into a newly constructed channel to the Stillwater River (Figure 2-9 and Figure 2-10). Only conceptual locations and channel designs have been provided. All water from below 5,000 feet would flood the mine workings. It is estimated to take 38 years for intercepted ground water below 5,000 feet, at an assumed rate of 350 gpm, to eventually flood the underground workings and discharge from the 5000E and 5000W adits (Thompson 2004).

2.4.2.2 Tailings Waters

2.4.2.2.1 Stillwater Tailings Impoundment

Operational Tailings Waters Management

Supernatant water management. Management of and volume of supernatant water during operations would be the same as for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A. No plans have been proposed for BTS treatment of tailings waters during operations.

Tailings mass dewatering and consolidation. Tailings mass dewatering and consolidation during operations would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Underdrains. There would be no underdrains, as with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Closure Tailings Waters Management

Supernatant water management. At closure, supernatant water would be mixed with adit water, treated through the BTS plant, and discharged via the Hertzler Ranch LAD system and east-side or Stillwater Valley Ranch percolation ponds (Figure 2–8). SMC has estimated that dewatering and treating the supernatant water would take up to one year.

SMC tested a ratio of ten parts adit water to one part tailings waters to determine the feasibility of using BTS treatment (Gilbert 2004a). Test work demonstrated that undiluted tailings waters could be treated through the BTS without toxic effects to microorganisms (SMC 2006b).

Existing evaporators over the Stillwater tailings impoundment could be used as a contingency for disposing of supernatant water. Hertzler Ranch LAD would be the primary disposal method rather than evaporation.

Tailings mass dewatering and consolidation. Aggressive placement of reclamation cover materials would assist in forcing out tailings mass water and increasing tailings consolidation. The tailings mass contains an estimated five million gallons of water that would be released during dewatering, consolidation, and reclamation (Knight Piésold 2004).

Dewatering and consolidation would be conducted as described for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, except accelerated dewatering and aggressive cover placement would occur within 12 to 14 months (Knight Piésold 2007). SMC did not propose any alternative, additional, or contingency invasive techniques for improving dewatering and consolidation of the tailings mass other than those described in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

As a result of a tailings density study, SMC would not use subgrade stabilization fabrics to bridge soft areas in the surface of the tailings (Knight Piésold 2000a). SMC proposes to use a combination of 24 inches of waste rock and/or glacial borrow material plus eight inches of soil and/or borrow material for capping the impoundment. As reclamation covers are placed on tailings, tailings slimes would likely advance ahead of the cover placement operations. Tailing slimes that advance ahead of cover placement would be surrounded and capped without the use of geo-textiles (Knight Piésold 2007). Tailing would be deposited with a one-percent gradient toward the seepage outlet structure at the north end of the

impoundment (Figure 2-11) where slimes would accumulate (Knight Piésold 2007).

Sprinklers currently being used for tailings dust control during operations would not be used during closure under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A.

Underdrains. There would be no underdrains, as with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Seepage through the cover. Seepage through the cover would be routed to the BTS for treatment for a maximum of one year during capping activities or pumped into the underground workings. Modeling by SMC for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A indicates that seepage through the cover would move laterally along the tailings surface under the reclamation cover. The rate of seepage through the cover during closure is estimated at an average of 2 gpm and a peak of 8.3 gpm (Knight Piésold 2000c). The seepage outlet structure would be located at the north end of the impoundment. Seepage through the cover and tailings mass water would be piped to the lined west-side BTS feed ponds 1 and 2. During closure, seepage would be combined with adit and tailings waters in the feed ponds and treated in the BTS plant prior to discharge to the Hertzler Ranch LAD system, the east-side percolation ponds, or the Stillwater Valley Ranch percolation ponds.

Post-Closure Tailing Water Management

Supernatant water management. There would be no supernatant water to be managed during post-closure.

Tailings mass dewatering and consolidation. Tailings would have been dewatered and consolidated during closure, and tailings mass water would not need to be managed during post-closure.

Underdrains. There would be no underdrains, as with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Seepage through the cover. During post-closure, seepage through the cover would be routed through an unlined channel to the new west-side percolation pond and then on to the Stillwater River (Figure 2-10). Conceptual channel designs have been provided (Knight Piésold 2007).

2.4.2.2.2 Hertzler Ranch Tailings Impoundment

Operational Tailings Waters Management

Supernatant water management. As under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, the Hertzler Ranch tailings impoundment would contain an average of two feet of supernatant water on the tailings, which equals up to 40 million gallons (Weimer 2006b). SMC would dispose of excess supernatant water, if needed, during operations via the BTS and Hertzler Ranch LAD system (Knight Piésold 2007).

Tailings mass dewatering and consolidation. The tailings deposition method would be the same as that for No Action Alternative 1A. The estimated volume of water contained in the tailings mass during operations would be the same as that for No Action Alternative 1A.

Underdrains. The use of the underdrain system during operations would be the same as that for No Action Alternative 1A.

Liner leakage. Liner leakage is estimated to be 0.2 gpm with underdrains open (Knight Piésold 2000c).

Closure Tailing Water Management

Supernatant water management. At closure, up to 40 million gallons of supernatant water from the Hertzler Ranch tailings impoundment would be pumped at a minimum rate of 100 gpm to the LAD storage pond (Weimer 2006b). Hertzler Ranch supernatant water would be mixed with treated adit water or treated mixed adit water and Stillwater tailings waters and land applied via the Hertzler Ranch LAD system for up to one year.

The quality of tailings supernatant water would be similar to that of the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, as described in Section 3.1.2.1. The quality of Hertzler Ranch supernatant water mixed with treated adit or treated mixed adit and Stillwater tailings waters from the BTS is discussed in Section 4.1.1.1. Although a 10:1 mixing ratio was used in the analysis, SMC has not specified a mixing ratio. SMC would use the ratio that required the least amount of treated adit or treated mixed adit and Stillwater impoundment supernatant water to dilute the Hertzler Ranch tailings water prior to LAD. Dewatering of the Hertzler Ranch tailings impoundment could be supplemented by pumping and evaporating the unmixed water over the tailings mass.

Tailings mass dewatering and consolidation. SMC estimates that the tailings mass would contain 14 million gallons of water, of which 5 million would be released during dewatering, consolidation, and reclamation. It would take a maximum of one year to remove all tailings waters. Water released from the tailings mass would be pumped to the LAD storage pond, mixed with treated adit water or treated mixed adit water and Stillwater tailings waters, and land applied via the Hertzler Ranch LAD system. Alternately, SMC could evaporate the water over the tailings mass.

An operational density study shows denser tailings than originally anticipated, such that stabilization fabrics should not be necessary (Knight Piésold 2000a). SMC did not propose to use stabilization fabrics.

SMC did not propose any additional contingencies or specific invasive dewatering methods for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A. The possible methods mentioned in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A would remain the same.

As with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, no contingencies were proposed to handle problems if consolidation does not occur as planned or for differential settling of tailings surface. No grading of tailings was proposed. The tailings grade would be a minimum of one percent toward the seepage outlet structure at the south end of the impoundment (Figure 2-12) (Knight Piésold 2007).

Dust control during closure would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, except that sprinklers would not be used during dewatering and capping.

Underdrains. The underdrains would be used until seepage decreases to 9 gpm, which is expected to occur within four years after operations cease (Knight Piésold 2000b).

Liner leakage. During closure, while the underdrains are open, liner leakage would be the same as described for operations above.

Seepage through the cover. The peak rate for seepage through the cover with the underdrains open would be 10.4 gpm with an average seepage rate of 0.2 gpm (Knight Piésold 2000c). Modeling indicates that seepage through the cover would move laterally along the tailings surface under the reclamation cover (Knight Piésold 2000b). A seepage outlet structure was added during the impoundment's final design process. The seepage would discharge through this structure on the south end of the embankment (Figure 2-12) (Knight Piésold 2007). It would then be piped via gravity from the outlet structure to the Hertzler Ranch LAD storage pond. Slimes would accumulate in the southern end of the impoundment.

During closure, seepage through the cover, along with other sources of tailings waters from the Hertzler Ranch tailings impoundment, would be combined with treated adit water or treated mixed adit and Stillwater impoundment supernatant water prior to discharge to the Hertzler Ranch LAD system. These combined waters would be land applied at the Hertzler Ranch LAD system for up to one year while the tailings facility is being reclaimed (Knight Piésold 2007).

Post-Closure Tailing Water Management

Supernatant water management. There would be no supernatant water to be managed during post-closure.

Tailings mass dewatering and consolidation. Tailings mass water would have been removed during closure and would not need to be managed during post-closure.

Underdrains. The underdrains would be plugged when discharge rate equals 9.0 gpm or less, which is anticipated to require up to four years (Wolfe 2001). Decommissioning of the underdrains would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A. After the underdrains are plugged, there would be no seepage from the underdrains to be handled during post-closure.

Liner leakage. Liner leakage would change to 0.4 gpm as a result of plugging the underdrains (Knight Piésold 2000c).

Seepage through the cover. With the underdrains plugged, peak seepage through the cover would be 18.3 gpm with an average seepage rate of 1.8 gpm (Knight Piésold 2000c). During post-closure, untreated seepage would be discharged through the riprapped channel to the LAD storage pond (SMC 2006c), where it could mix with irrigation water supplemented by the Tandy Ditch. This mixed water would be used for agricultural irrigation or evaporated in the bottom of the LAD storage pond, depending on landowner preference (Gilbert 2003). The riprapped channels would be five feet wide and two feet deep with 2:1 slopes (Knight Piésold 2007).

2.4.2.3 Storm Water Management

2.4.2.3.1 Stillwater Tailings Impoundment

Storm Water Flow Rate

Modeling used 30 and 50 percent runoff from a 100-year, 24-hour storm event and was broken out on a monthly basis (Knight Piésold 2000b).

Operational Storm Water Management

Storm water management would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A (SMC 2007b).

Closure Storm Water Management

Reclamation Cover Design and Construction

The reclamation cover would consist of 24 inches of waste rock and/or borrow material and 8 inches of soil or borrow material, for a total of 32 inches of growth medium (Knight Piésold 2007). Total volume of waste rock and/or borrow material needed on the impoundment surface would be 209,000 cy.

The reclamation cover final grade would have a minimum slope of one percent to the north end of the impoundment after all long-term settlement has occurred (Knight Piésold 2007) (Figure 2-10, Figure 2-11, and Figure 2-13). The reclamation cover would be revegetated with grasses and forbs. The reclamation cover

would be completed and implemented during closure. Only routine maintenance would be needed during post-closure.

Until the reclamation cover is completely installed, storm water would collect on the tailings surface and would be removed along with other tailings waters during dewatering and consolidation. After the reclamation cover is installed, storm water from the impoundment would be routed to the existing sediment retention basin below the 5000W adit.

Storm water would run off the reclamation cover to the seepage outlet structure and discharge to a channel down the embankment (Knight Piésold 2007). The seepage outlet structure, which is essentially a spillway, would be sized to handle a 100-year, 24-hour storm event. The reclamation plan includes a riprapped channel from the low spot in the tailings to the seepage outlet structure (Knight Piésold 2007)

Post-Closure Storm Water Management

During post-closure, storm water would be routed through a channel to the west-side percolation pond to the Stillwater River.

2.4.2.3.2 Hertzler Ranch Tailings Impoundment

Storm Water Flow Rate

Modeling for reclamation cover and storm water channel designs used 30 and 50 percent runoff from a 100-year, 24-hour storm event, and the rate was broken out on a monthly basis (Knight Piésold 2000b; Knight Piésold 2000c).

Operational Storm Water Management

Storm water management. Storm water management would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Closure Storm Water Management

Reclamation Cover Design and Construction

Tailings consolidation testing would be conducted before closure to finalize the depths and volume of cover materials as under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A. After the tailings are dewatered, SMC would construct a tailings reclamation cover with an average of 24 inches of borrow material that would be stockpiled during construction of the impoundment. The borrow material would then be covered with a total of 24 inches of subsoil and soil. No stabilization fabric would be required. The reclamation cover would be completed during closure. Only routine maintenance would be needed during post-closure.

The final grade of the reclamation cover would average one percent. A seepage outlet structure would be located at the south end of the impoundment (Knight Piésold 2007). The Reclamation Plan includes a design for the riprapped channel that would extend from the low spot in the tailings to the seepage outlet structure

at the southern end of the impoundment before discharging to the Hertzler LAD storage pond (Knight Piésold 2007).

Post-Closure Storm Water Management

Routing of post-closure storm water runoff would be the same as that during closure after reclamation cover placement. The storm water runoff channel at the

south end of the impoundment would discharge to the Hertzler LAD storage pond (Knight Piésold 2007).

2.4.2.3.3 General Stillwater Mine Site

During closure, SMC would route mine site storm water around the northwest corner of the impoundment to an existing sediment retention basin. During post-closure, the storm water channel would be connected from the mine adit channel to a new percolation pond, then under FAS 419 to the Stillwater River (Figure 2-10). Some mine site storm water would be routed from the south end of the impoundment to Mountain View Creek during closure and post-closure (Figure 2-10) (Knight Piésold 2007)). The SWPPP at the mine site would need to be updated to address closure and post-closure. There is no SWPPP needed for the Hertzler Ranch, as described for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

2.4.2.4 Reclamation

Under this alternative, existing facilities would be reclaimed as described for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A with the following changes:

- The lined west-side feed ponds near the BTS plant would be reclaimed after the BTS plant was decommissioned (Knight Piésold 2000b).
- The two east-side percolation ponds would remain in place during closure and post-closure. They would be reclaimed, and the channel would be routed through the ponds to the Stillwater River (Knight Piésold 2003).
- The four Stillwater Valley Ranch percolation ponds would be reclaimed, but the historic trout ponds would remain in place.
- Raises would be plugged and capped with native materials (USFS and DEQ 2002).
- Borrow Area No. 1 would be reclaimed at a 2:1 slope without soil replacement (Knight Piésold 2008).
- The clarifiers would be removed within the first six months of closure. The BTS plant and pipelines would be decommissioned and reclaimed within one year when all MPDES effluent limits and the TIN nondegradation load limit of 100 lbs/day could be met without treatment.

2.4.2.5 Monitoring and Maintenance Plans

2.4.2.5.1 Monitoring Plans

Operational and/or closure monitoring plans would be the same as those described for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, except for the following:

- Seepage through the reclamation cover for the Stillwater tailings impoundment would be monitored as influent to the BTS plant to determine if there is a need for treatment prior to disposal during closure.
- Settlement of the tailings at the Stillwater and Hertzler Ranch tailings impoundments would be monitored on a 100-foot grid (Wolfe 2001).
- Adit water would be sampled as long as is needed for the dilution of tailings waters.

- As with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, no post-closure monitoring plans are proposed.

2.4.2.5.2 Maintenance Plans

Closure maintenance plans for water management facilities would be the same as those described for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, with one exception: the Plan of Operations would cover the management and maintenance of the BTS plant and associated facilities during the first year of closure, after which the BTS would be reclaimed.

As with the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, there are no plans for maintaining water management facilities, including channels, seepage outlet structures, armored channels, LAD storage pond, and east-side percolation ponds during post-closure.

2.4.3 Stillwater Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3A

This alternative is similar to the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A. The primary differences focus on determining more specific detail and time frames for closure and post-closure water management. These differences are intended to decrease time needed for mine decommissioning and site reclamation. This alternative also increases monitoring and maintenance requirements throughout mine life. The discussion presented in the following sections focuses on the specifics of this alternative that differ from the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A.

2.4.3.1 Adit Water

As with the Stillwater Mine WMP No Action Alternative 1A and Proposed Action Alternative 2A, described in Sections 2.4.1 and 2.4.2, respectively, adits at the Stillwater Mine would continue to intercept and discharge ground water.

2.4.3.1.1 Operational Adit Water Management

Operational adit water management would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A (Figure 2-1).

2.4.3.1.2 Closure Adit Water Management

Closure adit water management would be the same as that for the Stillwater Mine WMP Proposed Action 2A, except that 12 weeks would be required for underground decommissioning and draining underground equipment fluids. The clarifier and the BTS would be available for use up to 18 months, if needed.

West-side: Above and Below 5,000 feet

At closure, west-side adit water above and below 5,000 feet would be mixed with Stillwater tailings waters for up to 18 months, treated in the BTS, and routed to the Hertzler Ranch LAD area. Adit water above and below the 5,000-foot level would be routed to the underground workings at some point in time between 12 weeks and 18 months, if no further treatment is required (Figure 2-14).

During the growing season, SMC would dispose of all water stored over the winter in the 100 MG Hertzler Ranch LAD storage pond with adit and tailings waters. There is no requirement at the Hertzler Ranch to LAD at agronomic rates. SMC's LAD system is operated to maximize evaporation and evaporates 30 percent of the water that enters the central pivot irrigation system. Only 70 percent of the water that enters the central pivot irrigation system reaches the soil.

East-side: Above 5,000 feet

For the first 12 weeks, east-side water above 5,000 feet would be routed to the east-side clarifier and then to the new percolation pond on the east-side. Then the east-side clarifier would be decommissioned, and east-side water above 5.000 feet would be routed to the underground workings.

East-side: Below 5,000 feet

For up to 18 months, east-side water below 5,000 feet could be routed to the following locations: west-side clarifier, BTS, Hertzler Ranch LAD system, underground mine workings, and/or east-side or Stillwater Valley percolation ponds (Figure 2-14). East-side adit water below the 5,000-foot level would be routed to the underground workings at some point in time between 12 weeks and 18 months, if no further treatment were required.

2.4.3.1.3 Post-Closure Adit Water Management

Based on the volume of underground workings and a ground water inflow rate of 650 gpm, it would take an estimated 11.4 years for the mine workings to flood with all adit water directed into the mine (Thompson 2004). The agencies performed an independent analysis based on an intercepted ground water flow of 2,020 gpm, and concluded it would take an estimated 4 – 11 years for the mine workings to flood with all adit water directed into the mine.

Once the mine workings flooded, all adit water would discharge from the west-side shaft, which is the topographic low point. Discharge would enter a channel designed and constructed as a trout stream that would then flow to the Stillwater River (Figure 2-15 and figure 2-16). Channel design must be submitted with the next annual report after the ROD is issued, if this alternative is selected. The channel must be designed to handle the approved 2,020 gpm adit flow plus the 100-year, 24-hour storm event. Because the discharge from the underground workings would come from the shaft, no east or west-side channels from the adits to the Stillwater River would be constructed.

2.4.3.2 Tailings Waters

2.4.3.2.1 Stillwater Tailings Impoundment

Operational Tailings Waters Management

Supernatant water management. Operational supernatant water management would be the same as under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A (Section 2.4.1.2.1).

Tailings mass dewatering and consolidation. Tailings mass dewatering and consolidation would be the same as under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Underdrains. There would be no underdrains, as described for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Closure Tailing Water Management

Supernatant water management. Under this alternative, as soon as untreated adit water TIN concentrations drop to a point that the supernatant water could be percolated without violating the 100-lb/day MPDES permit limit, the supernatant

water would be directed to underground workings. At that point in time, the BTS could be used to treat undiluted Stillwater tailings waters prior to discharge to Hertzler Ranch LAD storage pond (Figure 2-17).

SMC would expand its annual monitoring of the Stillwater tailings impoundment under this alternative. The annual monitoring would include evaluating existing tailings consolidation, estimating supernatant water volume, estimating the time needed for final tailings consolidation, and monitoring tailings grade. SMC's annual reports would include discussions of current tailings management. SMC would submit a tailings density report every five years prior to bond review.

Tailings mass dewatering and consolidation. Under this Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A, tailings mass dewatering and consolidation would be the same as under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except that slimes liberated during cover placement would be pumped to the underground workings at the 5,000W adit. Tailings waters would be pumped and treated for up to 18 months. Aggressive placement of waste rock or glacial till and other approved technologies would be used for dust control.

Underdrains. There would be no underdrains, as described in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as that described in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Seepage through the cover. Seepage through the cover during closure will be managed the same as under the Stillwater Mine Closure and Post-Closure WMP Proposed Action 2A, except the BTS would be available for up to 18 months, needed for treatment of tailings waters.

Post-Closure Tailing Water Management

Supernatant water management. There would be no supernatant water to be managed during post-closure.

Tailings mass dewatering and consolidation. Once the reclamation cover is completed, any tailings waters liberated would report as seepage through the cover and be routed through the seepage outlet structure, be mixed with storm water runoff, and be discharged to the Stillwater River.

Underdrains. There would be no underdrains, as described in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as described in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Seepage through the cover. During post-closure, routing of seepage through the cover would be the same as described for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except it would combine with underground mine water discharging from the shaft (Figure 2-16).

2.4.3.2.2 Hertzler Ranch Tailings Impoundment

Operational Tailings Waters Management

Supernatant water management. Volume and operational management of supernatant water would be the same as for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, as described in Section 2.4.2.2.2.

Tailings mass dewatering and consolidation. Tailings mass dewatering and consolidation during operations would be the same as under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except for additional monitoring detailed below in Section 2.4.3.5.1.

Underdrains. The use of the underdrain system during operations would be the same as under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Liner leakage. Liner leakage would be the same as under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Closure Tailings Waters Management

Supernatant water management. The management of supernatant water would be the same as described for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except the BTS would be kept for up to 18 months, if needed.

Tailings mass dewatering and consolidation. For closure, tailings mass dewatering and consolidation would be the same as under the Stillwater Mine Closure and Post-Closure WMP Proposed Action 2A, except tailings slimes that accumulated ahead of cover placement would be pumped to the south end of the LAD storage pond. Treated adit water would be available for up to 18 months of closure to mix with Hertzler Ranch tailings waters prior to LAD. After 18 months, tailings waters would be pumped to the LAD storage pond and land applied. No contingencies would be required for tailings consolidation or differential settling.

Dust control during closure would consist of a combination of spray irrigation, aggressive borrow material placement, rock mulch, or other approved technologies.

Underdrains. During closure, underdrains would be managed the same as described in the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A.

Liner leakage. The liner leakage would be the same as in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Seepage through the cover. Seepage through the cover would be the same as described for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except seepage through the cover would be land applied at the Hertzler Ranch LAD system for up to 18 months while the tailings facility is being reclaimed.

Post-Closure Tailings Waters Management

Supernatant water management. There would be no supernatant water to be managed during post-closure.

Tailings mass dewatering and consolidation. Tailings mass water would have been removed during closure and would not need to be managed during post-closure.

Underdrains. Underdrains would remain open to facilitate consolidation and to allow anaerobic denitrification (Gilbert 2004b, Knight Piésold 2004). During post-closure, the underdrain collection sumps would be converted to percolation ponds by removing the liners and pumps. The sumps would be filled with gravel, and underdrain seepage would fill the sump and percolate into the ground beyond the sump.

Liner leakage. Liner leakage would be the same as in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Seepage through the cover. The flow rate would be the same as described for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A during closure.

2.4.3.3 Storm Water Management

2.4.3.3.1 Stillwater Tailings Impoundment

Storm Water Flow Rate

The storm water runoff flow rate is the same as in the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A.

Operational Storm Water Management

Storm water management would be the same as that for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Closure Storm Water Management

Reclamation Cover Design

Cover design would be the similar to the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, except SMC could use waste rock and/or borrow for the capping material and the grade of the swale would be steeper. The agencies assume that differential settling would occur.

Post-Closure Storm Water Management

SMC would submit a conceptual riprapped channel design with the next annual report after approval. This channel design and sizing would be the same as in the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except the channel would collect and transport mine site storm water and mine water exiting the shaft.

2.4.3.3.2 Hertzler Ranch Tailings Impoundment

Storm Water Flow Rate

The storm water runoff flow rate is the same as in the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A

Operational Storm Water Management

Storm water management would be the same as described in the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A.

Closure Storm Water Management

Reclamation Cover Design

Thickness of the reclamation cover cap would be the same as for the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, except no stabilization fabric would be used (Figure 2-7). The agencies assume differential settling would occur. The final grade of the reclamation cover would be the same as the Stillwater Mine Closure and Post-Closure WMP Proposed Alternative Action 2A

During closure, storm water routing would be the same as in the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A.

Post-Closure Storm Water Management

Routing of post-closure storm water runoff would be the same as in the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A.

2.4.3.3.3 General Stillwater Mine Site

Storm water routing would be the same as under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, except during post-closure the sediment retention basins would be reclaimed. An unlined channel mimicking a trout stream would be constructed from the mine shaft to the Stillwater River.

2.4.3.4 Reclamation

Under this Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A, existing facilities would be reclaimed, as described for No Action Alternative 1A, except for the following changes:

- The underdrains of the Hertzler Ranch tailings impoundment would report to reclaimed unlined percolation ponds.
- Bat-friendly gates would be installed on the 5000W and 5000E adits. The design would be submitted with the next annual report if this alternative were selected. All other adits would be backfilled with 50 feet of waste rock over a 100-foot-long steel pipe installed for possible drainage. No heavy mesh steel doors would be used.
- A steel-mesh grate would be installed on the shaft collar to prevent unauthorized shaft access, protecting human health and safety and precluding wildlife impacts.

- Water would not discharge out of the adits but from the mine shaft, which is the low point opening into the underground mine workings.
- The two east-side percolation ponds would be reclaimed, and the channel from the 5000E adit to the Stillwater River would not be constructed because all water would exit from the mine shaft.
- The channel from the mine shaft to the Stillwater River would be designed and constructed to function as a trout stream when mine water discharges from the shaft. The design would be submitted with the next annual report after a ROD has been issued.

- Borrow Area No. 1 would be reclaimed to at least an overall 2.5:1 slope with steeper slopes at the top and concave slopes at the base. The slope would be undulating to mimic natural slopes.

Unlike the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, the west-side clarifier and BTS would be maintained for up to 18 months, if necessary. The clarifier, BTS, and pipelines would be decommissioned and reclaimed after 18 months.

2.4.3.5 Monitoring and Maintenance Plans

2.4.3.5.1 Monitoring Plans

Operational and/or closure monitoring plans would be submitted with the annual report and would be the same as those described for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, with the following additional items:

Operations and Closure Monitoring

- Annual tailings deposition would be monitored to verify the tailings grade during operations.
- Annual supernatant water volume would be monitored during operations.
- The tailings density in both impoundments would be monitored every five years.
- Specific recommendations for impoundment monitoring and management at the Stillwater tailings impoundment are included in the Knight Piésold Tailings Density Study (Knight Piésold 2000a). These operational controls would also be implemented at the Hertzler Ranch tailings impoundment.
- Tailings impoundment function and structural integrity would be monitored.
- A revised water monitoring plan for the Hertzler Ranch LAD that includes both surface water and ground water monitoring must be submitted to and approved by the agencies, if this alternative is selected. This would include sampling for nutrients, salts, and biomonitoring.
- Water quality at the Hertzler Ranch impoundment underdrains would be monitored quarterly during operations and closure.

Post-Closure Monitoring

Post-closure monitoring would continue until the bond is released or the MPDES permit is no longer needed:

- Ground water and surface water quality would be monitored as required by approved water monitoring plans and the MPDES permit in place during post-closure. Monitoring frequency may be reduced.
- Mine shaft water quality would be monitored quarterly the first year discharge begins and annually thereafter until water quality stabilizes.
- Mine shaft water elevation would be monitored twice a year until mine water exits the shaft.
- Tailings impoundment function and structural integrity would be monitored annually for the first five years and then once every five years.
- The seepage outlet and seepage through the cover discharge channel function would be monitored annually for the first five years and then once every five years.
- Water from the seepage outlet structure at the Hertzler Ranch tailings impoundment would be monitored for quality and flow rate quarterly until water quality stabilizes.

2.4.3.5.2 Maintenance Plans

Plans for the maintenance of water management facilities at closure would be submitted with the first annual monitoring report. These plans would be the same as those for Stillwater Mine WMP Proposed Action Alternative 2A, except for the addition of the following facilities:

- Storm water, mine shaft, and seepage outlet structure discharge channels;
- An underdrain percolation pond at the Hertzler Ranch impoundment;
- Other water management facilities including LAD facilities, pipelines, the Hertzler Ranch LAD storage pond, percolation ponds, and storm water retention ponds for up to 18 months during closure.

The post-closure monitoring and maintenance plans would address the following items to be evaluated annually during the first five years of post-closure and once every five years thereafter until the bond is released or the MPDES permit is no longer needed:

- Function of all ponds—percolation ponds, storm water sediment retention basins, and Hertzler Ranch LAD storage pond.
- Channel function of all storm water, shaft, and seepage outlet structure discharge channels, and the underdrains.

2.4.4 East Boulder Mine Closure and Post-Closure Water Management Plan No Action Alternative 1B

As with SMC's Stillwater Mine, environmental analyses for the East Boulder Mine have disclosed impacts of the approved operational WMP (DEQ and USFS 1998a; DEQ and USFS 1998b). A closure and post-closure WMP was not specifically considered for the East Boulder Mine. To date, no plans have addressed the need for long-term adit water treatment before disposal, management and treatment of tailings waters, seepage through the cover, or underdrain seepage.

2.4.4.1 Adit Water

East Boulder Mine's underground development has intercepted ground water. SMC grouts to reduce ground water inflows where discharge levels over extended periods are persistently high, generally greater than 100 gpm.

Adit water discharge averaged 150 gpm during 2009 (Wolfe 2009pc). The maximum adit discharge permitted is 737 gpm (Stillwater PGM Resources 1990). Adit water picks up suspended sediment, nitrogen compounds, and salts as it moves through the underground mine workings. Blasting residues are the source of the nitrogen compounds and salts. SMC cannot exceed the MPDES nondegradation average TIN limit of 30 lbs/day for all mine water discharges to the East Boulder River during operations and closure.

The components of the East Boulder Mine LAD system are described below in the context of the East Boulder Mine area. The locations of LAD areas 2 and 6 are shown on Figure 2-27. The East Boulder Mine is located in a steep, glaciated, mountainous valley at an elevation of 6,300 feet amsl with slopes ranging from zero to 65 percent. Surface water drainage patterns are influenced by the natural slopes and depressions formed as a result of glaciation and later modified by mine development.

The East Boulder Mine area is a logged lodgepole pine forest dominated by grassland with young conifers and shrubs reestablishing over time. The East Boulder Mine soils are well drained, with moderate amounts of weathering and soil development. Soils are glacial in origin and contain 18 to 20 percent clay and up to 90 percent cobbles and gravels (coarse fragments). Permeability is moderately rapid. Water-holding capacity is moderate and ranges from 5.0 to 9.5 inches per acre depending on soil type and coarse fragment content (CES 2008). Grasses and lodgepole pine grow well on these soils because the soils have moderate water-holding capacity despite the rockiness. Soil permeability and drainage in the East Boulder Mine LAD areas (NRCS 2006a) are considered suitable for LAD center pivot irrigation, snowmaking, or evaporation (CES 2008).

The East Boulder Mine LAD area slopes range from 2 to 10 percent. The steeper slopes and drainageways reduce water infiltration and increase runoff. Conversely, vegetation increases infiltration and reduces runoff. Runoff from the

LAD area would flow to natural glacial depressions or to constructed runoff collection and percolation ponds. No mine runoff reaches the East Boulder River (Knight Piésold 2000c and CES 2008).

East Boulder Mine LAD areas 2, 3-Upper, and 4 have been permitted but not constructed. LAD Area 6 has been constructed and is operational, but is not used on a regular basis. The East Boulder Mine LAD system could be operated in summer through a center pivot irrigator and evaporators and in winter through snowmakers (Figure 2-18). LAD would be constrained by evapotranspiration during the growing season, and in winter, by temperature, humidity, and mechanical function of the snowmaker/evaporators (CES 2008).

Use of the percolation pond provides flexibility for operations and closure. The percolation pond would be used preferably and when LAD is not possible or when the LAD feed pond is full. The lack of water storage capacity at the East Boulder Mine makes the percolation pond a critical discharge point during operations. If LAD would be used as the primary disposal method, there would be times when LAD is not possible for 30 days or more (CES 2008). When that occurs, the percolation pond would need to be used for discharge. If the adit flow rate increases and the MPDES permitted nitrogen limit cannot be achieved using the mine percolation pond and LAD Area 6, consideration would be given to constructing contingency LAD areas 2, 3-Upper, and 4.

2.4.4.1.1 Operational Adit Water Management

During operations, adit water discharge is directed to a clarifier to remove sediment and then is routed through the East Boulder Mine BTS/Anox system to treat nitrogen compounds. After BTS/Anox treatment, the water is recycled underground for mining, routed to LAD Area 6 for summer land application and winter snowmaking, would be routed to LAD Areas 2, 3, and 4 if constructed, and/or routed to the percolation pond (Figure 2-18). Treated adit water can be discharged to the East Boulder River under the MPDES permit, but no pipeline or channel is in place. The BTS water treatment plant has been approved through the MPDES Permit (MT–0026808) and the Plan of Operations (SMC 1998).

To date at the East Boulder Mine, the operational flow rate of 150 gpm adit water has been low enough that little or no LAD has been necessary. The treated adit water can be routed to the percolation pond in compliance with the 30 lb/day nitrogen MPDES permit limit. There is a requirement in the East Boulder Mine MPDES permit to LAD at agronomic rates. SMC's LAD Area 6 consists of five evaporator/snowmaker units that may be used to treat and dispose of mine water during the growing season using LAD and winter using snowmaking. The East Boulder Mine LAD Area 6 is operated similarly to the Hertzler Ranch LAD system in that it maximizes evaporation. About 30 percent of the water that enters the evaporator/snowmaker units is evaporated. Only 70 percent of the water that enters the units reaches the soil (CES 2008).

The 1998 operational WMP describes mixing process water with adit water and routing it to the BTS for treatment and disposal. For more detailed information about operational tailings waters management, please refer to Section 2.4.4.2.

2.4.4.1.2 Closure Adit Water Management

SMC cannot exceed the MPDES average TIN limit of 30 lbs/day for all mine water discharge during closure. The Plan of Operations does not specify a time frame for treating adit water during closure. Adit water management at closure would be the same as during operations, except the clarifier would be decommissioned after one year while the BTS would be retained for up to three years (Figure 2-19). Under the 1998 WMP, mixed adit and tailings waters would not be routed directly to the East Boulder River. No provisions for mixing tailings waters with adit water prior to BTS treatment were considered during closure.

2.4.4.1.3 Post-Closure Adit Water Management

During post-closure, adit water would be directly discharged to the East Boulder River without treatment (Figure 2-19). The water would be routed to the river via a new channel constructed from the adits. No channel design was proposed, analyzed, or approved, although conceptual routing was described in the Plan of Operations. Channel designs are to be submitted 12 months before closure (DSL 1993) and must be designed to handle the approved 737 gpm adit flow plus the 100-year storm event for the drainage area.

2.4.4.2 Tailings Waters

The East Boulder tailings impoundment would be used throughout the life of the mine and would be reclaimed at mine closure. Closure plans are similar to those for the Hertzler Ranch tailings impoundment at the Stillwater Mine. SMC considers the chemistry of process water and tailings waters to be equivalent (Stillwater PGM Resources 1990).

2.4.4.2.1 Operational Tailings Waters Management

Supernatant Water Management

During operations, water in the East Boulder tailings impoundment includes supernatant water on top of the tailings and water entrained in the tailings mass. No volume of supernatant water was initially specified. Tailings water quality has been disclosed in previous environmental documents and Appendix C, Table of Untreated Adit and Tailings Water Quality, in this document. SMC maintains an average of two feet of standing water on top of the tailings during operations for use in the milling process, as a storage reservoir for water management considerations, and for dust control. At full development, up to 35 million gallons of supernatant water would be on top of the East Boulder tailings impoundment (Wolfe 2006b). This is the optimum volume of process water SMC needs readily available for milling, concentrating, and controlling dust (Gilbert 2003).

There is no plan for operational monitoring of supernatant water volume in the Plan of Operations. If SMC needs to reduce the volume of water in the impoundment for any reason, it can evaporate tailings waters over the impoundment surface using evaporators and sprinklers. Tailings waters have never been routed through the BTS system to the LAD system.

Tailings Mass Dewatering and Consolidation

During operations, the tailings mass continuously consolidates and dewaters from its own weight. Tailings deposition is controlled by changing spigotting locations. During operations, the tailings waters are continuously recycled and used in the milling process and for dust control within the tailings impoundment.

Underdrain Seepage

An underdrain system consisting of numerous gravel and pipe finger drains was constructed on top of the tailings impoundment's bottom liner. The purpose of this system is to reduce water pressure on top of the liner and to hasten consolidation of the tailings mass. The underdrain system was not part of SMC's original design, but was included during the final design process for the tailings impoundment (Figure 2-21) (Knight Piésold 1999a). The underdrain collection sump and pump house are located on the northwest side of the impoundment. The underdrain is open during operations and has an average flow rate of 30 gpm (Wolfe 2007).

Liner Leakage

The East Boulder tailings impoundment is lined with a 100-mil HDPE liner. Leakage through the liner is estimated to be less than 1.0 gpm (DSL et al. 1992b).

2.4.4.2.2 Closure Tailings Waters Management

Supernatant Water Management

No time frame for disposal of supernatant water during closure was specified. Dewatering of the East Boulder tailings impoundment would be accomplished by pumping and evaporating the tailings waters over the tailings mass (Stillwater PGM Resources 1990). Excess tailings waters could be pumped to the clarifier, combined with mine adit water, treated in the BTS/Anox, and/or land applied (SMC 1998). Sprinklers could be used to irrigate revegetated areas, such as the dam face and tailings surface, to dispose of supernatant water, tailings mass water, and/or underdrain seepage (Figure 2-21).

As with the Stillwater Mine impoundments, no contingencies or specific invasive dewatering methods were specified or approved. The 1990 SMC Plan of Operations mentions several methods to facilitate dewatering and consolidation, including horizontal drains, trenching, and scarifying, but no specific commitments were made.

Tailings Mass Dewatering and Consolidation

The Plan of Operations does not contain an estimate of the additional volume of water contained within the tailings mass that would be removed, treated, and disposed during closure. There is no estimate of the length of time required to achieve tailings mass consolidation, although drying and settling have been estimated to take two years (Knight Piésold 1999b). Dewatering has been estimated to take two to three years (Knight Piésold 2001). The agencies assumed that two years would be required to dewater the tailings impoundment sufficiently so the

reclamation cover could be placed (USFS and DEQ 2002). SMC is required to conduct consolidation and settlement studies prior to mine closure (DSL 1993). The primary means of tailings consolidation and dewatering during operations and closure of the East Boulder tailings impoundment would be the continuous discharge of the underdrain system.

Rapid tailings dewatering and consolidation would enable cap placement on tailings. Where the tailings surface remains too soft to support construction equipment, SMC could use subgrade stabilization fabrics, borrow material, or a combination of the two to bridge the soft areas (Stillwater PGM Resources 1990). An SMC tailings density study shows denser tailings than originally anticipated (Knight Piésold 2000a). The use of a subgrade stabilization fabric is not anticipated (Knight Piésold 2001).

No contingencies are included in the approved reclamation plan to address problems if tailings consolidation does not occur as anticipated. The plan does not include contingencies for differential settling of the tailings surface after consolidation. After the tailings have been dewatered, the tailings surface would be regraded to provide a minimum one percent slope toward the seepage outlet structure at the south end (Figure 2-21) (Knight Piésold 1999b; Knight Piésold 2000a). Rock mulch, sprinklers, or a chemical binder may be used to control dust while the tailings are dewatered, if necessary (Stillwater PGM Resources 1990). SMC made no commitments to any specific method or duration of dust control.

Underdrain Seepage

After the reclamation cover is constructed, SMC anticipates that seepage from the tailings into the underdrain system would become negligible, although the time frame was not defined (Knight Piésold 1999b; Brouwer 2003). Once flows are negligible, the underdrains would be decommissioned (Stillwater PGM Resources 1990).

Liner Leakage

Liner leakage would be the same as that described above for operations.

Seepage through the Cover

Surface water seepage through the reclamation cover was not discussed in the Plan of Operations or accompanying environmental documents. Seepage through the cover during the closure phase was originally anticipated to infiltrate and percolate into the tailings, collect above the liner, and report to the underdrain or as liner leakage. No means of collecting, routing, treating, or disposing of the seepage through the cover was proposed or approved, and no estimate of seepage rate was made.

Seepage through the cover would preferentially collect along the interface between the more permeable cover material and the underlying less permeable tailings. To promote the free drainage of seepage through the cover, a seepage outlet structure was added during the impoundment's final design phase (Knight Piésold 1999b). Seepage through the cover would gravity flow from the seepage

outlet structure through a channel and pipeline to the BTS plant for treatment or be directly routed to the percolation pond (Figure 2-19) (Knight Piésold 1999b).

2.4.4.2.3 Post-Closure Tailings Waters Management

Supernatant Water Management

All supernatant water would have been removed from the tailings impoundment during closure. There would be no supernatant water to be managed during post-closure.

Tailings Mass Dewatering and Consolidation

The reclamation cover system would have been placed on the impoundment during closure. Any water liberated during post-closure would report to the seepage outlet structure as seepage through the cover.

Underdrain Seepage

Underdrains would have been plugged when the flow became negligible (Figure 2-20). There would be no underdrain seepage to be handled during post-closure.

Liner Leakage

Liner leakage would be the same as that described above for operations.

Seepage through the Cover

The Plan of Operations did not identify any routing or disposal of seepage through the cover during post-closure. SMC's final impoundment design states that seepage would be routed to the East Boulder River at post-closure, but no location or design was provided (Knight Piésold 1999b).

2.4.4.3 Storm Water Management

2.4.4.3.1 East Boulder Tailings Impoundment

Storm Water Flow Rate

No storm water flow rate from the tailings impoundment was defined for operations, closure, and post-closure.

Operational Storm Water Management

Storm water falling on the tailings impoundment's inner slopes during operations would be contained within the impoundment. Runoff from the outer slopes of the impoundment would be managed according to SMC's approved SWPPP (SMC 2007b).

Reclamation Cover Design

SMC must conduct field tests to assess consolidation of the tailings before closure in order to finalize the depths and volume of cover materials needed to

achieve post-settlement gradients (Knight Piésold 1999b). Results from these tests would be used to finalize the cover design.

After the tailings are dewatered sufficiently, SMC would construct a tailings reclamation cover and revegetate it in a manner similar to the Hertzler Ranch tailings impoundment. SMC first would cover the tailings surface with an average of 48 inches of waste rock or borrow material. The reclamation cover would be mounded prior to soil placement to help route storm water off the reclaimed surface (Knight Piésold 1999b). This reclamation cover material would then be covered with 22 inches of subsoil and 6 inches of soil (USFS and DEQ 2002).

The final grade of the reclamation cover is designed to have a minimum one percent slope from the center of the impoundment to the edges (Figure 2-21). The reclamation cover would be revegetated with grasses, forbs, and trees.

Closure Storm Water Management

The one percent slope of the reclamation cover would prevent storm water from ponding on the cover's surface. Storm water would either infiltrate the cover or flow across the cover and down over the edges of the impoundment at unspecified locations (Knight Piésold 1999a). No separate channels would be needed to route storm water.

Post-closure Storm Water Management

Post-closure storm water management would be the same as during closure.

2.4.4.3.2 General East Boulder Mine Site

SMC has an operational SWPPP for all mine disturbances within the permit boundary including the LAD areas (SMC 2007b). The SWPPP does not address closure or post-closure storm water management. Storm water would be managed as it is during operations. Unlike the Stillwater Mine, the East Boulder Mine site has no defined storm water drainages because the primary mine access road acts as a confinement dike between the mine and the East Boulder River. All water up to a 100-year storm event would be contained and percolated on site. No storm water diversions/channels would be required.

Even though the SWPPP does not address storm water management at closure, storm water captured in the diversion ditch above the impoundment would continue to be routed into the percolation pond. During post-closure, a short drainage channel would connect the diversion channel with the mine adit water drainage channel. The combined flows would be conveyed to the East Boulder River in a constructed channel. There are no other storm water facilities approved for the mine site area for closure or post-closure.

2.4.4.4 Reclamation

The existing facilities would be reclaimed according to approved plans (Stillwater PGM Resources 1990; SMC 1998). In addition to these general practices, the following reclamation activities would occur:

- Adits would be plugged to prevent public access, but allow for seepage discharge (Stillwater PGM Resources 1990).
- Adits with no beneficial use would be backfilled with waste rock (USFS and DEQ 2002).
- Raises would be plugged and capped with native materials (USFS and DEQ 2002).
- Decommissioning of the BTS plant and mine site LAD system is included in the agency reclamation bond calculations (USFS and DEQ 2002). Reclamation of the pipelines between the mill site and the USFS boundary is also included.
- The clarifier, BTS plant, pipelines, percolation pond, and mine site LAD facilities would be reclaimed when the nondegradation TIN load limit of 30 lbs/day was met without treatment.
- Clarifiers would be removed after the first 12 months of closure. The BTS would be decommissioned after three years.
- LAD facilities would be removed during post-closure (Knight Piésold 2001).

2.4.4.5 Monitoring and Maintenance Plans

2.4.4.5.1 Monitoring Plans

Operational Monitoring

- The ambient quality of surface water and ground water would be monitored according to the approved operating plan and MPDES permit (SMC 1998; DEQ 2000).

Closure Monitoring

- Adit water would be monitored until it meets MPDES nondegradation permit limits (SMC 1998; DEQ 2000).
- Storm water discharges to surface waters would be sampled as required by the MPDES permit and the SWPPP after the closure diversion channel is constructed (SMC 2007b).
- Underdrain seepage out of the underdrain outlet at the East Boulder tailings impoundment would be monitored until the underdrain outlet is plugged (Knight Piésold 1999a).
- There are no monitoring requirements for quantity and quality of seepage through the cover, liner leakage, percolation ponds, or discharge channel function.
- Reclamation covers would be monitored for settlement and consolidation during the closure period on a 100-foot sampling grid (Knight Piésold 1999b). No time frame or frequency was specified.

Post-Closure Monitoring

Post-closure monitoring would include the following (USFS and DEQ 2002):

- Ground water and surface water quality

- Tailings settlement
- Channel function
- Seepage outlet structure function
- Seasonal monitoring of gravity flow adit water quality and quantity

2.4.4.5.2 Maintenance Plans

Reclamation bond calculations include three years of managing and maintaining the following: storm water and adit discharge channels, the seepage through the cover outlet structure, and the channel during closure (USFS and DEQ 2002). The plans include managing and maintaining the BTS plant and associated facilities during closure. Mine reclamation could take up to four years.

There are no plans for maintaining water management facilities, including channels, during post-closure, although post-closure maintenance is included in agency reclamation bond calculations in the form of a perpetual care fund (USFS and DEQ 2002).

2.4.5 East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B

Under this alternative, SMC proposes to modify its operational WMP for the East Boulder Mine to include closure and post-closure water collection, treating, routing, and disposal. The plan would require SMC to continue operating the East Boulder BTS and associated water treatment facilities during mine closure until the provisions of the MPDES permit are met. During post-closure, no mine water treatment would be required.

2.4.5.1 Adit Water

As with the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, as described in Section 2.4.4.1, adits at the East Boulder Mine would continue to intercept ground water.

Operational Adit Water Management

Operational adit water management would be the same as that for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B (Figure 2-18).

Closure Adit Water Management

At closure, water from the adit would be routed through the clarifier, mixed with tailings waters, and treated in the BTS for up to one year (Knight Piésold 2000b). After tailings waters are gone, adit water would be treated through the clarifier and BTS, if needed, until water quality meets MPDES permit limits. The clarifier would be decommissioned after one year. (Figure 2-22).

The routing and disposal of adit water at closure would differ from East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B. Preferential adit water disposal would consist of the following: mine site percolation pond; LAD Area 6; LAD Areas 2, 3, and 4; and the East Boulder River.

Post-Closure Adit Water Management

When adit water meets MPDES effluent limits without treatment, adit water would be routed to the percolation pond (Figure 2-23). Conceptual designs for the routing channel are shown on Figure 2-24 but are not sized to handle the approved 737 gpm adit flow plus the 100-year, 24-hour storm event for the drainage area. Once adit water TIN levels meet SMC's MPDES permit limits without additional treatment, SMC would decommission and reclaim the BTS plant and East Boulder Mine LAD system (Figure 2-23).

2.4.5.2 Tailings Waters

2.4.5.2.1 Operational Tailings Waters Management

Supernatant Water Management

As discussed for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, SMC maintains approximately up to 35 million gallons of supernatant water within the East Boulder tailings impoundment during operations (Wolfe 2006b). Operational management of the supernatant water would be the same as for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, as described in Section 2.4.4.2.1.

Tailings Mass Dewatering and Consolidation

It is estimated that 14 million gallons of water are contained in the tailings mass, but only 5 million gallons would be liberated during capping (Knight Piésold 2004). As the tailings consolidate under their own weight, tailings mass water would be liberated from the tailings mass.

Underdrains

The underdrain system remains open during operations, just as in the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B.

Liner Leakage

During operations, liner leakage is estimated to be between 0.1 gpm and 0.3 gpm (Knight Piésold 2000c).

2.4.5.2.2 Closure Tailings Waters Management

Supernatant Water Management

Supernatant water would be mixed with adit water and treated in the BTS plant. Treated water could be routed to the following sites: the mine site percolation pond; LAD Area 6 for summer land application and winter snowmaking; LAD Areas 2, 3, and 4; or directly to the East Boulder River. Tailings supernatant water would be removed from the impoundment within a maximum of one year (Knight Piésold 2007). SMC also could evaporate some of the untreated tailing water over the impoundment using existing spray evaporation equipment.

The quality of supernatant water would be the same as that for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B. Mixing of adit and tailings waters would be conducted until adit water TIN content is reduced to a level allowing disposal without treatment. At that point, tailings waters would be treated in the BTS without mixing (Knight Piésold 2007). SMC has performed successful BTS plant tests at its Stillwater Mine based on a mixing ratio of ten parts adit water to one part tailings waters. Subsequent testing showed that tailings waters can be treated in the BTS without mixing adit water and not cause any reduction in TIN treatment (Weimer 2006c). The mixing ratio at the East Boulder BTS plant would be based on these test runs. Water quality of the treated supernatant water was disclosed in the SMC treatment study

(Weimer 2006c). After BTS treatment, tailings water would be routed for disposal as discussed above (Figure 2-22).

This alternative does not contain contingencies or specific invasive dewatering techniques other than those mentioned in the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B.

Tailings Mass Dewatering and Consolidation

SMC estimates that the tailings mass would contain approximately five million gallons of water that would be released during dewatering, reclamation cover placement, and long-term consolidation (Knight Piésold 2004). SMC would maintain the clarifier for up to one year during impoundment dewatering (Knight Piésold 2007). Water released from the tailings mass during dewatering, reclamation cover placement, and consolidation would be collected, treated, and routed for disposal as described above under operations.

Dewatering would be accomplished through tailings consolidation, natural drying, and surface loading during reclamation cover placement. The reclamation cover would be placed aggressively to accelerate tailings dewatering and consolidation, to allow equipment to operate on the southern end of the impoundment, and to control dust (Knight Piésold 2007). No sprinkling would occur during cap placement. The use of subgrade stabilization fabrics may not be necessary (Knight Piésold 2000a). The plan does not include contingencies for differential settling of the tailings surface (Figure 2-21).

Underdrains

The underdrain system would operate as described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B. During closure, the underdrains would be used until seepage decreases to 9 gpm, which is expected to occur within four years (Knight Piésold 2003). Once seepage reaches 9 gpm, the underdrain outlet would be plugged.

Liner Leakage

Liner leakage is estimated to range between 0.1 gpm and 0.3 gpm after the underdrain outlet is decommissioned (Knight Piésold 2000c).

Seepage through the Cover

Modeling suggests that seepage through the cover would vary depending on whether the underdrain system was open or plugged and the amount of cover runoff. The peak rate for seepage through the cover with the underdrain outlet open is estimated at 124.3 gpm, with an average annual seepage rate of 6.9 gpm (Knight Piésold 2000c). The peak rate for seepage through the cover with the underdrain outlet plugged will be discussed in post-closure, Section 2.4.5.2.3.

Seepage through the cover would report to the outlet structure located at the south end of the impoundment. From the outlet structure, the seepage through the cover would be routed to the percolation pond for disposal or the BTS for treatment, depending on water quality during closure (Figure 2-22; Wolfe 2001).

The seepage through the cover would be treated for up to one year with adit water in the BTS (Knight Piésold 2007).

2.4.5.2.3 Post-Closure Tailings Waters Management

Supernatant Water Management

Supernatant water would be removed during closure. There would be no supernatant water to be managed during post-closure.

Tailings Mass Dewatering and Consolidation

Tailings would have been dewatered and consolidated during closure, and tailings mass water would not need to be managed during post-closure.

Underdrain Seepage

Underdrains will be plugged. There would be no seepage from the underdrain outlet to be managed during post-closure.

Liner Leakage

Liner leakage would be the same as was described for closure (Figure 2-23).

Seepage through the Cover

The peak rate for seepage through the cover with the underdrains plugged is estimated at 133.2 gpm, with an average annual seepage rate of 9.1 gpm (Knight Piésold 2000c). Seepage through the cover would be managed the same as during closure, except it would be routed to the percolation pond (Figure 2-23).

2.4.5.3 Storm Water Management

2.4.5.3.1 East Boulder Tailings Impoundment

Storm Water Flow Rate

The storm water runoff flow rate is assumed to be 30 to 50 percent of precipitation based on a 100-year, 24-hour storm event, but the actual flow rate was broken out on a monthly basis. (Knight Piésold 2000b).

Operational Storm Water Management

SMC would continue to manage storm water according to the approved SWPPP.

Reclamation Cover Design

The reclamation cover design for the Proposed Action alternative is similar to the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, except the reclamation cover would consist of 24 inches of waste rock and borrow material, 22 inches of subsoil, and 6 inches of soil (Knight Piésold 2007).

Closure Storm Water Management

The final cover grade would mimic the tailings slope at a minimum of one percent grade, resulting in a natural swale to the south end of the impoundment (Figure 2-21), rather than a mound configuration as in East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 1B. Storm water runoff would flow down the swale to the impoundment embankment channel and into the percolation pond (Knight Piésold 2007). A conceptual channel design is provided in Knight Piésold 2007.

Post-Closure Storm Water Management

Post-closure storm water routing from the reclamation cover would be the same as that for closure. The seepage outlet structure would be sized to handle seepage through the cover and storm water runoff from a 100-year, 24-hour storm event (SMC 2007b).

2.4.5.3.2 General East Boulder Mine Site

Under this alternative, existing storm water facilities would be retained (SMC 2007b).

2.4.5.4 Reclamation

Under this alternative, existing facilities would be reclaimed as described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, except for the following:

- The BTS and LAD facilities would be reclaimed after one year of closure.
- The clarifier, BTS, and LAD facilities would be reclaimed during the second year of closure (Knight Piésold 2007).

2.4.5.5 Monitoring and Maintenance Plans

2.4.5.5.1 Monitoring Plans

Operational and/or closure monitoring plans would be the same as those described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, except for the following:

- Impoundment seepage through the cover would be sampled at the impoundment prior to treatment in the BTS (Wolfe 2001).
- Settlement monitoring would be performed on a 100-foot grid (Wolfe 2001).

Post-closure monitoring would be the same as described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B.

2.4.5.5.2 Maintenance Plans

Maintenance plans at closure would be the same as described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, except that the water treatment facilities would be maintained for up to one year.

Post-closure maintenance plans would include monitoring and maintenance every five years for the following items until the bond is released:

- Function of storm water sediment retention basins
- Adit discharge and storm water channels function
- Seepage through the cover outlet and underdrain function
- Function of armored channel on tailings embankment

2.4.6 East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B

This alternative is similar to East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B. The major differences include extension of potential time frames for water management activities and reclamation cover cap thickness. The discussion presented in the following sections focuses on the specifics of this alternative that differ from Proposed Action Alternative 2B.

2.4.6.1 Adit Water

2.4.6.1.1 Operational Adit Water Management

Operational adit water management would be the same as that for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B (Figure 2-18).

2.4.6.1.2 Closure Adit Water Management

Adit water would be managed as described for the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B, except for the following (Figure 2-25):

- LAD Areas 2, 3, and 4 would be used prior to the percolation ponds, if disposal of mine waters through percolation ponds potentially violates the MPDES average 30 lbs/day TIN limit.
- The clarifier and BTS would be retained for up to 18 months or until adit and tailings waters no longer require treatment.

2.4.6.1.3 Post-Closure Adit Water Management

Post-closure routing and disposal of adit water would be the same as that for the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B, except adit water would bypass the percolation pond and go straight to the East Boulder River (Figure 2-23 and Figure 2-26). If this alternative is selected, SMC must submit final channel designs with the next annual report after the ROD is issued. The channels must be designed to handle a 737 gpm adit flow rate or the actual closure adit flow rate plus the 100-year, 24-hour storm event for the drainage area.

2.4.6.2 Tailings Waters

2.4.6.2.1 Operational Tailings Waters Management

Supernatant Water Management

Operational management of supernatant water would be the same as for the East Boulder Mine WMP No Action Alternative 1B and the Proposed Action Alterna-

tive 2B, except SMC would be required to report annually the volume of supernatant water contained within the tailings impoundment to the agencies.

Tailings Mass Dewatering and Consolidation

The estimated volume of water contained in the tailings mass and tailings deposition method during operations would be the same as for the East Boulder Mine WMP Proposed Action Alternative 2B (Figure 2-18), except SMC would be required to report annually the volume of water in the tailings mass, as well as the tailings consolidation and grade .

Underdrain Seepage

The use of the underdrain system during operations would be the same as that for the East Boulder Mine WMP No Action Alternative 1B and Proposed Action Alternative 2B.

Liner Leakage

During operations, liner leakage would be the same as that for the East Boulder Mine WMP No Action Alternative 1B and Proposed Action Alternative 2B.

2.4.6.2.2 Closure Tailings Waters Management

Supernatant Water Management

Supernatant water management and disposal would be the same as that described for the East Boulder Mine WMP Proposed Action Alternative 2B, except water would preferentially go to LAD Area 6, then to LAD Areas 2, 3, and 4 before the percolation pond, if needed, to prevent violation of MPDES water quality limits.

Tailings Mass Dewatering and Consolidation

The volume of tailings mass water treated during closure would be the same as the East Boulder Mine WMP Proposed Action Alternative 2B, except the time frame to complete dewatering and treatment of the East Boulder impoundment waters would be extended up to 18 months, if needed, as compared to the 12 month timeline in the Proposed Action Alternative 2B. Treated tailings waters would preferentially go to LAD Area 6, then to LAD Areas 2, 3, and 4 before the mine site percolation pond, if needed, to prevent violation of MPDES water quality limits (Figure 2-25).

Dewatering and consolidation of the tailings mass needed to place the reclamation cover could be extended up to 18 months. Sprinklers could be installed for controlling dust blowing off the tailings.

Underdrain Seepage

Management of the underdrain seepage would be the same as the East Boulder Mine WMP Proposed Action Alternative 2B, except the underdrain seepage could be pumped back onto the tailings impoundment surface for up to 18 months, if needed.

Liner Leakage

Liner leakage during closure would be the same as described for the East Boulder Mine WMP No Action Alternative 1B and Proposed Action Alternative 2B.

Seepage through the Cover

Management of seepage through the cover would be the same as described for the East Boulder Mine WMP Proposed Action Alternative 2B, except seepage could be managed for up to 18 months.

2.4.6.2.3 Post-Closure Tailings Waters Management

Supernatant Water Management

There would be no supernatant water to manage during post-closure.

Tailings Mass Dewatering and Consolidation

Tailings mass water would have been removed during closure and would not need to be managed during post-closure.

Underdrain Seepage

Unlike the East Boulder Mine WMP Proposed Action Alternative 2B, the impoundment underdrain would remain open during post-closure and continue to discharge into the underdrain sump. The liner and the pump in the underdrain sump would be removed when flow decreases to 9 gpm. The sump would be converted to a percolation pond.

Liner Leakage

Liner leakage would be the same as that described above for operations.

Seepage through the Cover

During post-closure, untreated seepage through the cover would be managed the same as described in the East Boulder Mine WMP Proposed Action Alternative 2B.

2.4.6.3 Storm Water Management

2.4.6.3.1 East Boulder Tailings Impoundment

Storm Water Flow Rate

The storm water runoff would be managed the same as under the East Boulder Mine WMP Proposed Action Alternative 2B.

Operational Storm Water Management

Storm water management would be the same as under the East Boulder Mine WMP No Action Alternative 1B.

Reclamation Cover Design

After the tailings are dewatered sufficiently, SMC would construct a tailings reclamation cover and revegetate it in the same manner as described for the East Boulder Mine WMP No Action Alternative 1B. The final reclamation cover grade would be the same as the tailings surface grade. Differential settling of tailings and the overlying reclamation cap would be anticipated over time.

Closure Storm Water Management

Storm water management and routing during closure would be the same as that for the East Boulder Mine WMP Proposed Action Alternative 2B

Post-Closure Storm Water Management

Post-closure routing of storm water runoff would be the same as that for the East Boulder Mine WMP Proposed Action Alternative 2B, except that the channel down the embankment would be sized to handle a 100-year, 24-hour storm event.

2.4.6.3.2 General East Boulder Mine Site

Mine water channel designs would be the same as those for the East Boulder Mine WMP Proposed Action Alternative 2B, except that the drainage channels must be sized to handle adit water, mine site storm water runoff, and seepage through the cover. Closure and post-closure storm water routing would be the same as operational routing, except some mine site storm water would drain into the channel to the East Boulder River.

2.4.6.4 Reclamation

Under this East Boulder Mine WMP Agency-Mitigated Alternative 3B, existing facilities would be reclaimed the same as under the East Boulder Mine WMP Proposed Action Alternative 2B, except for the following changes:

- The adits would be closed with bat-friendly gates. No heavy mesh steel doors would be used. The design would be submitted with the next annual report following approval.
- The channel from the adits to the East Boulder River would be constructed. The final channel would be designed to handle the approved 737 gpm adit flow plus the 100-year, 24-hour storm event for the drainage area. If this alternative were selected, a conceptual design would be submitted with the next annual report after the ROD is issued.

2.4.6.5 Monitoring and Maintenance Plans

Under this East Boulder Mine WMP Agency-Mitigated Alternative 3B, closure and post-closure storm water facilities monitoring and maintenance plans would be submitted with the first annual monitoring report after the ROD is issued.

2.4.6.5.1 Monitoring Plans

Operational, closure, and post-closure monitoring plans would be the same as those described for the East Boulder Mine WMP Proposed Action Alternative 2B, with the following additional items:

Operational Monitoring

- Annual monitoring would include evaluating existing tailings consolidation, estimating supernatant and tailings mass water volumes, and monitoring tailings grade. SMC would submit a tailings density report every five years.
- The location of the seepage outlet structure would be updated based on tailings topography during the 5-year reviews.
- Tailings impoundments function and structural integrity would be monitored.

Closure Monitoring

- Mine adit water quality would be monitored quarterly.
- Water quality at the impoundment underdrain outlet would be monitored quarterly.
- Seepage through the cover would be monitored quarterly for quality and flow rate.

Post-closure Monitoring

All post-closure monitoring would continue until the reclamation bond is released or the MPDES permit is no longer needed.

- Ground water and surface water quality would be monitored according to approved water monitoring plans and MPDES permit conditions in place at time of closure.
- Tailings impoundment function and structural integrity would be evaluated annually for the first five years and then once every five years.
- The function of the tailings impoundment seepage outlet structure, seepage through the cover discharge channel, storm water management facilities, and percolation pond would be monitored annually for the first five years and then once every five years.
- Adit water quality and quantity would be monitored quarterly during the first year and annually thereafter.

2.4.6.5.2 Maintenance Plans

Water management facilities maintenance plans for closure would be the same as those for the East Boulder Proposed Action Alternative 2B, except for the following items:

- Storm water conveyance channels
- Impoundment seepage outlet structure and riprapped channel down impoundment embankment
- Underdrain seepage outlet structure
- Other water management facilities including LAD facilities, pipelines, percolation ponds, and storm water retention ponds

The post-closure water management facilities maintenance plans would address the following items to be conducted annually during the first five years of post-

closure and once every five years thereafter until the bond is released or the MPDES permit is no longer needed:

- Function of all ponds including percolation ponds and sediment retention basins;
- Function of all water conveyance channels including storm water, adit, and seepage outlet discharge channel; and
- Function of seepage outlet structure and underdrain.

2.4.7 Boe Ranch Land Application Disposal System No Action Alternative 1C

Under this alternative, the Boe Ranch LAD system would not be constructed. SMC would continue to manage mine waters during operations, closure, or post-closure at the East Boulder Mine according to its current WMP (SMC 1998).

2.4.7.1 Adit Water

Under this alternative, SMC would continue to manage adit water as described for the East Boulder Mine No Action Alternative 1B in Section 2.4.4.1. SMC would continue to route treated adit water during operations and closure to the BTS plant, percolation pond, and mine site LAD facilities.

2.4.7.2 Tailings Waters

Under this alternative, SMC would handle supernatant water, tailings mass water, underdrain seepage, liner leakage, and seepage through the cover from the East Boulder tailings impoundment as described for the East Boulder Mine WMP No Action Alternative 1B in Section 2.4.4.2.

2.4.7.3 Storm Water

2.4.7.3.1 East Boulder Tailings Impoundment

Storm water management for the East Boulder tailings impoundment would remain the same as described for the East Boulder Mine WMP No Action Alternative 1B in Section 2.4.4.3.1.

2.4.7.3.2 General Mine Site Facilities

The SWPPP for the mine site would be the same as that described for East Boulder Mine WMP No Action Alternative 1B in 2.4.4.3.2 (SMC 2007b).

2.4.7.3.3 Boe Ranch

The Boe Ranch LAD facilities would not be constructed for the Boe Ranch LAD System No Action Alternative 1C, and no storm water would need to be managed at Boe Ranch.

2.4.7.4 LAD Facilities

2.4.7.4.1 Mine Site and Boe Ranch LAD Systems

LAD System Use During Operations and Closure

The LAD system use during operations and closure would be the same as that for the East Boulder Mine No Action Alternative 1B (Figure 2-27). The Boe Ranch LAD system, as described under the Boe Ranch LAD System Proposed Action Alternative 2C, would not be constructed and utilized under the Boe Ranch LAD System No Action Alternative 1C.

To date at the East Boulder Mine, the operational flow rate of 150 gpm adit water has been low enough that little or no LAD has been necessary. The treated adit water can be routed to the percolation pond in compliance with the 30 lb/day nitrogen MPDES permit limit. There is a requirement in the East Boulder Mine MPDES permit to LAD at agronomic rates. SMC's LAD Area 6 consists of five evaporator/snowmaker units that may be used to treat and dispose of mine water during the growing season using LAD and during the winter using snowmaking. The East Boulder Mine LAD Area 6 is operated similarly to the Hertzler Ranch LAD system in that it maximizes evaporation. About 30 percent of the water that enters the evaporator/snowmaker units is evaporated. Only 70 percent of the water that enters the units reaches the soil (CES 2008).

LAD System Use During Post-Closure

The mine site LAD facilities would be decommissioned as described in East Boulder Mine No Action Alternative 1B. The Boe Ranch LAD system would not be constructed and utilized under the Boe Ranch LAD System No Action Alternative 1C.

2.4.7.5 Reclamation

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be constructed. Reclamation would be the same as described in the East Boulder Mine WMP No Action Alternative 1B

2.4.7.6 Monitoring and Maintenance Plans

All monitoring and maintenance for operations, closure, and post-closure would occur as described for East Boulder Mine WMP No Action Alternative 1B Section 2.4.4.5. No maintenance plans would be required for the Boe Ranch LAD system because it would not be constructed.

2.4.8 Boe Ranch LAD System Proposed Action Alternative 2C

SMC's proposed Boe Ranch LAD system could be constructed and used in conjunction with the East Boulder Mine water management facilities if operation and closure water quality at the East Boulder Mine cannot meet mine site MPDES limits. If constructed, the Boe Ranch LAD system would be similar to the Hertzler Ranch LAD facilities, which manage water from the Stillwater Mine. The Boe Ranch LAD system proposal would involve piping mine waters from the East Boulder Mine to a company-owned ranch, where it could be stored and land applied. SMC proposes the Boe Ranch LAD system to provide flexibility for treatment and disposal of mine water, to provide for the beneficial use of mine water in an agricultural setting during operations and the first year of closure, and to protect ground and surface water quality.

If constructed, the Boe Ranch LAD system would be SMC's preferred location for disposal of treated adit water during operations and treated adit and tailings waters during the first year of closure (Figure 2-28). Mine site water management facilities would be available for use during mine operations and closure, as described for East Boulder Mine WMP Proposed Action Alternative 2B.

The Boe Ranch LAD system would be located on a dissected glacial terrace ranging in elevation from 5,700 to 5,900 feet. The terrace contains a depression that would become the location of the proposed for the LAD storage pond (Figure 2-32). Slopes at the Boe Ranch range from zero to 35 percent or more. Center pivots could operate on slopes up to 20 percent. Site topography is influenced by both glacial deposits and uplifted bedrock. Natural drainage is channeled from three ephemeral drainages. These drainages slope toward the existing Mason Ditch, a historic irrigation ditch, located between the Boe Ranch LAD system, and the East Boulder River (Figure 31). Some ground water in the area discharges to the East Boulder River (Figure 2-31).

The Boe Ranch soils have less rock than the soils at the East Boulder Mine. Soils are deep and well-drained with moderately-high permeability (NRCS 2006b). Organic matter ranges from 2 to 4 percent. The LAD area predominantly consists of two soil units, Unit A and Unit B. Soil water-holding capacity in soil Unit B (7.8 inches) is less than in soil Unit A (11.6 inches). Review of soil survey data from NRCS 2006b indicates that soil permeability and drainage at the Boe Ranch are not considered limiting factors for the proposed LAD center pivot irrigation, snowmaking, or evaporation (CES 2008).

The Boe Ranch LAD system would have 10 center pivots for growing season LAD on 194 acres (Figure 2-32). If the Boe Ranch LAD system were developed, the growing season LAD application rate would increase during June and July then decrease by September as air temperatures cool and the length of day shortens and plant uptake is reduced.

2.4.8.1 Adit Water

2.4.8.1.1 Operational Adit Water Management

The Boe Ranch LAD area would provide SMC with operational flexibility, and if constructed, would be SMC's preferred location for disposal of treated adit water during operations (Figure 2-28). Adit water would be treated before it is pumped to the Boe Ranch LAD system. The treatment would be the same as that described for East Boulder Mine WMP Proposed Action Alternative 2B during operations (Figure 2-18).

The Boe Ranch LAD area would be operated similarly to the Hertzler Ranch LAD system in that it would maximize evaporation. About 30 percent of the water that would enters the evaporator/snowmaker units or center pivots is evaporated. Only 70 percent of the water that enters the units or center pivots reaches the soil (CES 2008). Under Proposed Action Alternative 2C, LAD would be applied at agronomic rates.

When LAD is not possible at the Boe Ranch, treated adit water would be routed to the Boe Ranch LAD storage pond or disposed of at the East Boulder Mine percolation pond and LAD facilities during mine operations (Figure 2-28). The Boe Ranch LAD System Proposed Action Alternative 2C, if constructed and operated, would manage water during the growing season the same as the East Boulder Mine, except the preferred disposal location would be the Boe Ranch LAD area. Evaporation over the Boe Ranch LAD storage pond could be practiced when needed to reduce the volume of water discharged through the LAD system. No summer irrigation is planned for the snowmaking area at the Boe Ranch (Figure 2-28).

Snowmaking at the Boe Ranch would be managed the same as at the East Boulder Mine. Snowmaking reduces the stored volume of water at times when LAD would not be possible. Snow would accumulate, melt, and either infiltrate into the soil or runoff into the Boe Ranch LAD storage pond. It is estimated that 30 percent of the snow would melt and runoff on frozen ground back into the pond for subsequent growing season LAD.

As with the East Boulder Mine LAD area, the LAD system would be operated up to 12 hours per day. The Boe Ranch LAD storage pond would have a capacity of 108 MG and receive treated adit water year-round for growing season LAD or winter snowmaking. The pond would store treated adit water when LAD is not scheduled, not possible, or when adit flows exceed the Boe Ranch LAD system capacity.

2.4.8.1.2 Closure Adit Water Management

Treatment and disposal of adit water during the first year of closure would be the same as for the East Boulder Mine WMP Proposed Action Alternative 2B, except that disposal preferentially would occur at the Boe Ranch LAD area, if constructed (Figure 2-29).

2.4.8.1.3 Post-Closure Adit Water Management

After the first year of closure, adit water would not be routed to Boe Ranch, but would be disposed of at the mine site as described for East Boulder Mine WMP Proposed Action Alternative 2B. During post-closure, adit water would be managed at the mine site (Figure 2-30).

2.4.8.2 Tailings Waters

2.4.8.2.1 Operational Tailings Waters Management

Operational tailings water management would be the same as the East Boulder Mine WMP No Action Alternative 1B Closure Tailings Waters Management.

As described under the East Boulder Mine WMP Proposed Action Alternative 2B, supernatant water from the East Boulder tailings impoundment would be mixed with adit water and other tailings waters for up to one year during closure. Under this Boe Ranch LAD System Proposed Action Alternative 2C, the treated mixed waters preferentially would be pumped to Boe Ranch, if constructed, for land application. Mine water disposal could also occur at the mine site LAD facilities as under Proposed Action Alternative 2B (Figure 2-29).

2.4.8.2.2 Post-Closure Tailings Waters Management

At post-closure, there would be no tailings waters to manage. The Boe Ranch LAD system would not be used.

2.4.8.3 Storm Water

2.4.8.3.1 East Boulder Tailings Impoundment

Storm water management for the East Boulder tailings impoundment would remain the same as described for the East Boulder Mine WMP Proposed Action Alternative 2B.

2.4.8.3.2 General Mine Site Facilities

The SWPPP for mine site LAD areas would be the same as described for the East Boulder Mine WMP Action Alternative 1B (SMC 2007b).

2.4.8.3.3 Boe Ranch

All storm water will be contained within facilities constructed during operations. No SWPPP would be required at the Boe Ranch because there would be no storm water runoff from the Boe Ranch permit area.

2.4.8.4 LAD Facilities

2.4.8.4.1 Mine Site LAD System

LAD System Use During Operation and Closure

If needed, mine site LAD facilities could be used for disposal of treated mine waters during mine operation and closure (Figure 2-29).

LAD System Use During Post-Closure

The mine site LAD facilities would be decommissioned as described in East Boulder Mine WMP Proposed Action Alternative 2B.

2.4.8.4.2 Boe Ranch LAD System

The Boe Ranch LAD system, if constructed, would consist of a pipeline, LAD storage pond, LAD center pivots, evaporators, and snowmakers (Figure 2-31 and Figure 2-32). The proposed Boe Ranch LAD facilities would disturb about 52 acres (Table 2-5). Almost 90 percent of this disturbance would occur on privately owned land.

The rest would occur on state land leased or otherwise controlled by SMC. SMC has purchased a road right-of-way across the state land section.

Table 2–5 Disturbance under Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C

	Disturbance by Surface Ownership			
Facility	**Private[1] (acres)**	**State (acres)**	**USFS (acres)**	**Total (acres)**
Roads and pipelines	9.2	6.8	0	16.0
LAD storage pond and spillway	32.0	0	0	32.0
Pump house, LAD system piping	1.0	0	0	1.0
Soil and unsuitable material stockpiles	3.0	0	0	3.0
Total	45.2	6.8	0	52.0

Note:
1. Private land all owned by SMC

LAD System Use During Operation

During the growing season (generally April through October), SMC would route adit water to the clarifier and the BTS plant and preferentially pump it to the Boe Ranch LAD storage pond. The treated adit water would be disposed of at the Boe Ranch LAD facilities (Figure 2-31).

The Boe Ranch LAD system could dispose of more than 350 gpm via the center pivots during the growing season (Figure 2-28). Using both the mine site and the Boe Ranch LAD facilities, SMC believes they could dispose of up to 1,450 gpm during the growing season (Knight Piésold 2000b; SMC and Knight Piésold 2002).

LAD System Use During Closure

The Boe Ranch LAD facilities would be used for up to 12 months to dispose of mixed treated adit and tailings waters. The mine site water management facilities could be used if needed. After one year, the Boe Ranch LAD system would not be used (Figure 2-29).

LAD System Use During Post-Closure

Boe Ranch LAD facilities would not be used during post-closure.

2.4.8.4.3 Boe Ranch Pipeline and Roads

Existing Pipeline and Road

During operations and closure, the existing and new pipelines to the Boe Ranch would route water from the mine to the Boe Ranch LAD facilities. No changes are proposed to the existing 33,000 feet of pipeline currently installed in the East Boulder Mine access road right-of-way.

New Pipeline and Roads

The 11,700-foot extension of the existing pipeline would start in the right-of-way of Sweet Grass County Road 31 and proceed north to the Boe Ranch LAD storage pond in a new Bench Road right-of-way. About 6,200 feet of the new pipeline and road would cross State of MT land in Section 16 (Figure 2-32). Disturbances associated with construction and operation associated with the new pipeline in the road are outline in Table 2-4.

Pipeline construction would follow standard procedures. The pipeline extension would be constructed of Schedule 20 steel pipe with corrosion protection coatings and HDPE pipe. The pipeline would be equipped with a leak detection system. The pipeline would be buried 6.5 feet deep, below the depth of the frost line. It would be welded and bedded; and the trench would be backfilled and compacted. These measures would protect against freezing. The pipeline would be tested using nondestructive procedures, including hydrostatic testing with uncontaminated water to 200 percent of the operating pressure. The pipeline would follow the undulating road profile. Where appropriate, air/vacuum valves would be installed at high points, and drain valves would be installed at low points. Valves would be located in locked, tamper-proof, watertight manholes designed to carry traffic loads and prohibit inflow of surface runoff. Pre-cast concrete manholes with joint seals would be installed.

The pipeline would operate as a pressurized gravity system with full flow at all times. A level control (LC) system would be installed at the mine site LAD feed pond to regulate the flow rate in the pipeline. The control valve would operate at the maximum design discharge rate of 1,200 gpm, and the LC system would throttle the valve at lower discharges to maintain submergence of the intake and full flow in the pipeline.

To provide access to the Boe Ranch LAD facilities, the Bench Road from Sweet Grass County Road 31 paralleling Mason Ditch would be used and an access road would be constructed heading west to the LAD storage pond. The new Bench Road and access road would be constructed above the pipeline after pipeline installation. No road construction specifications have been provided.

2.4.8.4.4 LAD Storage Pond

The 24-acre LAD storage pond would be located in a valley at the Boe Ranch (Figure 2-32). Overall disturbance acreage for the LAD storage pond can be found in Table 2-4.

The LAD storage pond embankment would be 55 feet high, 30 feet wide, and 600 feet long at an elevation of 5,750 feet (SMC and Knight Piésold 2002). The pond is designed to be 35 feet deep including a 6-foot freeboard. Freeboard includes 3 feet for storage of a 25-year, 24-hour precipitation event and 3 feet for wave run-up. The total pond capacity would be 108 million gallons. This equals seven months of storage capacity at 350 gpm.

Interior pond slopes would be graded to 5H:1V to provide fill material for the embankment and facilitate liner placement. The pond would be lined with an 80-mil HDPE liner system on a compacted soil base. The liner would be anchored in a trench along the pond perimeter road and the embankment crest.

An 8-foot-high wildlife fence along the pond perimeter would prevent wildlife and livestock from damaging the liner and becoming trapped in the pond. SMC would construct the fence with treated wood posts and low-visibility wire mesh.

A minimum of 12 inches of soil would be stripped from the basin, embankment, roads, and other facilities. Soil and materials unsuitable for embankment construction and pond foundation construction would be stockpiled separately below the LAD storage pond and reclaimed (Figure 2-32). The estimated volume of stockpiled material (soil and unsuitable materials) would be 264,810 cubic yards and would cover 3.2 acres (Knight Piésold 2000b).

The Montana Department of Natural Resources and Conservation (DNRC) has determined that the LAD storage pond would be a high-hazard dam because it would contain more than 50 acre-feet of water and has the potential to cause loss of life in the event of dam failure (Voeller 2002). As long as SMC maintains an approved mine operating permit, it is not required to submit an Operation, Maintenance, and Emergency Preparedness Plan that complies with DNRC's high hazard dam requirements. Because the LAD storage pond would be left in place post-closure, SMC or any successor would be required to obtain a DNRC high-hazard dam operating permit.

2.4.8.4.5 Center Pivot LAD

LAD storage pond water would be pumped via buried pipelines directly to 10 center pivots located on 194 acres for secondary treatment to remove nutrients and dispose of mine water (Figure 2-32). SMC would apply mine water at an irrigation rate that through evaporation, plant uptake, and soil storage would minimize nitrates percolating below the root zone. The center pivots could apply up to 1,500 gpm, which equates to 0.017 inch of water per hour or 7.66 gallons per minute per acre during a 12-hour day (SMC and Knight Piésold 2002). At this rate, SMC could apply 94 million gallons of mine water over approximately seven months per year on the 194-acre LAD area.

SMC believes mine water application would increase forage production. SMC expects to graze the LAD areas using a short-duration, high-intensity grazing system to manage the increased vegetation. Portable electric fences would be used to manage the livestock.

2.4.8.4.6 Evaporators and Snowmaking Systems

Mine Site Systems

Mine site evaporators and snowmakers could be used during operations and closure as discussed in East Boulder Mine WMP Proposed Action Alternative 2B (Figure 2-29). During post-closure, tailings waters would have been treated and disposed of during closure, the cap would be in place, and the evaporators and snowmakers would not be available (Figure 2-30).

Boe Ranch Systems

SMC would install nine evaporators on the LAD storage pond embankment south crest and five snowmakers on native ground south of the pond (Figure 2-32). Operational evaporator design capacity would be 172 gpm during the growing season. Each snowmaker would use 25 gpm during colder months. These two systems would dispose of a total of 45 million gallons per year (SMC and Knight Piésold 2002). Runoff from beneath the evaporator/snowmaker units would be channeled over native ground onto the HDPE liner and back into the LAD storage pond.

2.4.8.5 Reclamation

2.4.8.5.1 Mine Site

Reclamation of the mine facilities would be the same as described for the East Boulder Mine WMP No Action Alternatives 1B and the Boe Ranch LAD System No Action Alternative 1C.

2.4.8.5.2 Existing Pipeline and Roads

Reclamation of the existing portion of the Boe Ranch pipeline in the access road would be the same as described for the East Boulder Mine WMP No Action Alternatives 1B.

2.4.8.5.3 New Pipeline and Roads

Concurrent reclamation of the new disturbances associated with new pipeline installation outside of the road prism would be performed within 12 months after construction. Once the pipeline trench was backfilled and compacted, 12 inches of soil would be placed, and the trench would be seeded. Where the pipeline would be constructed beside the road, the trench would be backfilled, and a minimum of 12 inches of soil would be placed and seeded with approved mixtures.

The entire pipeline would be abandoned in place after the first year of closure. Abandonment would consist of grouting the pipeline as described under East Boulder Mine WMP No Action Alternative 1B. The pipeline manholes would be reclaimed by filling with compacted soil. Any new disturbance created while abandoning the pipeline would be reclaimed.

Portions of the Bench Road, the Boe Ranch access road, and the road on the State of MT land in Section 16 would be reclaimed after mine closure. SMC's recla-

mation would consist of recontouring where required and full revegetation within the road right-of-way.

2.4.8.5.4 Boe Ranch LAD System

SMC does not propose to reclaim the Boe Ranch LAD system because it could benefit the ranch after the East Boulder Mine ceases operation. The center pivots and LAD storage pond could be used in subsequent agricultural operations using water rights from the Mason Ditch or other sources.

2.4.8.6 Monitoring and Maintenance Plans

2.4.8.6.1 Monitoring Plans

Monitoring during construction would focus on the preservation of cultural resources. An archaeologist would monitor all cultural resource sites identified within the project's area of potential effect during construction to ensure they are not inadvertently disturbed by project-related developments. An archaeologist would also be present to monitor any additional ground disturbances that have not been planned yet, such as storm water control features.

Monitoring during operations and closure would be the same as described for the East Boulder Mine WMP No Action Alternative 1B, with the following additions:

- A new Pipeline Monitoring and Spill Contingency Plan would be developed to address designs, inspections, and leak detection response.
- A Boe Ranch LAD system monitoring plan for operations and the first year of closure would include:
  - Lysimeters
  - Soil sampling
  - Ground water wells and downgradient springs sampling
  - Surface water sampling in the East Boulder River
  - Precipitation and evaporation monitoring
  - BTS effluent quantity and quality

Post-closure monitoring at Boe Ranch is not proposed.

2.4.8.6.2 Maintenance Plans

Maintenance plans for the mine site would be the same as described for operations and closure under the East Boulder Mine WMP Proposed Action Alternative 2B.

No maintenance plans for operation and closure are proposed for the Boe Ranch.

Maintenance plans for the mine site would be the same as described for post-closure under the East Boulder Mine WMP Proposed Action Alternative 2B.

No maintenance plans for post-closure are proposed for the Boe Ranch.

2.4.9 Boe Ranch LAD System Agency-Mitigated Alternative 3C

The Boe Ranch LAD area, if constructed, would provide SMC with flexibility during operations and closure. If this alternative is approved and SMC decides to construct it, the Boe Ranch LAD System Agency-Mitigated Alternative 3C incorporates several mitigation measures not included in the Boe Ranch LAD System Proposed Action Alternative 2C. These measures have been included specifically to minimize adverse effects associated with discharges of nitrates and salts to soils, ground water, and surface water. In addition, mitigations would reduce the potential for mass wasting, LAD storage pond embankment instability, adverse impacts to cultural resources, and high-hazard dam failure during operation, closure, and post-closure.

2.4.9.1 Adit Water

Management and disposal of adit water during operations and closure would be the same as for the Boe Ranch LAD System Proposed Action Alternative 2C, except that water management facilities, including those at the Boe Ranch, could be used for up to 18 months (Figure 2-33). During post-closure, mine waters would be managed as described for the Boe Ranch LAD System Proposed Action Alternative 2C (Figure 2-34).

2.4.9.2 Tailings Waters

Management and disposal of tailings waters during operations and closure would be the same as for the Boe Ranch LAD System Proposed Action Alternative 2C, except that water management facilities, including those at Boe Ranch, could be used for up to 18 months. During post-closure, mine waters would be managed as described for the Boe Ranch LAD System Proposed Action Alternative 2C.

2.4.9.3 Storm Water

2.4.9.3.1 East Boulder Tailings Impoundment

Storm water management for the East Boulder tailings impoundment would be the same as described for East Boulder Mine WMP Proposed Action Alternative 2B in Section 2.4.5.3.1.

2.4.9.3.2 General Mine Site Facilities

The SWPPP for mine area would be the same as described for East Boulder Mine WMP Proposed Action Alternative 2B (SMC 2007b).

2.4.9.3.3 Boe Ranch

No SWPPP would be required at the Boe Ranch as described for Boe Ranch LAD System Proposed Action Alternative 2C.

2.4.9.4 LAD Facilities

2.4.9.4.1 Mine Site LAD System

LAD System Use During Operations and Closure

Mine site LAD facilities would be used for contingency disposal of treated adit water during mine operations and closure, as described for Boe Ranch LAD System Proposed Action Alternative 2C, except that water management facilities could be available for up to 18 months, if needed.

LAD System Use During Post-Closure

Mine site LAD facilities would be decommissioned as described in Boe Ranch LAD System Proposed Action Alternative 2C.

2.4.9.4.2 Boe Ranch LAD System

LAD System Use During Operation and Closure

Use of the Boe Ranch LAD facilities would be the same as described under Boe Ranch LAD System Proposed Action Alternative 2C, except LAD center pivot P10 would not be used due to mass wasting concerns. The area of center pivots P4 and P9 would be reduced by 50 percent and require additional operational and closure monitoring due to mass wasting concerns. The Boe Ranch LAD system would be available for up to 18 months during closure, if needed.

Unlike the Boe Ranch LAD System Proposed Action Alternative 2C, the Agency-Mitigated Alternative 3C would eliminate P10 and would constrain LAD on P4 and P9. SMC would apply water at greater than agronomic rates during operation and closure to ensure flushing of salts.

LAD System Use During Post-closure

Boe Ranch LAD facilities would not be used for disposal of mine waters during post-closure.

2.4.9.4.3 Boe Ranch Pipeline and Roads

Existing Pipeline and Roads

Use of the existing pipeline would be the same as under the Boe Ranch LAD System Proposed Action Alternative 2C.

New Pipeline and Roads

The location and construction of the new portion of the pipeline would be the same as that for the Boe Ranch LAD System Proposed Action Alternative 2C, except that final routing of the pipeline, the Bench road, and the access road would be field-approved by DEQ and DNRC. An access road design must be submitted prior to construction. This design must include:

- The Bench Road and access road would be 16 feet wide with a graveled surface.

- Soil would be windrowed along the down slope side of the road.
- A bridge on the access road would be constructed over the Mason Ditch to protect the ditch.
- Six 28-inch-diameter culverts would be installed at drainages.
- Standard state and USFS BMPs would be used to control erosion and storm water along the pipeline and road corridor.

2.4.9.4.4 LAD Storage Pond

The Boe Ranch LAD storage pond would be constructed and operated as described for Proposed Action Alternative 2C, except that soil and unsuitable materials for embankment construction would be stockpiled out of the drainage bottom (Figure 2-35).

DNRC has determined that the LAD storage pond embankment would be a high-hazard dam. Under this Agency-Mitigated Alternative 3C, SMC would be required to submit an Operations, Maintenance and Emergency Preparedness Plan that meets the DNRC dam safety program requirements. SMC would also be required to reduce the total storage capacity of the LAD storage pond at post-closure to less than 50 acre-feet. The modified LAD storage pond would then no longer be a high-hazard dam. Prior to construction of the pond, SMC would submit a plan to reduce the LAD storage pond capacity at closure.

2.4.9.4.5 Center Pivot LAD System

Under this Boe Ranch LAD System Agency-Mitigated Alternative 3C, a more detailed LAD system design, operation, management, and monitoring plan would be required and would need the agencies' approval prior to facility installation.

During operations, the LAD system would be modified using data collected from additional lysimeters, shallow ground water wells, soil sampling and testing, and precipitation data from the on-site weather station.

2.4.9.4.6 Evaporators and Snowmaking Systems

Mine Site Systems

Use of the mine site evaporators and snowmaking systems during operations and closure would be similar to that described in the Boe Ranch LAD System Proposed Action Alternative 2C, except these systems could be used up to 18 months during closure. These evaporators and snowmakers would not be available for use during post-closure.

Boe Ranch LAD Systems

The snowmaking system could only be used after the ground is frozen. Pivot P10 would not be constructed and the area of pivots P4 and P9 would be reduced by 50 percent and require additional operational and closure monitoring due to mass wasting concerns.

2.4.9.5 Reclamation

2.4.9.5.1 Mine Site

Reclamation of mine site facilities would be the same as described in the East Boulder Mine WMP Proposed Action Alternative 2B, except that the tailings impoundment would be capped and reclaimed as described in the East Boulder Mine WMP No Action Alternative 1B.

2.4.9.5.2 Existing Pipeline and Roads

Reclamation of the existing portion of the Boe Ranch pipeline and Sweet Grass County Road 31 would be the same as described for the East Boulder Mine WMP No Action Alternative 1B.

2.4.9.5.3 New Pipeline and Roads

Reclamation of the new pipelines and roads would be the same as described for the Boe Ranch LAD System Proposed Action Alternative 2C, except that the new pipeline manholes would be grouted.

2.4.9.5.4 Boe Ranch LAD System

The Boe Ranch LAD system would not be reclaimed as described for the Boe Ranch LAD System Proposed Action Alternative 2C. The center pivots and LAD storage pond would be left in place as under Proposed Action Alternative 2C; however, the storage pond's embankment height would be reduced so the impoundment would retain less than 50 acre-feet of water, eliminating the high-hazard classification. Any disturbance from reduction of the LAD storage pond embankment would be reclaimed.

2.4.9.6 Monitoring and Mitigation Plans

2.4.9.6.1 Monitoring Plans

Monitoring during operations and closure would be similar to the Boe Ranch LAD System Proposed Action Alternative 2C, with the following differences as detailed in Appendix B.

- SMC would be required to submit a detailed Boe Ranch LAD system monitoring plan prior to system operation. A conceptual monitoring plan is provided in Appendix B. This information would provide the data on inputs of nitrogen compounds and salts to the LAD area.
- Additional monitoring equipment, such as lysimeters and moisture probes, would be installed downgradient of the snowmakers under each center pivot.
- SMC would monitor any new downgradient seeps and springs above the Mason Ditch monthly during the irrigation season until flow ceases.
- SMC would monitor soils and vegetation at the LAD sites to assess the fate and transport of nitrogen and salts applied in water via land application. SMC would conduct periodic soil testing to determine if nitrogen and salt loads and other soil constituents could leach into ground water.

- SMC would monitor the flow rate of the East Boulder River during the irrigation season so that the LAD application rate could be adjusted as needed to prevent nitrogen exceedances in surface water.
- Agency-Mitigated Alternative 3C would set an action level for the total concentration of nitrogen and salts in ground water. This level defines a concentration of nitrogen and salts at which SMC would undertake a corrective action. Appendix B presents the action level and action plan.
- Soils that are susceptible to slumping or mass wasting would be monitored monthly during irrigation application season.
- SMC would use ground water monitoring data to adjust mine water application rates, so ground water would not exceed the nitrogen and salts action level in Appendix B.
- A weather station would be installed to collect data for determining the appropriate amount of water to apply via the center pivots. In addition to precipitation and evaporation to be collected under Proposed Action Alternative 2C, temperature, relative humidity, and wind data would be collected. These site-specific data would be used to determine the appropriate Boe Ranch LAD system water balance.
- SMC would protect all monitoring equipment from grazing cattle.

Post-closure monitoring would not occur if closure monitoring indicates no water quality concerns or LAD storage pond embankment stability problems. After mine water disposal at Boe Ranch is complete, and if a private landowner purchases the Boe Ranch, agency authority would no longer apply.

2.4.9.6.2 Maintenance Plans

Maintenance plans would be the same as described for operations and closure under the East Boulder Mine WMP Proposed Action Alternative 2B and the Boe Ranch LAD System Proposed Action Alternative 2C.

The post-closure East Boulder mine site maintenance plan would be the same as the East Boulder Mine WMP Agency-Mitigated Alternative 3B

2.4.10 Alternatives Considered but Eliminated from Detailed Consideration

Several preliminary alternatives were identified during the scoping process. Elements of some of these alternatives were incorporated into the Agency-Mitigated Alternatives. Others have been considered but dismissed as discussed below.

2.4.10.1 Adit Plugging (Plugging to Prevent Discharge of Water)

Public comment indicated that the MEPA/NEPA analysis should consider an alternative that would plug the adit openings at closure. Respondents stated that plugging adit openings would reduce the amount of adit water ultimately discharged to the surface environment.

The agencies concluded that plugging the adits with tailings or waste rock would not prevent adit water discharge. Water would seep through or around the backfill. Tailings used as backfill would also be susceptible to erosion from water seeping and could cause problems with sediment or turbidity. This alternative could increase the amount of time that adit water containing nitrates would seep from the adits.

The agencies considered an alternative that would plug the adit openings with concrete. Concrete can be used to create an effective seal at the adit entrance, but plugging adits with concrete does not ensure that all adit water would remain confined within the mine workings. Water pressure would increase and could result in uncontrolled discharge(s) through fractures in the rock. The ability to treat the water discharged from these fractures would be limited if adits were plugged.

The agencies also reviewed closure requirements with SMC and concluded that at the Stillwater Mine, the mine discharge would flow from the shaft rather than the mine adits because the shaft is at a lower elevation than the adits. If the shaft were filled with waste rock and tailings, the same problems described above for plugged adits would potentially occur. If the shaft were plugged with concrete and the adits were not, then the adit water would flow through the adit waste rock and tailings backfill before exiting the adits. If the shaft and adits were plugged with concrete, some water could still flow out of fractures in the surrounding rock.

These plugging options would not adequately address purpose and need (Section 1.1) and could violate the MT Water Quality Act in the short term. The agencies believe that allowing the water to flow out of the shaft at the Stillwater Mine and the adits at the East Boulder Mine provides the best opportunity for managing the water.

2.4.10.2 Closure and Post-Closure Water Treatment Evaluations

Comments received indicated that changes to the closure and post-closure WMPs at the two mine sites should not be included in this MEPA/NEPA analysis. Some respondents felt that, considering the size of the ore body, closure of the mines is many years into the future. These respondents also indicated that new mining methods, such as the use of non-nitrate based explosives, might be developed. Thus, they indicated that revising post-closure WMPs at this time is not prudent.

The MMRA and federal regulations in 36 CFR 228 require a closure and post-closure WMP for each mine, even though it may change in the future. Because the Proposed Action is in response to these legal requirements, the agencies cannot eliminate SMC's closure and post-closure WMP proposal from consideration in this MEPA/NEPA analysis. Closure and post-closure WMPs are necessary for reclamation bond calculations.

2.4.10.3 Long-term Treatment of Adit Water and Runoff from the Tailings Impoundments before Discharging

Some respondents indicated the agencies should not allow SMC to discharge adit water and runoff from the tailings impoundments at the Stillwater and East Boulder mines directly to rivers, even if the water meets nondegradation standards for water quality. Something could lower the quality of the water discharged from adits and the tailings impoundments in the future, and direct discharge would allow this degraded water to enter rivers without treatment. Instead, the water should be discharged through percolation ponds or wetlands constructed specifically for this purpose.

The MPDES permit limits for both mines are based on nondegradation standards. Water meeting those permit limits could be discharged directly to the Stillwater and East Boulder rivers without affecting their quality. If nitrates and sediment in the discharged water meet permit limits or even background levels by the end of the closure period, the agencies could not require SMC to construct wetlands or percolation ponds to dispose of mine waters.

The ore body geochemistry is analyzed quarterly to determine the acid rock production potential for this material. Annual reports and agency site inspections conducted at the Stillwater Mine and the East Boulder Mine have not identified any geochemical problems to date. The geochemical consistency of the 28-mile-long ore body indicates little potential for acid generation or near-neutral metal leaching over time.

The low acid-generating potential and metal-leaching potential, combined with water quality discharge permit limits, provide sufficient rationale to eliminate this alternative from further consideration. The treatment of adit water is addressed in all alternatives. The monitoring plans in the agency-mitigated alternatives include long-term monitoring of mine waters prior to direct discharge. It is not reasonably foreseeable that runoff from the reclaimed impoundments and mine sites would change water chemistry over time.

2.4.10.4 Alternative Waste Rock and Tailings Disposal Methods

Some respondents indicated that the MEPA/NEPA analysis should evaluate alternative methods of reclaiming waste rock piles and disposing of tailings. Use of these alternative methods may require different closure and post-closure WMPs. Water quality monitoring to date does not indicate a need to consider alternative waste rock and tailings disposal methods.

Some respondents indicated that the MEPA/NEPA analysis should evaluate backfilling adits with waste rock with the objective of reducing area requirements for waste rock disposal on the surface. SMC currently places up to 60 percent of waste rock and tailings underground. Placement of additional waste rock in mined-out adits could potentially increase short-term nitrogen and salt concentrations in adit water discharge.

Other options might include using waste rock as riprap to stabilize additional areas or as a source of road surfacing materials. Stillwater County and MDT have used SMC's waste rock for years as road base material. Use of waste rock off-permit would be considered and analyzed on a project-specific basis, but does not meet purpose and need (Section 1.1) and is not related to closure and post-closure WMPs.

The agencies have required SMC to explore the use of tailings paste technology (DEQ and USFS 1998b). SMC has actively investigated this method of tailings disposal. If SMC determines in the future that it would like to change to paste tailings, a MEPA/NEPA analysis and approval by the agencies would be required. The effects of the changes in methods would be evaluated on the approved closure and post-closure WMPs in effect at that time. Results indicate that paste tailings in the Stillwater Valley would be susceptible to wind erosion during operations (Kuipers and Associates and SMC 2006).

2.4.10.5 Boe Ranch LAD System MT Pollutant Discharge Elimination System (MPDES) Permit Alternative

Some comments received indicated that the MEPA/NEPA analysis should consider an alternative that covers the facility with a MPDES permit. Respondents indicated that this permit should also address all sources of pollution from the mine site. There were also concerns that surface water discharges could compound the situation in 303(d) listed waters that are in need of a Total Maximum Daily Load (TMDL) designation.

Both mine sites currently have MPDES permits for mine water discharges. A MPDES-specific alternative need not be developed to evaluate the need for an MPDES permit at the Boe Ranch site. The water quality/quantity analysis conducted for this EIS evaluated the potential for discharges of nitrogen and salts from the Boe Ranch LAD facility to reach surface waters. The analysis indicated no potential to violate either ground water standards of 10 mg/L of TIN or surface water standards in the East Boulder River.

Throughout operational monitoring, if water quality changes occur, the agencies can still require a MPDES permit as mitigation and address the issue of a TMDL at the same time. A MPDES permit alternative is not necessary to address this comment.

2.4.10.6 Alternative Locations for the Proposed Boe Ranch LAD System

One response to the project scoping document indicated that the MEPA/NEPA analysis should consider alternative locations for the proposed Boe Ranch LAD facilities. Suggested alternative locations included additional sites on the GNF and other state or private lands. Other respondents stated that the permitted areas on the GNF should not be considered because they are inconsistent with the Good Neighbor Agreement between SMC, the Northern Plains Resource Council, and Cottonwood Resource Council. Scoping comments suggested that the analysis should consider evaporators and advanced water treatment, which may eliminate the need for land application, as well as changes to water management and explosives practices that may reduce the volume of water discharged and concentrations of nitrogen.

The proposed Boe Ranch site is located in a natural bowl about one mile from the East Boulder River. No alternative sites were identified on private or GNF lands with physical and climatological advantages over the proposed Boe Ranch site. SMC owns the Boe Ranch, and the agencies cannot require SMC to purchase other private lands. The use of the Boe Ranch meets the purpose and need as defined in Chapter 1. Analysis disclosed in this EIS concludes that use of the Boe Ranch would meet all state and federal water quality standards.

2.5 Comparison of Alternatives Components

Tables 2-6, 2-7 and 2-8 at the end of this chapter summarize the alternative components for the nine alternatives described above. Summary tables of the major differences among alternatives (Tables S-4, S-5, and S-6) can be found in the Executive Summary.

2.6 Comparison of Environmental Effects

Tables 2-9, 2-10 and 2-11 at the end of this chapter summarize the potential environmental effects of the nine alternatives disclosed in Chapter 4.

2.7 Agencies' Preferred Alternatives

This EIS documents the agencies' analysis of nine alternatives, three each for the Stillwater Mine Closure and Post-Closure Water Management Plan, the East Boulder Mine Closure and Post-Closure Water Management Plan, and the Boe Ranch LAD System. Three alternatives must be selected, one for each location. The agencies' preferred alternatives are the following:

- Stillwater Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3A

- East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B

- Boe Ranch LAD System Agency-Mitigated Alternative 3C

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Stillwater Mine			
Adit Water Management			
Adit water management—Water quality	Adit water quality information was disclosed in previous environmental documents (Montana Department of State Lands et al. 1992)	Same as No Action	Same as No Action
Adit water management — Flow rate	The Stillwater Mine discharges up to 650 gpm of adit water (Weimer 2009pc). The permitted discharge rate is 2,020 gpm from the two adits at the mine site (DEQ and USFS 1998b). MPDES Permit No. MT0024716 allows a rate of 2,000 gpm.	Same as No Action	Same as No Action
Adit water management — Operational treatment method	Operational BTS water treatment is only approved through the MPDES permit; it is not part of the approved Plan of Operations. The construction of the water treatment facility was approved through a minor revision. MPDES permits encourage the use of new and improved technologies.	Same as No Action, but BTS treatment would be incorporated into the Plan of Operations. Adit water would be land applied and treated through the BTS in order to meet the MPDES discharge limits.	Same as No Action and Proposed Action for operations
Adit water management — Operational routing	During normal operational routing, all west-side adit water and water below 5,000 feet is routed to the west-side clarifier, then to the lined west-side feed ponds #1 and 2, then to the BTS plant, then to the lined west-side feed pond #3, then to one of four locations: Hertzler LAD System, east-side or Stillwater Valley Ranch percolation ponds, or directly to the Stillwater River as authorized by the existing approved MPDES permit (Fig. 2-4). SMC has never discharged treated adit water directly to the Stillwater River.	Same as No Action	Same as No Action
	East-side adit water above the 5,000-foot level gravity flows out the adit and is routed to the clarifier, then to the east-side or Stillwater Valley percolation ponds (DEQ and USFS 1998a).		
	SMC has the flexibility to route water for operational purposes without going to treatment as long as MPDES permit requirements are met.		
Adit water management — Time frame	No time frame was specified for water treatment in the Plan of Operations.	SMC estimates that it would require up to 6 weeks removing or draining all fluids from underground equipment (KP 2007) once underground mine equipment is removed and fluids are drained.	The agencies estimate that equipment draining or removal would require up to 12 weeks.
		Adit water treatment anticipated for 6 months but would continue for up to a maximum of 12 months.	Adit water treatment would continue for up to 18 months as needed for dilution at Hertzler for LAD.
Adit water management — Treatment method at closure	The BTS can treat in excess of 1000 gpm. SMC historically has treated 350 to 400 gpm at up to 40 ppm nitrogen, which is consistent with the quality of tailings water.	BTS treatment rate and nitrogen content same as No Action and would be added to the Plan of Operations.	BTS treatment rate and nitrogen content same as No Action and would be added to the Plan of Operations.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
	A closure water treatment method was not specified or approved in the Plan of Operations. It is assumed treatment methods used during operations would continue. SMC would still be required to meet MPDES permit limits during closure. No provisions for mixing supernatant water with adit water prior to treatment during closure were considered.		
Adit water management — Closure water routing and disposal **(West side)**	**West side: Above 5,000 feet** At closure, under the Plan of Operations, 5000W adit would be routed to the new west-side percolation pond until water quality standards are met. Once MPDES limits are met, the west-side percolation ponds would be reclaimed, and adit water would be routed directly to the Stillwater River (SMC 1994b). As authorized by the existing approved MPDES permit, all west-side adit water above 5,000 feet is routed to the BTS prior to land application or percolation as described above for operations. (Fig. 2-4)	**West side: Above 5,000 feet** At closure, west-side adit water above 5,000 feet would be mixed with Stillwater tailing waters for up to 6 months and treated through the clarifier and BTS . At 6 months the west side clarifier would be decommissioned. For 6 months to 12 months, water above the 5,000 foot level would be routed directly to the BTS if need for mixing with tailing waters . Adit water above the 5,000-foot level would be routed to the underground working after 12 months.	**West side: Above 5,000 feet** At closure, west-side adit water above 5,000 feet would be mixed with Stillwater tailing waters for up to 18 months and treated through the clarifier and BTS. Adit water above the 5,000-foot level would be routed to the underground working at some point between 12 weeks and 18 months.
	West side: Below 5,000 feet Routing of west-side water below the 5,000-foot level was not defined in the Plan of Operations but would report to the underground mine workings. The existing plans do not mention the mixing of adit and supernatant waters.	**West side: Below 5,000 feet** West-side adit water below 5,000 feet would be mixed with Stillwater tailing waters up to 6 months and treated through the clarifier and BTS . After 6 months, the west side clarifier would be removed. For 6 - 12 months, water above the 5,000-foot level would be routed directly to the BTS with tailings water. After 12 months, west adit water below the 5,000 foot level would be routed to the underground workings The BTS would be available for a maximum of 12 months. Treated adit water or mixed adit/tailing waters would be routed to the Hertzler Ranch LAD System for disposal for up to one year (KP 2007). SMC would not route any treated mixed adit/supernatant water directly to the Stillwater River although it is a disposal option under the MPDES permit.	**West side: Below 5,000 feet** West-side adit water below 5,000 feet would be mixed with Stillwater tailing waters up to 18 months and treated through the clarifier and BTS . After 18 months, the west side clarifier would be removed. The BTS would be available for a maximum of 18 months. Treated adit water or mixed adit/tailing waters would be routed to the Hertzler Ranch LAD System for disposal for up to 18 months (KP 2007). SMC would not route any treated mixed adit/supernatant water directly to the Stillwater River although it is a disposal option under the MPDES permit.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Adit water management — Closure water routing and disposal **(East side)**	**East-side: Above 5,000 feet** East-side water above 5,000 feet would gravity flow to the east-side clarifier and be routed to the east-side percolation ponds or the Stillwater Valley Ranch percolation ponds. (DEQ and USFS 1998a).	**East-side: Above 5,000 feet** East-side mine water above 5,000 feet would be routed to the east-side clarifier for 3 months and then routed to the percolation ponds (Figure 2-6) (KP 2007). After the east-side clarifier is decommissioned, the water would be routed directly to the percolation ponds.	**East-side: Above 5,000 feet** For the first 3 months all east-side water above 5,000 feet would be handled per the Proposed Action. The east-side clarifier would be decommissioned after 3 months once all equipment was drained or removed from the underground workings. After 3 months all east-side water above 5,000 feet would go to the underground workings.
	East-side: Below 5,000 feet Routing of east-side water below the 5,000 foot level was not defined in the Plan of Operations but would report to the underground mine workings.	**East-side: Below 5,000 feet** East-side adit water below 5,000 feet would be mixed with Stillwater tailing waters up to 6 months and treated through the west-side clarifier and BTS . After 6 months the west-side clarifier would be removed. For 6 - 12months, water above the 5,000-foot level would be routed directly to the BTS with tailings waters for treatment. For the 12 months, the treated water would go to the Hertzler Ranch LAD system, east-side percolation ponds, or Stillwater Valley Ranch percolation ponds Within 1 year, east-adit water below the 5,000 foot level would be routed to the underground workings	**East-side: Below 5,000 feet** For up to 18 months, east-side water below 5,000 feet would be routed to the west-side clarifier, BTS and the Hertzler Ranch LAD, the underground mine workings, or east-side or Stillwater Valley percolation ponds. Within 18 months, east-adit water below the 5,000 foot level would be routed to the underground workings
Adit water management — Post-closure water routing and disposal	Adit water would be directed to the percolation ponds and eventually to Stillwater River via new constructed channels from 5000E and 5000W adits.	After the BTS plant is decommissioned, west-side adit water would be routed through a new west-side percolation pond for percolation and discharged to a constructed channel to the Stillwater River (KP 2000b). The east-side percolation pond would be reclaimed and a constructed channel would flow through it to the river.	All adit water would be directed to flood workings, eventually reporting as discharge from the west-side mine shaft. The mine water would discharge to a channel designed as a trout stream to the Stillwater River. Since the discharge from underground would come from the shaft, no east-side channel to the Stillwater River is required.
	The time to flood mine workings was never estimated.	SMC estimates it would take 38 years to flood and exit the mine at the 5,000 adits with water only from below 5,000 feet and an assumed flow rate of 350 gpm (Thompson 2004).	It is estimated it would take 4-11 years for mine workings to fill with mine water from all sources and exit the mine shaft (Thompson 2004).
	No channel design proposed, analyzed, or approved. Conceptual routing only described. Channel designs to be submitted 12 months before closure (DSL 1992)	Routing of conceptual channel is specified on Figure 2-9.	The trout stream design will be considered when preparing final design of channel from mine shaft to surface waters. A conceptual channel design must be submitted with the next annual report if this alternative is approved. The channel must be designed to handle the approved 2,020-gpm adit flow plus the 100-year/24-hour storm event for the drainage area.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Tailings Impoundment Water Management			
Stillwater Tailings Impoundment			
Stillwater Impoundment Supernatant water management— Volume of supernatant water	No volume was specified initially, but up to 30 million gallons was analyzed in the 2000 tpd EIS. This equals about 2 feet of supernatant of water over the tailings.	Up to 30 million gallons of supernatant water (Gilbert 2003).	Same as Proposed Action.
	No plan for operational monitoring of supernatant water volume in Plan of Operations.	Same as No Action	SMC would be required to annually monitor tailings supernatant water volume.
Stillwater Impoundment Supernatant water management— Volume of water contained in tailings mass	No estimate was given of the additional volume of water (contained in the tailings mass) that would be removed during dewatering and consolidation during closure .	12 million gallons are estimated to be contained in the tailings mass. 5 million gallons (contained in tailings mass) would be released during dewatering, reclamation, and consolidation (KP 2004)	Same as the Proposed Action.
Stillwater Impoundment Supernatant water management— Tailing water quality	Tailings water quality was disclosed in previous environmental documents.	The quality of tailings water would be the same as No Action.	Same as No Action.
Stillwater Impoundment Supernatant water management— Tailing water quality after mixing	Until April 2008, SMC had not proposed mixing of tailings and adit water for disposal considered. A recent minor revision was approved by the agencies, which allows for mixing and treatment of adit and supernatant waters and then LAD of this effluent stream at the Hertzler Ranch LAD (SMC 2008).	SMC proposes to mix tailings water with adit water and treat the mixture through the BTS until the tailings impoundment has been dewatered. SMC tested a mixture of 10 parts adit water to 1 part tailings supernatant water (Gilbert 2004a). Subsequent test work demonstrates that 100% tailings water can be treated through the BTS without toxic effects (SMC 2006b).	Adit water would only be mixed with tailings supernatant water until underground equipment is removed. Undiluted supernatant tailings water would then be treated in the BTS and discharged to the Hertzler Ranch LAD area for land application. During the test work, treated tailings water was disposed at the Hertzler Ranch LAD system with no water quality or vegetative impacts (SMC 2006b).
Stillwater Impoundment Supernatant water management— Operational use and routing	Supernatant water from the Stillwater impoundment is pumped to the floatation circuit and eventually to the Hertzler impoundment with tailings from the concentrator. Additionally, during dredging operations tailings water is used to transport tailings from the Stillwater Impoundment to the Hertzler Impoundment. Tailings water is also necessary to prevent freeze drying and blowing dust from the exposed tailings beaches, especially during the winter months.	Same as No Action	Same as No Action.
Stillwater Impoundment Supernatant water management— Closure time frame	No time frame was ever specified (SMC 1994b). The 1990 Plan of Operations says 2 years on page 4-51, Table 4.10-7 for tailings consolidation, which includes dewatering.	SMC proposes a maximum of 12 months to dewater and treat Stillwater impoundment tailings waters. Six months assuming no dilution. 12 months is a conservative estimate, since SMC has calculated that three to six months would be all that is necessary to dewater the impoundment.	Same as Proposed Action except that the time frame for dewatering and disposal of all tailing waters would be 18 months.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Stillwater Impoundment Supernatant water management— Primary techniques and disposal location during closure	Impoundment dewatering would use natural drying by pumping and evaporating water over tailings mass. (SMC 1994b). The BTS is in place for operational use under the MPDES permit. The BTS is not linked to dewatering in the Plan of Operation for closure.	Supernatant water would be mixed with adit water and treated in the BTS before being routed to the Hertzler Ranch LAD System. Treated mixed adit/supernatant waters could also be disposed via the east-side or Stillwater Valley Ranch percolation ponds. SMC would not route any treated mixed adit/supernatant waters directly to the Stillwater River, although it is a disposal option under the MPDES permit.	Same as Proposed Action except mixed adit/supernatant water would be treated for the first 3 months. From then on, only undiluted supernatant water would be treated in the BTS and routed to the Hertzler Ranch LAD system. Adit water would be mixed with tailings waters after 3 months if dilution is needed to address Hertzler Ranch LAD concerns.
Stillwater Impoundment Supernatant water management— Alternate, additional, or contingency invasive techniques during closure	SMC could install an enlarged spray evaporation system over the tailings to dispose of excess water (SMC 1994b). SMC may also use a sprinkler irrigation system to irrigate revegetated areas with supernatant water (SMC 1994b).	Evaporators over the Stillwater tailings impoundment already exist and could be used for disposing untreated or treated supernatant water,	Same as Proposed Action.
	SMC proposed to use a combination of methods, which may include the use of horizontal drains, trenching, and sumping (SMC 1994b). The Plan of Operations does not contain any specific invasive dewatering methods.	Same as No Action.	No invasive dewatering contingencies would be required. SMC would annually monitor volume of supernatant water and tailings consolidation. Consolidation assessment would be done every 5 years prior to bond review.
Stillwater Impoundment Tailings dewatering and consolidation— Time frame	Drying and settling are estimated to take 2 yrs (DSL et al. 1992).	SMC proposed accelerated dewatering and aggressive cover placement within a 12 to 14 month time frame (KP, 2007). Slimes would be surrounded and capped without geotextile.	This alternative is similar to the Proposed Action, but accelerated placement of the reclamation cover and pumping of tailings mass water and some slimes from the impoundment into the mine workings would reduce the time frame for dewatering, consolidation and reclamation cover placement.
Stillwater Impoundment Tailings dewatering and consolidation— Techniques	SMC is dredging tailings during operations in order to consolidate tailings.	No other consolidation techniques have been proposed. Aggressive placement of reclamation cover materials would assist in forcing out tailings mass water and increasing tailings consolidation.	This alternative would be the same as the Proposed Action, except for the addition of the following: ➢ A formal tailings density study would be completed every five years during operations. ➢ After most of the supernatant water has been removed, tailings mass water and some slimes would be pumped to the underground workings. Pumps capable of moving slimes would be required. ➢ Annual monitoring would address estimated densities, tailings grade, and volume of supernatant water.
Stillwater Impoundment Tailings dewatering and consolidation— Subgrade stabilization	SMC may use subgrade stabilization fabrics and/or waste rock to allow equipment operation on tailings surface (SMC 1994b).The current bond calculation includes 25 percent stabilization fabric.	No subgrade stabilization fabrics would be used. SMC density study shows denser tailings than originally anticipated (KP 2000a). SMC proposes the use of glacial borrow material for capping the impoundment.	No stabilization fabric would be needed for reclamation prior to placement of the reclamation cover. Waste rock or borrow material would be added aggressively.
Stillwater Impoundment Tailings dewatering and consolidation— Contingencies	No contingencies are provided if consolidation does not occur as planned or if problems arise.	Same as No Action.	Same as No Action.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Stillwater Impoundment Tailings dewatering and consolidation— Tailings dust control during closure	A rock mulch, sprinkler, or chemical binder may be used, if necessary, to control dust while tailings are being dewatered prior to final reclamation. (SMC 1994b). No commitment to anything specific was made within the Plan of Operations and no time frame was specified.	Same as No Action except that sprinklers would not be used during dewatering and capping sequence.	Rock mulch would be used for dust control. Aggressive placement of waste rock or glacial till as a reclamation cover would expedite consolidation time frame and minimize dust.
Stillwater Impoundment Underdrains	Finger drains were originally approved in 1985, but approval of impoundment final design removed finger drains.	Same as No Action.	Same as No Action.
Stillwater Impoundment Liner leakage	Data indicate leakage would be less than 0.6 gpm (KP 2000band the 1985 EIS stated leakage through the liner would be less than 1 gpm (See pages IV-7-9 in 1985 EIS). Liner thickness increased from 60 to 100 mil during the final design approval process.	Same as No Action.	Same as No Action.
Stillwater Impoundment Seepage through the cover— Tailings final grade	A tailings grade was not specified.	No grading of tailings was proposed (KP 2007). Tailings would be deposited at an average 1% grade to the storm water channel (Figure 2-11).	Same as Proposed Action. Operational tailings deposition would slope to the north end of the impoundment.
	No contingencies were provided for differential settling of the tailings surface or for effect on seepage through the cover from storm water runoff from the tailings impoundment surface.	Same as No Action.	Annual monitoring of the tailings grade would be reported to agencies in an annual report to document the tailings deposition grade. Differential settling is not a concern at final reclamation.
Stillwater Impoundment Seepage through the cover— Flow rate	No flow rate was specified, as seepage through the cover was not anticipated.	Modeling suggests that average seepage through the cover during post-closure would be 2 gpm or less and peak seepage would be 8.3 gpm (KP 2000c: Table 4.1).	Same as Proposed Action
Stillwater Impoundment Seepage through the cover— Seepage outlet structure	No seepage outlet structure was defined since seepage through the cover was not anticipated in the approved reclamation design and plan. Slimes accumulation is located in the north portion of the impoundment.	Seepage outlet structure would be located at the north end of the impoundment (Fig. 2-11). Slimes accumulation would remain in the northern portion of the impoundment.	Same as Proposed Action. Annual monitoring of tailings grade to be in the annual report would be used to determine the exact location of seepage outlet structure.
Stillwater Impoundment Seepage through the cover— Treatment method and time frame during closure	No method or time frame for treating seepage through the cover during closure was contained in the Plan of Operations.	Seepage through the cover would be routed to the BTS for a maximum of 12 months during capping activities or pumped into the underground workings.	Same as Proposed Action except the BTS would be available for 18 months.
Stillwater Impoundment Seepage through the cover— Routing during closure	Seepage through the cover was originally anticipated to infiltrate the tailings, collect above the liner, and discharge as liner leakage (DSL and USFS 1985).	Modeling indicates the preferred pathway would be lateral discharge at the tailings surface and reclamation cover interface (KP 2000c.). During capping, seepage through the cover and tailings mass water would be routed to the west-side BTS feed pond. Once capping activities are completed, seepage would report to the outlet channel and be routed to new west-side percolation pond (Figure2-15).	The seepage outlet structure would be constructed on the north end of the impoundment. During placement of the reclamation cap, any seepage through the cover would be routed to the west side clarifier, then to the BTS, and ultimately to Hertzler LAD system.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Stillwater Impoundment Seepage through the cover—Routing during post-closure	No post-closure routing was specified.	During post-closure, seepage through the cover would be routed to an unlined channel to the new west-side percolation pond to the Stillwater River .	After placement of the reclamation cap, seepage through the cover would be routed to the seepage outlet channel and to the Stillwater River with shaft discharge water (Fig. 2-15).
Stillwater Impoundment Seepage through the cover—Channel designs for routing at closure and post-closure	Not included in the approved Plan of Operations	During closure, seepage through the cover would be piped to the new west side BTS feed pond.	At post-closure, the seepage outlet channel would consist of a rip rapped trapezoidal channel down the embankment and to a storm water channel. The channel would be 5 feet wide, 2 feet deep with 2:1 slopes and routed to the sediment retention basin located on the north side below the impoundment (Figure 2-15). This channel would also route mine water from the shaft.
Hertzler Ranch Tailings Impoundment			
Hertzler Ranch Impoundment Supernatant water management—Volume of supernatant water	No volume initially was specified. SMC maintains 2 feet of supernatant water on the Hertzler Ranch tailings impoundment.	The average volume of supernatant water would be up to 40 million gallons of free water (Weimer 2006b).	Same as Proposed Action.
	No plan for operational monitoring of supernatant water volume is in the currant Plan of Operations.	Same as No Action.	SMC would be required to annually monitor tailings supernatant water volume.
Hertzler Ranch Impoundment Supernatant water management—Volume of water contained in tailings mass	The Plan of Operation does not contain an estimate of the additional volume of water contained within the tailings mass to be removed, treated, and disposed of during closure.	It is estimated that 14 million gallons is contained in the tailings mass but only 5 million would be removed during capping (KP 2004).	Same as Proposed Action.
Hertzler Ranch Impoundment Supernatant water management—Tailing water quality	Water quality is disclosed in previous environmental documents. (DEQ and USFS 1998a)	Same as No Action.	Same as No Action.
Hertzler Ranch Impoundment Supernatant water management—Tailing water quality after mixing	Mixing of tailings waters with treated adit water for disposal was included in final design documents (KP 1999b).	SMC would not treat Hertzler impoundment tailings waters through the BTS. For up to 12 months, SMC would pump Hertzler supernatant water to the Hertzler LAD storage pond where it could be mixed with treated adit and/or tailings waters from the Stillwater Impoundment and land applied at Hertzler Ranch.	Same as Proposed Action except that all Hertzler and Stillwater impoundment waters would be treated and disposed of within 18 months.
Hertzler Ranch Impoundment Supernatant water management—Operational use and routing	Supernatant water from the Hertzler impoundment is pumped to the Stillwater impoundment for use in the milling circuit and is used for dust control on the impoundment beaches.	Same as No Action	Same as No Action
Hertzler Ranch Impoundment Supernatant water management—Closure time frame	The Mine Waste Management Plan (SMC 1996) references back to the 1990 Plan of Operations, which states that tailings consolidation, including dewatering, will take 2 years.	SMC proposed a maximum of 12 months to dewater all tailing waters. This is a conservative estimate, since SMC has calculated that three to six months is all that is necessary to remove supernatant water from the impoundment.	All Hertzler and Stillwater tailings supernatant waters would be land applied within 18 months.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Hertzler Ranch Impoundment Supernatant water management— Primary dewatering techniques and disposal location during closure	Impoundment dewatering would use natural drying by pumping and evaporating water over the tailings mass (KP 1999a, 1999b). The final design for the Hertzler Ranch impoundment includes land application of tailings supernatant water with treated adit water, but this was not included in the conceptual design in the 1998 EIS.	Tailings supernatant water would be pumped to the LAD storage pond, mixed with treated adit or mixed adit/Stillwater impoundment supernatant water and land applied at the Hertzler Ranch site.	Same as Proposed Action.
Hertzler Ranch Impoundment Supernatant water management— Alternate, additional, or contingency invasive techniques during closure	No plans are approved for any specific invasive dewatering methods.	Same as No Action.	Same as No Action, except SMC would annually monitor the volume of supernatant water and tailings consolidation. A detailed consolidation survey would be done every 5 years prior to bond review.
Hertzler Ranch Impoundment Tailings dewatering and consolidation— Closure time frame	Drying and settling is estimated to take 2 years.	Aggressive dewatering and placement of reclamation cover material described above would take a maximum of 12 months.	Similar to the Proposed Action, but tailings slimes would be deposited in the south end of the LAD storage pond. Treated adit water would be available for up to 18 months to mix with Hertzler Ranch tailings prior to LAD.
Hertzler Ranch Impoundment Tailings dewatering and consolidation— Techniques	Underdrains are currently constructed and are used to facilitate dewatering and tailings consolidation.	Same as No Action along with aggressive placement of reclamation cover material.	Same as Proposed Action
Hertzler Ranch Impoundment Tailings dewatering and consolidation— Subgrade stabilization	SMC may use subgrade stabilization fabrics and/or borrow materials to allow equipment to operate on the tailings surface.	Subgrade stabilization fabrics would not be used because SMC's density study shows denser tailings than originally anticipated (KP 2000a).	Same as Proposed Action.
Hertzler Ranch Impoundment Tailings dewatering and consolidation— Contingencies	No contingencies were provided if consolidation does not occur as planned or if problems arise.	Same as No Action.	Same as No Action.
Hertzler Ranch Impoundment Tailings dewatering and consolidation —Tailings dust control	A rock mulch, sprinkler, or chemical binder may be used, if necessary, to control dust while tailings are being dewatered prior to final reclamation. SMC made no specific commitment within the Plan of Operations and no time frame was specified.	Same as No Action except that sprinklers would not be used during dewatering and capping sequence.	Rock mulch would be used for dust control. Aggressive placement of borrow as a reclamation cover would expedite consolidation time frame and minimize dust.
Hertzler Ranch Impoundment Underdrains	Underdrains are constructed and would be used to facilitate dewatering and tailings consolidation. The underdrains would be decommissioned when seepage flows are negligible. SMC anticipates negligible seepage after reclamation cover construction. The underdrains would be plugged, the sump pump would be removed, and collection ponds would be reclaimed (Wolfe 2001). The Stage 1 underdrain is open and discharges water at a rate of 30 gpm as of December 2007 (Weimer 2008b). The Stage 2 underdrain would discharge between 150 and	Same as No Action except the underdrain would be used until seepage is 9 gpm, which is anticipated to take 4 years (KP 2000b) and the outlet pipe would be plugged with grout (Wolfe 2001).	Underdrains would remain unplugged to facilitate further tailings consolidation and anaerobic denitrification (KP 2004, Gilbert 2004b). During post-closure, the sumps would be converted to percolation ponds by removing the liners and pumps. The sumps would be filled with gravel and underdrain seepage would fill the sump and percolate or overflow onto the native ground beyond the sump.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
	200 gpm initially but would decrease to a rate of approximately 50 gpm after 2 to 3 years.		
Hertzler Ranch Impoundment Liner leakage	Liner leakage would be less than 0.1 gpm (SMC 1996). The liner thickness is 60 mil.	Same as No Action, liner leakage would increase to 0.4 gpm when the underdrains are plugged (KP 2000c).	Same as No Action.
Hertzler Ranch Impoundment Seepage through the cover—Tailings final grade	A tailings grade was not specified. No contingencies were provided for differential settling of the tailings surface nor the effect on seepage through the cover or storm water runoff from tailings impoundment surface.	No grading of tailings is proposed (KP 2007). The tailings grade would average 1% towards the seepage outlet structure at the south end of the tailings impoundment (KP 2007)	Same as Proposed Action. Annual monitoring of tailings grade would be reported to agencies in the annual report to document tailings deposition and tailings grade.
Hertzler Ranch Impoundment Seepage through the cover—Flow rate	No flow rate was specified because seepage through the cover was not anticipated.	Peak seepage through the cover with underdrains open during closure is estimated at 10.4 gpm with an average seepage rate of 0.2 gpm. Peak seepage through the cover with underdrains plugged during post-closure is estimated to increase to 18.3 gpm with an average seepage rate of 1.8 gpm (KP 2000c)	The underdrains would not be plugged so the flow rate would not be expected to decrease during post-closure.
Hertzler Ranch Impoundment Seepage through the cover—Seepage outlet structure	No seepage outlet structure was included in the Plan of Operations since seepage through the cover was not anticipated in approved reclamation plan.	A seepage outlet structure would be located at southern end of the impoundment (See Figure 2-12)(KP 2007). Slimes accumulation is located in the southern end of the impoundment.	Same as Proposed Action (KP 2007). Annual monitoring of tailings grade in the annual report would be used to determine the exact location of the seepage outlet structure.
Hertzler Ranch Impoundment Seepage through the cover—Treatment method and time frame during closure	No method or time frame for treating seepage through the cover during closure was contained in the Plan of Operations.	Seepage through the cover would be land applied at Hertzler Ranch LAD system for up to 12 months while the tailings facility is being reclaimed (KP 2007).	Similar to the Proposed Action. Seepage through the cover would be land applied at Hertzler Ranch LAD system for up to 18 months while the tailings facility is being reclaimed.
Hertzler Ranch Impoundment Seepage through the cover—Routing during closure	Seepage through the cover was originally anticipated to infiltrate and percolate through the tailings, collect above the liner, and report as liner leakage (DEQ and USFS 1998a).	Modeling indicates the preferred pathway for seepage through the cover would be lateral discharge at the tailings surface and reclamation cover interface (KP 2000b). During closure, the seepage through the cover would discharge laterally at the seepage outlet structure on the southern end of the embankment. Seepage through the cover would be piped to the Hertzler Ranch LAD storage pond. There, it could be mixed in the LAD storage pond with treated adit or adit/Stillwater impoundment supernatant water, if available, and land applied at the Hertzler Ranch (SMC 2006c)	Same as Proposed Action.
Hertzler Ranch Impoundment Seepage through the cover—Routing during post-closure	The need for seepage through the cover routing at post-closure was not anticipated under the original Plan of Operations.	During post-closure, seepage through the cover would be routed to the LAD storage pond through a rip rapped channel (SMC 2006c) where it could either mix with irrigation water supplemented from the Tandy Ditch and be used for agricultural irrigation or it could naturally evaporate in the bottom of the LAD storage pond, depending on landowner preference (Gilbert 2003).	Same as Proposed Action.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Hertzler Ranch Impoundment Seepage through the cover—Channel designs for routing at closure and post-closure	A channel design was not included in the approved Plan of Operations (DEQ and USFS 1998a).	The rip rapped, trapezoidal channels would be 5 feet wide, 2 feet deep with 2:1 slopes (KP 2007).	Same as Proposed Action.
Storm Water Management			
Stillwater Tailings Impoundment			
Stillwater Impoundment Storm water runoff —Flow rate at closure and post-closure	Flow rate was not specified.	Cover runoff flow rate is assumed to be 30 to 50 percent of precipitation (KP 2000b) but actual flow rate was broken out on a monthly basis based on a 100-year, 24-hour storm event. (KP 2000b).	Same as Proposed Action.
Stillwater Impoundment Storm water runoff —Reclamation cover design	SMC would conduct tailings consolidation tests before closure to finalize depths and volume of cover materials needed to achieve post settlement gradients (Stipulation 7 in 1994 ROD).	The reclamation cover design provided in the KP 2007 Reclamation Plan would be 24 inches of waste rock and/or borrow and 8 inches of soil/or borrow material for a total of 32 inches of growth medium.	Same as Proposed Action except SMC would construct an average 42 inches thick cap, which would then be covered with 8 inches of soil for a total of 50 inches.
	SMC would construct a burrow/waste rock reclamation cover. While the original Plan of Operations said waste rock would only be used if necessary, the 1994 Reclamation plan includes 335,600 cubic yards (Table 4.9-1) of waste rock to be placed on impoundment surface, which is about 42 inches thick.	Total volume of waste rock or borrow material needed is 209,000 cy.	Total volume needed is 128,000 cy.
	24 inches of subsoil/soil (with a minimum of 12 inches of soil) would cover the borrow/waste rock	Same as No Action, except 8 inches of borrow would be used for soil medium (KP 2007).	Same as No Action with 8 inches of soil or approved soil substitute placed on the waste rock or borrow materials.
Stillwater Impoundment Storm water runoff —Reclamation cover final grade	The final cover surface would be graded to 1 percent away from the embankment to the northwest corner (SMC 1994b). This would create a gentle swale down the center of the tailings impoundment. A berm has been constructed along the west side of the impoundment to preclude any storm water from running onto the impoundment. This berm and flow path would route water to the south and into Mountain View Creek.	Similar to No Action. Recent design (KP 2007) has the gradient sloping to the north end (Figure 2). Storm water diversion on the west side of the impoundment is the same as No Action.	Same as Proposed Action. The agencies assume that differential settling would occur in areas of slimes concentrations and shallow depressions would occur on top of the impoundment.
Stillwater Impoundment Storm water runoff—Impoundment spillway	A spillway was analyzed in the 1985 EIS, but it was eliminated in the final design due to inclusion of the west-side storm water diversion berm and the routing of up-gradient storm water to percolation ponds or through diversion ditches along Forest Service Road 2846 to Mountain View Creek. No spillway design was provided to route storm water off the reclamation cover to drainage channels during post-closure.	The updated design (KP 2007) shows minimal cap grade to the northern seepage outlet structure discharging to a channel down the embankment. The seepage outlet structure, which is essentially a spillway, would be sized to handle a 100-year, 24-hour storm event.	Same as Proposed Action.
Stillwater Impoundment Storm water runoff —Channel designs	No specified design was proposed or approved. Only conceptual routing was provided.	SMC proposes a rip-rapped channel design from the low spot in the tailings to the seepage outlet structure in the northern end (KP 2007).	Same as Proposed Action. SMC would be required to submit all final storm water channel designs by the date of the first annual report if amendment is approved.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Stillwater Impoundment Storm water runoff — Closure and post-closure runoff routing	The SWPPP Figure 4.1-2 shows some of the drainage patterns at final reclamation, but the drainage patterns are incomplete. A path to the river and removal of ponds and basins was not included. A description of operational storm water routing is included in SMC 2007; these systems would be in place at start of closure.	An updated design (KP 2007) shows minimal cap grade to the northern end seepage outlet structure discharging to a channel down the embankment (KP 2007, Figure 2).	Same as Proposed Action except during post-closure, the channel from the reclaimed sediment retention basin to the Stillwater River would connect with the channel from the mine shaft.
	Once the reclamation cover has been installed, storm water runoff would drain into a channel and exit in the northwest corner of the impoundment (SMC 1994b: Figure 4.2-1). Flow would enter a constructed channel and be routed into a sediment retention basin (SMC 1994b: Figure 4-2.1). During post-closure, SMC may use one of two options identified in SMC 1994b (pg 4-16) to route storm water once it leaves the impoundment. One option would be to connect the drainage channel to a new storm water channel down the road west of the impoundment towards Mountain View Creek. The second option would be to route storm water to the adit water channel from the 5000W portal to the Stillwater River. SMC would submit a plan 12 months prior to closure.	Storm water from the impoundment would be routed to the existing sediment retention basin below the adit during closure. At post-closure, storm water would be routed through the sediment retention basin to a channel to the Stillwater River. The storm water routing on the remainder of the mine site would be the same as No Action.	An unlined channel mimicking a trout stream would be constructed from the mine shaft to the Stillwater River. At post-closure, storm water would be routed through the reclaimed sediment retention basin to a channel to the Stillwater River The storm water routing on the remainder of the mine site would be the same as No Action.
Hertzler Ranch Tailings Impoundment			
Hertzler Ranch Impoundment Storm water runoff— Flow rate closure and post-closure	A flow rate was not defined or previously analyzed.	Cover runoff flow rate is assumed to be 30 to 50 percent of precipitation (KP 2000b) but actual flow rate is broken out on a monthly basis based on a 100-year, 24-hour storm event. (KP 2000c).	Same as Proposed Action.
Hertzler Ranch Impoundment Storm water runoff — Reclamation cover design	SMC would conduct tailings consolidation tests before closure to finalize depths and volume of cover materials needed to achieve post settlement gradients. Detailed cover design would not be provided until final reclamation.	Same as No Action	Same as No Action, but SMC must repost annual tailings consolidation and deposition.
	SMC would cover the surface of the tailings with an average of 48 inches of borrow material that was stockpiled during construction of the impoundment. If necessary for stabilization, up to 25 percent of the tailings surface may be covered with geo-fabric. The borrow material would then be covered with a total of 24 inches of subsoil and soil. There would be a minimum of 12 inches of soil.	SMC would cover the surface of the tailings with an average of 24 inches of borrow material that was stockpiled during construction of the impoundment. The borrow material would then be covered with a total of 24 inches of subsoil and soil. No stabilization fabric would be required.	Same as No Action, except that the stabilization fabric would not be used.
Hertzler Ranch Impoundment Storm water runoff — Reclamation cover final grade	The center of the tailings impoundment would be mounded so that the final surface would slope 1 percent to the edges away from center of impoundment (KP 2000a).	SMC proposes an average cap grade of 1 percent in forming a swale to the southern channel.	Same as Proposed Action The agencies assume that differential settling would occur in areas of slimes concentrations and shallow depressions would occur on top of the impoundment.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Hertzler Ranch Impoundment Storm water runoff — Impoundment spillway	No spillway was included in the original impoundment design.	SMC proposed a seepage outlet structure at the southern end of the impoundment.	Same as Proposed Action.
Hertzler Ranch Impoundment Storm water runoff — Channel designs	No separate channel would be needed for cover runoff, as water would either flow into the cover or uniformly over the edge of the embankments (SMC 1996).	SMC has proposed a design for the rip-rapped channel from the low spot in the tailings to the seepage outlet structure at the southern end of the impoundment, which would discharge to the Hertzler LAD storage pond in (KP 2007).	Same as Proposed Action. SMC would be required to submit all final storm water channel designs by the date of the first annual report if amendment is approved.
Hertzler Ranch Impoundment Storm water runoff — Closure runoff routing	Once the reclamation cover has been installed, cover runoff would flow over the edges of the embankment—no channel would be constructed on the impoundment cover surface.	During closure, storm water would collect within the impoundment and would be discharged with supernatant water. Once the reclamation cover has been installed, storm water would flow through the storm water runoff channel at the southern end of the impoundment that would discharge to the Hertzler LAD storage pond (Fig. 2, KP 2007).	Same as Proposed Action.
Hertzler Ranch Impoundment Storm water runoff —Post-closure runoff routing	Cover runoff would uniformly flow to and over the edges of the impoundment so that no channel would be constructed (SMC 1996).	SMC proposes a storm water runoff channel design at the southern end of the impoundment that would discharge to the Hertzler LAD storage pond.	Same as Proposed Action.
General Mine Site Area			
General Mine Site Area Storm water runoff— Closure runoff routing	Closure storm water routing is not addressed in the 1996 Plan of Operations. SMC has a new operational SWPPP (SMC 2007b) for the Stillwater Mine site, but it does not address requirements, facilities, and management of storm water during closure. Operational facilities would be in place and would most likely be used during closure. There is no SWPPP for the Hertzler Ranch since there is no potential for runoff to reach surface water resources.	Same as No Action. Routing of storm water on the west and east sides would be the same as during operations. The SWPP will need to be updated for closure and post-closure. The Hertzler Ranch Impoundment does not need a SWPP.	The requirements and facilities of the operational SWPPP would be carried over into closure. Some of the SWPPP BMPs, which are not applicable, would be removed as part of the closure process. A site review would be needed at closure to verify location and sizing of channels.
General Mine Site Area Storm water runoff— Post-closure runoff routing	Post-closure storm water routing is not addressed in the 1996 Plan of Operations. SMC has a new operational SWPPP (SMC 2007b) but it does not address requirements, facilities, and management of storm water facilities during post-closure. Operational facilities would be in place and would most likely be used during post-closure. There is no SWPPP for the Hertzler Ranch since there is no potential for runoff to reach surface water resources.	During post-closure, storm water from the north and west would be routed to a channel connected to the mine adit channel, routed under FAS 419, to a storm water catchment basin and then to the Stillwater River . Some mine site storm water from the south and west sides of the impoundment would be routed to Mountain View Creek (KP 2007). Routing of storm water on the east side would be the same as during operations.	Storm water routing would be the same as Proposed Action, but the sediment retention basins would be reclaimed. The channel from the mine shaft would connect to this channel to form a trout stream. Storm water routing on the east side would be the same as the Proposed Action.
Reclamation			
Reclamation--General	General facilities reclamation is described in Fig. 2-11, SMC 1994b and other supplemental documents.	Same as No Action	Same as No Action except the underdrains at the Hertzler Ranch would report to reclaimed unlined percolation ponds.
	Adits with a future beneficial use, primarily the 5,000 level adits, would be secured with heavy mesh steel doors to retain future access and to facilitate water management (SMC 1988).	Same as No Action	Only the 5,000 level adits would be gated with bat friendly gates. All other adits would be backfilled with 50 feet of waste rock over a 100-foot steel pipe installed for possible drainage. No heavy mesh steel doors would be used.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
			A steel-mesh grate would be installed on the shaft collar to prevent unauthorized shaft access, protecting human health and safety and preclude wildlife impacts.
	Water would discharge out the 5,000-foot adits into a channel to the Stillwater River. All other adits with no beneficial use would be backfilled with waste rock.	Same as No Action.	Water would not discharge out the adits but from the mine shaft, which is the low point opening into the underground mine workings.
	A new west-side percolation pond constructed below the adit during closure would be reclaimed when adit water met MPDES effluent limits without treatment and could be directly discharged to the Stillwater River (SMC 1994b).	Since no new percolation pond would be constructed below the adit, there would be no pond to reclaim and reclaim there. Lined west-side feed ponds near the BTS plant would be reclaimed after the BTS plant was decommissioned (KP 2000b).	Same as Proposed Action.
	All east-side ponds and channels would remain in place (SMC 1994b). A channel would be constructed from the percolation pond to the Stillwater River (DEQ and USFS 1998a).	Two east-side percolation ponds would remain in place during closure and post-closure (Knight Piésold 2003) The ponds would be reclaimed and the channel would be routed through the ponds to the Stillwater River. Four Stillwater Valley Ranch percolation ponds would be reclaimed, but the historic trout ponds would remain in place.	Since all east-side water shall remain within the mine, the two east-side percolation ponds would be reclaimed and a channel would not be constructed, as all water would exit from the mine shaft on the west side. The Stillwater Valley Ranch percolation pond closure would be the same as Proposed Action.
	The Hertzler Ranch LAD storage pond and the LAD infrastructure would be left in place for the landowner's use (MR 04-001).	Same as No Action	Same as No Action.
	Decommissioning of the BTS is not addressed in the MPDES permit or the Plan of Operations. Reclamation of the pipelines between the mill site and Hertzler Ranch was covered in the 1998 EIS.	The BTS would be decommissioned after 12 months.	Same as Proposed Action, except the BTS would be decommissioned after 18 months.
	Plugging and capping of raises is not addressed by the approved Plan of Operations or the 1994 Reclamation Plan	Raises would be plugged and capped with native materials (USFS and DEQ 2002).	Same as Proposed Action
Reclamation—Borrow Area No.1	No detailed reclamation plan was provided.	Borrow Area No. 1 would be reclaimed at 2:1 without soil replacement (Knight Piésold 2007).	Borrow Area No. 1 would be reclaimed at 2.5:1 with steeper slopes at the top and concave slopes at the base. The slope should not be a flat slope but should undulate to mimic natural slopes.
Reclamation—Time frame	The clarifier, BTS, and LAD system removal and reclamation time frame was not specified.	Clarifiers would be removed after the first 12 months of closure. The BTS plant and pipelines would be decommissioned and reclaimed at the end of closure when all MPDES water quality limits and the nitrate nondegradation load limit of 100 lbs/day could be met without treatment, which is anticipated to take 12 months. LAD facilities would be removed during post-closure if not wanted by the landowner.	Same as Proposed Action, except the west-side clarifier would be maintained for 18 months in order to assist with dewatering of the Stillwater Impoundment. The BTS would be decommissioned after 18 months. The east side clarifier would be removed after 3 months. Hertzler Ranch LAD facilities would remain in place for future use by landowner or rancher.

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Monitoring and Maintenance Plans			
Monitoring Plans—Operations and closure	➢ Adit water would be monitored until it meets MPDES permit limits and the permit terminates. ➢ Storm water discharges to surface waters would be sampled as required by the MPDES permit until it expires. Sampling would be according to the SWPPP (SMC 2007b) ➢ Ambient surface and ground water quality would be monitored according to the approved water monitoring plan (Hydrometrics, Inc. 1999). ➢ Reclamation covers would be monitored for settlement and consolidation during closure period (Stipulation #7, 2,000 TPD EIS. The plan to be submitted prior to closure)(DEQ & USFS 1992b). ➢ Water seeping out of the underdrains at the Hertzler Ranch tailings impoundment would be sampled until the underdrains were plugged. ➢ No quality/quantity monitoring of supernatant water requirements for seepage through the cover, liner leakage, and percolation ponds or discharge channel function is currently contained in the 1996 Plan of Operations.	Same as No Action except: ➢ Seepage through the cover for the Stillwater tailings impoundment would be monitored as influent to the BTS plant to determine if there is a need for treatment prior to disposal during closure. ➢ Settlement monitoring would be done on a 100-foot grid (Wolfe 2001). ➢ Adit water would be sampled as long as is needed for the dilution of Stillwater tailings impoundment supernatant water.	Same as Proposed Action except: ➢ Annual monitoring of tailings deposition to verify tailings grade at both impoundments would be required during operations. ➢ Annual monitoring of volume of supernatant water would be required during operations. ➢ Tailings density would be measured every 5 years during operations at both impoundments. ➢ Monitoring of tailings impoundments function and structural integrity. ➢ Submittal of a revised water monitoring plan for the Hertzler Ranch LAD would be required ➢ Surface water and ground water monitoring must be submitted to and approved by the agencies, if this alternative is selected. This would include sampling for nutrients, salts, and biomonitoring. ➢ Quarterly monitoring of shaft water quality and elevation starting at closure. ➢ Quarterly monitoring of water quality at Hertzler Ranch impoundment underdrain outlets during operations and closure.
Monitoring Plans —Post-closure	No post-closure monitoring plans are included in the Plan of Operations.	Same as No Action.	Post-closure monitoring would address the following items until bond is released: ➢ Monitoring of ground water and surface water quality according to approved water monitoring plans and as long as MPDES permit would be in place during post-closure ➢ Quarterly monitoring of shaft water quality the first year after closure and annually thereafter. ➢ Twice a year monitoring of shaft water elevation until mine water exits the shaft. ➢ Tailings impoundment function and structural integrity would be monitored annually for the first 5 years and then once every 5 years. ➢ Seepage outlet structures and discharge channels function would be monitored annually for the first 5 years and then once every 5 years. ➢ Hertzler Ranch surface and ground water monitoring for nitrogen, nutrients and salts.
Maintenance Plans—closure	Management and maintenance of the BTS and associated facilities during closure is not incorporated into the Plan of Operations. SMC would be required to maintain all ponds as specified by its MPDES permit and SWPPP (SMC 2007b). SMC has a 5-year maintenance plan for	Same as No Action except: ➢ The Plan of Operations would incorporate BTS management and maintenance during the first year of closure after which the BTS would be reclaimed.	A plan would be submitted, with the first annual monitoring report to describe closure and post-closure storm water facilities monitoring and maintenance Same as Proposed Action with maintenance plans for the

Table 2-6 Comparison of Alternative Components for the Stillwater Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
	percolation ponds and storm water sedimentation retention ponds (SMC 1994a) at closure.		additional items: ➢ Storm water mine shaft channel ➢ Seepage outlets structures. ➢ Underdrain for the percolation pond at Hertzler Ranch. ➢ Other water management facilities including LAD facilities, pipelines, Hertzler Ranch LAD storage pond, percolation ponds, and storm water retention ponds for up to 18 months during closure.
Maintenance Plans—post-closure	Maintenance of water management facilities during post-closure is not included in the Plan of Operations.	Same as No Action	The Post-closure maintenance plan would include the following items to be conducted annually during the first five years of Post-closure and once every five years thereafter: ➢ Function of all ponds including percolation ponds, storm water sedimentation or retention ponds. ➢ Storm water, west side shaft, and seepage outlet discharge channel function ➢ Function of seepage outlet structures and underdrains

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
East Boulder Mine			
Adit Water Management			
East Boulder Adit water management—Water quality	Adit water quality was disclosed in previous environmental documents (SMC 1998).	Same as No Action.	Same as No Action.
East Boulder Adit water management —flow rate	Average adit outflow is 15 gpm (Wolfe 2009). Permitted discharge is 737 gpm from the mine adits (Stillwater PGM Resources 1990).	Same as No Action.	Same as No Action.
East Boulder Adit water management — operational treatment method	BTS water treatment is approved through the MPDES permit and the approved Plan of Operations.	Same as No Action.	Same as No Action.
East Boulder Adit water management — Operational Routing	After going through the clarifier and BTS treatment, adit water is recycled underground for use in mining, routed to LAD Area 6 for summer land application or winter snowmaking, or routed to the percolation pond.	Same as No Action.	Same as No Action.
East Boulder Adit water management —time frame for closure water treatment	No time frame was specified for closure water treatment in the Plan of Operations although the bond calculations used 3 years (USFS and DEQ 2002).	Underground decommissioning timeframe is anticipated to be 6 weeks.	Underground decommissioning timeframe is anticipated to be 8 weeks
		At closure, adit water would be routed through the clarifier, mixed with tailing waters, and treated in the BTS for up to 12 months or until tailing waters are gone.	The agencies assume that treatment time frame may require18 months until the MPDES permit limits would be met. In order to sustain microbe populations in the BTS, adit and tailing waters treatment must begin immediately at closure.
		After tailing waters are gone, adit water would be treated through the clarifier and BTS, if needed, until water quality meets MDPES permit limits. Based on estimates from the Troy Mine and East Boulder Mine operational shut-downs in 2006, water quality is estimated to meet MPDES discharge standards within 3-6 months of cessation of operations (KP 2007).	This treatment time frame includes adit and tailing waters.
East Boulder Adit water management — Closure treatment method	A closure water treatment method was not specified or approved in the Plan of Operations or the 1998 WMP. SMC would be required to meet MPDES permit limits during closure. BTS treatment during closure was included in bond calculations (USFS and DEQ 2002). No provisions for mixing supernatant and tailings mass waters with adit water prior to treatment during closure were considered.	BTS treatment of adit water during mine closure would be incorporated into Plan of Operations. At closure, adit water would initially be mixed with tailing waters and would be actively treated through the BTS (KP 2000b). 5 of the 14 million gallons of tailings mass water would be treated with tailing supernatant water and adit waters during closure.	Same as Proposed Action

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
East Boulder Adit water management — Closure treatment, routing, and disposal	Routing was not specified under the Plan of Operations and the MPDES permit, but would likely follow operational preferences: adit water would be routed to the clarifier for first year of closure, the BTS plant, and then mine LAD Area 6 for summer land application and winter snowmaking, mine LAD areas 2, 3, and 4 as contingencies, the mine site percolation pond, or directly to the East Boulder River (Fig. 2-19). SMC would not route any treated adit water directly to the river (SMC 1998). The BTS would be decommissioned between 1 and 3 years (KP 2001).	Same as No Action, except that the proposed disposal preference would be the mine site percolation pond followed by LAD Area 6 rather then LAD areas 2, 3, and 4 because they are not constructed.	Same as No Action except, this alternative would minimize use of the percolation pond since use of the percolation pond does not reduce nitrogen loads and preferentially use LAD Areas 2, 3, and 4. In addition, the clarifier and BTS would be retained for up to 18 months or until adit and tailing waters no longer require treatment. Current ground water models indicate the potential for treatment and disposal of up to 250 gpm with no violation of MPDES Permit criteria. Fig. 2-20)
East Boulder Adit water management — Post-closure routing and disposal	Adit water would be discharged directly to the East Boulder River without treatment in a new, constructed channel.	Adit water would be routed through the percolation pond and then to the East Boulder River.	Adit water would be routed directly to the East Boulder River.
	No channel design was proposed. Conceptual routing is only described. Channel designs would be submitted 12 months before closure (DSL, USFS and DHES 1992)	Routing and conceptual channel designs are provided (Brouwer 2003). When adit water quality meets MPDES permit limits without treatment, adit water would be routed directly to the percolation pond.	Same as Proposed Action, except final channel design would b~~e~~ submitted with next annual report if this alternative was approved. Conceptual channel must be designed to handle the 737-gpm adit flow plus the 100-year/24-hour storm event for the drainage area.
East Boulder Tailings Impoundment Water Management			
East Boulder Impoundment Supernatant water management— Volume of supernatant water	No volume was initially specified. SMC maintains an average of 2 feet of freestanding water over the tailings for operational purposes. At full development, up to 35 million gallons of supernatant water would be on top of the tailings (Wolfe 2006b).	Average volume of supernatant water would be up to 35 million gallons of free water (not in the tailings mass) (Wolfe 2006b).	Same as Proposed Action.
	No plan for operational monitoring of supernatant water volume in the Plan of Operations.	Same as No Action.	SMC would be required to annually monitor tailings supernatant water volume.
East Boulder Impoundment Supernatant water management— Volume of water contained in tailings mass	No estimate of the additional volume of water contained in the tailings mass (to be removed during dewatering and consolidation) is provided in the Plan of Operations.	SMC estimates 14 million gallons are contained in the tailings mass. It is estimated that 5 million gallons would be released at cap placement and require treatment (KP 2004).	Same as Proposed Action.
East Boulder Impoundment Supernatant water management— Tailing water quality	Tailings water quality has been disclosed in previous environmental documents.	Same as No Action.	Same as No Action.
East Boulder Impoundment Supernatant water management— Tailing water treatment methodology and water quality after treatment	No mixing of tailings supernatant and adit waters quality were previously considered. No supernatant water treatment method was previously considered at closure.	Mixing of tailings and adit waters would be conducted until adit water nitrogen content is reduced to a level that allows disposal without treatment. At that point, tailing waters would be treated in the BTS without mixing (KP 2007). The quality of mixed tailings and adit waters has	Same as Proposed Action.

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
		previously been tested. SMC mixed and treated a ratio of 10 parts adit water: 1 part tailing water with no change in nitrogen treatment (SMC 2006b). Subsequent testing showed that tailing waters can be treated in the BTS without mixing adit water and show no reduction in the nitrogen treatment (Weimer, 2006). Water quality of the treated supernatant water is disclosed in the SMC treatment study (Weimer, 2006). After BTS treatment, tailing waters would go to the percolation pond. Land application could be utilized for additional reduction of nitrogen if MPDES permit limits were an issue at closure (Figure 2-22).	
East Boulder Impoundment Supernatant water management— Closure time frame	No time frame was specified in the Plan of Operations.	SMC estimates a maximum of 12 months to dewater all impoundment waters, assuming an impoundment dewatering pumping rate of 250 gpm (KP 2007).	Maximum of 18 months to dewater and treat all impoundment waters.
East Boulder Impoundment Supernatant water management— Primary dewatering techniques	Impoundment dewatering would use natural drying and spray evaporation (Stillwater PGM Resources 1990). Excess supernatant water could be pumped to the clarifier, if necessary, combined with mine adit water and treated in the BTS, and then land applied (SMC 1998).	Treated water would be pumped to the clarifier and BTS for treatment, then routed to the following sites: the mine site percolation pond; LAD Area 6 for summer land application and winter snowmaking; LAD areas 2, 3, and 4; or directly to the East Boulder River. (Figure 2-22) (KP 2007).	Same as Proposed Action, except water would preferentially go to LAD Area 6, then to LAD Areas 2, 3, and 4 before the percolation pond, if needed, to prevent violation of MPDES water quality limits (Figure 2-25).
East Boulder Impoundment Supernatant water management— Alternate, additional, or contingency invasive techniques during closure	The 1990 SMC Plan of Operations mentions horizontal drains, trenching, and scarifying, but SMC did not commit to any specific invasive dewatering methods. If other dewatering methods are needed, other methods would be evaluated (Stillwater PGM Resources 1990).	No alternate or contingency invasive techniques are proposed during closure.	Same as Proposed Action
East Boulder Impoundment Tailings consolidation— Time frame	Drying and settling of tailings are estimated to take 2 years (KP 1999b). Dewatering, as described above, would take 2 to 3 years, which is a component of tailings consolidation (KP 2001).	Pumping, settling, and dewatering would require a maximum of 12 months (KP 2007).	Pumping, settling, and dewatering would require a maximum of 18 months.
East Boulder Impoundment Tailings dewatering and consolidation— Techniques	Tailings deposition would be controlled by variable spigotting locations (KP 2000a).	SMC would aggressively place the reclamation cap to accelerate tailings dewatering and consolidation (KP 2007).	SMC would annually monitor volume of supernatant water and estimated tailings density. A formal tailings consolidation study would be done every 5 years prior to bond review.
East Boulder Impoundment Tailings dewatering and consolidation— Subgrade stabilization	SMC may use subgrade stabilization fabrics and/or borrow materials to allow equipment operation on the tailings surface (Stillwater PGM Resources 1990) but has not committed to the use of either. The KP density study	SMC would aggressively place the reclamation cap to allow trafficability. SMC would also cap or surround the slimes at the southern end of the impoundment (KP 2007).	Same as Proposed Action. SMC would add waste rock or borrow as fast as possible as needed especially during the winter.

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
	shows denser tailings than originally anticipated, so no fabric would be needed (KP 2000a). The possible use of subgrade stabilization fabric was removed during bond calculation (KP 2001).		
East Boulder Impoundment Tailings dewatering and consolidation— Contingencies	No contingencies are proposed if consolidation does not occur as planned.	In addition to aggressively placing the reclamation cap, SMC would maintain the clarifier for tailings mass water removal. Contingency deposition of slimes could occur in the lined LAD feed pond and the new Event Pond (KP 2007).	Same as Proposed Action.
East Boulder Impoundment Tailings dewatering and consolidation— Tailings dust control during closure	Rock mulch, sprinkling or a chemical binder would be used during operation and while the tailings are being dewatered at closure (Stillwater PGM Resources 1990). SMC did not commit to any specific method or time frame.	SMC would aggressively place the reclamation cap to control dust on the impoundment (KP 2007). No sprinkling would occur during cap placement.	Same as Proposed Action.
East Boulder Impoundment Underdrains— Closure and post-closure	Underdrains were not in the Plan of Operations. An underdrain system was included during final design (KP 1999a) and approved (DEQ/USFS letter May 28, 1999). Drains would be closed when seepage showed that quantity of seepage was negligible (Brouwer 2003). The underdrain flow rate is 30 gpm (Wolfe 2007) Underdrain seepage is pumped back to the impoundment.	The underdrain would be used until seepage is 9 gpm, which is anticipated to take 4 years (Brouwer 2003). Underdrain seepage would not be treated after the BTS was decommissioned. Decommissioning would involve removal of the collection sump and plugging of the outlet pipe using staged packer grouting with a stable non-shrink cement-bentonite grout (Wolfe 2001).	Recent monitoring and test work associated with the underdrains has revealed that these drains act as bio-treatment filters that actually denitrify the tailing water to very low concentrations. Underdrains would remain unplugged to facilitate consolidation and to allow anaerobic denitrification (KP 2004). The sump would be modified to a percolation basin at post-closure. During closure, the underdrain seepage would be pumped back onto the tailings impoundment surface for up to 18 months.
East Boulder Impoundment Liner leakage	Leakage through the liner would be less than 1.0 gpm. (DSL et al. 1992) Liner thickness is 100 mil.	Same as No Action except leakage through the liner is estimated to be 0.1 to 0.3 gpm (KP 2000b).	Same as Proposed Action.
East Boulder Impoundment Seepage through the cover— Tailings final grade	The tailings grade would be an average of 1 percent toward the seepage outlet structure at the south end of the impoundment. No contingencies were proposed for differential settling of the tailings surface nor the effect on seepage through the cover or storm water runoff from tailings impoundment surface.	Tailings deposited during operations would drain and establish a natural slope to the southern end of the impoundment (toward the seepage outlet structure). The target slope would be an average grade of 1 percent (KP 2007, Figure 1).	Same as Proposed Action. Annual monitoring of the tailings grade and deposition would need to be reported to agencies in an annual report.
East Boulder Impoundment Seepage through the cover— Flow rate	No seepage through the cover flow rate was specified.	With underdrains open during closure, seepage would range from an annual average rate of 6.9 gpm or less to a peak seepage rate of 124.3 gpm (KP 2000b). With underdrains plugged during post-closure, seepage would range from an annual average rate of 9.1 gpm or less to a peak seepage rate of 133.2 gpm (KP 2000c: Table 3.1).	Same as Proposed Action for closure as underdrains would be left open during closure and post-closure.
East Boulder Impoundment Seepage through the cover— Seepage outlet structure	No seepage outlet structure was included in the 1990 Plan of Operations since seepage through the cover was not anticipated in approved reclamation plan. A seepage	Same as Proposed Action but seepage outlet structure would be located in the south end of the impoundment (KP 2007, Figure 1).	Same as Proposed Action.

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
	outlet structure at south end of the impoundment was included in the 1999 final impoundment design (KP 1999b, Fig. 2-21).		
East Boulder Impoundment Seepage through the cover—Treatment method during closure	No method or time frame for treating seepage through the cover during closure was contained in the 1990 Plan of Operations. At closure, under the final impoundment design, the seepage water would be treated in the BTS plant or discharged through the percolation pond, but no time frame was specified (KP 1999b).	The seepage through the cover would be treated for up to 12 months with adit water in the BTS (KP 2007).	Same as Proposed Action, except that the seepage through the cover would be treated up to 18 months.
East Boulder Impoundment Seepage through the cover—Routing during closure	Seepage through the cover was originally anticipated to infiltrate and percolate through the tailings, collect above the liner, and report as liner leakage (DSL et al. 1992). Under the final impoundment design (KP 1999b), SMC determined seepage through the cover would discharge laterally at the seepage outlet structure on the south end of the embankment. Seepage would flow a short distance down the embankment through a pipe to either the surge pond or the percolation pond (Fig. 2-21). At closure, this seepage water would be routed to the BTS plant or the percolation pond (KP 1999b). A conceptual design, but no routing, was provided for the pipe between the outlet and the percolation or surge pond used during closure.	Modeling indicates the preferred pathway would be lateral discharge at the tailings surface and reclamation cover interface (KP 2000b). Modeling suggests seepage through the cover would vary depending on whether the underdrain system was open or plugged and the amount of cover runoff. The seepage through the cover routing would be the same as the No Action Alternative. Seepage through the cover would be routed to either the percolation pond for disposal or to the surge pond for treatment in the BTS, depending upon water quality and quantity during closure (Wolfe 2001).	Same as Proposed Action, but the seepage outlet structure would be constructed at the southern end of the impoundment.
East Boulder Impoundment Seepage through the cover—Routing during post-closure	No post-closure routing was specified.	During post-closure, seepage through the reclamation cover would be routed to the percolation pond (Figure 2-23).	Same as Proposed Action.
East Boulder Impoundment Seepage through the cover—Channel designs for routing at closure and post-closure	No channel or pipeline design was included in the approved 1990 Plan of Operations. Under the 1999 Final Impoundment Design (KP 1999b), seepage through the cover would gravity flow from the seepage outlet structure through a channel and pipeline to the BTS for treatment or to the percolation pond until water quality standards are met. SMC's final impoundment design states seepage would be routed to East Boulder River at post-closure, but no location or design was provided (KP 1999b).	Same as No Action.	The seepage outlet structure would discharge to a rip-rapped channel that discharges to the percolation pond. The rip-rapped, trapezoidal channel would be 5 feet wide, 2 feet deep with 2:1 slopes. Channel designs must be updated in the next annual report after the ROD is issued if this alternative is approved.
Storm Water Management			
East Boulder Tailings Impoundment			
East Boulder Impoundment Storm water runoff — Flow rate	The storm water flow rate was not defined.	The actual storm water flow rate was not provided because it would vary according to storm intensity, duration, and the amount of infiltration into the reclamation cover. Modeling used 30 and 50 percent runoff from a 100-year, 24-hour storm event and was broken out on a monthly basis (KP 2000b)	Same as Proposed Action.

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
East Boulder Impoundment Storm water runoff — Reclamation cover design	SMC would conduct tailings consolidation tests before closure to finalize depths and volume of cover materials needed to achieve post-settlement gradients (KP 1999b). These tests would be used to finalize the cover design.	A reclamation cover design was provided in the KP 2007 Reclamation Plan.	Same as No Action.
	SMC would construct a reclamation cover consisting of 48 inches of waste rock, borrow and/or boulders with 28 inches of subsoil/soil (USFS and DEQ 2002; KP 1999b).	SMC would construct a reclamation cover consisting of 24 inches feet of waste rock, borrow material, and/or boulders and 28 inches of subsoil/topsoil (KP, 2007)	SMC would construct a reclamation cover consisting of an average of 48 inches of feet of waste rock, borrow material, and/or boulders with 28 inches of subsoil/soil
East Boulder Impoundment Storm water runoff — Reclamation cover final grade	Final surface graded 1 percent to edges away from center of impoundment (KP 1999b).	Tailings deposited during operations would establish a natural swale to the southern end with a minimum grade of 1 percent. The final cover grade would mimic the tailings slope at an average of 1 percent grade (KP, 2007).	The final reclamation cover grade would be the same as the tailings surface grade. The agencies assume that differential settling would occur in areas of slimes concentrations, and shallow depressions would occur on top of the impoundment.
East Boulder Impoundment Storm water runoff — Routing during operations	Storm water off the inner slopes of the tailings impoundment during operations is contained within the impoundment. Runoff from the outer slopes of the impoundment is managed according to SMC's approved SWPPP (SMC 2007b).	Same as No Action.	Same as No Action.
East Boulder Impoundment Storm water runoff — Closure and post-closure runoff routing	During the later part of closure, once the reclamation cover has been installed, runoff would flow over the edges of the embankment. No channel would be constructed on the impoundment cover surface (KP 1999a).	Storm water runoff would follow the cover slope toward the southern end of the impoundment down the tailing embankment channel into the percolation pond (KP 2007, Figure 1).	Same as Proposed Action.
East Boulder Impoundment Storm water runoff — Channel designs	No separate channel would be needed for cover runoff, as water would either flow into the cover or over the edge of the embankments (KP 1999a)	Conceptual design provided in KP 2007.	SMC would submit detailed storm water channel designs sized to handle a 100-year/24-hour storm event by the date of the first annual report if this alternative is approved.
East Boulder Impoundment Storm water runoff — Impoundment spillway	No spillway included in original impoundment design.	The seepage outlet structure would be sized to handle seepage through the cover and storm water runoff from a 100 yr/24-hour storm event (KP 2007).	Same as Proposed Action, except that the channel down the embankment would be sized to handle a 100-year/24-hour storm event.
General Mine Site Area			
General Mine Site Area Storm water runoff— Operational and Closure Runoff routing	SMC's operational SWPPP would apply during closure (SMC 2007b).	Same as No Action.	Same as No Action.
General Mine Site Area Storm water runoff—Post-closure runoff	SMC's operational SWPPP does not address requirements, facilities, and management of storm water facilities during post-closure.	Same as No Action, except at post-closure, natural storm water sediment retention basins would be retained. All run off and run on diversion channels constructed at closure would be retained (SMC 2007b).	Same as Proposed Action.

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
Reclamation			
Reclamation—General	The current closure plan for the adits includes plugging of the portals to prevent public access, but would still allow for discharge (Stillwater PGM Resources 1990). The two mine adits would be backfilled with waste rock if there is no potential future beneficial use (USFS and DEQ 2002).	Same as No Action.	The adits would be backfilled and bat friendly gates would be installed. No heavy mesh steel doors would be used.
	Raises would be plugged and capped with native materials (USFS and DEQ 2002).	Same as No Action.	Same as No Action.
	Decommissioning of the BTS and removal of the mine-site LAD system are addressed in the 2002 bonding calculations. Reclamation of the existing portion of the Boe Ranch pipeline between the mill site and the USFS boundary was covered in a minor revision (USFS and DEQ 2002, MR00-001, June 5, 2000). The BTS, pipelines, and mine-site LAD system would be reclaimed during post-closure when all water quality limits are met without treatment.	Same as No Action, except that the BTS and LAD facilities would be reclaimed after 12 months of closure.	Same as No Action, except that BTS and LAD facilities would be reclaimed after 18 months of closure.
Reclamation—Time frame	Clarifiers would be removed after the first 12 months of closure. The BTS would be decommissioned after 3 years. LAD facilities would be removed during post-closure. (KP 2001).	The clarifier, BTS, and LAD facilities would be removed during the second year of closure (KP 2007).	Same as Proposed Action except that water treatment facilities would be removed after 18 months.
Monitoring and Maintenance Plans			
Monitoring Plans—operations and closure	➢ Adit water would be continually monitored according to 1998 WMP until it meets MPDES permit limits and the permit expires. ➢ Storm water discharges to surface waters would be sampled as required by MPDES permit until it expires. Sampling would be done according to the SWPPP (SMC 2007b). ➢ Ambient surface and ground water quality would be monitored (SMC 1998). ➢ Water seeping out the underdrain at the East Boulder impoundment would be sampled until it was plugged (KP 1999a). ➢ No monitoring requirements for seepage through the cover, liner leakage, the percolation pond or the discharge channel function were proposed in the 1990 Plan of Operations. ➢ Reclamation covers would be monitored for settlement and consolidation for closure period (KP 1999b). ➢	Same as No Action except for the following items: ➢ Seepage through the cover would be sampled and monitored at the impoundment (Wolfe 2001. ➢ Settlement monitoring would be done on a 100-foot grid (Wolfe 2001).	Same as Proposed Action except: ➢ Annual monitoring of tailings deposition would be conducted during operations to verify the tailings grade at the impoundment. ➢ Annual monitoring of volume of supernatant water would be required during operations. ➢ Measure tailings density every 5 years during operations at the impoundment. ➢ Monitor tailings impoundments function and structural integrity. ➢ Quarterly monitoring of mine adit water quality starting at closure. ➢ Quarterly monitoring of water quality at impound-ment underdrain outlet during operations and closure. ➢ Quarterly monitoring of seepage through the cover at closure.

Table 2–7 Comparison of Alternative Components for the East Boulder Mine Closure and Post-Closure Water Management Plan

Location/Component	No Action Alternative 1B	Proposed Action Alternative 2B	Agency Mitigated Alternative 3B
Monitoring Plans—Post-closure	No post-closure monitoring plans are included in the 1998 WMP. The USFS and DEQ 2002 bond calculations include the following items: ➢ Ground water and surface water quality ➢ Tailings settlement ➢ Channel function ➢ Seepage outlet function ➢ Seasonal monitoring of adit water quality and quantity	Same as No Action	Post-closure monitoring would address the following items until the bond is released or the MPDES permit is no longer needed: ➢ Monitoring of ground water and surface water quality according to approved water monitoring plans and MPDES permit in place at time of closure. ➢ Annual monitoring of tailings impoundment function and structural integrity for the first 5 years and then once every 5 years. ➢ Annual monitoring of the function of the seepage outlet structure, seepage through the cover discharge channel, storm water facilities, and percolation pond for the first 5 years and then once every 5 years. ➢ Quarterly monitoring of adit water quality and quantity during the first year and annually thereafter.
Maintenance Plans—Closure	Bond calculations in 2002 included 3 years of maintenance with reclamation completed in the fourth year. Maintenance includes: ➢ Channel maintenance. ➢ Managing and maintaining the BTS and associated facilities during closure is also included	Same as No Action, except the water treatment facilities would be maintained up to 12 months.	The Agency-mitigated closure maintenance plan would include the additional items for up to 18 months: ➢ Storm water conveyance channels. ➢ Seepage outlet structure ➢ Underdrain seepage outlet structure. ➢ Rip rapped channel on tailings impoundment embankment. ➢ other water management facilities including LAD facilities, pipelines, percolation pond, and sediment retention basins.
Maintenance Plans—Post-closure	Maintenance of water management facilities during post-closure is not included in the Plan of Operations or 1998 WMP. Post-closure maintenance is included in the agency bond calculations (USFS and DEQ 2002).	The post-closure maintenance plan would include monitoring and maintenance every five years for the following items until bond is released (KP 2007). ➢ Function of storm water sediment retention ponds. ➢ Adit discharge and storm water channel function. ➢ Seepage through the cover outlet and underdrain function. ➢ Function of armored channel on tailings embankment.	The Post-closure maintenance plan would include the following items to be conducted annually during the first five years of post-closure and once every five years thereafter: ➢ Function of all ponds including percolation pond, and sediment retention basin. ➢ Storm water, adit discharge, and seepage outlet discharge channel function ➢ Function of seepage outlet structure and underdrain

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
Boe Ranch LAD System			
Adit Water	Adit water would be handled as described in the East Boulder No Action Alternative 1B during operations, closure, and during post-closure.	If constructed, the Boe Ranch LAD system would be SMC's preferred location for disposal of treated adit water during operations and treated adit and tailings waters during the first year of closure (Figure 2-28). After the first year of closure, the BTS would be decommissioned and no more water would be routed to Boe Ranch if constructed.	Same as Proposed Action except the water treatment facilities, including those at Boe Ranch, would be retained for up to 18 months. During post-closure, adit water would be managed as described for the East Boulder Proposed Action 2C.
Tailings Impoundment Waters	During operation, closure, and post-closure, tailings impoundment waters may be handled as described for East Boulder No Action Alternative 1B.	At closure, supernatant and tailing mass waters would be pumped to the water treatment system, with adit water, if necessary, for up to 1 year and routed to the Boe Ranch LAD system if constructed (Figure 2-29). At post-closure, no tailings impoundment water would be disposed of at the Boe Ranch.	Same as Proposed Action except that water treatment facilities could be retained up to 18 months.
Storm Water Management			
East Boulder Tailings Impoundment			
East Boulder Impoundment Storm water management	Storm water management for the East Boulder Tailings Impoundment would remain the same for operations, closure, and post-closure as described for the East Boulder Mine No Action Alternative 1B.	Storm water management for the East Boulder Tailings Impoundment would remain the same as described for the East Boulder Mine Proposed Action Alternative 2B.	Storm water management for the East Boulder Tailings Impoundment would remain the same as described for the East Boulder Mine Proposed Action Alternative 2B.
General Mine Site Area			
General Mine Site Area Storm water management	The SWPPP for the mine site would be the same as that described for the East Boulder Mine No Action Alternative 1B (SMC 2007b).	The SWPPP for the mine site LAD areas would be the same as described for the East Boulder Mine No Action Alternative 1B (SMC 2007b).	The SWPPP for mine site LAD areas would be the same as described for the East Boulder Mine Proposed Action Alternative 2B (SMC 2007b).
Boe Ranch Storm water management	The Boe Ranch LAD system would not be constructed under this alternative.	No SWPPP would be required at the Boe Ranch because there would be limited storm water runoff from the LAD area. Most storm water runoff would drain into the LAD storage pond, and no overland flow to surface waters is anticipated.	No SWPPP would be required at the Boe Ranch as described for Proposed Action Alternative 2C.
LAD Facilities			
Mine Site LAD System			
Mine Site LAD System— Use during operations	Same as for the East Boulder Mine No Action Alternative 1B.	The mine site LAD facilities would be used for contingency disposal of treated adit water during mine operation as described for the East Boulder Mine Proposed Action Alternative 2B (Figure 2-18).	The use of mine site LAD facilities would be similar to the Proposed Action Alternative 2C during operations. The discharge capacity during the growing season at LAD Area 6 would range from 8 to 60 gpm, 12 hrs per day with a summer average of 14 gpm. The discharge capacity of snow making would average 90 gpm, 12 hrs per day with a

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
			45 gpm average for the winter period. (Burgard 2008). The percolation pond would not typically be needed unless the Boe Ranch Storage Pond was not available and flows exceeded the mine site LAD capacities. The capacity of the percolation pond is more than can be produced from the adits and the tailings impoundment.
Mine Site LAD System— Use during closure	Same as for the East Boulder Mine No Action Alternative 1B.	If the Boe Ranch is not constructed, the percolation pond would be the primary disposal site for treated adit and tailing waters followed by routing to contingency disposal areas in order of preference for up to 1 year as shown in Figure 2-19 (KP 2007).	With the Boe Ranch LAD system in place, the mine site LAD facilities would only be used for contingency disposal for up to 18 months of closure as described for Proposed Action Alternative 2C.
Mine Site LAD System— Use during post-closure	Same as for the East Boulder Mine No Action Alternative 1B	The mine site LAD facilities would be decommissioned as described in East Boulder Mine Proposed Action Alternative 2B.	The mine site LAD facilities would be decommissioned as described in East Boulder Mine Proposed Action Alternative 2B.
Boe Ranch LAD System			
Boe Ranch LAD System— Use during operations	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	Phase 1b LAD facilities at Boe Ranch, if constructed, would include the LAD storage pond, a new pipeline extension, ten center pivots, and a pump house (Figure 2-32). During the growing season, which is generally April through October, SMC would route adit water to the clarifier and the BTS plant and pump it to the Boe Ranch LAD storage pond. The treated water would be disposed of at the Boe Ranch LAD facilities (Fig. 2-28). The Boe Ranch LAD system could dispose of more than 350 gpm via the center pivots during the growing season (Figure 2-28). Using both the mine site and the Boe Ranch LAD facilities, SMC could dispose of up to 745 gpm during the growing season.	Use of the Boe Ranch LAD facilities would be the same as described under Proposed Action Alternative 2C, except LAD center pivot #10 would not be used due to mass wasting concerns. Pivots #4 and 9 would require additional monitoring due to mass wasting concerns.
Boe Ranch LAD System— Use during closure	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	If constructed, the Boe Ranch LAD facilities would be used during the first year of closure to dispose of treated adit and tailing waters (Figure 2-29). After 1 year, the Boe Ranch LAD system use would not be used for mine water disposal.	Same as Proposed Action, except the Boe Ranch LAD facilities would be used up to 18 months (Figure 2-33), Pivot #10 would be eliminated, and Pivots # 4 and #9 would be increasingly monitored.
Boe Ranch LAD System— Use during post-closure	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	Boe Ranch LAD facilities would not be used during post-closure.	Same as Proposed Action.
Boe Ranch Pipeline and Roads			
Boe Ranch Pipeline and Roads — Existing pipeline and roads	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C	During operations and closure, the existing pipe would be used along with a newly constructed pipeline to Boe Ranch to route water from the mine to the Boe Ranch LAD facilities. No changes are	Use of the existing pipeline would be the same as Proposed Action Alternative 2C.

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
		proposed to the existing pipeline and Sweet Grass County Road 31.	
Boe Ranch Pipeline and Roads— New pipeline and roads	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C	If the Boe Ranch LAD system were constructed, the 11,700-foot extension of the existing pipeline would start in the right-of-way of Sweet Grass County Road 31 and proceed north into the Boe Ranch in a new Bench Road right-of-way to the Boe Ranch LAD storage pond. About 6,200 feet of the new pipeline and road would cross State of Montana land in Section 16. With a disturbance width of 50 feet, construction of the new pipeline and road would disturb a total of about 16 acres of which 6.8 acres are on state lands and 9.2 acres on private lands. This new pipeline would be an extension of the existing pipeline described under No Action Alternative 1C. Construction of the new portion of the Boe Ranch pipeline would follow standard procedures and would be constructed of Schedule 20 steel pipe with corrosion protection coatings and HDPE pipe. The pipeline would be equipped with a leak detection system. The pipeline would be buried to a depth of 6.5 feet (approximate depth of the frost line). The manhole covers would be designed to carry traffic loads and prohibit inflow of surface runoff.	Location and construction of the new portion of the Boe Ranch pipeline would be the same as the Proposed Action Alternative 2C. Final pipeline routing would be field approved by the agencies.
	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C	If the Boe Ranch LAD system were constructed, the Bench Road from Sweet Grass County Road 31 paralleling Mason Ditch and the access road heading west to the LAD storage pond would be constructed to provide access to the Boe Ranch LAD facilities. The new Bench Road and access road would be constructed above the pipeline after pipeline installation. No road construction specifications are provided.	Same as Proposed Action except, final road design would be field approved by the agencies. The access road design must be submitted prior to road construction and include the following items: ➢ The Bench Road and access road would be 16-foot wide with a graveled surface. ➢ Soil would be windrowed along the road along the down slope portion of the road. ➢ A bridge on the access road would be installed over Mason Ditch to protect the ditch. ➢ Six 28-inch culverts would be installed. ➢ Standard state and USFS BMPs would be used to control erosion and storm water along the road and pipeline corridor.
LAD Storage Pond			
LAD Storage Pond—Design Specifications	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	If constructed, the LAD storage pond would be located in a valley at Boe Ranch. The LAD storage pond would occupy about 24 acres. Overall disturbance for the pond, embankment, soil stockpiles, and other LAD facilities would	The LAD storage pond would be constructed as described under the Proposed Action Alternative 2C.

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
		encompass 36 acres on private lands. The pond embankment would be 55 feet high with a crest width of 30 feet and a crest length of 600 feet. The pond was designed to be 35 feet deep including a 6-foot freeboard. It would provide a total storage capacity of 108 million gallons for storing water through the winter. Slopes of the interior basin would be graded to 5H: 1V. The pond would be lined with an 80-mil HDPE membrane and fenced with an 8-foot high wildlife fence.	
	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C	A minimum of 12 inches of soil would be stripped from the basin, embankment, roads, and other facilities and stockpiled for reclamation below the LAD storage pond. Earthen materials that are unsuitable for use in constructing the embankment would be stockpiled downstream and reclaimed. The amount of material in stockpiles below the pond would be 264,810 yd^3 and would cover 3.2 acres (KP 2000, Figure 2-35).	The quantity of soil and unsuitable materials to be salvaged and stockpiled would be the same as the Proposed Action. The stockpiles would be located on the hillside out of the drainage below the pond east of the proposed site between elevations of 5,620 and 5,730 feet.
LAD Storage Pond—High hazard status	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	DNRC has determined the LAD storage pond is a high-hazard dam (Voeller 2002). While SMC maintains a mine operating permit, it is not required to submit an operation, maintenance and emergency preparedness plan that complies with DNRC's high-hazard dam requirements since SMC is exempt from obtaining a DNRC operating permit while it has an approved DEQ mine operating permit. Since the LAD storage pond would be left in place post-closure, SMC or any successor would be required to get a DNRC operating permit.	Under the Agency-Mitigated Alternative 3C, SMC would be required to submit an Operations and Maintenance Plan and an Emergency Preparedness Plan that meets the DNRC dam safety program requirements. SMC would also be required to reduce the total storage capacity of the LAD storage pond at post-closure to less than 50 acre-feet. The modified LAD storage pond would no longer be a high hazard dam. Prior to construction of the pond, SMC would submit a plan to reduce the LAD storage pond capacity at closure (Figure 2-26).
Center Pivot LAD			
Center Pivot LAD	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	If the Boe Ranch LAD system were constructed, water in the LAD storage pond would be pumped to buried pipelines directly from the pond to 10 center-pivots for disposal at a rate that would limit nitrate migration below the root zone. The center-pivots would support a maximum LAD rate of almost 1,500 gpm, which equates to 0.017 inches per hour or 7.66 gpm/acre during a 12-hour day. At this rate, SMC could apply about 94 million gallons of mine water over approximately 7 months a year to the 194 acres in Section 17. SMC expects to graze the LAD areas using a short-duration, high-intensity grazing system. This system would likely use portable electric fences to manage the livestock.	A more detailed LAD system design, operation, and management plan would be required and approved by the agencies prior to facility installation. This plan would be operated in compliance with Montana DEQ LAD guidelines and based on experience gained at the Hertzler Ranch. The :LAD system operation would be modified using data collected from additional lysimeters, shallow ground water wells, soil sampling and testing, and precipitation data from an on-site weather station. Monitoring equipment would be protected from grazing cattle. If the Boe Ranch LAD system were constructed, use of the mine site systems during operations and closure would be similar to that described in the Proposed Action 3B, except it would be used for up to 18 months.

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
Evaporator and Snowmaking Systems			
Evaporator and Snowmaking Systems—Mine site systems	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C	If the Boe Ranch LAD system were constructed, the mine site LAD systems (percolation pond and LAD Area 6) would be used for contingencies during operations and the first year of closure (Figure 2-29). The mine site LAD system would be the primary water disposal system after the first year of closure. These systems would not be available for use during post-closure. (Fig. 2-29)	The mine site LAD systems would be used for contingencies during operations and up to 18 months during closure.
Evaporator and Snowmaking Systems—Boe Ranch LAD systems	The Boe Ranch LAD system would not be constructed under No Action Alternative 1C.	In addition to the center pivots, an evaporator and snowmaker system would be installed on the LAD storage pond embankment crest and up-gradient of the lined surface of the pond if the Boe Ranch LAD system is constructed. The system would consist of nine evaporators and five snowmakers. SMC expects to evaporate about 172 total gpm during the warmer months and make snow at 25 gpm per unit during colder months and dispose of a total of 45 million gallons per year. Runoff from these evaporator/snowmaker units would flow over native ground onto the HDPE liner and back into the LAD storage pond.	Same as Proposed Action, except SMC could only use the snowmaking system after the ground is frozen. The percolation rate through the soil above the liner must be monitored to limit the risk of mass movement.
Reclamation			
Reclamation—Mine site LAD facilities	The existing facilities would be reclaimed according to approved plans as described under the East Boulder Mine No Action Alternative 1B.	Reclamation of mine site LAD facilities would be the same as No Action Alternatives 1B and 1C.	Reclamation of mine site LAD facilities would be the same as No Action Alternatives 1B and 1C.
Reclamation—Existing pipeline and roads	The existing facilities would be reclaimed according to approved plans as described under the East Boulder Mine No Action Alternative 1B.	Reclamation of mine site LAD facilities would be the same as No Action Alternatives 1B and 1C.	Reclamation of mine site LAD facilities would be the same as No Action Alternatives 1B and 1C.
Reclamation—New pipeline and roads	The existing facilities would be reclaimed according to approved plans as described under the East Boulder Mine No Action Alternative 1B.	If the new Boe Ranch pipeline is constructed, concurrent reclamation of the new pipeline corridor disturbance outside the road prism would be completed within 12 months. Where the pipeline would be constructed off the road, the trench would be backfilled and a minimum of 12 inches of soil would be placed and seeded with approved mixtures. The new pipeline would be grouted and abandoned in place after the first year of closure. Manholes would be reclaimed by filling with compacted soil. Any new disturbance created while abandoning the pipeline would be reclaimed.	Reclamation of the new pipeline corridor would be the same as the Proposed Action except manholes along the East Boulder Mine access road would be reclaimed as per Sweet Grass County specifications if they were more stringent than those proposed under Proposed Action Alternative 2C.
	No roads would be constructed at Boe Ranch.	If the Boe Ranch LAD system were constructed, the Bench Road and the Boe Ranch access road would	Same as Proposed Action.

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
		be reclaimed after closure of the mine. Reclamation would consist of recontouring where required and revegetation within the roads' rights-of-way.	
Reclamation—Boe Ranch LAD System	The existing facilities would be reclaimed according to approved plans as described under the East Boulder Mine No Action Alternative 1B.	If the Boe Ranch LAD system were constructed, it would not be reclaimed. The center pivots and LAD storage pond could be used in subsequent agricultural operations using water rights on the Mason Ditch.	The center pivots and LAD storage pond would be left in place as under the Proposed Action Alternative 2C. The storage pond's embankment height would be reduced so the impoundment would retain less than 50 acre-feet to eliminate the high-hazard dam classification. All disturbance caused by the LAD storage pond embankment reduction would be reclaimed.
Monitoring and Maintenance Plans			
Monitoring Plans			
Monitoring Plans—operations and closure	All monitoring would continue as previously described under East Boulder Mine No Action Alternative 1B for operations and closure.	If the Boe Ranch LAD system were constructed, monitoring would be the same as No-Action Alternatives 1B and 1C with the following additions: ➢ New Pipeline Monitoring and Spill Contingency Plan would be developed to address designs, inspections, and leak detection response. ➢ Boe Ranch LAD system operational and closure monitoring plan would include: o Lysimeters o Soil sampling o Ground water monitoring wells and downgradient springs o Surface water in East Boulder River o Precipitation and evaporation o BTS water quality	All monitoring plans required for the Agency Mitigated Alternative are included in Appendix B of the EIS. The Boe Ranch LAD system operational and closure monitoring plan under the Proposed Action Alternative 2C would incorporate or expand the following: o Additional lysimeters, soil moisture probes would be installed under each center pivot and down gradient of the snowmakers. o Monthly monitoring of any new downgradient seeps and springs above the Mason Ditch during irrigation season until flow ceases. o Expanded soils and vegetation sampling to assess fate and transport of nitrogen and salts. o Action limits would be set for total concentration of nitrogen and salts and the subsequent actions SMC would take should those levels be reached. o SMC would monitor the flow rate of the East Boulder River during the irrigation season so that the LAD application rate could be adjusted as needed to prevent nitrogen exceedances in surface water. o SMC would use ground water monitoring data to verify mine water application rates so that ground water would not exceed the nitrogen and salts action level. o Slope stability would be monitored monthly in soils susceptible to slumping or mass wasting around center pivots during use of the Boe Ranch LAD system during operations and closure. o Climate monitoring would be expanded.

Table 2-8 Comparison of Alternative Components for the Boe Ranch Land Application Disposal Proposal

Location/Component	No Action Alternative 1C	Proposed Action Alternative 2C	Agency Mitigated Alternative 3C
			o All monitoring equipment would be protected from grazing cattle.
Monitoring Plans—post-closure	No monitoring would be required for the Boe Ranch LAD area since the system would not be constructed.	No post-closure monitoring was proposed.	Post-closure monitoring would not occur if closure monitoring indicates no water quality concerns or LAD storage pond stability problems. If the Boe Ranch is purchased by a private landowner, agency authority would not extend to the Boe Ranch.
Maintenance Plans			
Maintenance Plans—operations and closure	All maintenance plans for operations and closure would be the same as described for East Boulder Mine WMP No Action Alternative 1B	Maintenance plans for the mine site would be the same as described for operations and closure under the East Boulder Mine WMP Proposed Action Alternative 2B. No maintenance plans for operation and closure are proposed for the Boe Ranch.	Maintenance plans would be the same as described for operations and closure under Proposed Action Alternatives 2B and 2C with the additional following items: Closure maintenance plan would include the additional items for up to 18 months: ➢ Storm water conveyance channels. ➢ Seepage outlet structure ➢ Underdrain seepage outlet structure. ➢ Rip rapped channel on tailings impoundment embankment. Include other water management facilities including LAD facilities, pipelines, percolation pond, and sediment retention basins. The post-closure maintenance plan would include the following items to be conducted annually during the first five years of Post-closure and once every five years thereafter: ➢ Function of all ponds including percolation pond, and sediment retention basin. ➢ Storm water, adit discharge, and seepage outlet discharge channel function ➢ Function of seepage outlet structure and underdrain ➢ Function of rip rapped channels on tailings embankment
Maintenance Plans—post-closure	No maintenance plans would be required because the Boe Ranch LAD would not be constructed.	Maintenance plans for the mine site would be the same as described for post-closure under East Boulder Mine WMP Proposed Action Alternative 2B. No maintenance plans for post-closure are proposed for the Boe Ranch.	Same as No Action

Table 2-9 Effects Comparison Among Alternatives - Stillwater Mine and Hertzler LAD System

	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Water Quality and Quantity – 20+ years operational data at Nye and 10+ years at operational data Hertzler			
Closure and Post-Closure	TIN and Salts: @ 650 gpm – 2,020 gpm adit water and 80 MG tailings waters disposal at closure- **In compliance** with surface and groundwater standards/guidelines at the Stillwater Mine and Hertzler Ranch.	TIN: @ 650 gpm adit water and 80 MG tailings waters disposal at closure - **In compliance** with surface and ground water standards at the Stillwater Mine and Hertzler Ranch.	TIN and Salts: @ 650 gpm – 2,020 gpm adit water and 80 MG tailings waters disposal at closure - **In compliance** with surface and ground water standards/guidelines at the Stillwater Mine and Hertzler Ranch.
		Salts: @ 650 gpm adit water and 80 MG tailings waters disposal at closure – **Not in compliance** with ground water guidelines at Hertzler Ranch. **In compliance** with surface water standards/guidelines at the Stillwater Mine and Hertzler Ranch.	
		TIN and Salts: @ 2,020 gpm adit water and 80 MG tailings waters disposal at closure - **In compliance** with surface and groundwater standards/guidelines at the Stillwater Mine and Hertzler Ranch.	
		Summary: Analysis shows disposal of mine waters at a rate of 650 gpm at the Hertzler Ranch **would not be incompliance** with salts guidelines. Disposal of mine waters at a rate of 650 gpm at the Stillwater Mine and at a rate of 2,020 gpm at the Stillwater Mine and Hertzler Ranch during closure (12 months) **would comply** with TIN and salts water quality standards/guidelines*. *Unforeseen circumstances during closure could jeopardize compliance within a 12-month period and produce **short-term exceedances.**	Analysis shows disposal of mine waters at closure (18 months) would comply with water quality standards/guidelines.
	Surface Water Quantity: No effects	Surface Water Quantity: No effects	Surface Water Quantity: No effects
Wildlife and Aquatic Resources (Aquatics Only) – 20+ years of operational water quality and biomonitoring data			
Closure and Post-Closure	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.

Table 2-10 Effects Comparison Among Alternatives - East Boulder Mine

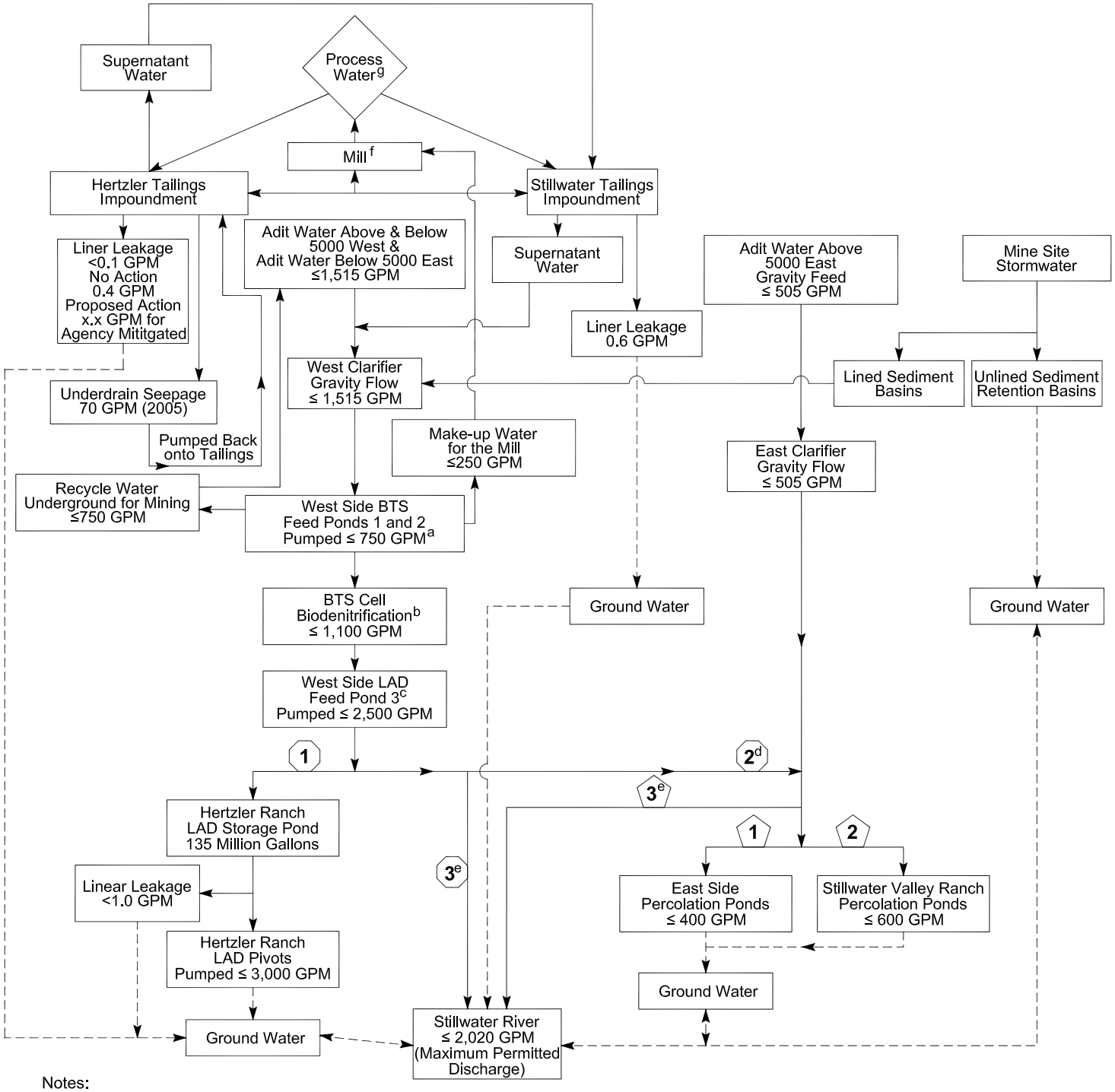
	No Action Alternative 1B	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B
Water Quality and Quantity – 10 years operational data at East Boulder			
Closure	TIN and Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal - **In compliance** with surface and groundwater standards/guidelines at mine site.	TIN: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal - **In compliance** with surface and groundwater standards at mine site. Analysis shows disposal of mine waters at closure (12 months) would comply with water quality standards.* *Unforeseen circumstances could jeopardize compliance within a 12-month period.	TIN: @ 150 gpm - adit water and 40 MG tailings waters disposal - **In compliance** with surface and groundwater standards at mine site. Analysis shows disposal of mine waters at closure (18 months) would comply with water quality standards.
		Salts: @150 gpm – 737 gpm adit water and 40 MG tailings waters disposal – **Not in compliance** with surface and ground water standards/guidelines at mine site.	Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal – **In compliance** with surface and groundwater standards/guidelines at mine site. Analysis shows disposal of mine waters at closure (18 months) would comply with water quality guidelines.
	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.
Post-Closure	TIN and Salts: @ 150 gpm – 737 gpm adit water disposal- **In compliance** with surface standards/guidelines at mine site.	TIN and Salts: @ 150 gpm – 737 gpm adit water disposal- **In compliance** with surface standards/guidelines at mine site.	TIN and Salts: @ 150 gpm – 737 gpm adit water disposal- **In compliance** with surface standards/guidelines at mine site.
	Surface Water Quantity: a 737 gpm adit water discharge rate **would not be in compliance** with the MPDES standard, which limits increased streamflow to less than 15%.	Surface Water Quantity: a 737 gpm adit water discharge rate **would not be in compliance** with the MPDES standard, which limits increased streamflow to less than 15%.	Surface Water Quantity: a 737 gpm adit water discharge rate **would not be in compliance** with the MPDES standard, which limits increased streamflow to less than 15%.
Wildlife and Aquatic Resources (Aquatics Only) – 10 years of operational water quality and biomonitoring data			
Closure	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	At 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal TIN and Salts loads **may have short-term adverse impact** on aquatic communities if the state standard of 1 mg/L TIN is violated or an exceedance of 250 mg/L TDS occurs.	Extension of closure timeline (18 months) would **reduce the possibility of a short-term adverse impact** on aquatic communities.
Post-Closure	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.	**TDS < 250 mg/L No effects** to aquatic communities based on water quality/quantity projections.

Table 2-11 Effects Comparison Among Alternatives - Boe Ranch LAD System

	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Water Quality and Quantity			
Operations	N/A.	TIN and Salts: @ 150 gpm – 737 gpm - **In compliance** with surface and groundwater standards/guidelines at Boe Ranch.	TIN and Salts: @ 150 gpm – 737 gpm - **In compliance** with surface and groundwater standards/guidelines at Boe Ranch.
	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.	Surface Water Quantity: N/A.
Closure	N/A.	TIN: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal –- **In compliance** with surface and groundwater standards at Boe Ranch.	TIN and Salts: @ 150 gpm – 737 gpm adit water and 40 MG tailings waters disposal- **In compliance** with surface and groundwater standards/guidelines at Boe Ranch.
		Salts: @ 150 gpm adit water and 40 MG tailings waters disposal- **In compliance** with surface and groundwater guidelines at Boe Ranch.	
		Salts: @ 737 gpm adit water and 40 MG tailings waters disposal- **Not in compliance** with surface and groundwater guidelines at Boe Ranch.	
		Summary: Analysis shows disposal of all mine waters at a rate of 737 gpm at the Boe Ranch during closure (12 months) **would comply** with TIN standards but **would not comply** with salts guidelines. Disposal of all mine waters at a rate of 150 gpm at the Boe Ranch during closure (12 months) **would comply** with TIN and salts water quality standards/guidelines.*. *Unforeseen circumstances could jeopardize compliance within a 12-month period.	Analysis shows disposal of mine waters at closure (18 months) would comply with water quality standards/guidelines.
		Surface Water Quantity: N/A.	Surface Water Quantity: N/A.
Post-Closure	N/A.	**No additional mine-related effects**.	**No additional mine-related effects.**
Wildlife and Aquatic Resources			
Operations	N/A.	**TDS < 250 mg/L in East Boulder River No effects** to wildlife/aquatic communities.	**TDS < 250 mg/L in East Boulder River No effects** to wildlife/aquatic communities.
Closure	N/A.	**No effects** to wildlife communities.	**No effects** to wildlife communities.
		Aquatic communities: If all mine waters are disposed at Boe Ranch (150 gpm – 737 gpm adit water and 40 MG tailings waters), salt loads **may have short-term adverse impacts** on aquatic communities if an exceedance of 250 mg/L TDS occurs.	Aquatic communities: Extension of closure timeline (18 months) **would reduce the possibility of a short-term adverse impact** on aquatic communities.
Post-Closure	N/A.	**TDS <250 mg/L No effects** to wildlife/aquatic communities.	**TDS < 250 mg/L No effects** to wildlife/aquatic communities.

Table 2-11 Effects Comparison Among Alternatives - Boe Ranch LAD System

	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Irrigation Practices			
Operations (@ 150 – 737 gpm adit water)	N/A.	Long-term changes in plant composition and noxious weed populations.	Long-term changes in plant composition and noxious weed populations.
		Potential for mass wasting at center pivots 4, 9, and 10.	Center pivot 10 would be eliminated. Center pivots 4 and 9 would be operated with increased monitoring to reduce potential for mass wasting.
		Increased TIN and salt loads in soils: soil productivity would be maintained due to annual flushing.	Increased TIN and salt loads in soils: soil productivity would be maintained due to annual flushing.
Closure (@ 150 – 737 gpm adit water and 40 MG tailings waters)	N/A.	Long-term changes in plant composition and noxious weed populations.	Long-term changes in plant composition and noxious weed populations.
		Increased potential for mass wasting at center pivots 4, 9, and 10 due to additional 40 MG of tailings water disposal during 12 month closure period.	Decreased potential for mass wasting at center pivots 4, 9, due to additional monitoring, an 18-month closure period, and elimination of center pivot 10.
		Increased TIN and salt loads in soils: soil productivity would be maintained due to annual flushing.	Increased TIN and salt loads in soils: soil productivity would be maintained due to annual flushing.
Post-Closure	N/A.	**No Additional Mine-Related Effects.**	**No Additional Mine-Related Effects.**
Cultural Resources			
Operations, Closure, and Post-Closure	N/A.	Direct adverse effects to the Boe Ranch drive-line site.	Direct adverse effects to the Boe Ranch drive-line site.
Stability of Boe Ranch LAD Storage Pond			
Operations and Closure	N/A.	Meets engineering standards for high-hazard dam: No effects projected to property, water quality, or stability.	Meets engineering standards for high-hazard dam: No effects projected to property, water quality, or stability. The DEQ would require an Operations, Maintenance, and Emergency Preparedness Plan that meets DNRC high-hazard dam requirements, reducing potential effects to property, water quality, and stability.
Post-closure	N/A.	Meets engineering standards for high-hazard dam: No effects projected to property, water quality, or stability.	Reduced potential for effects to property, water quality, and stability due to **elimination of high-hazard dam**. LAD storage pond volume would be reduced to less than 50 acre feet.



Notes:

a. Formerly west side percolation ponds 1 and 2.
b. The BTS plant would have to be expanded to handle 1,515 GPM.
c. Formerly west side percolation pond 3.
d. Water is routed to east side percolation ponds only if pumping to Hertzler Tailing Impoundment Ranch is unavailable.
e. Direct discharge to river is permitted but is last resort; no pipe works or drainage channel is currently in place.
f. Mill operations preferentially route tailings and process water to Hertzler Tailings Impoundment, then pump tailings water back to either the mill as make-up water or to the Stillwater Impoundment.
g. In this basically closed loop, water can be pumped in either direction between impoundments, or to either impoundment from the mill, Additional make-up water can be obtained from the BTS west-side feed ponds.

(1) Water management alternatives are ranked in order of preferred utilization for west-side waters.

(1) Water management alternatives are ranked in order of preferred utilization for east-side waters.

→ Direct flow - - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY
DRAFT EIS
Stillwater County, Montana

OPERATION WATER ROUTING AND HANDLING FOR THE STILLWATER MINE
ALTERNATIVES 1A, 2A, 3A

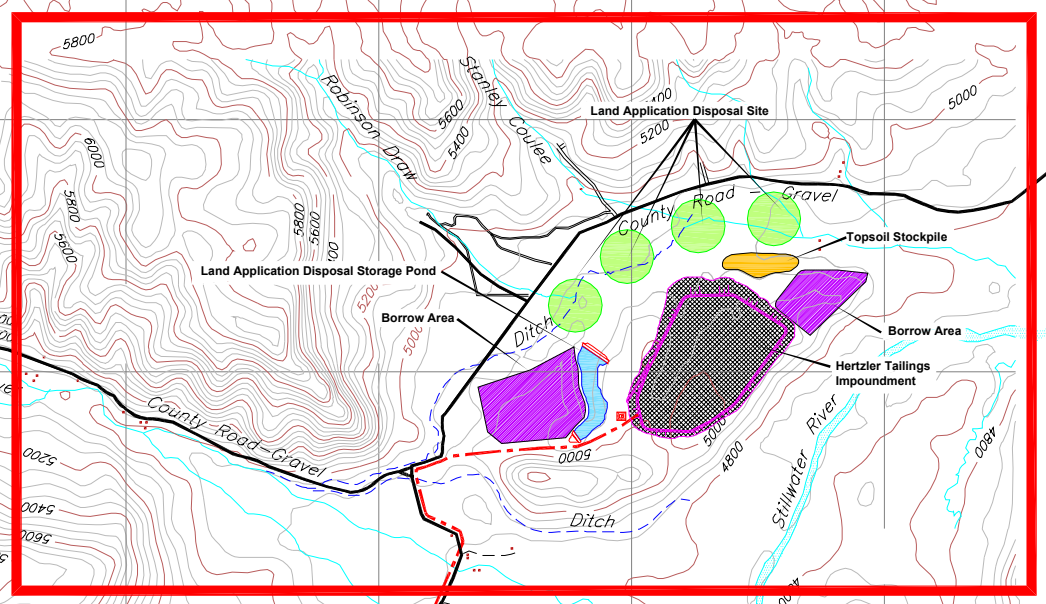
No Action-1A Agency-Mitigated-3A
Proposed Action-2A

DWG:1200 FIGS 06-14-08.dwg | LAYOUT:n2-1
DRAWN BY:ETC | PREPARED BY:DMC | DATE:06/24/2008

FIGURE **2-1**

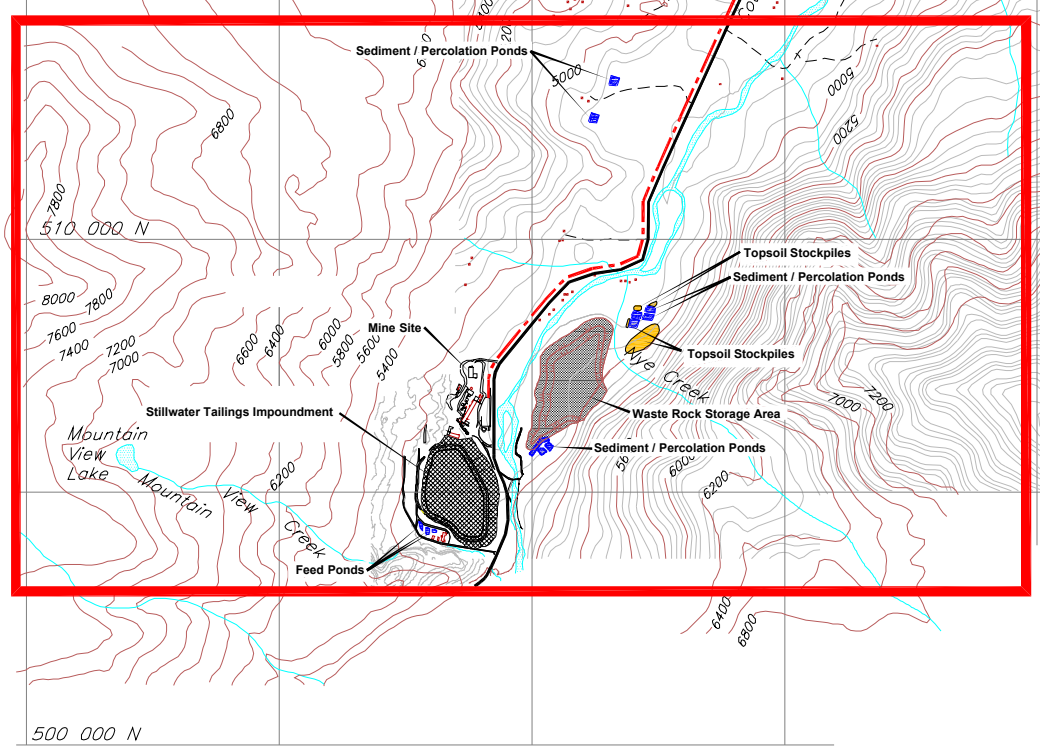
DETAIL A

see figure 2-3



DETAIL B

see figure 2-3



LEGEND

- Hertzler Pipeline Alignment
- Road
- Land Application Disposal Site
- Borrow Area
- Topsoil Stockpile
- Land Application Disposal Storage Pond
- Waste Rock Storage Area
- Tailings Impoundment
- Sediment / Percolation Pond

NORTH

STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

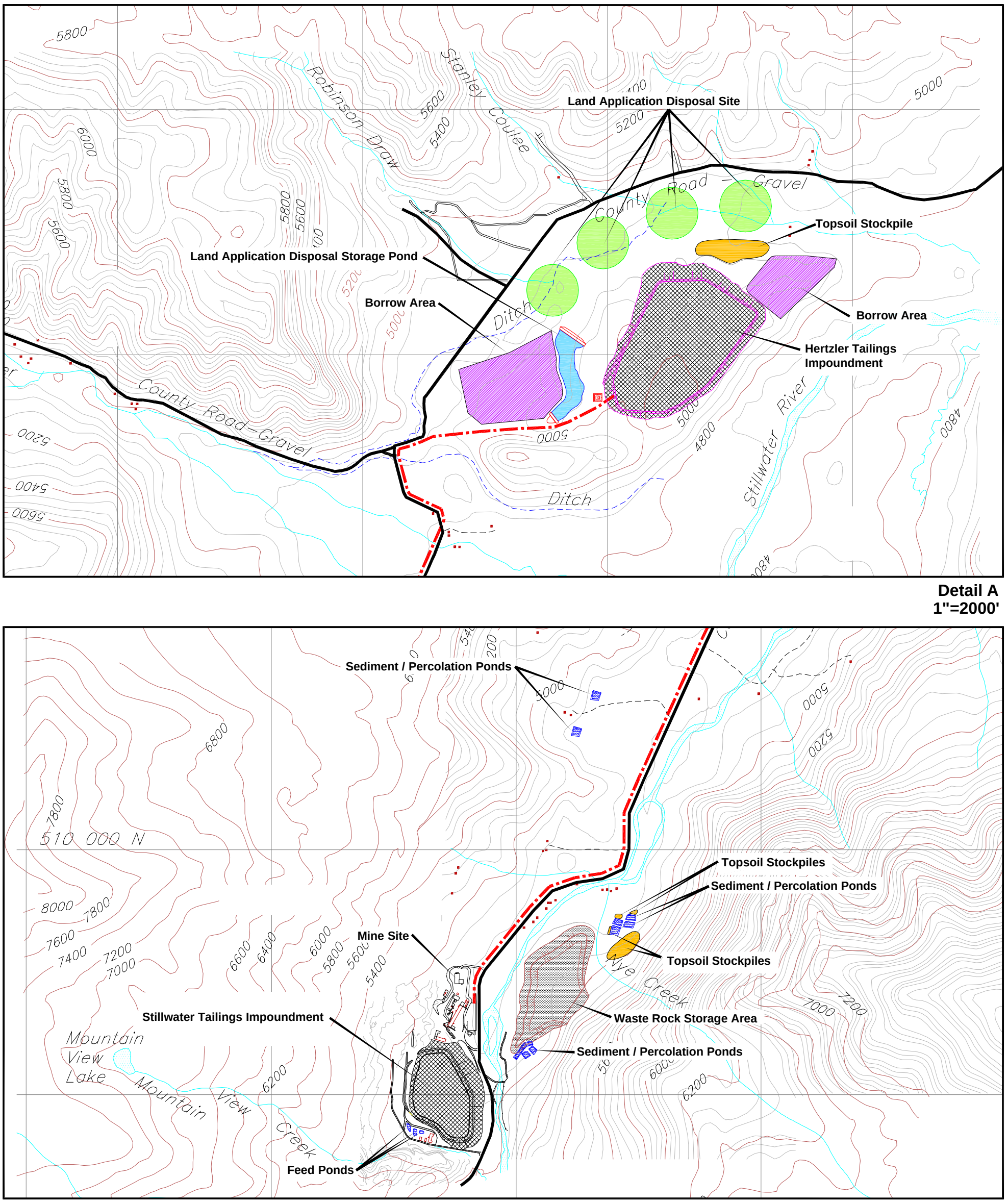
LOCATION OF HERTZLER RANCH AND STILLWATER MINE FACILITIES

0 1000 2000 3000 4000 Feet

FIGURE 2-2

DWG:Facilities.dwg | LAYOUT:2-2

DRAWN BY:ETC | PREPARED BY:DMC | DATE:1/12/2007



Detail A
1"=2000'

Detail B
1"=2000'

LEGEND

- Hertzler Pipeline Alignment
- Road
- Land Application Disposal Site
- Borrow Area
- Topsoil Stockpile
- Land Application Disposal Storage Pond
- Waste Rock Storage Area
- Tailings Impoundment
- Sediment / Percolation Pond

NORTH

STILLWATER MINING COMPANY

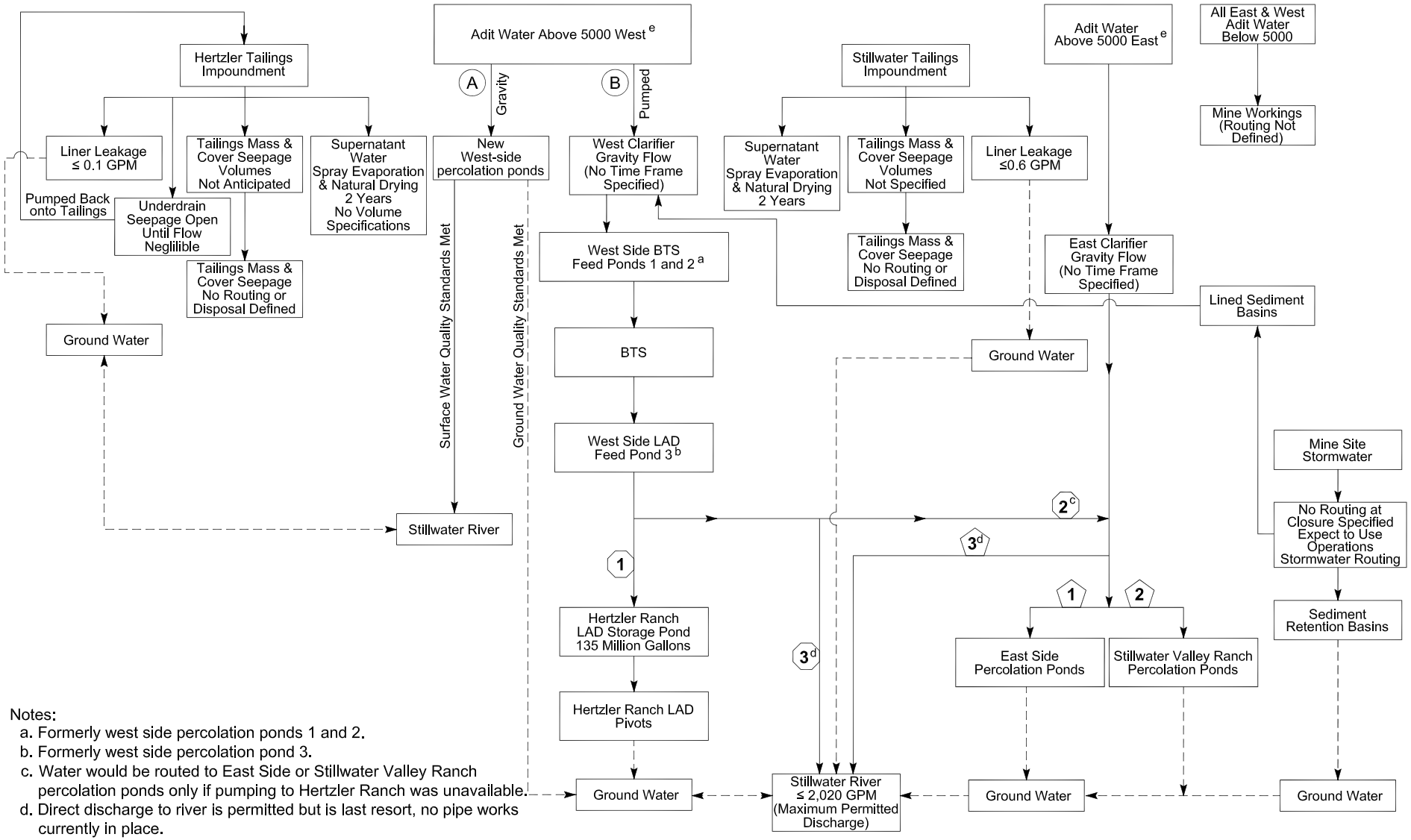
DRAFT EIS
Stillwater County, Montana

LOCATIONS OF PRIMARY FACILITIES COMPRISING THE STILLWATER MINE

0 1000 2000 3000 4000 Feet

FIGURE
2-3

DWG:Facilities.dwg	LAYOUT:2-3	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:1/12/2007



Notes:

a. Formerly west side percolation ponds 1 and 2.
b. Formerly west side percolation pond 3.
c. Water would be routed to East Side or Stillwater Valley Ranch percolation ponds only if pumping to Hertzler Ranch was unavailable.
d. Direct discharge to river is permitted but is last resort, no pipe works currently in place.
e. Permitted Flow is 2020 GPM from combined both adits.
f. No treatment methods specified for closure.

(1) Water management alternatives are ranked in order of preferred utilization for west-side waters.

(1) Water management alternatives are ranked in order of preferred utilization for east-side waters.

(A) Current plan of operations.

(B) Approved MPDES Permit.

→ Direct flow

- - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

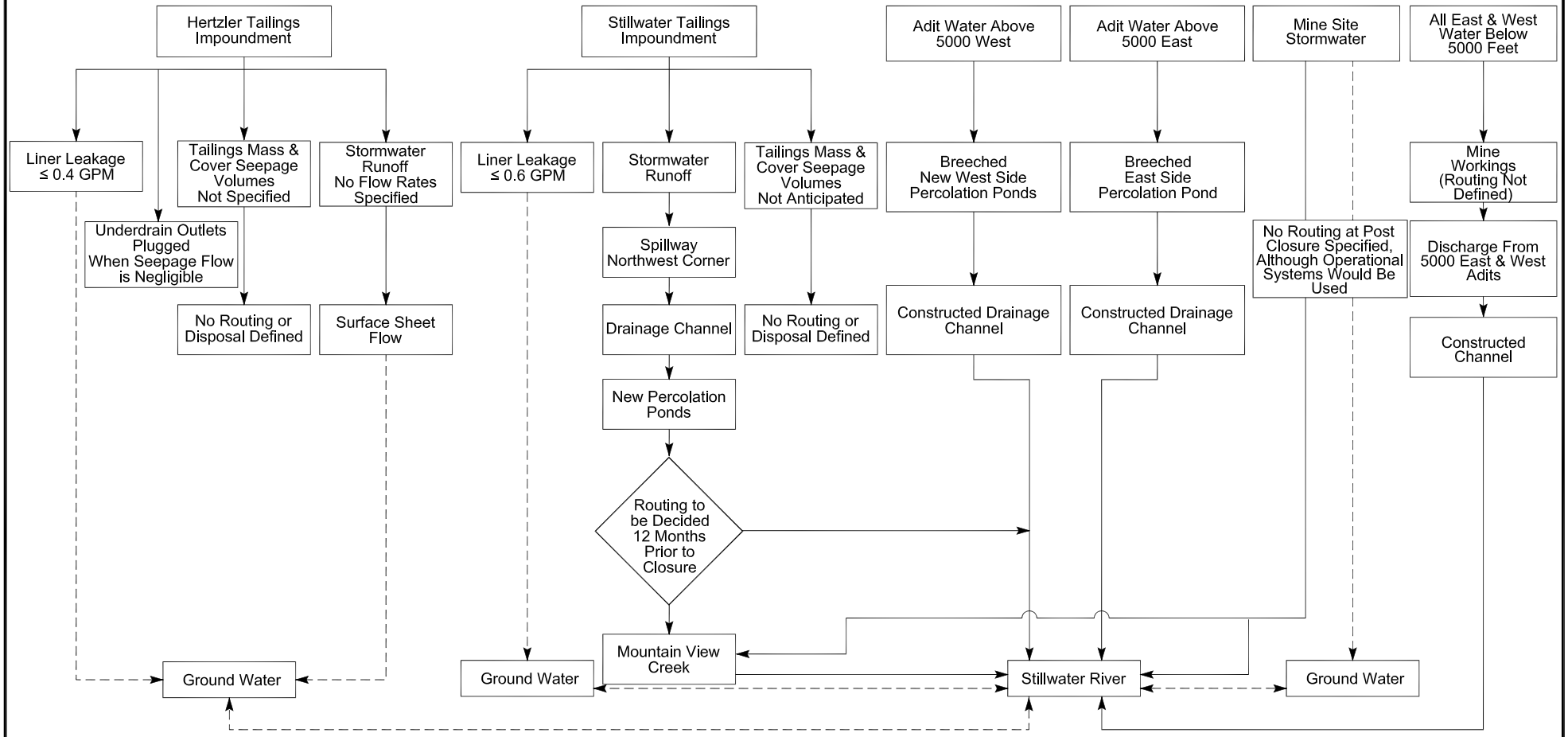
STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE STILLWATER MINE
NO ACTION ALTERNATIVE 1A

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-4
DRAWN BY:ETC	PREPARED BY:DMC	DATE: 6/24/2008

FIGURE **2-4**



Direct flow

Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

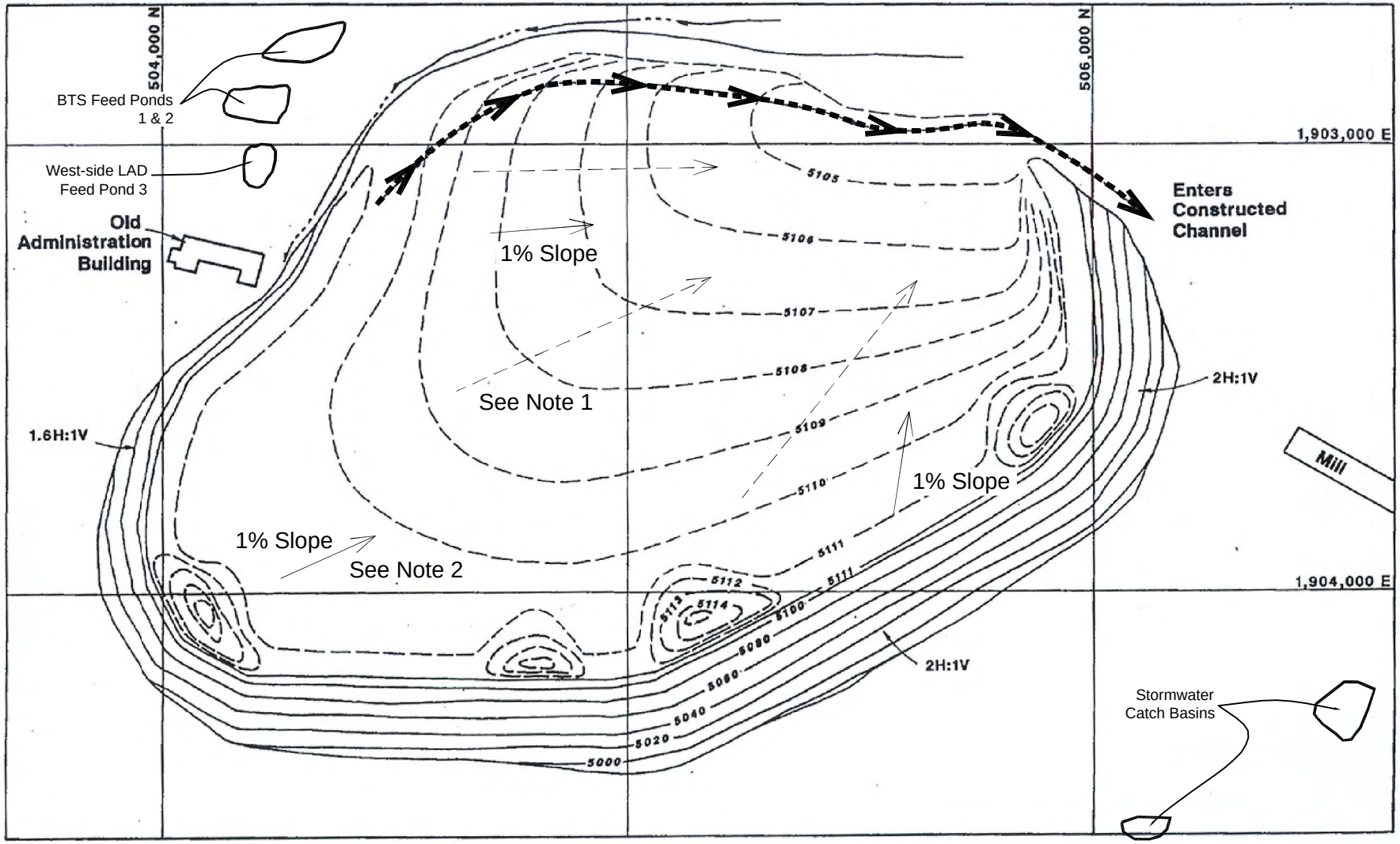
STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

POST CLOSURE WATER ROUTING AND HANDLING FOR THE STILLWATER MINE
NO ACTION ALTERNATIVE 1A

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-5
DRAWN BY:ETC	PREPARED BY:DMC	DATE: 6/24/2008

FIGURE **2-5**



LEGEND

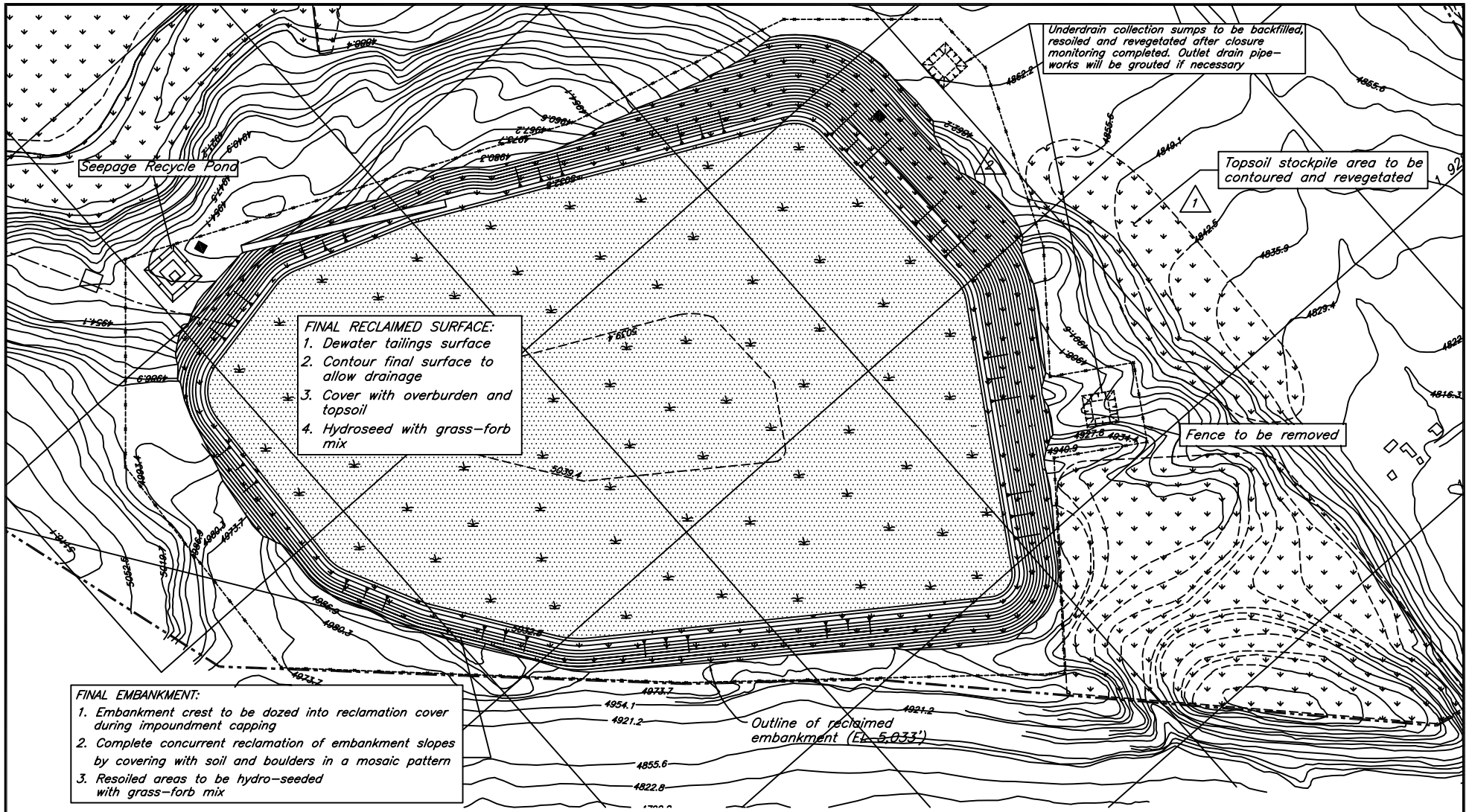
Drainage Ditch

NOTES

1. *Drainage is to the northwest*
2. *Reclamation Cover Grade is 1 percent*

NORTH

STILLWATER MINING COMPANY			
DRAFT EIS Stillwater County, Montana			
STILLWATER TAILINGS IMPOUNDMENT CLOSURE AND POST CLOSURE FINAL RECLAMATION COVER GRADE ALTERNATIVE 1A			
No Action			FIGURE 2-6
DWG:1200 FIGS 03-14-08.dwg		LAYOUT:n2-6	
DRAWN BY:ETC	PREPARED BY:DMC	DATE: 6/9/2008	



LEGEND

Revegetated embankment face and all excavated and recontoured surfaces: grasses and forbs

Revegetated tailings surface reclamation: grasses and forbs

NORTH

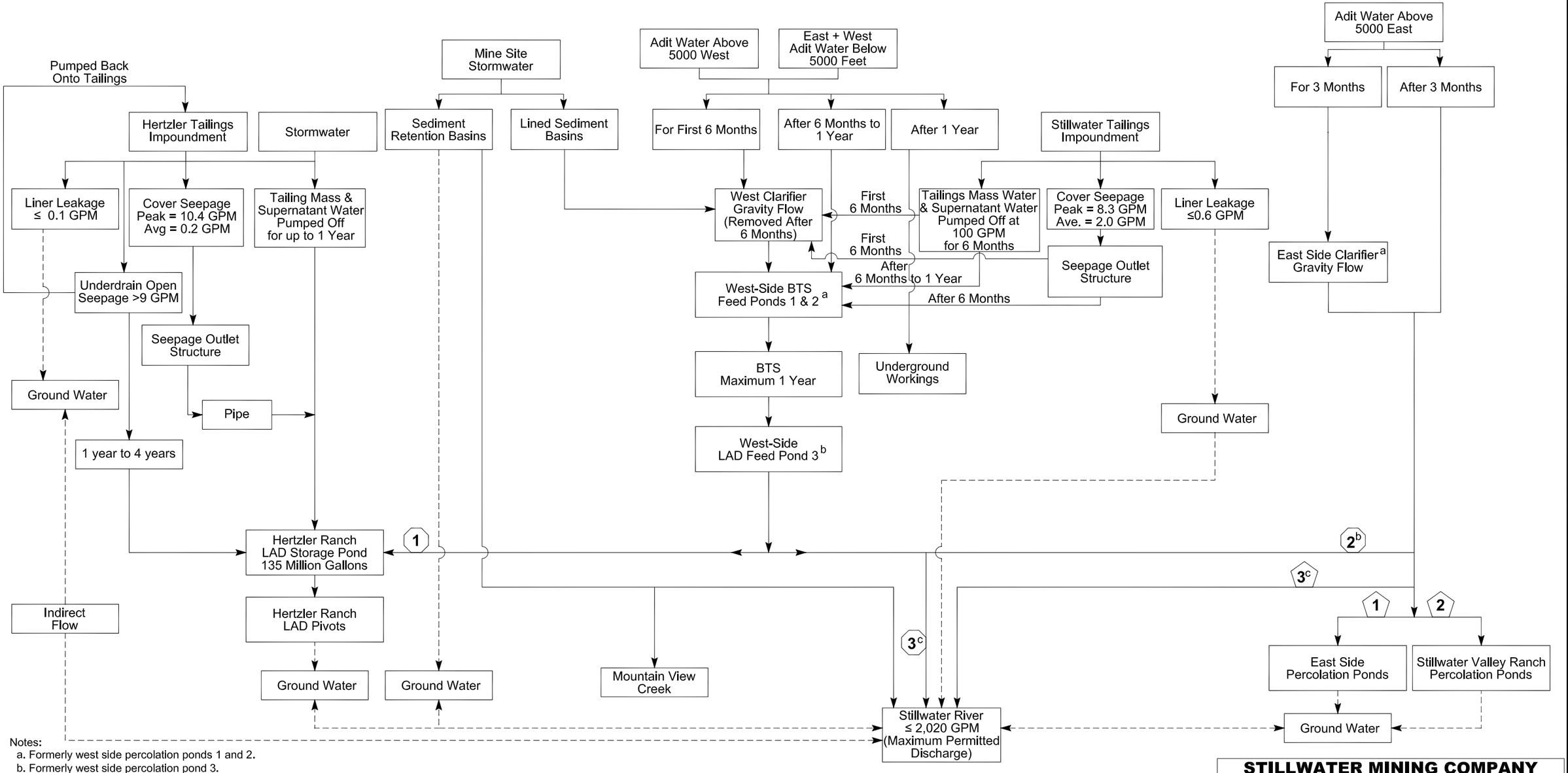
STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

HERTZLER TAILINGS IMPOUNDMENT CLOSURE AND POST CLOSURE FINAL RECLAMATION COVER GRADE, ALTERNATIVE 1A

FIGURE **2-7**

DWG:1200 01 2-6.DWG	LAYOUT: 2-6	
DRAWN BY: ETC	PREPARED BY: DMC	DATE: 04/17/06



Notes:

a. Formerly west side percolation ponds 1 and 2.
b. Formerly west side percolation pond 3.
c. Water would be routed to east side and Stillwater Valley Ranch percolation ponds only if pumping to Hertzler Ranch was unavailable.
d. Direct discharge to river is permitted but is last resort; no pipe works or discharge channels are currently in place.

(1) Water management alternatives are ranked in order of preferred utilization for west-side waters.

(1) Water management alternatives are ranked in order of preferred utilization for east-side waters.

→ Direct flow - - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.
The MPDES Permit would need to be modified.

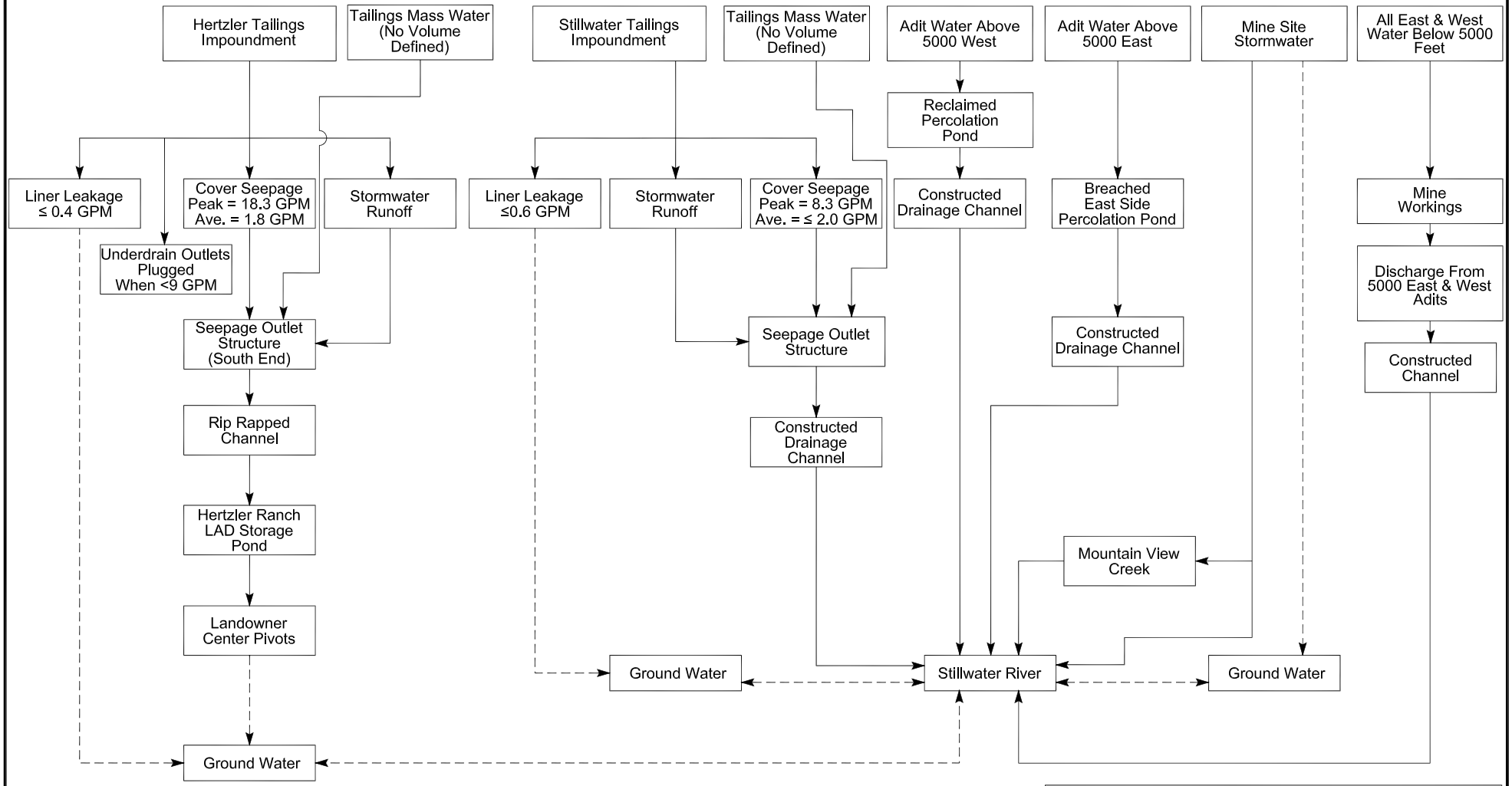
STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE STILLWATER MINE
PROPOSED ACTION ALTERNATIVE 2A

FIGURE **2-8**

DWG:1200 FIGS 06-14-08.dwg	LAYOUT:n2-8	
DRAWN BY:DMC	PREPARED BY:ETC	DATE:10/13/2006



Direct flow

Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

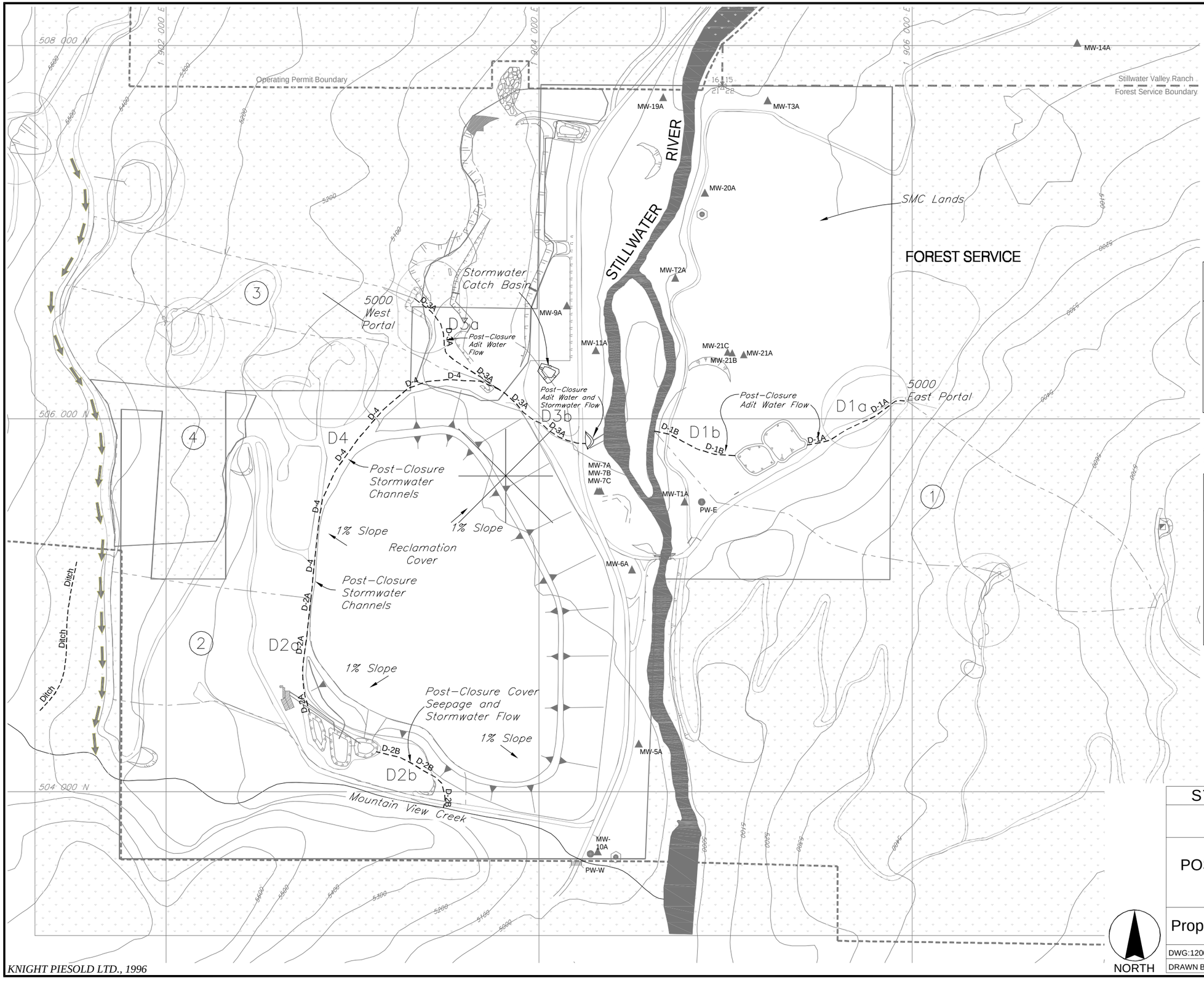
STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

POST CLOSURE WATER ROUTING AND HANDLING FOR THE STILLWATER MINE
PROPOSED ACTION ALTERNATIVE 2A

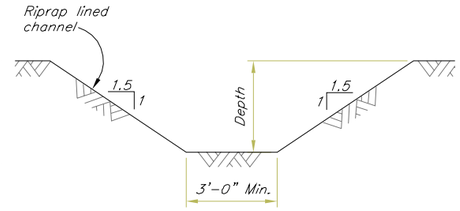
DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-9
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008

FIGURE **2-9**



NOTE

Mine Water Flows include seepage from the Tailings Facility as well as flows from the 5000 East and 5000 West Portals.



TYPICAL DITCH SECTION

Ditch	Length (ft)	Depth (ft)	Estimated Flows (cfs)		Design Capacity (cfs)
			Mine Water	Stormwater	
-- D-1A --	584	2.5	1.3	37	40
-- D-1B --	459	2.5	1.3	37	40
-- D-2A --	618	2.5	0.02	28	40
-- D-2B --	530	2.5	0.02	28	40
-- D-3A --	695	2.5	1.3	20	40
-- D-3B --	569	3.5	1.3	73	95
-- D-4 --	1793	3.0	_	54	65

* Design capacity exceeds estimated flows.
* Stormwater flows computed from the 100 year rainfall event.
* Ditches generally sized to minimum constructibility.
* Freeboard allowance of 0.5 ft. included on all ditches.

CATCHMENT	AREA (Acres)		
	Forest	SMC	Total
1	20.0	11.1	30.1
2	0.8	23.1	23.9
3	14.7	0.7	15.4
4	25.9	19.8	45.7

LEGEND

Forest Service Area

SMC Area

Existing Road Ditch (assumed to operate after mine closure)

0 250 500 750 1000 FT

NORTH

STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

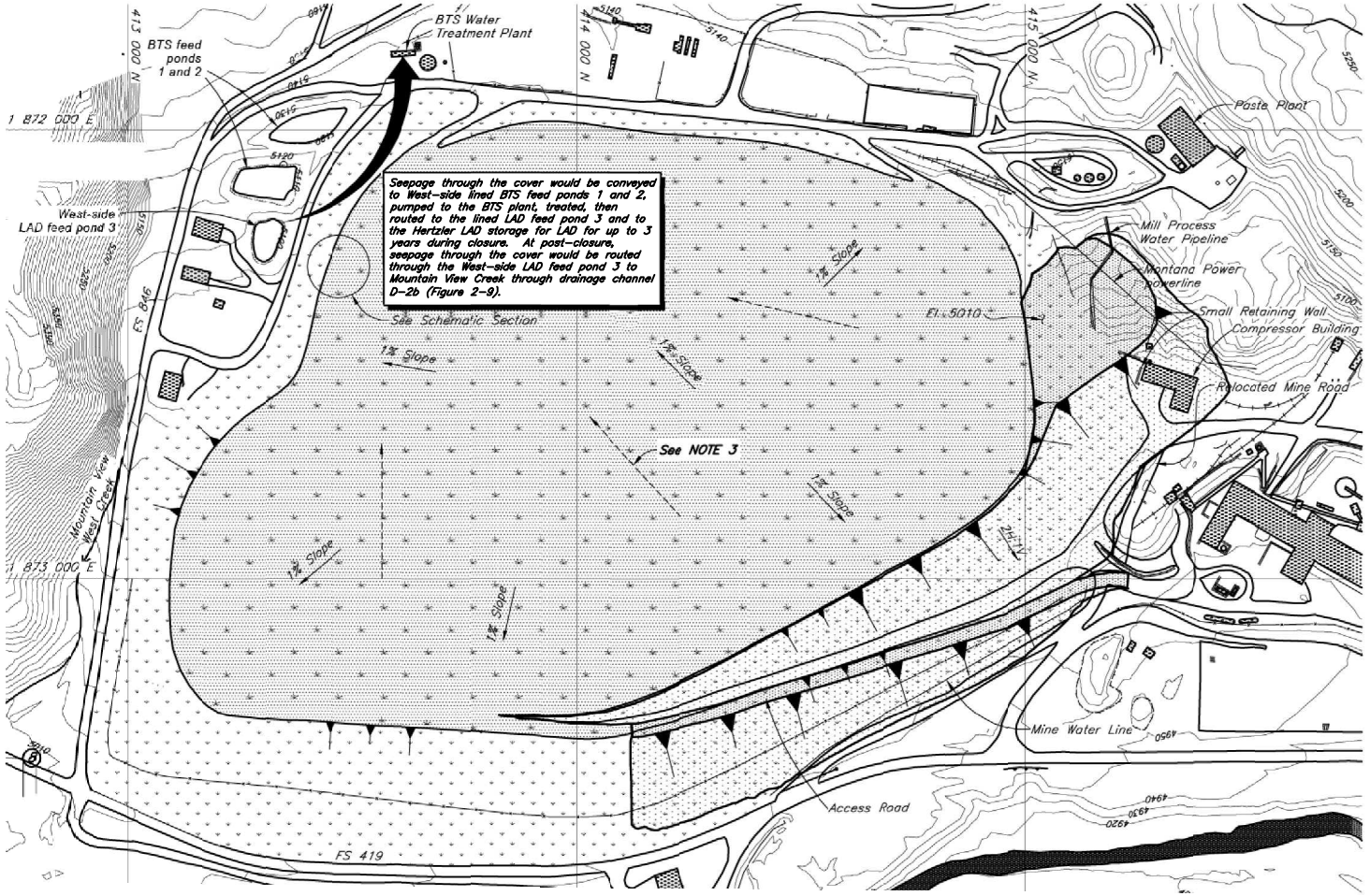
LOCATIONS OF THE PROPOSED POST CLOSURE DRAINAGE CHANNELS FOR THE STILLWATER MINE ALTERNATIVE 2A

Proposed Action

FIGURE 2-10

DWG:1200 01 008.dwg | LAYOUT:2-10
DRAWN BY:ETC | PREPARED BY:DMC | DATE:1/12/2007

KNIGHT PIESOLD LTD., 1996



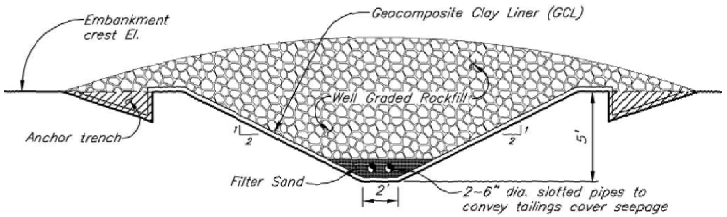
LEGEND

- Revegetated embankment face and all excavated and recontoured surfaces
- Revegetated Reclamation Cover surface
- 1% — Cover slope
- ---→ Underlying Tailings Surface slope

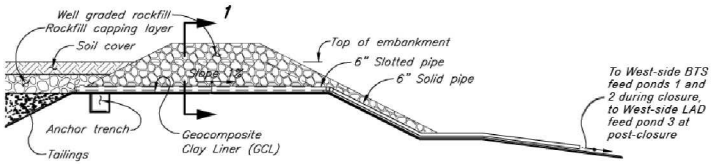
NOTES

1. Drainage channels to have capacity for 100-year storm event.
2. Treated water to be discharged to Stillwater River or other approved disposal sites.
3. The natural slope of the tailings surface will be greater than 1% after deposition. Strategic tailings deposition during operations will be employed to develop a natural low point where the seepage outlet will be located.
4. Figure previously issued as 31333/16, Figure 3 Revision 0.

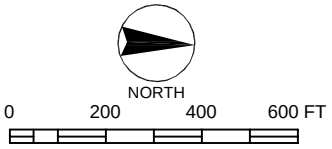
All facilities would be removed at post-closure except for drainage channels and any specific ponds identified to be replaced.



SECTION 1
SEEPAGE THROUGH THE COVER OUTLET
NTS

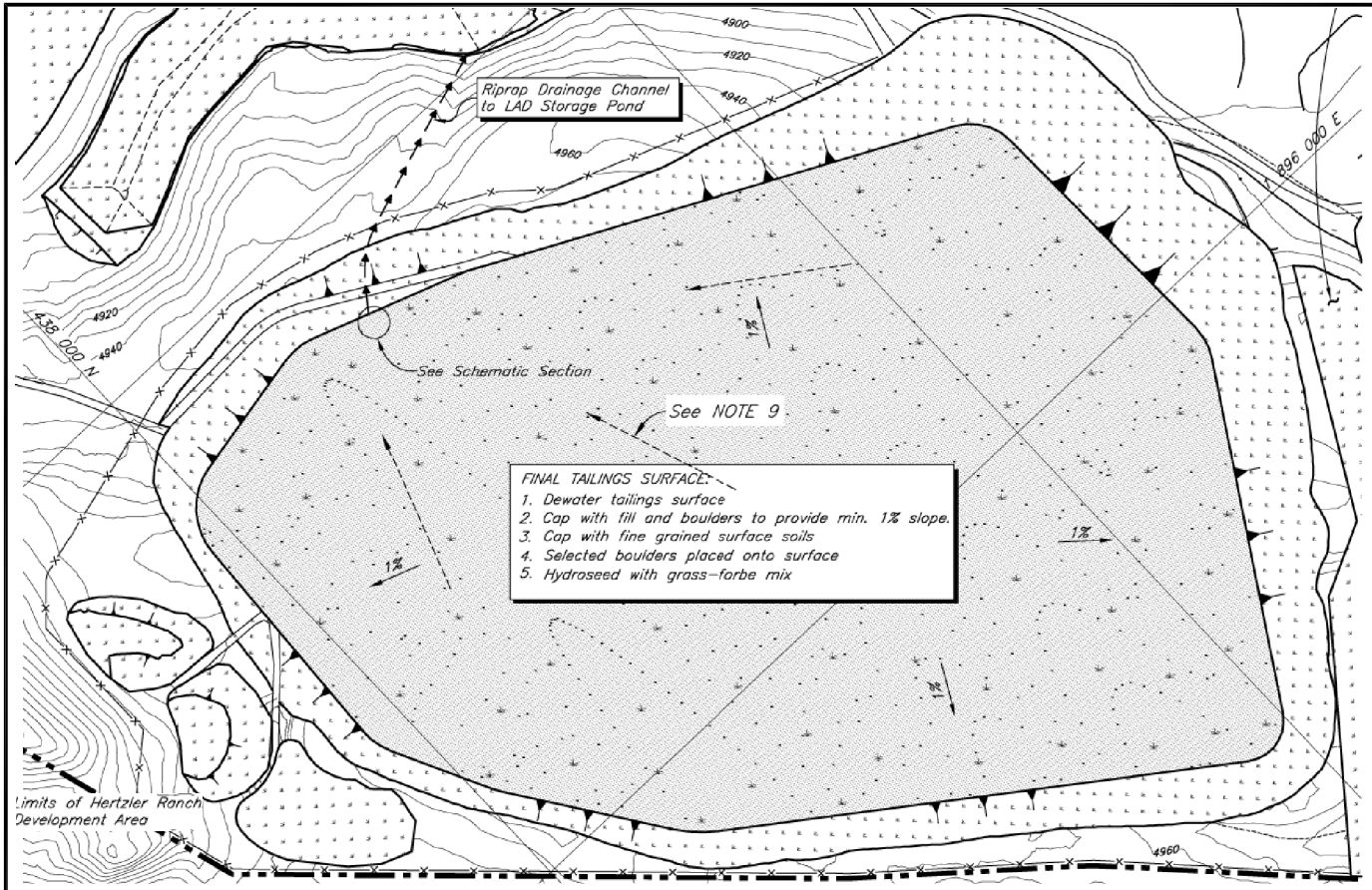


SCHEMATIC SECTION
CAP SEEPAGE OUTLET
NTS



KNIGHT PIESOLD LTD., 1996

STILLWATER MINING COMPANY		
DRAFT EIS Stillwater County, Montana		
STILLWATER TAILINGS IMPOUNDMENT CLOSURE AND POST CLOSURE FINAL RECLAMATION COVER GRADE ALTERNATIVE 2A		
Proposed Action		FIGURE 2-11
DWG:1200 2-11-.dwg	LAYOUT:2-11	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:12/21/2006



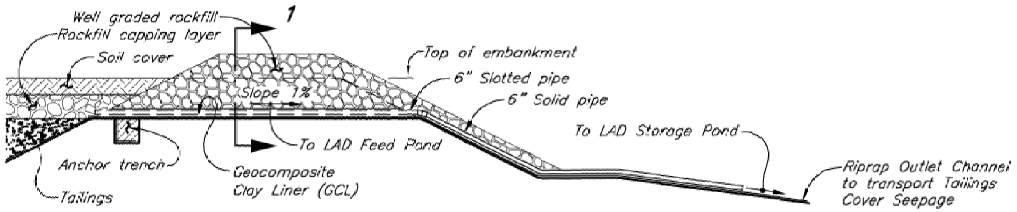
NOTES

1. Additional disturbances and stripped areas, due to roads, laydown areas, parking areas, boneyards, borrow areas, stormwater BMP's, monitoring stations, etc. will be resoiled and revegetated concurrently during operations when possible and/or at closure if necessary.
2. Fine grained surface soil will be placed at areas with a slope flatter than 2.5H:1V. Coarse grained surface soils to be placed at areas with a slope of 2.5H:1V or steeper.
3. Thickness of fill capping layer at surface of tailings will vary to compensate for differential consolidation settlements in the tailings and provide 1% grade for drainage. Selected boulders stockpiled during construction of the tailings impoundment may be included in the fill capping layer. The top foot of this material will be comprised of subsoil like borrow materials.
4. Surface of the tailings to be shaped, capped, graded and revegetated to ensure that the final surface blends with natural features to the greatest possible extent.
5. Outlet drain pipeworks from underdrain system will be grouted.
6. Fine grained surface soil is equivalent to clay loam and coarse grained surface soil is equivalent to stony loam.
7. Topographic information taken from file 4199.dwg as provided by Horizons, Inc. May 26, 1999.
8. The natural slope of the tailings surface will be greater than 1% after deposition. Strategic tailings deposition during operations will be employed to develop a natural low point where the seepage outlet will be located.
9. Figure previously issued as Figure 31333/16, Figure 2, Revision 0.

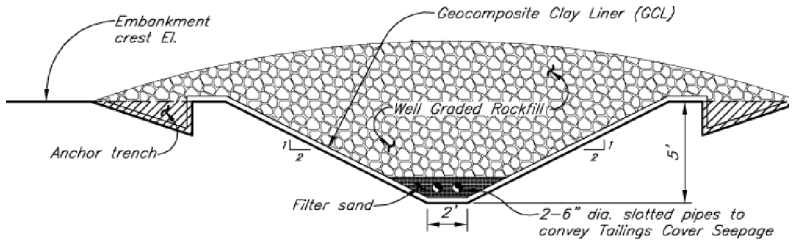
LEGEND

- Revegetated embankment face and all excavated and recontoured surfaces: grasses and forbes
- Revegetated tailings surface reclamation: grasses and forbes
- LAD — Land Application Disposal
- Archaeological feature
- 1% — Cover slope
- Underlying Tailings Surface slope

0 300 600 900 FT



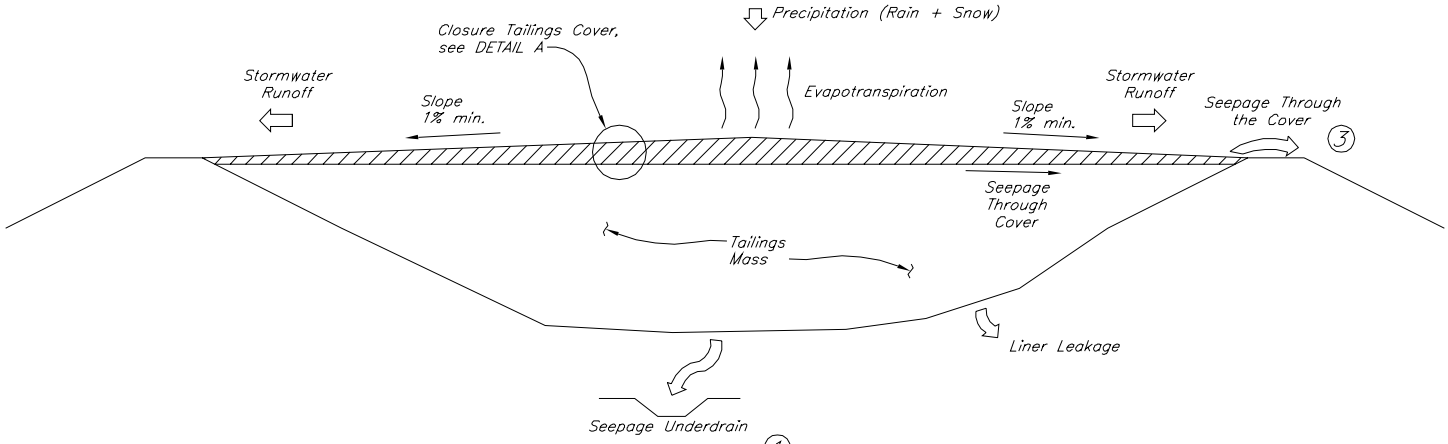
SCHEMATIC SECTION SEEPAGE OUTLET
NTS



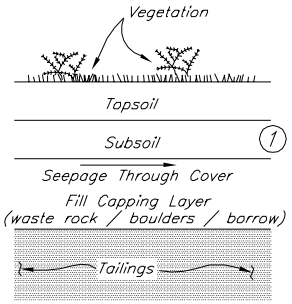
NORTH

STILLWATER MINING COMPANY		
DRAFT EIS Stillwater County, Montana		
HERTZLER RANCH TAILINGS IMPOUNDMENT FINAL ARRANGEMENT RECLAMATION PLAN, ALTERNATIVE 2A		
Proposed Action		FIGURE 2-12
DWG:1200 01 021.dwg	LAYOUT:2-12	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:12/21/2006

KNIGHT PIESOLD LTD., 1996



SCHEMATIC SECTION
NTS

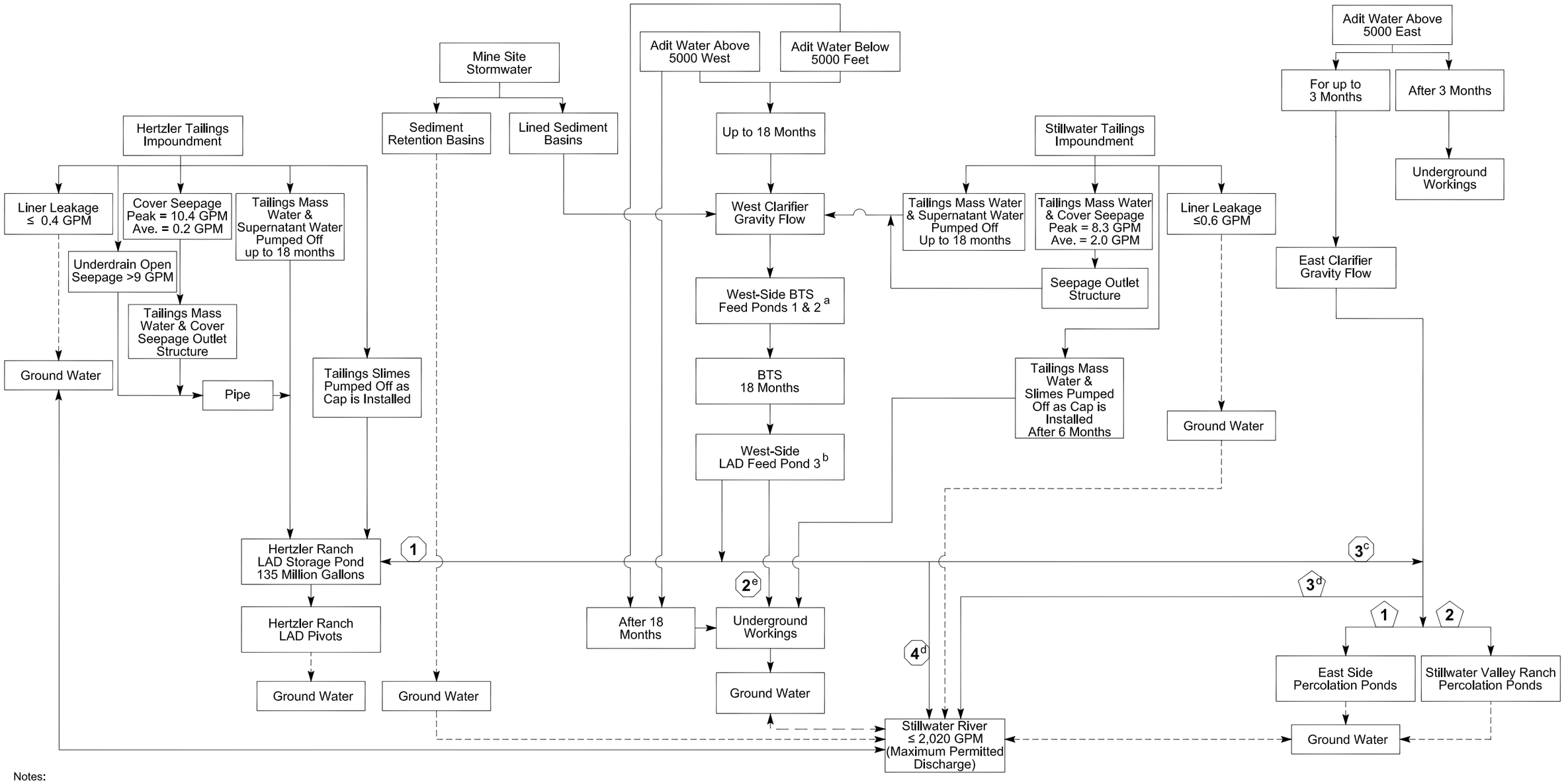


DETAIL A
POST-CLOSURE TAILINGS COVER
2
NTS

1. Applies only to East Boulder and Hertzler Impoundments
2. Applies to all SMC Impoundments
3. Does not apply to Stillwater Impoundment Alternatives 1A or 3A (see text for detail)

STILLWATER MINING COMPANY			
DRAFT EIS Stillwater County, Montana			
GENERIC SCHEMATIC OF POST CLOSURE TAILING FACILITIES ALL ALTERNATVES			
			FIGURE 2-13
DWG:1200 2-13.dwg	LAYOUT:2-13		
DRAWN BY:ETC	PREPARED BY:DMC	DATE:1/12/2007	

KNIGHT PIESOLD LTD., 1996



Notes:

a. Formerly west side percolation ponds 1 and 2.
b. Formerly west side percolation pond 3.
c. Water would be routed to east side and Stillwater Valley Ranch percolation ponds only if pumping to Hertzler Ranch was unavailable.
d. Direct discharge to river is permitted but is last resort; no pipe works are currently in place.
e. After 3 months, all adit water not needed for dilution of Hertzler tailings water (for LAD at Hertzler) would be routed to flood the underground workings.

(1) Water management alternatives are ranked in order of preferred utilization for west-side waters.

(1) Water management alternatives are ranked in order of preferred utilization for east-side waters.

→ Direct flow - - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

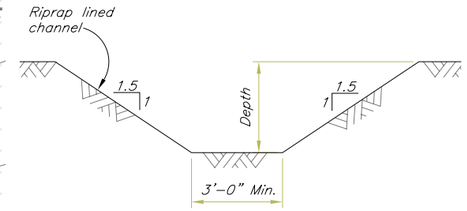
CLOSURE WATER ROUTING AND HANDLING FOR THE STILLWATER MINE AGENCY-MITIGATED ALTERNATIVE 3A

FIGURE **2-14**

DWG:1200 FIGS 06-14-08.dwg	LAYOUT:n2-14	
DRAWN BY:DMC	PREPARED BY:ETC	DATE:10/13/2006

NOTE

Mine Water Flows include seepage from the Tailings Facility as well as flows from the 5000 East and 5000 West Portals.



TYPICAL DITCH SECTION

Ditch	Length (ft)	Depth (ft)	Estimated Flows (cfs)		Design Capacity (cfs)
			Mine Water	Stormwater	
- - D-1A - -	584	2.5	1.3	37	40
- - D-1B - -	459	2.5	1.3	37	40
- - D-2A - -	618	2.5	0.02	28	40
- - D-2B - -	530	2.5	0.02	28	40
- - D-3A - -	695	2.5	1.3	20	40
- - D-3B - -	569	3.5	1.3	73	95
- - D-4 - -	1793	3.0	_	54	65

* Design capacity exceeds estimated flows.
* Stormwater flows computed from the 100 year rainfall event.
* Ditches generally sized to minimum constructibility.
* Freeboard allowance of 0.5 ft. included on all ditches.

CATCHMENT	AREA (Acres)		
	Forest	SMC	Total
1	20.0	11.1	30.1
2	0.8	23.1	23.9
3	14.7	0.7	15.4
4	25.9	19.8	45.7

LEGEND

Forest Service Area

SMC Area

Existing Road Ditch (assumed to operate after mine closure)

0 250 500 750 1000 FT

NORTH

KNIGHT PIESOLD LTD., 1996

STILLWATER MINING COMPANY

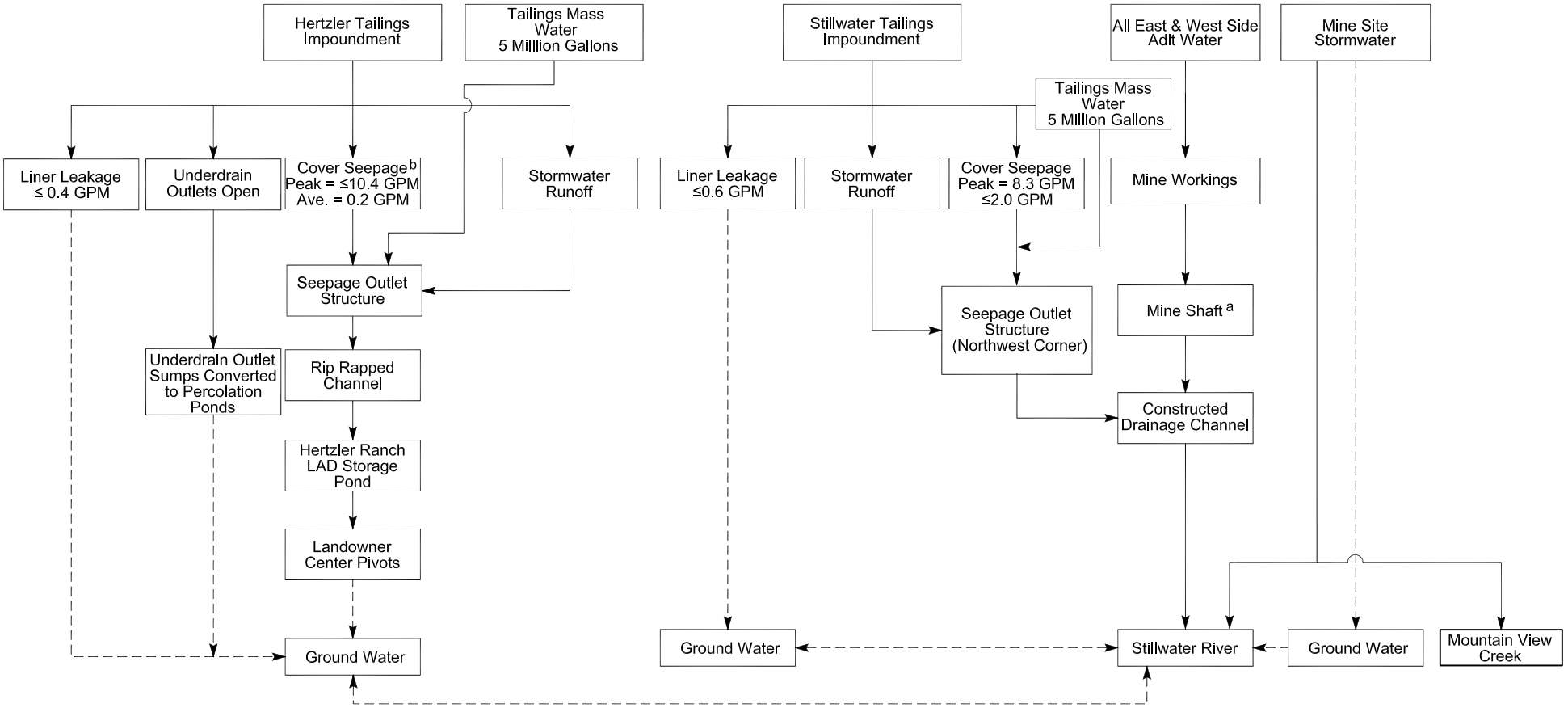
DRAFT EIS
Stillwater County, Montana

LOCATIONS OF THE PROPOSED POST CLOSURE DRAINAGE CHANNELS FOR THE STILLWATER MINE ALTERNATIVE 3A

Agency-Mitigated

FIGURE **2-15**

DWG:1200 01 008 ALT3A.dwg	LAYOUT:2-15	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:12/21/2006



Notes:

a. Flow out of mine shaft estimated to occur within 11.4 years after closure completed.

b. Discharge location would depend on where the seepage outlets and armored channels were placed relative to the LAD Storage Pond and the reclaimed underdrain sumps.

→ Direct flow

- - - → Indirect flow

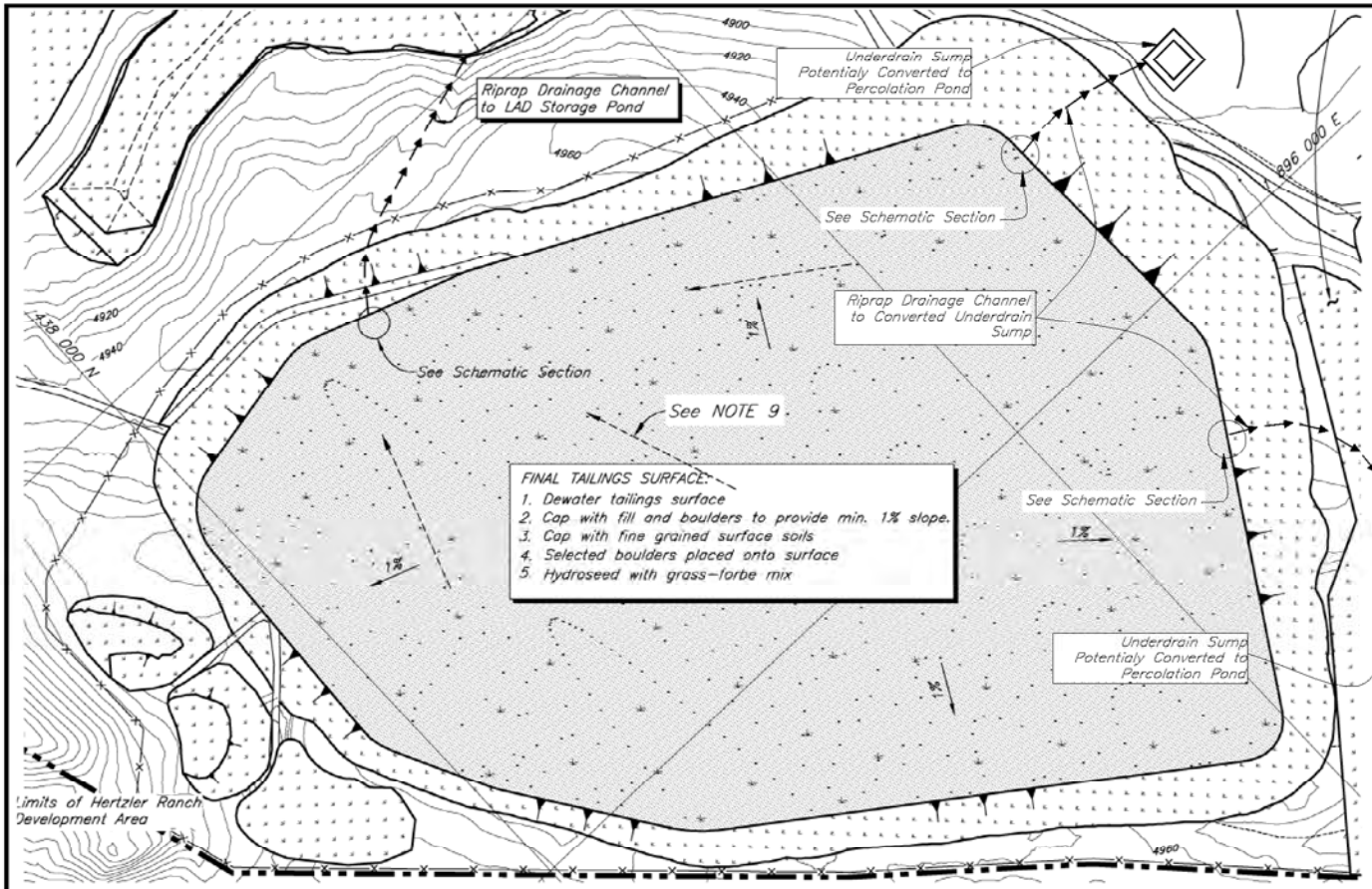
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

POST CLOSURE WATER ROUTING AND HANDLING FOR THE STILLWATER MINE AGENCY-MITIGATED ALTERNATIVE 3A

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-16	FIGURE 2-16
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	



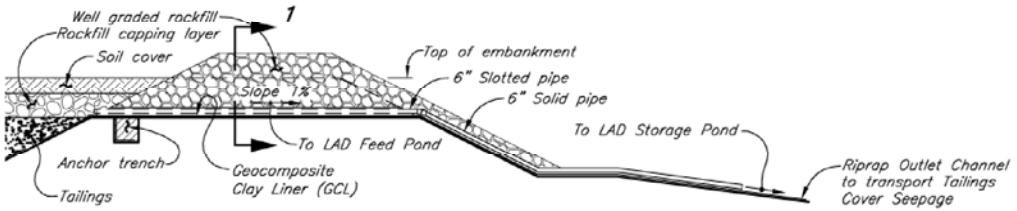
NOTES

1. Additional disturbances and stripped areas, due to roads, laydown areas, parking areas, boneyards, borrow areas, stormwater BMP's, monitoring stations, etc. will be resoiled and revegetated concurrently during operations when possible and/or at closure if necessary.
2. Fine grained surface soil will be placed at areas with a slope flatter than 2.5H:1V. Coarse grained surface soils to be placed at areas with a slope of 2.5H:1V or steeper.
3. Thickness of fill capping layer at surface of tailings will vary to compensate for differential consolidation settlements in the tailings and provide 1% grade for drainage. Selected boulders stockpiled during construction of the tailings impoundment may be included in the fill capping layer. The top foot of this material will be comprised of subsoil like borrow materials.
4. Surface of the tailings to be shaped, capped, graded and revegetated to ensure that the final surface blends with natural features to the greatest possible extent.
5. Outlet drain pipeworks from underdrain system will be grouted.
6. Fine grained surface soil is equivalent to clay loam and coarse grained surface soil is equivalent to stony loam.
7. Topographic information taken from file 4199.dwg as provided by Horizons, Inc. May 26, 1999.
8. The natural slope of the tailings surface will be greater than 1% after deposition. Strategic tailings deposition during operations will be employed to develop a natural low point where the seepage outlet will be located.
9. Figure previously issued as Figure 31333/16, Figure 2, Revision 0
10. Underdrain sump could be converted to percolation ponds if results of SMC's annual reports identify the need for multiple seepage outlets.

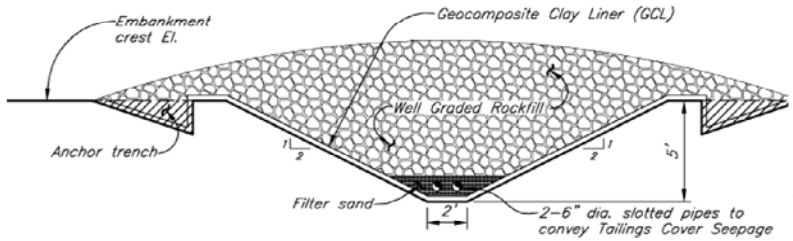
LEGEND

- Revegetated embankment face and all excavated and recontoured surfaces: grasses and forbes
- Revegetated tailings surface reclamation: grasses and forbes
- LAD — Land Application Disposal
- Archaeological feature
- 1% — Cover slope
- Underlying Tailings Surface slope

0 300 600 900 FT



SCHEMATIC SECTION
SEEPAGE OUTLET
NTS



NORTH

STILLWATER MINING COMPANY

DRAFT EIS
Stillwater County, Montana

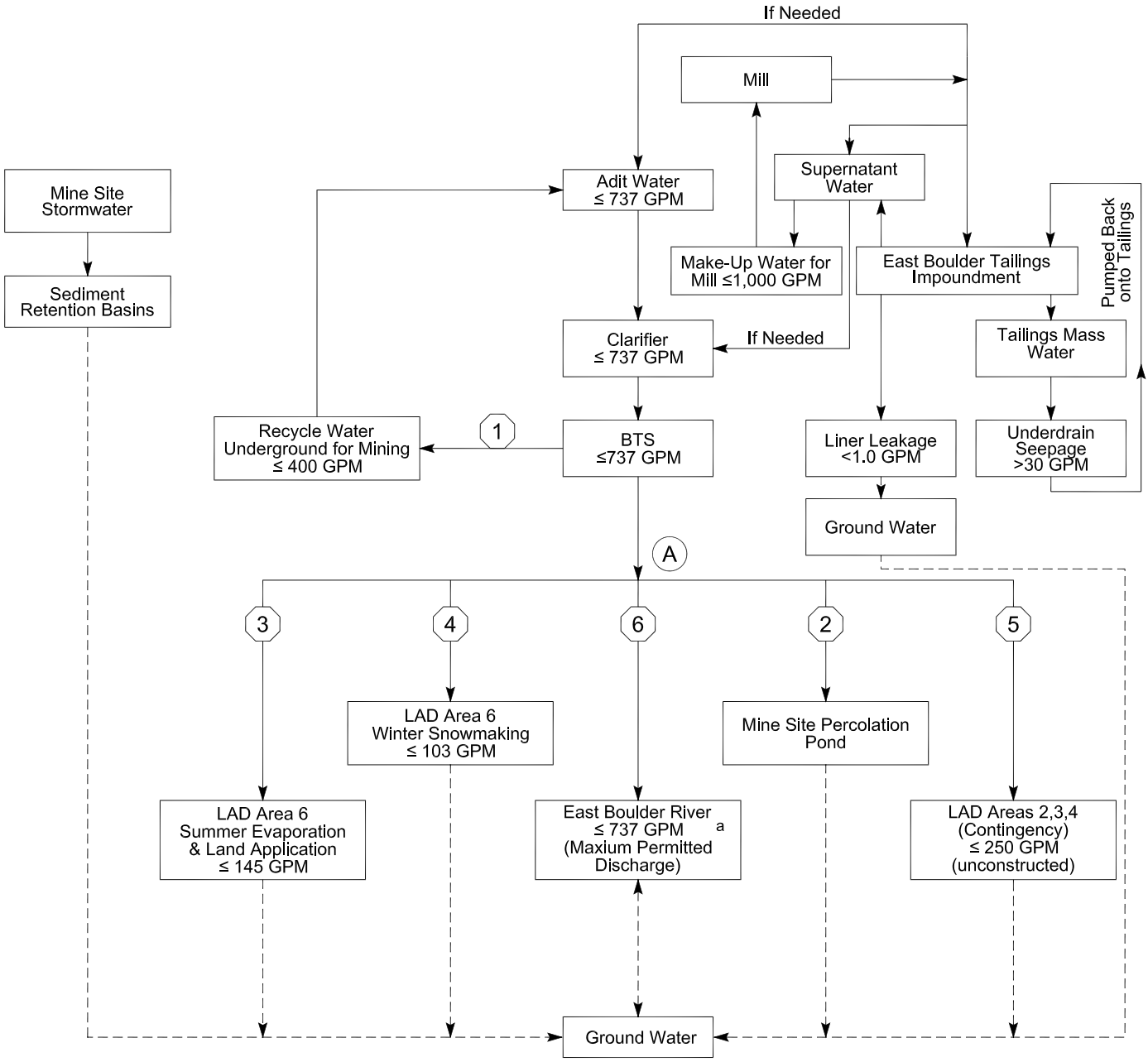
HERTZLER TAILINGS IMPOUNDMENT FINAL ARRANGEMENT RECLAMATION PLAN ALTERNATIVE 3A

Agency Mitigated

FIGURE **2-17**

DWG:1200 FIG 2-17 ALT3A.dwg	LAYOUT:2-17	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:12/21/2006

KNIGHT PIESOLD LTD., 1996



Notes:

a. Direct discharge to river is permitted, but is last resort; no pipe works or discharge channel are currently in place.

(1) Water management alternatives are ranked in order of preferred utilization.

(A) BTS Disposal Routing:

No Action (1B, 1C) - As shown on figure

Proposed (2B) - Number from left to right 3,4,6,2,5

Agency-Mitigated (3B) - Number from left to right 2,3,6,4,5

→ Direct flow

- - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

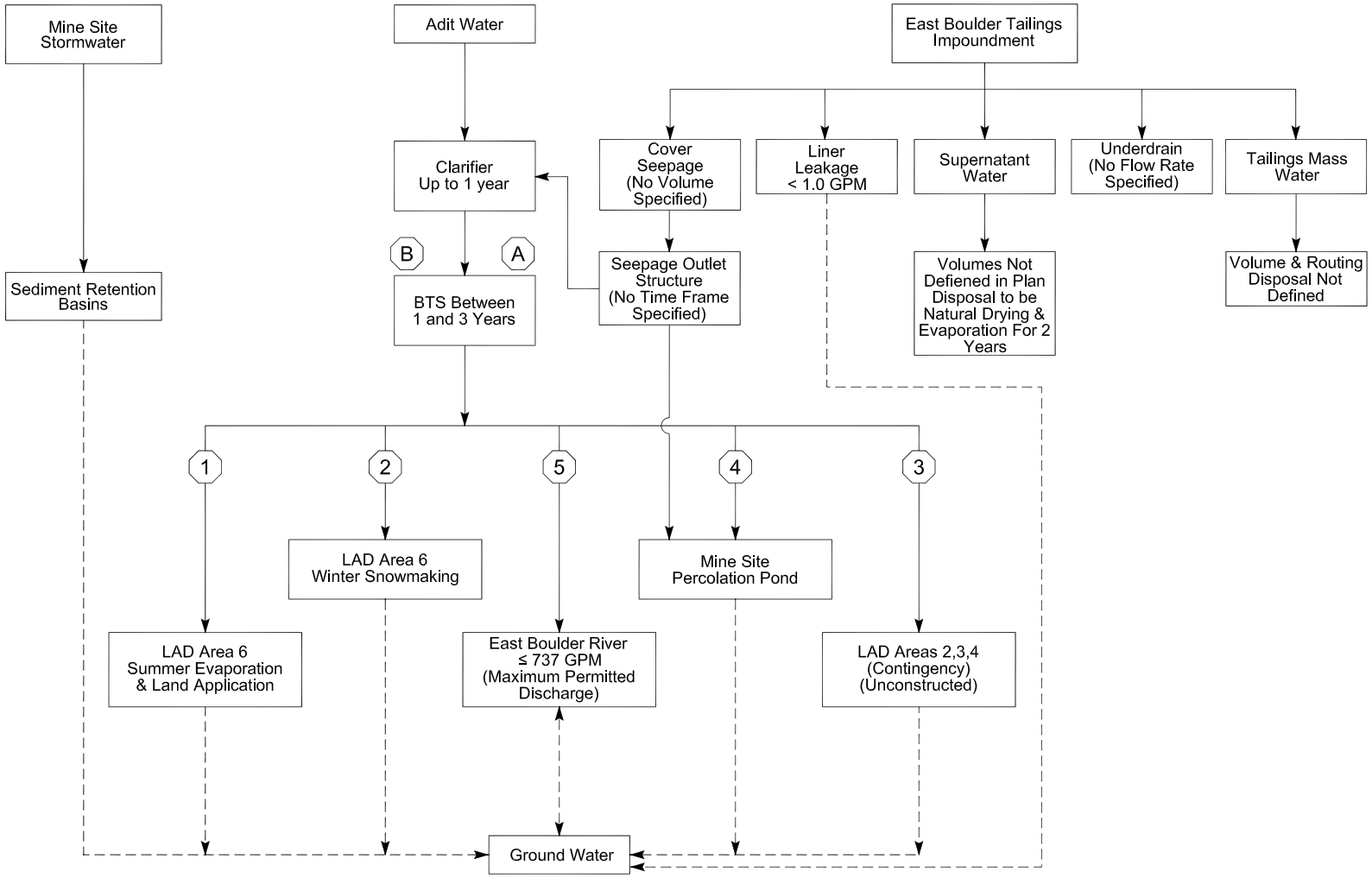
DRAFT EIS
Sweet Grass County, Montana

OPERATION WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE
ALTERNATIVES 1B, 2B, 3B, 1C

No Action-1B, 1C
Proposed Action-2B
Agency-Mitigated-3B

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-18
DRAWN BY:ETC	PREPARED BY:DMC	DATE:06/24/2008

FIGURE **2-18**



Notes:

(A) 2001 Reclamation bond used two years.

(B) Treatment method, time frame and routing not specified for closure in existing plan of operations.

→ Direct flow

- - - → Indirect flow

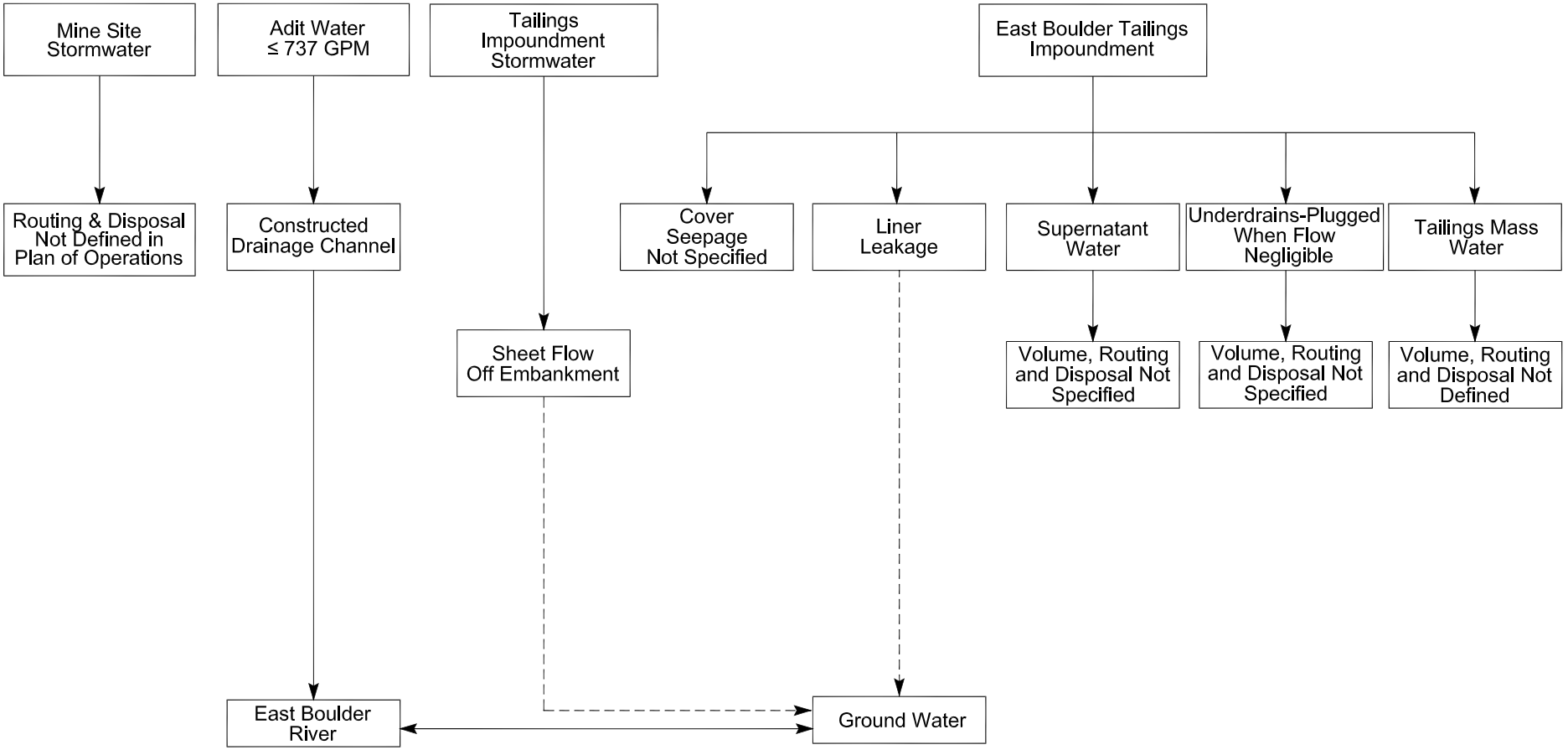
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE
NO ACTION ALTERNATIVES 1B, 1C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:new2-19	FIGURE 2-19
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	



→ Direct flow
- - - → Indirect flow
Flows shown on the figure are conceptual for water balance purposes.

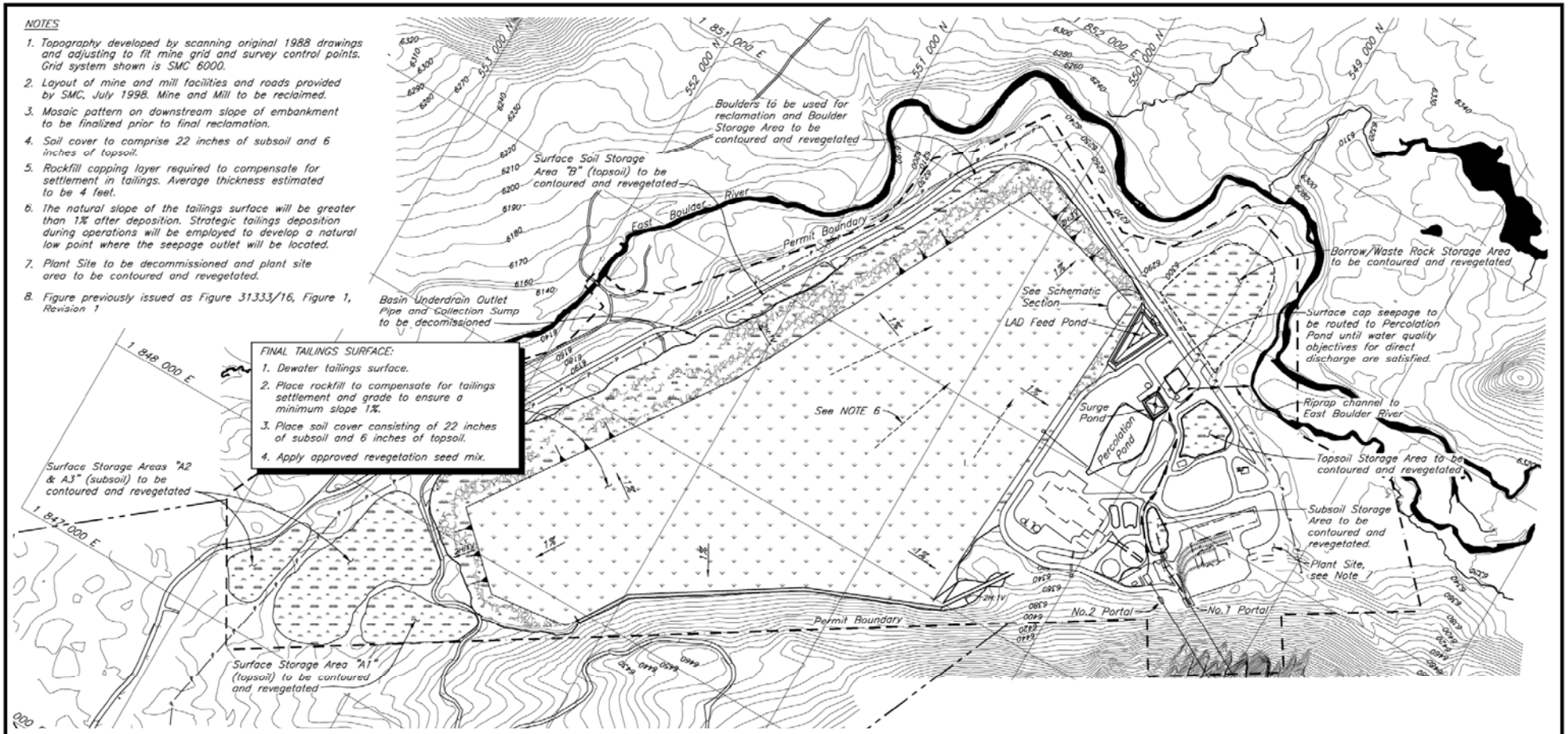
STILLWATER MINING COMPANY
DRAFT EIS
Sweet Grass County, Montana
POST CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE
NO ACTION ALTERNATIVE 1B, 1C

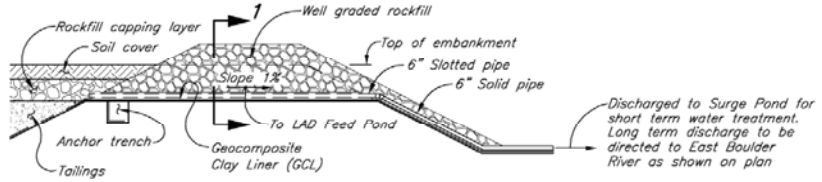
DWG:1200 FIGS 06-14-08.dwg		LAYOUT:new2-20
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008

FIGURE **2-20**

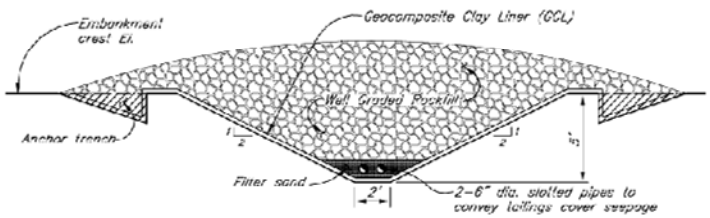
NOTES

1. Topography developed by scanning original 1988 drawings and adjusting to fit mine grid and survey control points. Grid system shown is SMC 6000.
2. Layout of mine and mill facilities and roads provided by SMC, July 1998. Mine and Mill to be reclaimed.
3. Mosaic pattern on downstream slope of embankment to be finalized prior to final reclamation.
4. Soil cover to comprise 22 inches of subsoil and 6 inches of topsoil.
5. Rockfill capping layer required to compensate for settlement in tailings. Average thickness estimated to be 4 feet.
6. The natural slope of the tailings surface will be greater than 1% after deposition. Strategic tailings deposition during operations will be employed to develop a natural low point where the seepage outlet will be located.
7. Plant Site to be decommissioned and plant site area to be contoured and revegetated.
8. Figure previously issued as Figure 31333/16, Figure 1, Revision 1





SCHEMATIC SECTION
CAP SEEPAGE OUTLET
NTS



SECTION 1
CAP SEEPAGE OUTLET
NTS

LEGEND

- Powerline
- Revegetated embankment face and all excavated and recontoured surfaces
- Revegetated tailings surface
- Selected coarse rockfill for embankment mosaic pattern
- Fill Slope Symbol
- 1% Cover slope
- Underlying Tailings Surface slope

NORTH

0 400 800 1200 FT

KNIGHT PIESOLD LTD., 1996

STILLWATER MINING COMPANY

DRAFT EIS

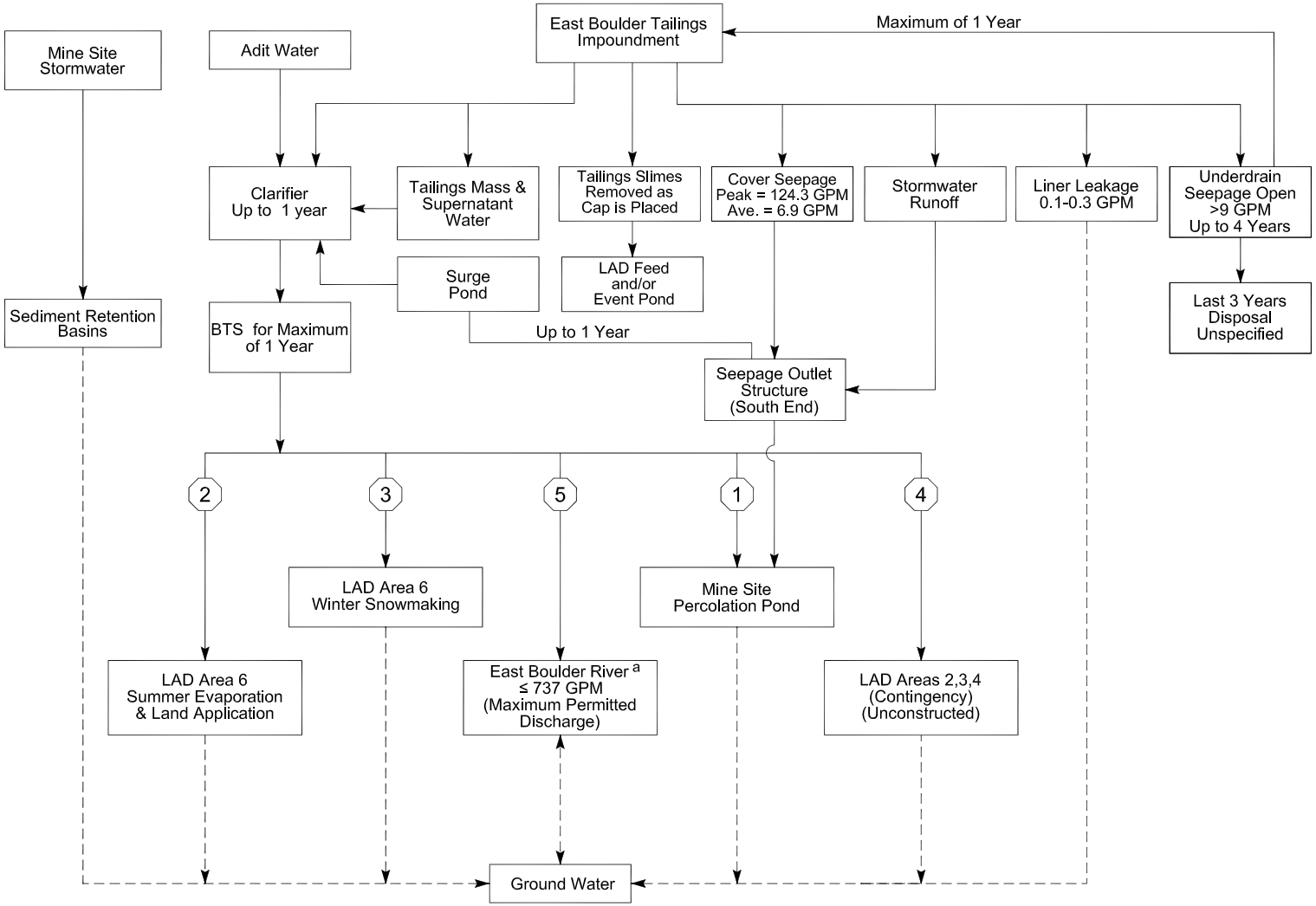
Sweet Grass County, Montana

EAST BOULDER TAILINGS IMPOUNDMENT FINAL RECLAMATION PLAN ALTERNATIVES 1B AND 2B

No Action and Proposed Action

FIGURE **2-21**

DWG: 1200 01 020.dwg	LAYOUT: 2-21	
DRAWN BY: ETC	PREPARED BY: DMC	DATE: 12/21/2006



Notes:

a. Direct discharge to the river is permitted, but is last resort; no pipe works are currently in place.

(1) Water management alternatives are ranked in order of preferred utilization.

Direct flow ——→

Indirect flow - - - →

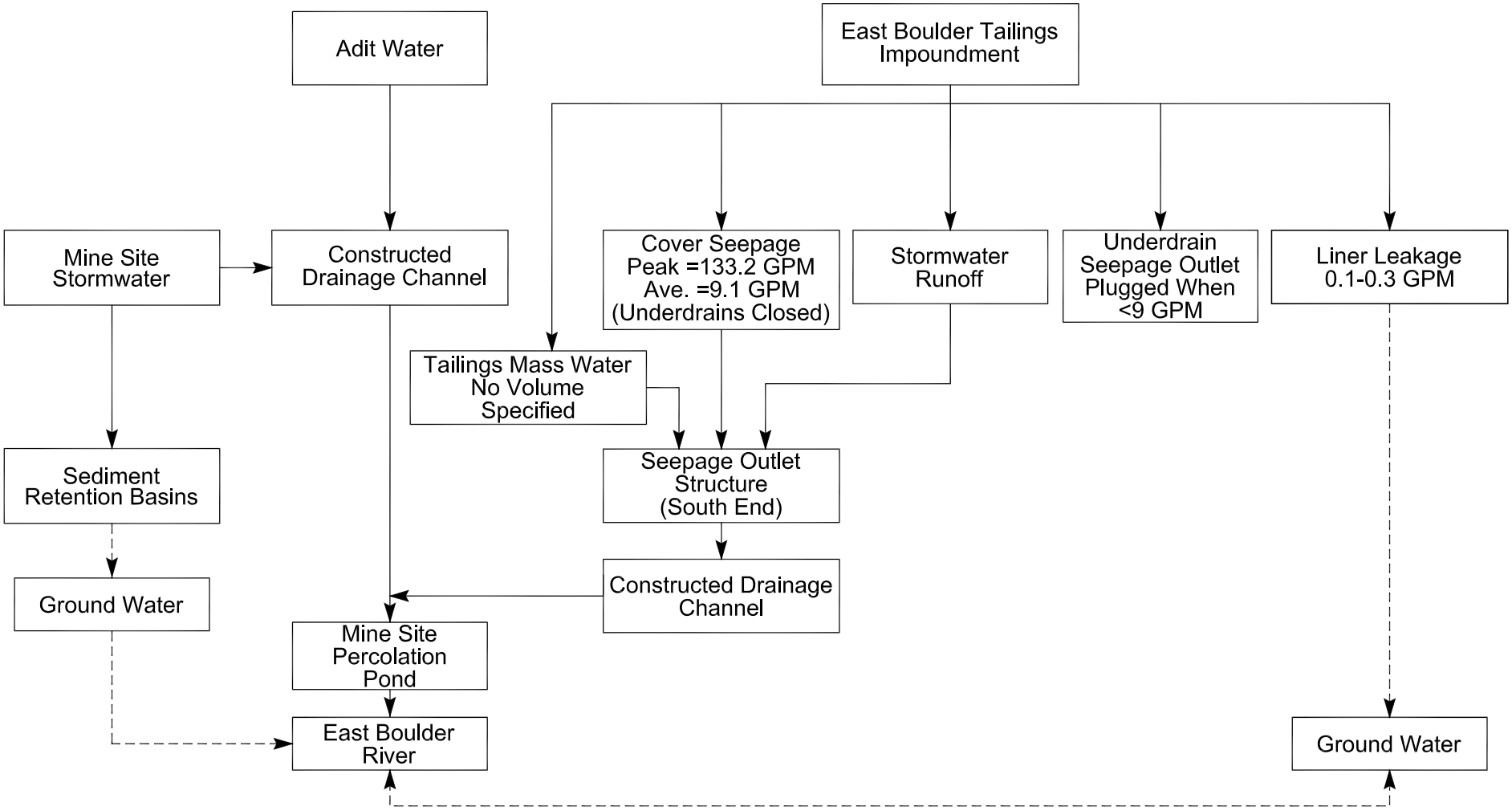
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE
PROPOSED ACTION ALTERNATIVE 2B

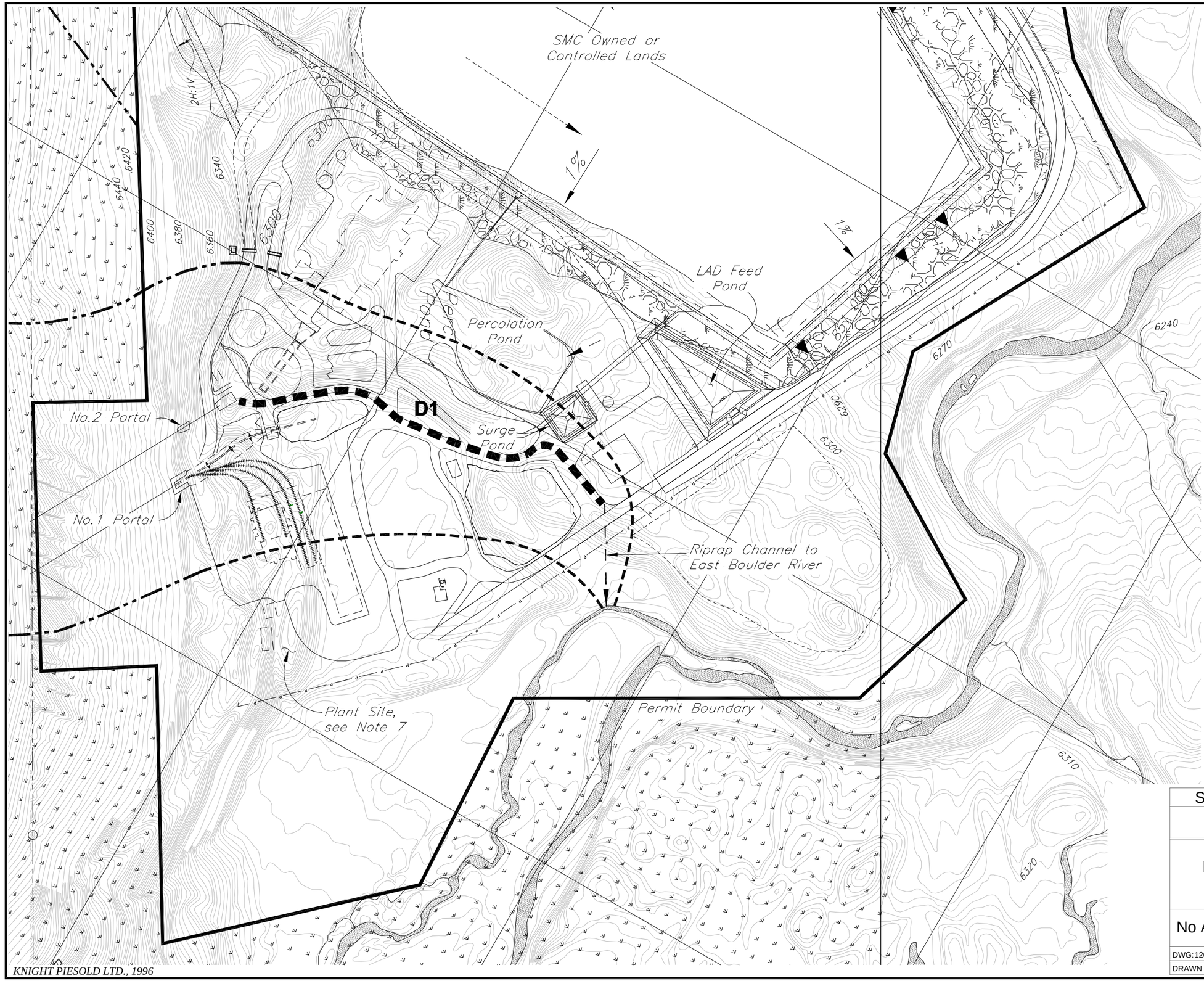
DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-22	FIGURE **2-22**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	

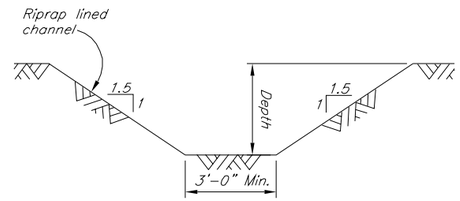


Direct flow
Indirect flow
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY
DRAFT EIS
Sweet Grass County, Montana
POST CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE
PROPOSED ACTION ALTERNATIVE 2B

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-23	FIGURE **2-23**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	





TYPICAL DITCH SECTION

Ditch	Length (ft)	Depth (ft)	Estimated Flows (cfs)		Design Capacity (cfs)
			Mine Water	Stormwater	
D1	1100	3.0	1.67	55.4	94

* Ditch capacity exceeds design flows and includes an extra 0.5 ft freeboard allowance.
* 1:100 Year events stormwater flows.
* Ditches sized to minimum constructibility.
* Catchment Area assumed, dependant on final contouring.

LEGEND

- Forest System Lands
- SMC Area

NORTH

0 125 250 375 500 FT

KNIGHT PIESOLD LTD., 1996

STILLWATER MINING COMPANY

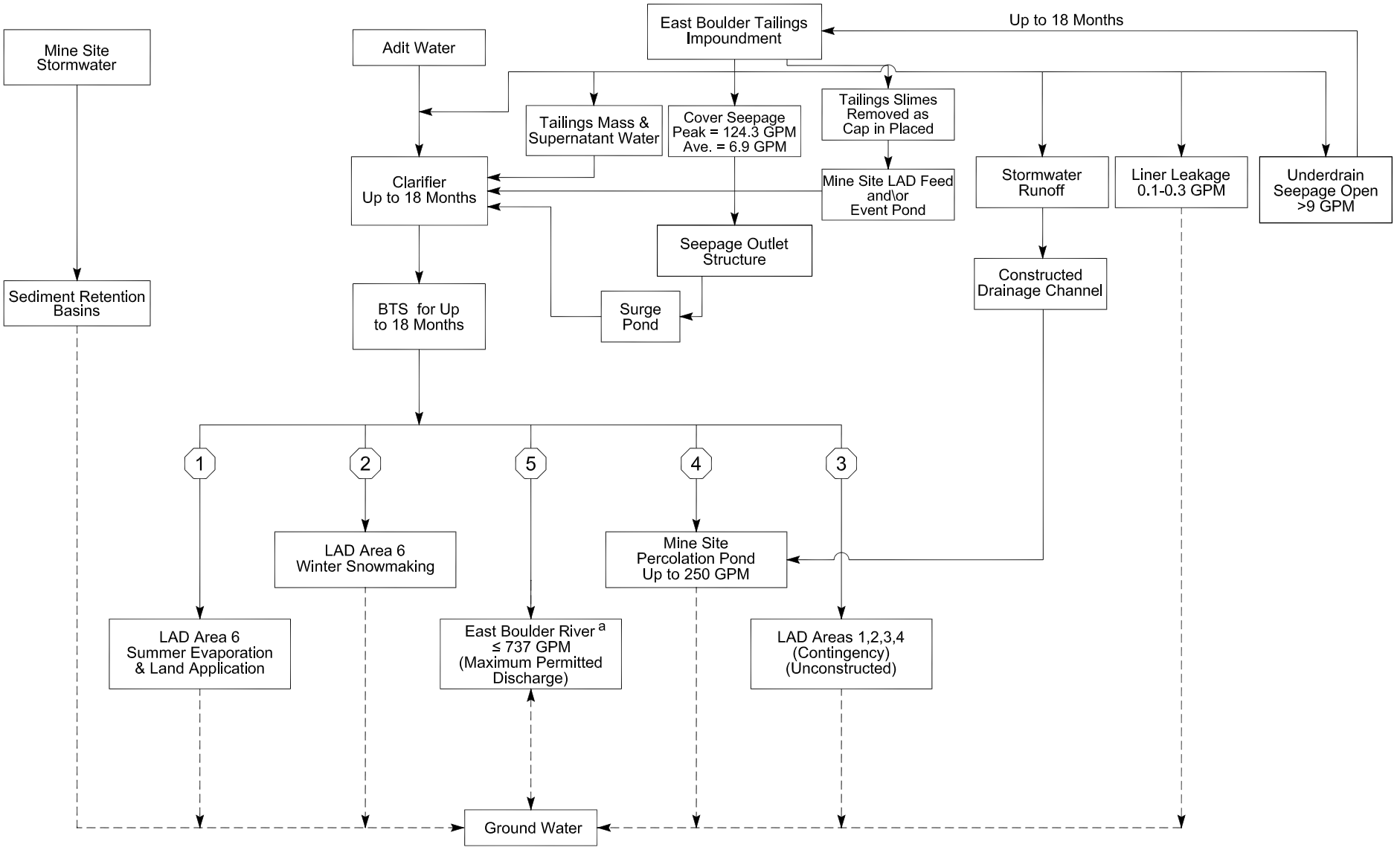
DRAFT EIS
Sweet Grass County, Montana

LOCATION OF THE PROPOSED
POST CLOSURE DRAINAGE DITCH
FOR THE EAST BOULDER MINE

No Action

FIGURE
2-24

DWG:1200 01 010.dwg	LAYOUT:n2-24	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:12/21/2006



Notes:

a. Direct discharge to the river is permitted, but is last resort; no pipe works are currently in place.

(1) Water management alternatives are ranked in order of preferred utilization.

→ Direct flow

- - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

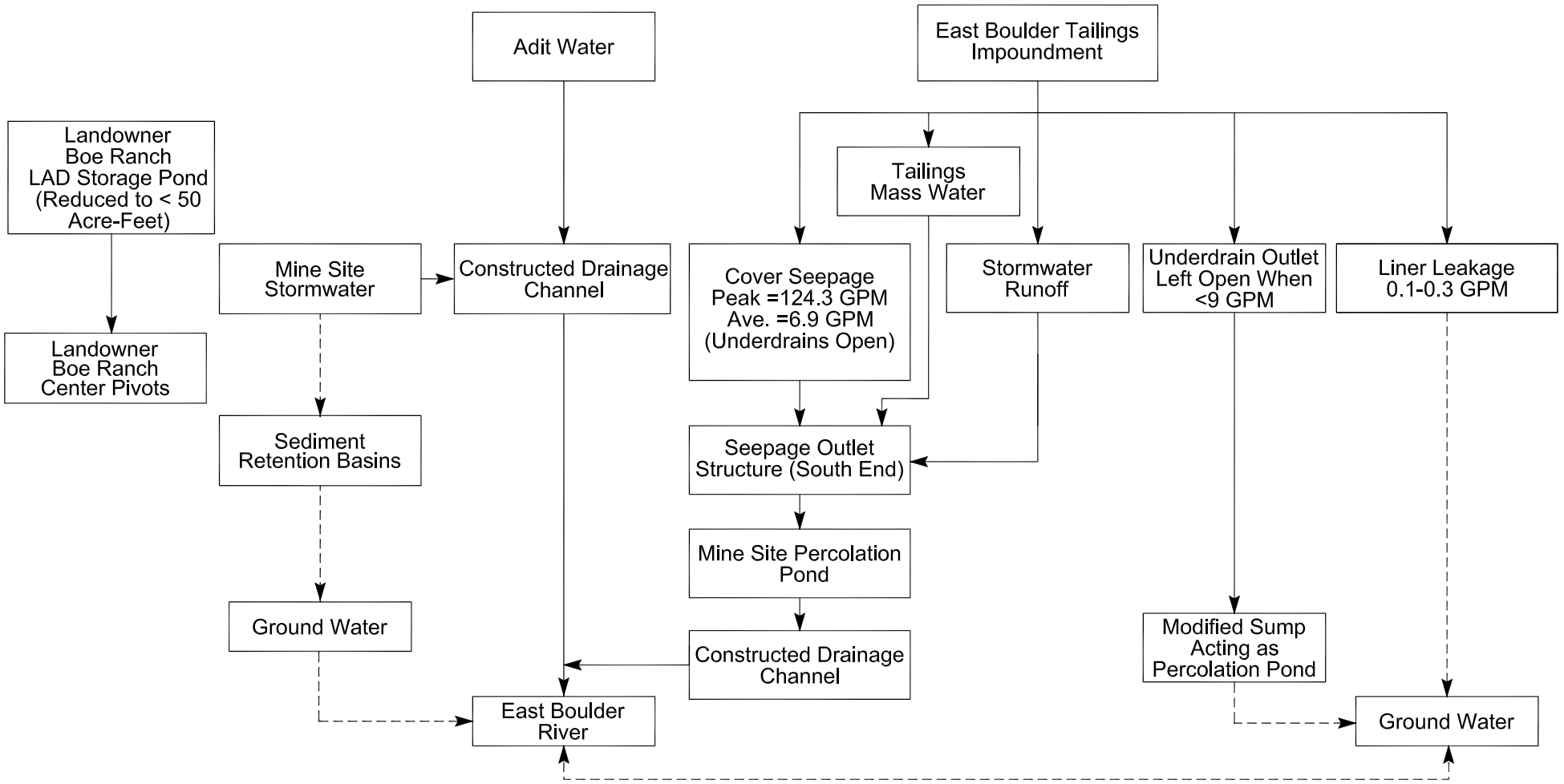
All tailings waters would report to groundwater after 18 months.

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE
AGENCY-MITIGATED ALTERNATIVE 3B

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-25	FIGURE **2-25**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	



Direct flow

Indirect flow

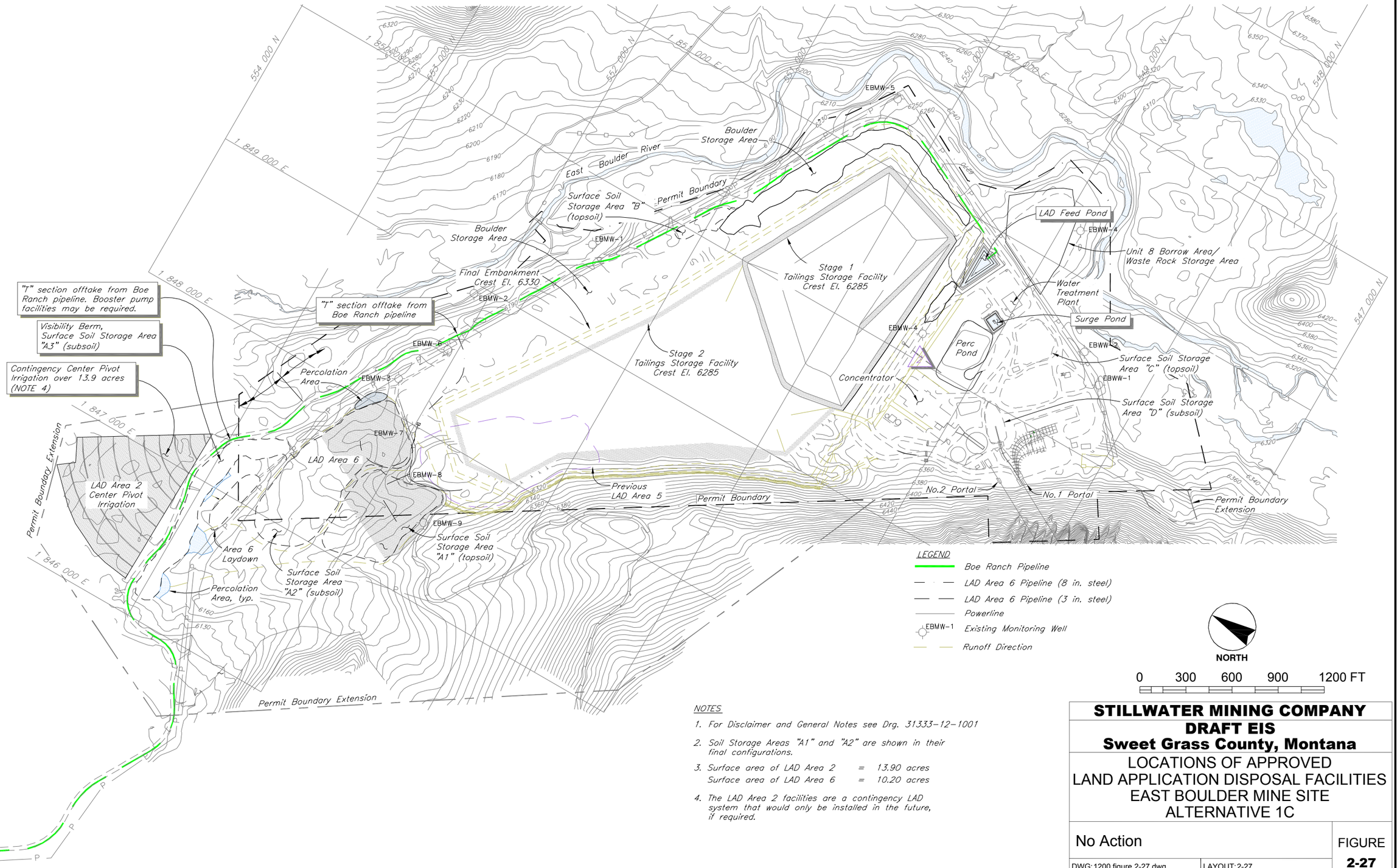
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

POST CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE AGENCY-MITIGATED ALTERNATIVE 3B AND BOE RANCH ALTERNATIVE 3C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-26	FIGURE **2-26**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	



NOTES

1. For Disclaimer and General Notes see Drg. 31333-12-1001
2. Soil Storage Areas "A1" and "A2" are shown in their final configurations.
3. Surface area of LAD Area 2 = 13.90 acres
   Surface area of LAD Area 6 = 10.20 acres
4. The LAD Area 2 facilities are a contingency LAD system that would only be installed in the future, if required.

KNIGHT PIESOLD LTD., EAST BOULDER PROJECT DESIGN 1996

STILLWATER MINING COMPANY

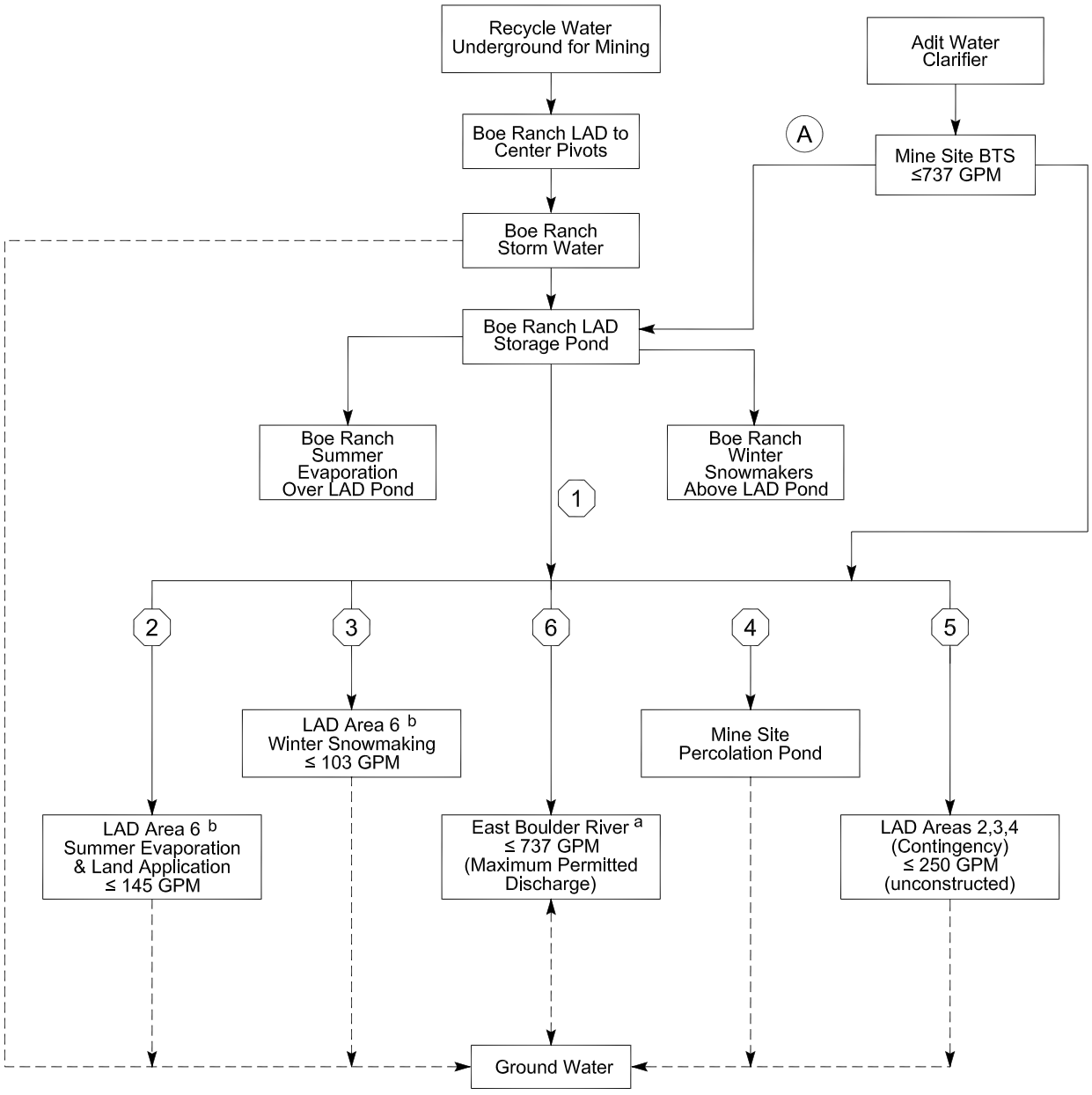
DRAFT EIS
Sweet Grass County, Montana

LOCATIONS OF APPROVED
LAND APPLICATION DISPOSAL FACILITIES
EAST BOULDER MINE SITE
ALTERNATIVE 1C

No Action

FIGURE **2-27**

DWG:1200 figure 2-27.dwg	LAYOUT:2-27	
DRAWN BY:DMC	PREPARED BY:ETC	DATE: 12/21/2006



Notes:

a. Direct discharge to East Boulder River is permitted, but is last resort; no pipe works or channels are currently in place.

b. The BOE Ranch Summer Evaporation and Winter Snowmaking System would be used seasonally before any water would be returned to the East Boulder Mine site for disposal.

(1) Water management alternatives are ranked in order of preferred utilization.

(A) Proposed Action Alternative 2C Use of 10 pivots as proposed.
Agency-Mitigated 3C Eliminates pivot #10 because of mass wasting concerns. Pivots #4 and #9 will need more monitoring during operation.

——→ Direct flow

- - - → Indirect flow

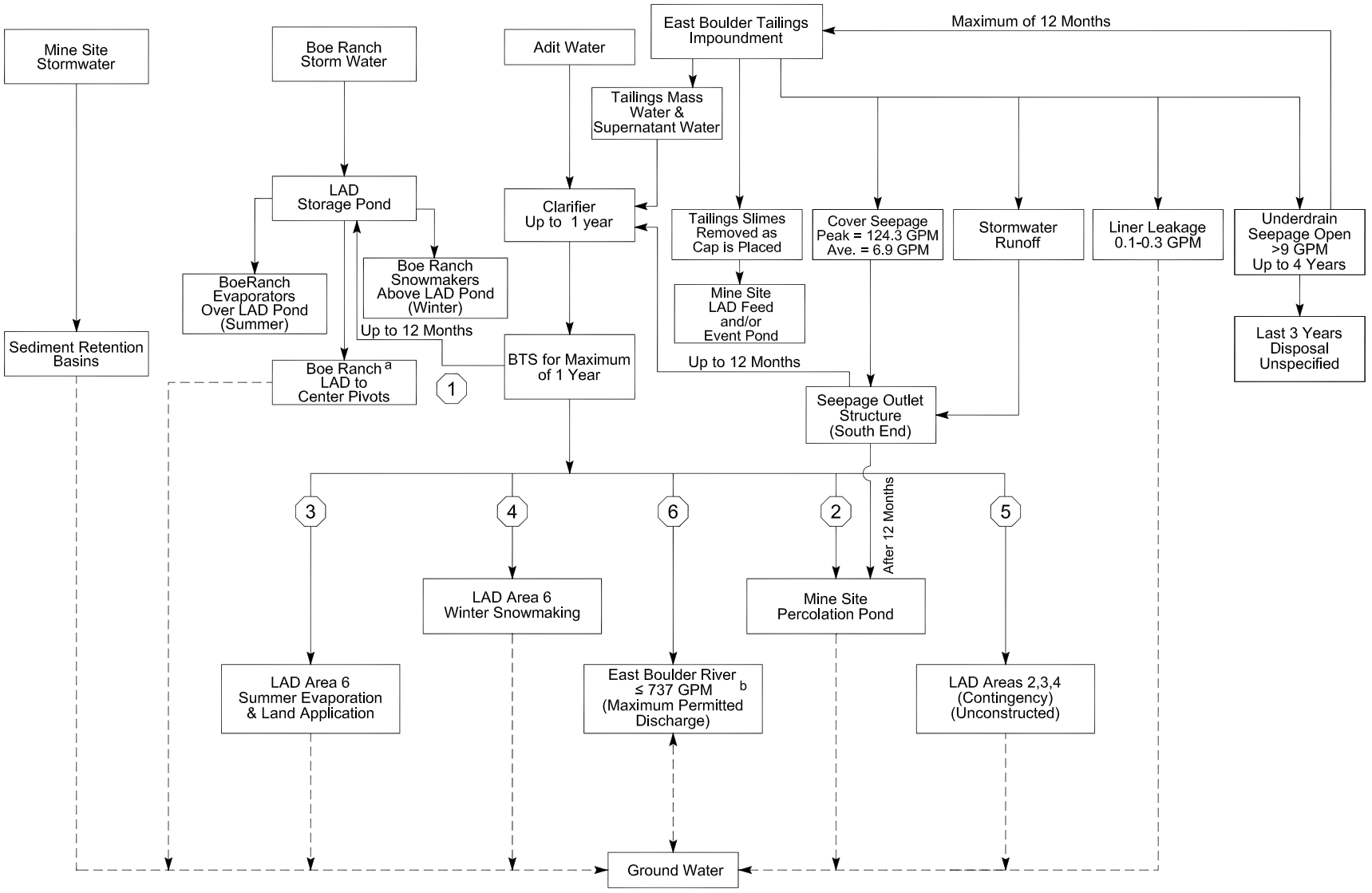
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

OPERATION WATER ROUTING AND HANDLING FOR THE BOE RANCH PROPOSED ACTION 2C, AGENCY-MITIGATED ALTERNATIVE 3C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:new2-28	FIGURE **2-28**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:06/24/2008	



Notes:

a. Under Proposed Action Alternative 2C all 10 center pivots would be available.

b. Direct discharge to the river is permitted, but is last resort; no pipe works or discharge channel are currently in place.

(1) Water management alternatives are ranked in order of preferred utilization.

→ Direct flow

- - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

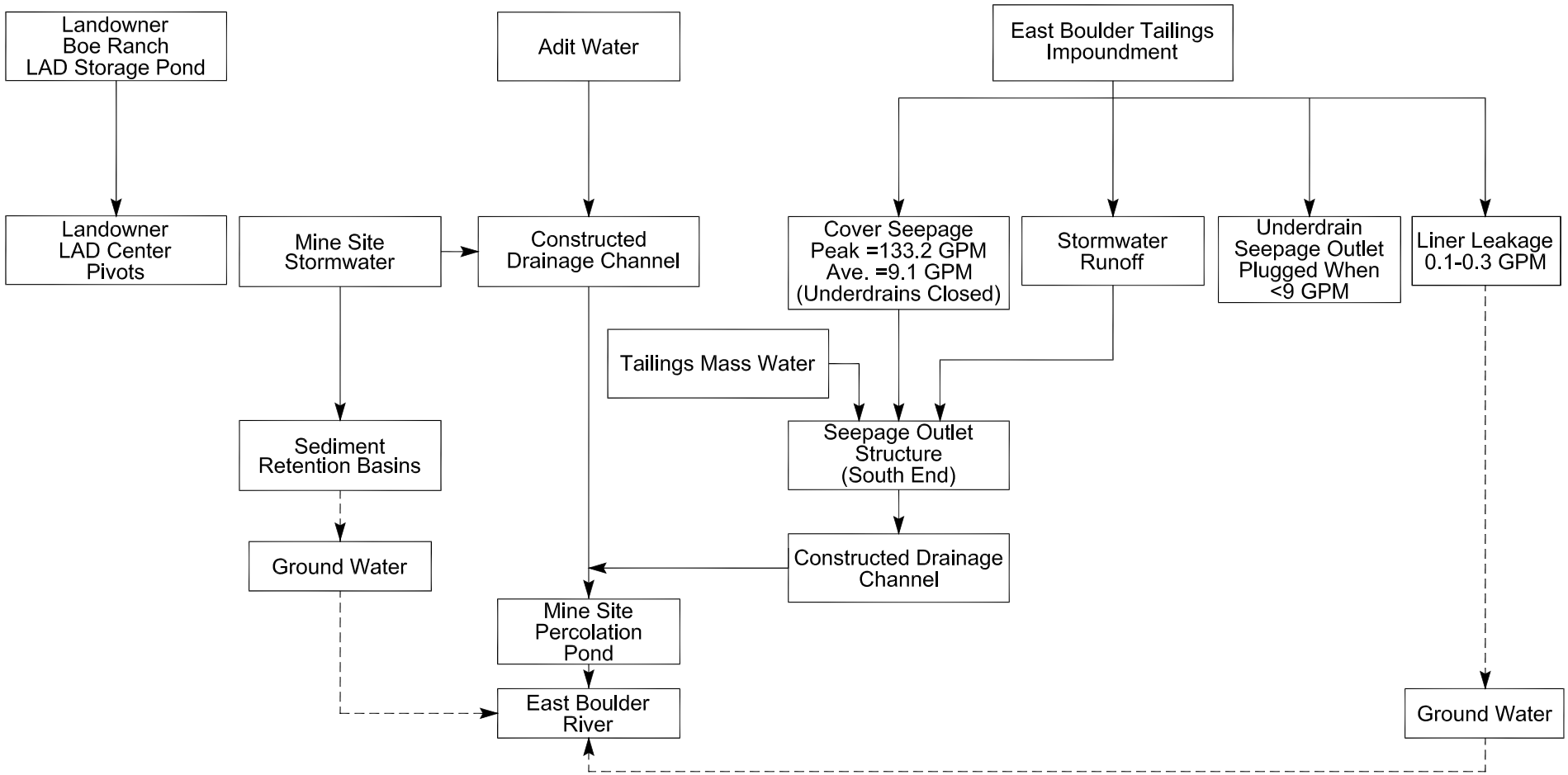
STILLWATER MINING COMPANY

DRAFT EIS

Sweet Grass County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE BOE RANCH PROPOSED ACTION ALTERNATIVE 2C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:new2-29	FIGURE **2-29**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	



Direct flow
Indirect flow
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY
DRAFT EIS
Sweet Grass County, Montana
POST CLOSURE WATER ROUTING
AND HANDLING FOR THE
BOE RANCH
PROPOSED ACTION ALTERNATIVE 2C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:new2-30	FIGURE **2-30**
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	

T 2 S
T 3 S
R 13 E
1 820 000 E
1 810 000 E
1 800 000 E
36
1
12
13
24
35
2
11
14
23
34
3
10
15
22
33
4
9
16
21
32
5
8
20
17
31
6
7
18
19
East Boulder River
Boulder River
FAS 298
Private Lands
Gallatin National Forest
State Land
Sweet Grass County Road 31
Boe Ranch Homestead
Mason Ditch
New Pipeline Proposed in Bench Road
Previously Approved Pipeline constructed in FS Road 205
SMC Lands
Proposed Boe Ranch LAD Facilities
LAD Storage Pond
Road
FS Road 205
Pipeline buried in FS Road 205 (constructed in 1999)
LAD feed Pond
East Boulder Mine Site Permit Boundary
Power Line
East Boulder River

LEGEND

19 Section Number
Boe Ranch Pipeline
Power Line
Roads
State Land

NORTH
0 1500 3000 4500 6000 FT

KNIGHT PIESOLD LTD., 1996

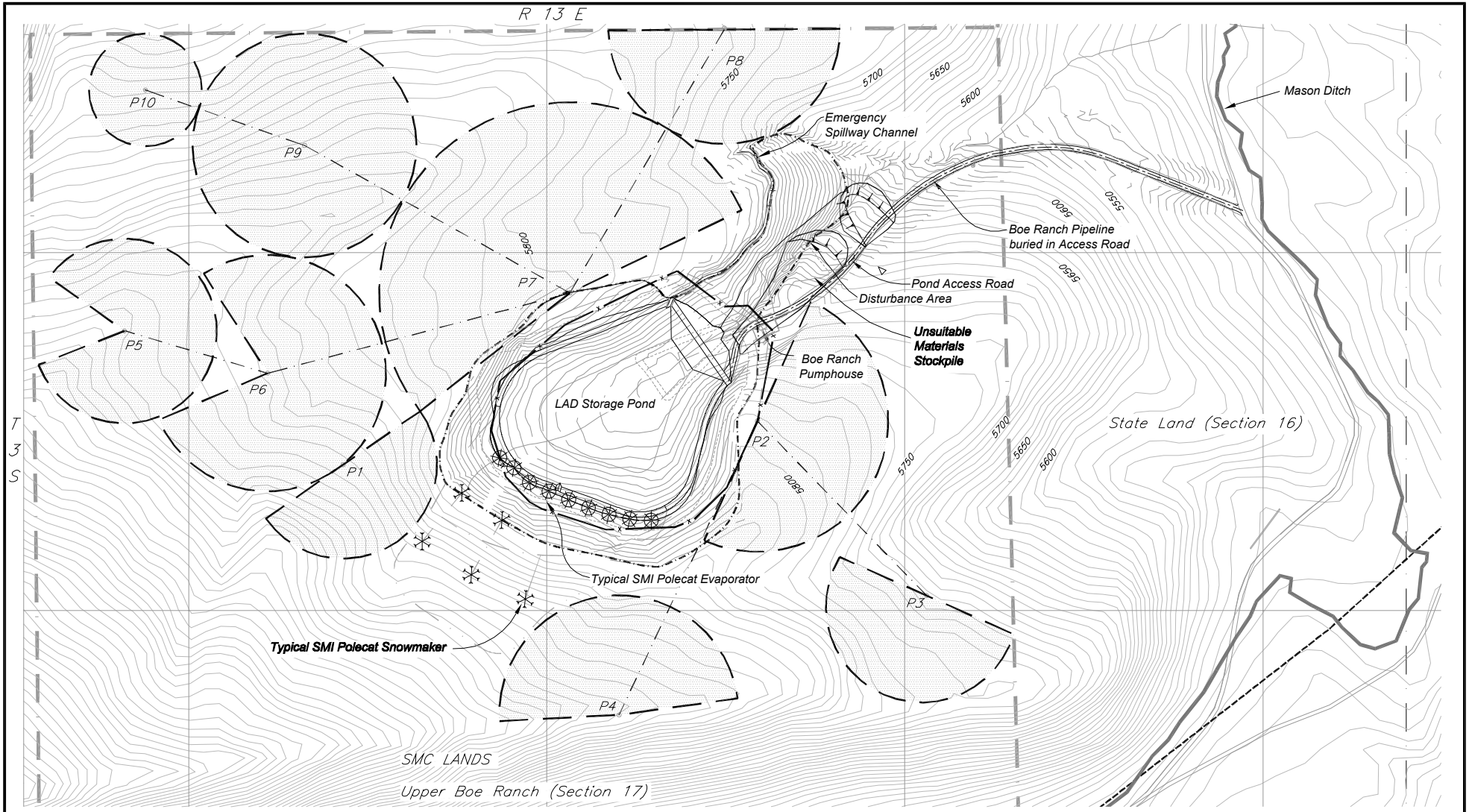
STILLWATER MINING COMPANY
DRAFT EIS
Sweet Grass County, Montana

OVERALL LAYOUT OF BOE RANCH AND EAST BOULDER MINE SITE LAND APPLICATION DISPOSAL SYSTEM ALTERNATIVE 2C

Proposed Action

FIGURE **2-31**

DWG:1200 01 012.DWG	LAYOUT: 2-31	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:1/12/2007



LEGEND

- Center Pivot Irrigation, Upper Boe Ranch
- Section Boundary
- Powerline
- Boe Ranch Pipeline
- Road
- Irrigation Feed Pipes
- Wildlife Fence

NORTH

0 200 400 800 FT

KNIGHT PIESOLD LTD., 1996

STILLWATER MINING COMPANY

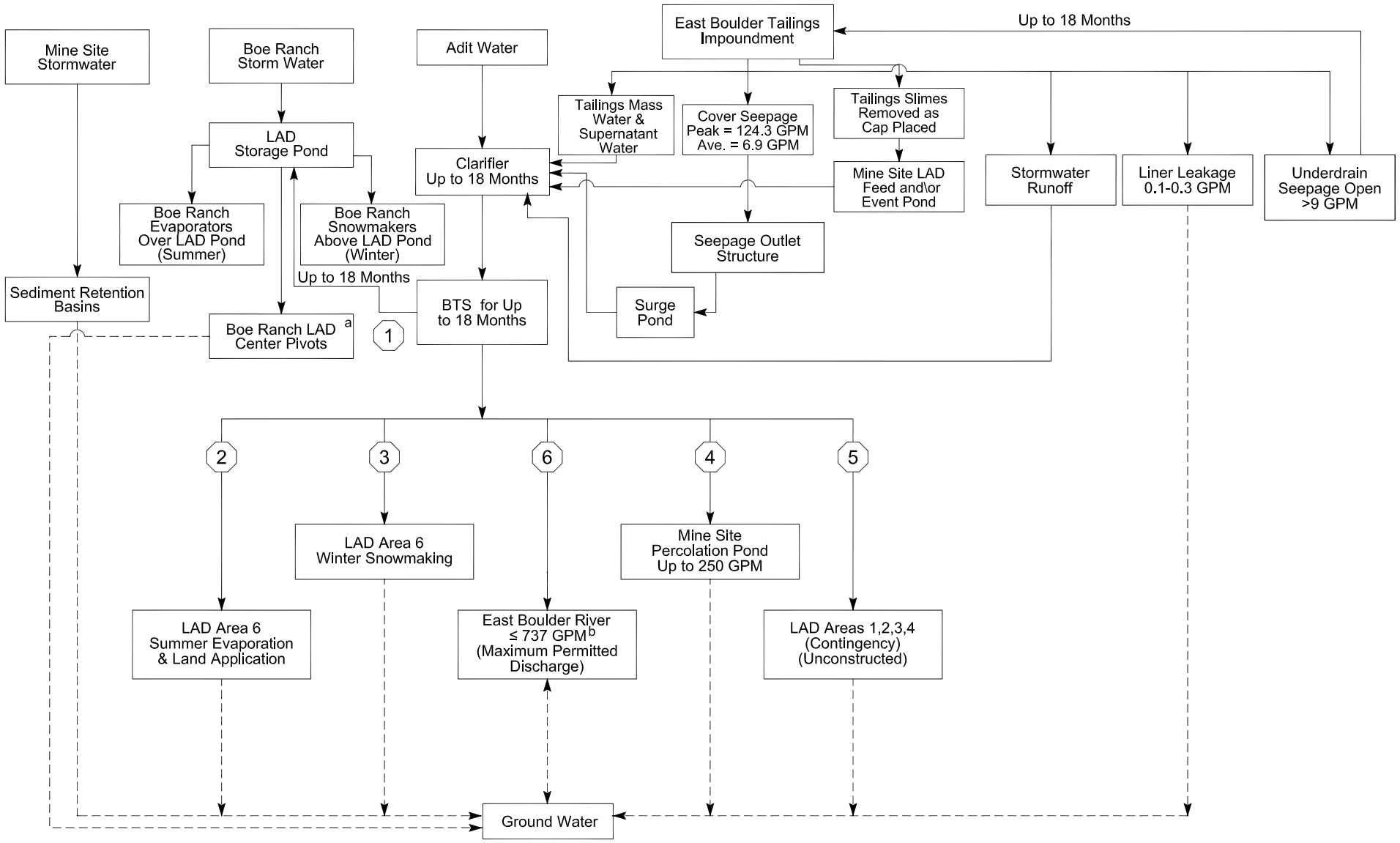
DRAFT EIS
Sweet Grass County, Montana

DETAILED LAYOUT OF LAND APPLICATION DISPOSAL SYSTEM
BOE RANCH CENTER PIVOT IRRIGATION
ALTERNATIVE 2C

Proposed Action

FIGURE **2-32**

DWG: 1200 01 013.dwg	LAYOUT: n2-32	
DRAWN BY: ETC	PREPARED BY: DMC	DATE: 12/21/2006



Notes:

a. Under Agency-Mitigated Alternative center pivot #10 is eliminated due to mass wasting concerns. Center pivots #4 and #9 will require additional monitoring.

b. Direct discharge to the river is permitted, but is last resort; no pipe works are currently in place.

(1) Water management alternatives are ranked in order of preferred utilization.

→ Direct flow

- - - → Indirect flow

Flows shown on the figure are conceptual for water balance purposes.

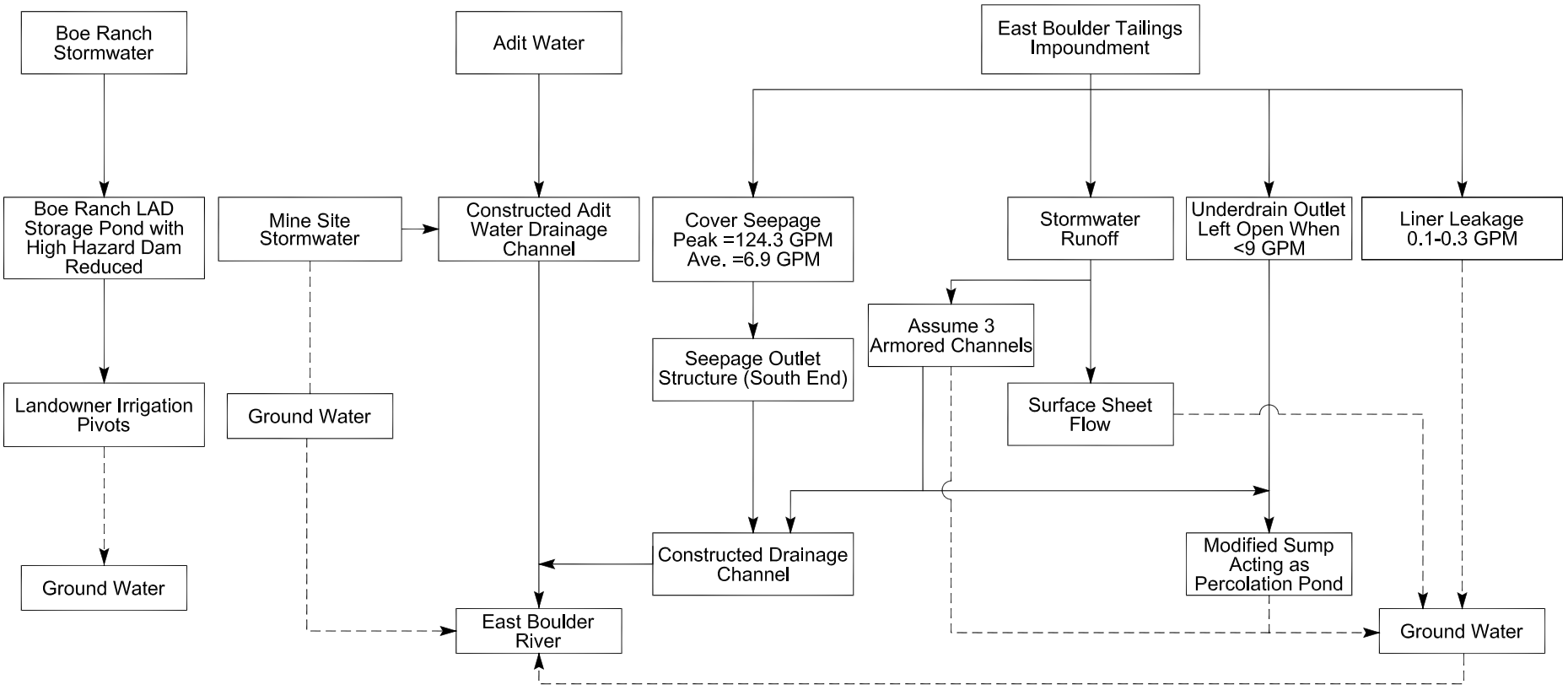
All tailings waters would report to groundwater after 18 months.

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

CLOSURE WATER ROUTING AND HANDLING FOR THE BOE RANCH AGENCY-MITIGATED ALTERNATIVE 3C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:new2-33	FIGURE 2-33
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	

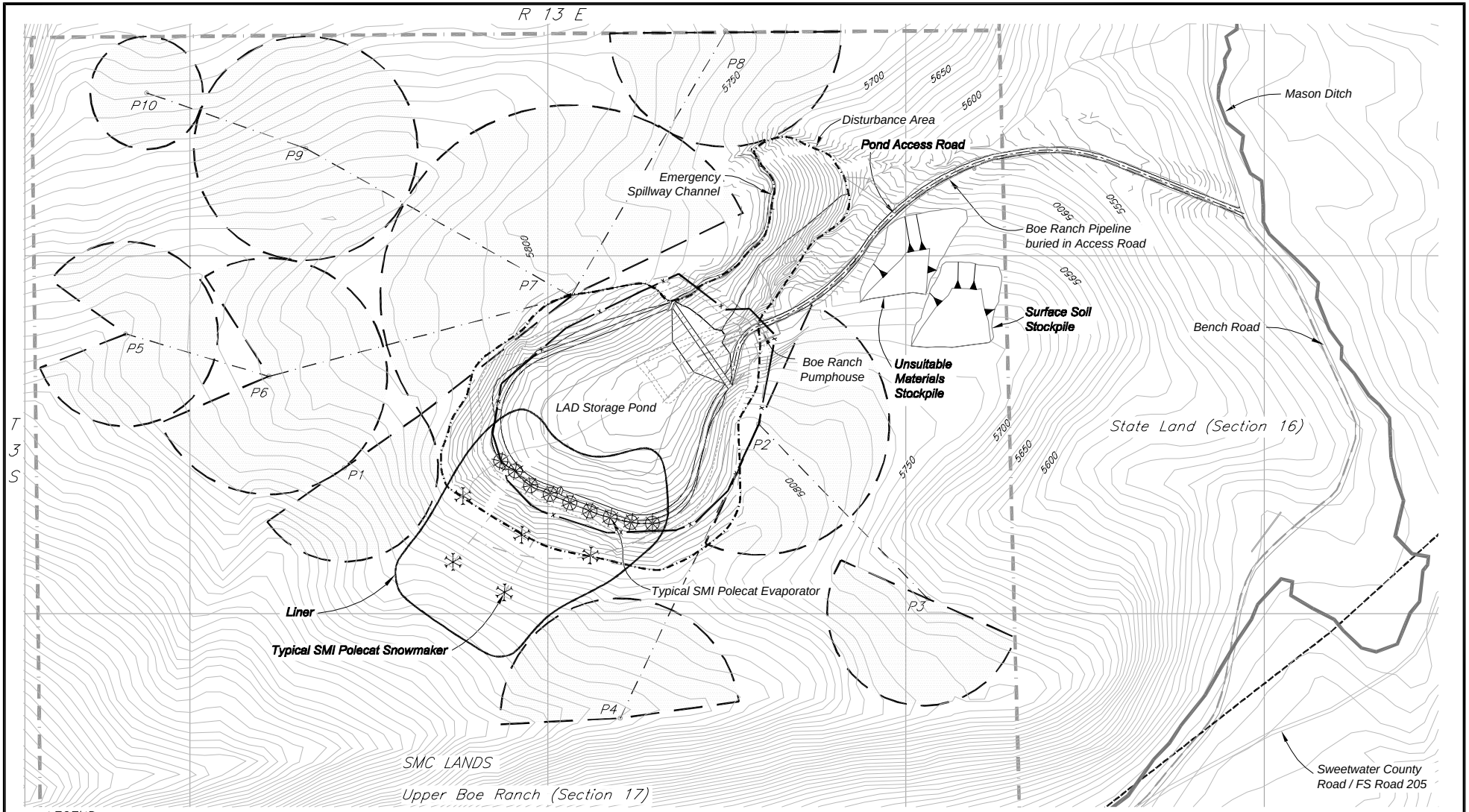


Direct flow
Indirect flow
Flows shown on the figure are conceptual for water balance purposes.

STILLWATER MINING COMPANY
DRAFT EIS
Sweet Grass County, Montana

POST-CLOSURE WATER ROUTING AND HANDLING FOR THE EAST BOULDER MINE WITH BOE RANCH LAD SYSTEM IN PLACE AGENCY-MITIGATED ALTERNATIVE 3C

DWG:1200 FIGS 06-14-08.dwg		LAYOUT:n2-34	FIGURE 2-34
DRAWN BY:ETC	PREPARED BY:DMC	DATE:6/24/2008	



LEGEND

- Center Pivot Irrigation, Upper Boe Ranch
- Section Boundary
- Powerline
- Boe Ranch Pipeline
- Road
- Irrigation Feed Pipes
- Wildlife Fence

NORTH

0 200 400 800 FT

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

DETAILED LAYOUT OF BOE RANCH LAD SYSTEM AND ALTERNATIVE LOCATIONS FOR STOCKPILES ALTERNATIVE 3C

Agency Mitigated

FIGURE 2-35

DWG: 1200 01 022.dwg	LAYOUT: 2-35	
DRAWN BY: ETC	PREPARED BY: DMC	DATE: 1/12/2007

T 2 S
T 3 S
R 13 E
1 820 000 E
1 810 000 E
1 800 000 E
36
1
12
13
24
35
2
11
14
23
34
3
10
15
22
33
4
9
16
21
32
5
8
17
20
31
6
7
18
19
East Boulder River
Boulder River
FAS 298
Private Lands
Gallatin National Forest
State Land
Sweet Grass
County Road 31
Boe Ranch
Homestead
Mason Ditch
SMC Lands
New Pipeline
Proposed
in Bench Road
Previously Approved
Pipeline constructed
in FS Road 205
Proposed
Boe Ranch LAD
Facilities
LAD Storage Pond
FS Road 205
Road
Pipeline buried in FS
Road 205
(constructed in 1999)
LAD feed Pond
East Boulder Mine
Site Permit Boundary
Power Line

LEGEND

19	Section Number
	Boe Ranch Pipeline
	Power Line
	Roads
	Monitoring Well Sites
	Streams
	State Land

NORTH

0 1500 3000 4500 6000 FT

KNIGHT PIESOLD LTD., 1996

STILLWATER MINING COMPANY

DRAFT EIS
Sweet Grass County, Montana

LOCATION OF GROUND WATER MONITORING WELLS AT THE BOE RANCH LAD SITE ALTERNATIVES 2C AND 3C

Proposed Action and Agency Mitigated

FIGURE 2-36

DWG: 1200 01 012.DWG	LAYOUT: 2-36	
DRAWN BY: ETC	PREPARED BY: DMC	DATE: 1/12/2007

Chapter 3 — Affected Environment

This chapter describes the affected environment for the project alternatives. The affected environment is the portion of the existing environment that could be impacted by the project. The information presented here focuses on issues identified through the scoping process (Section 2.1.2) and interdisciplinary analyses. Preliminary issues that are not affected by the Proposed Actions or Alternatives have been dismissed from additional analysis (Section 2.2.2).

3.1 Water Quality and Quantity

Previous documents, including the following, provide discussion and review of water resources near the Stillwater and the East Boulder mines:

Stillwater Mine

- *Anaconda Stillwater Project, 12-Month Environmental Baseline Report* (CDM 1981).
- *Final Environmental Impact Statement, Stillwater Project, Stillwater County, Montana.* (DSL and USFS 1985).
- *Decision Notice and Finding of No Significant Impact for the Stillwater Mining Company's Proposed East-Side Adit.* (DSL and USFS 1989).
- *Draft Environmental Impact Statement for the Stillwater Mine Expansion 2000 TPD Application to Amend Plan of Operation and Permit No. 00118.* (DSL et al. 1992a).
- *Final Environmental Impact Statement for the Stillwater Mining Company Underground Valley Crossing and Mine Plan. (DEQ 1996).*
- *Final Environmental Impact Statement for the Stillwater Mine Revised Waste Management Plan and Hertzler Tailings Impoundment.* (DEQ and USFS 1998a).

East Boulder Mine

- *Stillwater Project Surface Water Resources, Technical Report No. 4.* (Beak Consultants, Inc. 1982).
- *Stillwater Project Ground water Resources, Technical Report No. 5.* (Beak Consultants, Inc. 1983).
- *Water Resources Baseline Report for Stillwater PGM Resources, East Boulder Project, Sweetgrass County, Montana.* (Hydrometrics, Inc. 1990)
- *Final Environmental Impact Statement, East Boulder Mining Project, Sweet Grass County, Montana.* (DSL et al. 1992b).
- *Final Environmental Assessment Stillwater Mining Company East Boulder Project Water Management Plan* (DEQ 1999).

- *Stillwater Mining Company East Boulder Project, Water Management Plan, Appendix K, Boe Ranch LAD Alternative*. (Knight Piésold 2000c).

Stillwater Mining Company (SMC) monitors ground and surface water around both mines and submits the results of this monitoring to the agencies monthly, quarterly, or annually, in accordance with the applicable water quality monitoring plans. The discussion below is a brief summary of water resources.

3.1.1 Ground Water Quality and Quantity

3.1.1.1 Stillwater Mine

3.1.1.1.1 Stillwater Mine Site

Ground Water Occurrence

Two major aquifers in the Stillwater River valley near the Stillwater Mine contain ground water. These aquifers are fractured bedrock system and unconsolidated alluvium system. The bedrock outcrops on both sides of the Stillwater River and lies beneath the surficial deposits that occupy the valley. Ground water in the bedrock typically is confined to fractures, faults, joints, and shear zones. The occurrence and density of these fractures vary and are difficult to predict. Flows of ground water from the bedrock are localized and vary considerably. The bedrock aquifers are recharged mainly by snowmelt at higher elevations.

Ground water discharges from the bedrock aquifer into springs, creeks, and unconsolidated alluvial aquifers. The bedrock aquifers generally recharge the alluvial ground water systems, which in turn feed the Stillwater River. Adjacent to the Stillwater Mine the river feeds the ground water system. Water-bearing zones typically are encountered during underground mine development. Wells drilled into the bedrock generally yield little water and generally are not used as domestic water supplies. As a part of a regulatory Water Resources Monitoring Plan, SMC monitors three springs. These springs include the Upper Jones, the Buffalo Jump, and the East-side Spring (SP-3) (See Figure 3-1). SMC annually monitors other springs as part of its voluntary monitoring program.

The major source of ground water near the mine is alluvium within the Stillwater River valley. The alluvial ground water in the mine area generally flows to the northeast. Data from monitoring wells show that ground water flows from the alluvium on the valley sides parallel to and eventually into the Stillwater River near SMC-11 (Figure 3-1). Near the mine, the Stillwater River loses water to ground water. After flowing through a narrowing of the bedrock upstream of the mine, the river begins to lose water as it spreads out into the alluvial valley at SMC-1A. Downstream of the mine at SMC-11, the bedrock pinches together forcing the ground water from the alluvium back into the river. The Stillwater River alluvium has excellent water-yielding capability due to its ability to pass a large water volume.

Ground Water Quality

Water quality is affected by several factors. In general, water quality refers to the amount of soluble materials, such as minerals and organic compounds, dissolved

in water. Rain or snowmelt is relatively pure with respect to dissolved minerals. As precipitation enters the ground and encounters soil and rock, minerals dissolve into the water. Dissolved minerals can make water "hard" (high concentrations of bicarbonate) and give it flavor. Background water quality varies by location and usually refers to natural concentrations of minerals and organic compounds dissolved in ground or surface water. Baseline water quality refers to the level of water quality prior to the commencement of mining operations.

Mine operations may change water quality over time. Mine wastewaters are discharged by percolation and land applied at the SMC operations before eventually reporting to ground water. The extent to which these waters can degrade ground water quality is a function of constituent concentrations and the discharged volume of water. Mixing discharged mine wastewaters, which could include adit, tailings, and storm waters, with uncontaminated ground water reduces constituent concentrations.

Changes in adit water quality are not dependent directly on mine development levels. Water quality varies depending on the amount of underground development requiring the use of explosives, grouting, or tailings backfill of mined-out areas. Constituents found in SMC's mine wastewaters include the following: total inorganic nitrogen (TIN), which includes nitrates, nitrites, and ammonia from blasting residues; total dissolved solids (TDS), also referred to as salts in this document; phosphorus; and metals. The parameters of concern at the Stillwater Mine analyzed in this EIS are nitrogen and salts, specifically TDS and electrical conductivity (EC) (Section 2.2.1). Since the biological treatment system (BTS) has been in use at the Stillwater Mine, the maximum daily load of nitrogen discharged after treatment has been 50 pounds per day (lbs/day) TIN and an average of 3,830 lbs/day of salts.

The milling process uses adit water to recover platinum group metals. This process water contains finely ground rock, known as tailings, and is slurried into an impoundment. Tailings mass water is water that resides in pore spaces between the tailings particles. Water that collects on the surface of the tailings mass is called supernatant water. Reagents used in ore processing and metal recovery influence tailings water quality. The tailings mass water and supernatant water, which will be called tailings waters throughout this EIS, have elevated concentrations of constituents compared to adit water (Appendix C. Untreated Adit and Tailings Water Quality Table, DEQ 2009).

Water treatment can reduce constituents in discharged water. SMC has a biological treatment system (BTS) that reduces nitrogen in mine waters prior to discharge. The BTS is a denitrification reactor, which biologically converts nitrate to nitrogen gas.

Alluvial ground water near the Stillwater Mine is a Class I beneficial use, good quality, soft- to moderately-hard water that contains low concentrations of nitrogen and salts. The Class I beneficial use criterion is defined as having a natural specific conductivity of less than or equal to 1,000 microSiemens/cm. MicroSiemens are a measure of EC and are equivalent to micromhos/cm (µmhos/cm). For this document, 1 µmho/cm EC is approximately equivalent to

1.56 mg/L TDS. Heavy metals are typically at or below detection limits and are not of concern in this EIS (Section 2.2.2) (SMC 2008a).

Monitoring since 1986 indicates that mining operations generally have not changed ground water quality from the baseline condition, with the exception of some increases in concentrations of nitrogen and salts in some monitoring wells, as described in the following sections.

East-side

East-side Adit Water. Concentrations of nitrogen and salts from the east-side adit have declined since 2000. Nitrogen concentrations have decreased from 10.3 milligrams per liter (mg/L) in 2000 to less than 0.2 mg/L TIN in 2009. These concentrations were below the DEQ-7 Montana water quality standard for protection of human health during the 2000 to 2009 monitoring period (DEQ 2006). Salt concentrations in ground water below the east-side percolation ponds, as measured at monitoring well MW-14A, have shown a long-term steady state salt concentration trend. While the east side was being mined, salt concentrations climbed from a 1992 EC concentration of 248 µmhos/cm (159 mg/L TDS) to as high as 399 µmhos/cm (256 mg/L TDS). East-side mining stopped in 2000. EC in ground water during 2008 and 2009 is less than 164 µmhos/cm and meets the Class I beneficial use criterion for ground water (Appendix C, Figure MW-14A, DEQ 2009).

East-side Percolation Ponds. Nitrogen and salts concentrations were slightly elevated at downgradient monitoring locations during mining and disposal of adit water. Nitrogen and salts concentrations in ground water wells have varied seasonally, reflecting discharge of adit water into the shallow ground water system (SMC 2008a). Since cessation of east-side mining, nitrogen and salts concentrations have decreased in alluvial monitoring wells downgradient from the east-side percolation ponds.

East-side LAD Area. Land application disposal (LAD) utilizes irrigation similar to agricultural practices. LAD provides secondary treatment through plant uptake and chemical and microbial processes in the soils. At the Stillwater Mine, an east-side LAD system was used to treat mine waters from 1994-1999.

Nitrogen concentrations in MW-18A were as high as 4.4 mg/L TIN in 1996, but during the 2000 to 2007 monitoring period, the highest detected nitrogen concentration was 0.6 mg/L TIN (Figure 3-2) (SMC 2008a).

Salts concentrations in MW-18A were as high as 215 µmhos/cm (138 mg/L TDS) in 1996, but during the 2000 to 2007 monitoring period, the highest detected salts concentration was 106 µmhos/cm (68 mg/L TDS) (Figure 3-3) (SMC 2008a).

West-side

West-side Adit Water. West-side adit water nitrogen and salts concentrations are higher than those for east-side adit water, reflecting active mining on the west side. Concentrations of nitrogen from the west-side adit ranged between 13.8 and 41.3 mg/L during the 2000 to 2008 monitoring period. These elevated concentrations in untreated adit discharge water continue to be higher than

background levels due to use of nitrogen-based blasting agents (Appendix C. Untreated Adit and Tailings Water Quality Table, DEQ 2009).

West-side Percolation Ponds. Ground water from downgradient monitoring wells below the Stillwater tailings impoundment and the west-side percolation ponds is a magnesium bicarbonate type with low nitrogen and salt concentrations.

Concentrations of nitrogen in monitoring wells MW-6A and MW-11A, which are located downgradient from the Stillwater tailings impoundment, increased compared to 1986 baseline concentrations (Figure 3-2). SMC has made several operational improvements to reduce potential impacts to ground water since the startup of mining, including lining the west-side ponds. Since lining of the west-side ponds in 2000, monitoring well MW-6A has shown improved water quality (Figure 3-2). Water quality in MW-6A showed consistently low nitrogen concentrations throughout the monitoring period, while MW-11A displayed the highest nitrogen concentrations. The nitrogen concentration in MW-11A increased to 10.8 mg/L during 2007, which was attributed to tailings waters releases from the Stillwater tailings impoundment. Once the release was identified, mitigation measures were implemented. Ground water monitoring in 2008 has exhibited a downward trend in nitrogen concentrations in MW-11A (Figure 3-2).

Salts concentrations in downgradient monitoring wells, MW-6A and MW-11A, were elevated until 2000 when the west-side ponds were lined. Since that time, salts concentrations have decreased in MW-6A (Figure 3-2). The salts concentration in MW-11A increased during 2007, which was attributed to tailings waters releases from the Stillwater tailings impoundment. Once identified, mitigation measures were implemented. The trend of salts concentrations in ground water is shown in MW-11A (Figure 3-3).

Tailings Waters. During the 2002-2006 monitoring period, the nitrogen concentration in tailings waters ranged from 28.5 to 59.8 mg/L TIN. The salts concentration ranged from 1,290 to 2,960 mg/L TDS. Dissolved metal concentrations were near or below laboratory detection limits (Appendix C. Untreated Adit and Tailings Water Quality Table, DEQ 2009).

3.1.1.1.2 Hertzler Ranch

Ground Water Occurrence

There are two distinct units of ground water in the Hertzler Ranch area: sedimentary bedrock and unconsolidated surficial alluvium with glacial deposits. Colorado and Montana Group sedimentary rocks represent the two uppermost bedrock units underlying the Hertzler Ranch area. The Colorado Group consists mostly of shale with thinner horizons of interbedded sandstones. The total thickness is between 2,300 and 3,300 feet. The overlying Montana Group consists of alternating layers of shale and sandstone and is between 600 and 700 feet thick. Colorado and Montana Group shales restrict ground water movement (DSL and USFS 1985). Ground water is available in sedimentary rocks but generally is not used when more reliable near-surface water exists.

The depth of unconsolidated deposits ranges from 55 to 171 feet (DEQ and USFS 1998a). During most of the year, unconsolidated surficial alluvium and

glacial deposits are saturated at depths ranging from 76 feet in the western end of the area to 42 feet in the eastern end of the area where ground water approaches the Stillwater River. Water levels vary as much as 20 feet between low (winter and early spring) and high (late spring and summer) periods (DEQ and USFS 1998a).

Ground water can be extracted from unconsolidated surficial alluvium and glacial deposits at relatively high rates. Based on pumping and recovery tests, transmissivity of glacial outwash and the overlying alluvium ranges between 150,000 to 800,000 gallons per day per foot (gpd/ft) and 656 to 11,165 gpd/ft, respectively. Several observation wells in the area were capable of producing more than 200 gallons per minute (gpm) (DEQ and USFS 1998a).

Three springs are monitored in the Hertzler Ranch area. Two of these springs are located north of the area at Tandy and Stanley Coulees with flows ranging from 12.5 to 40 gpm. No flow rate is available for the third spring, the Hertzler Homestead Spring, which is located near the southeast toe of Bush Mountain (DEQ and USFS 1998a).

Alluvial ground water is recharged from precipitation, losses from streams, and contributions from bedrock aquifers. Infiltration of irrigation water from the Tandy Ditch, which runs through most of the area, also has been a major source of recharge. Use of the irrigation ditch was discontinued following startup of the Hertzler Ranch LAD system in 1999.

Ground Water Quality

Most ground water from unconsolidated alluvium and glacial deposits in the Hertzler Ranch area is suitable for Class I beneficial uses. In the Hertzler Ranch vicinity, SMC monitors ground water from 11 wells completed in alluvium or along the alluvium glacial/bedrock contact zone (Figure 3-1). In all wells, nitrogen concentrations have been below the Montana Numeric Water Quality Standard for protection of human health (10 mg/L or less) (DEQ 2006). The highest nitrogen concentrations during the 2000-2007 monitoring period were detected at HMW–3, which is located downgradient of the Hertzler Ranch LAD storage pond, with a concentration of 9.1 mg/L in May 2006 (SMC 2008a). Leakage from the improperly installed earthen liner within the Hertzler Ranch LAD storage pond can account for these elevated nitrogen concentrations. In 2006, the LAD storage pond was relined with high-density polyethylene (HDPE). Since that time, monitoring well HMW-3 has been dry.

Due to a leak in the tailings impoundment underdrain pipe, nitrogen concentrations for HMW–9, located directly north of the Hertzler Ranch tailings impoundment, increased from 1.2 mg/L to greater than 2.0 mg/L TIN. The leak has been repaired, and nitrogen concentrations are declining.

Several nitrogen concentration spikes have been observed in downgradient monitoring wells HMW-1 and HMW-10 (Figure 3-4). The highest observed concentration was 5.9 mg/L TIN in HMW-10 in 2004. The highest fluctuation in HMW-10 nitrogen concentrations resulted from agricultural fertilization of the alfalfa field in which it is located (Hydrometrics 2005). Nitrogen concentrations in the rest of the monitoring wells generally were below 1.0 mg/L (SMC 2008a).

In most ground water monitoring wells, water has low to moderate concentrations of salts. Water quality at well HMW-14, which is screened in the low-permeability Colorado shale and is located downgradient from the Hertzler Ranch tailings impoundment, has higher salts concentrations, up to 705 mg/L TDS, than other ground water monitoring wells (SMC 2008a). Salts concentrations in one upgradient well (HMW-4) and two downgradient wells (HMW-1 and HMW-10) are relatively stable, fluctuating between 112 and 234 mg/L (Figure 3-5).

The Hertzler Ranch ground water quality meets the Class I beneficial use criterion. In order to ensure that ground water at the Hertzler Ranch remains suitable for all beneficial uses with little or no treatment, the EC should not be above 1,000 µmhos/cm. An increase to between 1,000 and 2,500 µmhos/cm would decrease the quality of ground water, making it marginally suitable for beneficial uses (ARM 17.30.1006). To avoid long-term effects to ground water quality after mine closure, the ground water EC should meet the Class I beneficial use criterion.

Operational Water Management Activities

SMC maintains a water management program, including grouting to reduce ground water inflows into the mined areas, that is intended to protect both the quality and quantity of water resources. SMC has developed over 100 miles of underground workings in over 20 years of mining which has resulted in the mine intercepting 650 gpm of ground water (Weimer 2009pc).

Tailings waters are recycled between the Stillwater and Hertzler Ranch tailings impoundments and the mill (Figure 2-1). Adit water is used to makeup water lost to evaporation and to maintain the required water balance in the tailings impoundments and the mill circuits. Excess west-side adit water is treated and disposed through the LAD system at the Hertzler Ranch.

The BTS is more than 95 percent effective in the treatment of nitrogen compounds other than ammonia. The Hertzler Ranch LAD system provides secondary water treatment for remaining nitrogen compounds discharged from the BTS.

Lined west-side ponds limit percolation of untreated mine water. East-side percolation ponds are used to discharge east-side mine water that has returned to background conditions.

3.1.1.2 East Boulder Mine

3.1.1.2.1 East Boulder Mine Site

Ground Water Occurrence

The bedrock, unconsolidated surficial alluvium, and glacial deposits of the East Boulder River valley contain ground water. The wells at the site are up to 220 feet deep but do not penetrate bedrock, so the thickness of the unconsolidated surficial alluvium and glacial deposits has not been established (Hydrometrics 2008).

Paleozoic sediments and igneous rocks of the Stillwater Complex underlie the unconsolidated surficial alluvium and glacial deposits at the East Boulder Mine. Ground water in bedrock is present as a result of both primary matrix porosity and secondary permeability due to joints, fractures, and fault zones. The ability to transmit water through unfractured igneous rocks is low because the crystalline nature results in few void spaces within the rock matrix. The crystalline rocks of the Stillwater Complex are extensively jointed and faulted, providing potential for some ground water movement (DSL et al. 1992b).

The glacial deposits are a compacted mix of silt, sand, gravel, and boulders. Coarse-grained glacial lenses are located within the deposits at depths of 100 to 170 feet. Where identified, these lenses are generally 10 to 40 feet thick and variable in grain size distribution. Alluvial deposits are relatively shallow and underlain by glacial deposits, except where they encounter shallow bedrock on the valley sides (Hydrometrics 2008).

The coarse-grained glacial lenses conduct most of the ground water at the site. The permeability ranges from moderate to extremely high: hydraulic conductivities derived from aquifer pumping tests ranged from 12 to 567 feet per day. Ground water permeability in other glacial deposits is one or more orders of magnitude lower than the coarse-grained glacial lenses (Hydrometrics 2008).

The shallow alluvium is an important hydrologic unit and contributes recharge to the ground water system. Information on the hydrologic characteristics of the alluvial system is limited, as no wells are in this unit (Hydrometrics 2008).

Data from ground water monitoring wells at the East Boulder Mine (Figure 3-6) indicate that depth to ground water ranges from 100 to 200 feet in the East Boulder tailings impoundment area. The depth to ground water becomes shallower as the land surface slopes towards the East Boulder River and ranges from 25 to 35 feet. Water level data indicate that the regional ground water flow direction is approximately parallel to the trend of the valley, flowing from southeast to northwest with an average hydraulic gradient of 0.026 percent (Figure 3-7) (Hydrometrics 2008).

Ground water levels within individual wells fluctuate seasonally between 10 and 40 feet (Hydrometrics 2008). Seasonal fluctuations of ground water levels in 2007 ranged from 1 foot at EBMW-5 to 43 feet at EBMW-9. The extent of water level fluctuations is related to distance from the East Boulder River, with wells farther away from the river showing greater annual water level changes (SMC and Hydrometrics 2008b).

Water elevations in well WW-1 at the upstream end of the site are 70 to 100 feet below the elevation of the East Boulder River. Along the northeast-side of the permit area, the East Boulder River is approximately 5 to 10 feet above water level elevations in wells EBMW-5 and EBMW-1. Farther downstream near EBMW-2, the river elevation is approximately equal to ground water levels. There are no wells adjacent to the stream at locations farther downstream. Synoptic streamflow studies show streamflow gain from EBR-004 to EBR-004A, with inflows of 0.45 to 1 cubic feet per second (cfs). Data suggest that recharge occurs from the river into the ground water system in this area (Hydrometrics 2008).

The shallow ground water system is recharged through ground water inflow from upgradient areas, infiltration of surface water from the East Boulder River, water discharged to the percolation pond, and water from the septic drainfield at the mine. The East Boulder River serves as a source of both recharge and discharge for the shallow ground water system. River levels are higher than adjacent ground water levels along the upstream portion of the site, resulting in ground water recharge, but lower in elevation at the downstream end of the site, resulting in ground water discharge (Hydrometrics 2008).

Ground Water Quality

Since 1998, SMC has monitored ground water in 10 wells at the East Boulder Mine (Figure 3-6). SMC also monitors adit and tailings water quality. Ground water from these monitoring wells is classified as a calcium bicarbonate type water with low to moderate concentrations of salts (SMC and Hydrometrics, Inc. 2008b).

Ground water nitrogen concentrations during operations have increased compared to those during the baseline period. Nitrogen concentrations in upgradient ground water monitoring well WW-1 were less than 0.2 mg/L TIN from 1989 to 2008. Since mine operations began, nitrogen concentrations in downgradient ground water monitoring wells have increased (Appendix C, Figures EBMW-2, EBMW-3, EBMW-6, and EBMW-7, DEQ 2009). The highest nitrogen concentrations were measured at ground water monitoring well EBMW-6, which is located at the end of the ground water mixing zone downgradient of the tailings impoundment (Figure 3-8). Concentrations of nitrogen in this well sharply increased following an untreated adit water release in 2007 containing over 65 lbs of nitrogen (SMC and Hydrometrics, Inc. 2008b; SMC 2007c). This was the first time the Montana Pollutant Discharge Elimination System (MPDES) permit daily nitrogen load was exceeded since the MPDES permit was issued in 1998. Nitrogen concentrations in this well have been above the 10 mg/L ground water quality standard for protection of human health (Appendix C, Figure EBMW-6, DEQ, 2009).

Ground water salts concentrations have increased since operations began (Figure 3-8). Concentrations of salts in ground water monitoring well EBMW-6 sharply increased following the untreated adit water release in 2007 (SMC and Hydrometrics, Inc. 2008b; SMC 2007c). Salts concentrations in this well have not been above 641 mg/L TDS, which would equal the 1,000 µmhos/cm EC Class I ground water beneficial use criterion (Appendix C, Figure EBMW-6, DEQ, 2009).

Adit Water

Prior to treatment of adit water, the median nitrogen concentration is 38 mg/L TIN. The East Boulder Mine adit water is a sodium sulfate type with a median salts concentration of 550 mg/L TDS (Appendix C, Untreated Adit and Tailings Waters Quality Table, DEQ 2009).

Tailings Waters

The median nitrogen concentration of the East Boulder Mine tailings waters is 40 mg/L TIN. The median salts concentration is 897 mg/L TDS (Appendix C, Untreated Adit and Tailings Waters Quality Table, DEQ 2009).

Operational Water Management Activities

Since mining began, the East Boulder Mine has averaged a nitrogen discharge load of less than 7 lbs/day (Appendix C, East Boulder Mine MPDES History of Nitrogen Discharge, DEQ 2009). Although nitrogen in downgradient wells occurs in concentrations above baseline levels, to date there has been no measurable increase in surface water nitrogen at downgradient monitoring sites in the East Boulder River (Appendix C, Figures EBR-004 and EBR-004A, DEQ 2009).

Operational water management results in 98 percent of adit water being recycled for use in the underground mine. An active grouting program is in place to minimize inflow of ground water to the underground mine workings. On the surface, tailings waters are recycled between the tailings impoundment and the mill.

3.1.1.2.2 Boe Ranch

Reducing nitrogen in mine water is the focus of water management at the East Boulder Mine. Water treatment facilities at the East Boulder Mine include the BTS denitrification cells for the treatment of nitrate plus nitrite. A BTS nitrification system (Anox system) was constructed in 2006 for the treatment of ammonia (NH_3). LAD and snowmaking systems at the East Boulder Mine allow for secondary treatment of nitrogen during the summer and winter seasons. Construction of the Boe Ranch LAD system would provide additional secondary nitrogen treatment capacity.

Ground Water Occurrence

SMC has investigated ground water resources at the Boe Ranch (Knight Piésold 2000c). Based on ground water elevations in wells, a ground water divide was identified northwest of the proposed LAD area. Ground water that originates west of the divide migrates west to the Boulder River: ground water east of the divide migrates north or east to the East Boulder River (Figure 3-9).

The Mason Ditch, which is located between the proposed LAD area and the East Boulder River, is a local ground water recharge source. Ground water flowing from beneath the Boe Ranch LAD irrigation area would be mixed and diluted with Mason Ditch ground water recharge before reaching the East Boulder River. The amount of recharge to ground water at the Boe Ranch has not been quantified (Knight Piésold 2000c). Ground water discharge zones are evident as springs and seeps located more than one mile downgradient of the proposed LAD area (Figure 3-9) (Knight Piésold 2000c).

The Boe Ranch surface geology includes glacial till, with depths ranging from 10 to 80 feet thick, as well as colluvium and weathered shale bedrock (Knight Piésold 2000c). In the LAD area, bedrock is shallow, making the area susceptible to mass movement.

Ground Water Quality

Five baseline ground water monitoring wells were installed near the Boe Ranch (Figure 3-9). Depth to ground water in these wells ranges from 35 to 89 feet. Two wells, one completed in glacial till and one completed at the contact between glacial till and bedrock, are dry. Baseline concentrations of salts in samples collected from these wells in 2000 ranged from 484 µmhos/cm EC in well RMW–1 to 1,160 µmhos/cm EC in well RMW–3A (Knight Piésold 2000c).

Baseline concentrations of nitrogen ranged from <0.05 mg/L TIN in RMW-1 to 1.3 mg/L TIN in well RMW–2 (Knight Piésold 2000c).

In 2000, SMC sampled 11 springs located downgradient of the proposed Boe Ranch LAD area (Figure 3-9). Baseline concentrations of salts ranged from 147 µmhos/cm EC at spring RSP–2 to 1,470 µmhos/cm EC at spring RSP–3. Nitrogen values ranged from non-detectable at <0.05 mg/L TIN at spring RSP–9 to 0.94 mg/L TIN at spring RSP–6 (Knight Piésold 2000c). Between 2000 and 2007, SMC sampled four of the 11 springs (SP-10, SP-11, SP-46, and SP89-32). The salts concentrations ranged from 87 µmhos/cm EC in SP-46 in 2006 to 327 µmhos/cm EC in SP-11 in 2007. The concentration of nitrogen ranged from non-detectable at <0.05 mg/L TIN at SP89-32 in 2005 to 0.35 mg/L TIN at SP-11 in 2007 (SMC 2008b).

3.1.2 Surface Water Quality and Quantity

3.1.2.1 Stillwater Mine

The Stillwater Mine and the Hertzler Ranch are located within the Stillwater Watershed, Hydrologic Unit Code (HUC) 10070005. The major surface water feature is the Stillwater River, which flows within one-quarter mile to one mile from the Stillwater Mine and approximately one mile from the Hertzler Ranch tailings impoundment. From its headwaters originating in the Beartooth Mountains, the river flows northward as a major tributary to the Yellowstone River.

Large variations in flow rates characterize Stillwater River streamflows. Stream channel gradients range from about 254 feet per mile in the upper reaches to 16 feet per mile in the lower reaches of the Stillwater River (DEQ and USFS 1998a). Peak flows typically occur during June and July because of snowmelt and precipitation. Base or low flows occur during the winter. The average annual precipitation at the Stillwater Mine is 18.3 inches. Winter precipitation is mostly in the form of snowfall.

3.1.2.1.1 Stillwater Mine Site

Surface Water Quality

SMC continues to monitor surface water quality at nine monitoring stations near the Stillwater Mine site. Four stations are located on the Stillwater River (Figure 3-1). Water quality in the Stillwater River is generally good to excellent. Baseline concentrations of salts are low, ranging from 10 to 69 mg/L TDS upstream of the mine and from 14 to 77 mg/L TDS downstream of the mine (DEQ and USFS 1998a).

Between 2000 and 2007, the concentrations of salts in the Stillwater River ranged from 10 to 77 mg/L TDS (SMC 2008a). Figure 3-10 presents salts concentrations from two surface water monitoring stations during baseline and operational monitoring. As shown, no discernible increases in TDS concentrations have been observed between the upstream (SMC-1A) and downstream (SMC-11) monitoring sites. An anomalous TDS concentration reported for SMC-1A in December 2007 has been attributed to a sampling error.

Concentrations of salts are inversely related to stream discharge: that is, when river flows are high, concentrations of TDS are low and vice versa. Turbidity, concentrations of total suspended solids (TSS), and alkalinity in the Stillwater River are generally low.

Nitrogen concentrations in the Stillwater River ranged from 0.01 to 0.5 mg/L TIN between 1993 and 2007. Figure 3-11 illustrates the nitrogen trends at upstream (SMC-1A) and downstream (SMC-11) monitoring locations during baseline and operational monitoring. The downstream concentrations of nitrogen were slightly higher when compared to the upstream concentrations of nitrogen. Overall, nitrogen concentrations have decreased since the installation of the HDPE liner beneath the west-side percolation ponds and the removal of the septic tank leach field. As of 2008, the operational nitrogen concentration was less than baseline concentrations. Nitrogen concentrations are below both the Stillwater River MPDES permit limit of 1.0 mg/L TIN, and the 10 mg/L TIN Montana Numeric Water Quality standard DEQ-7 for protection of human health (DEQ 2006).

Surface Water Quantity

During operations, there is no surface water discharge to the Stillwater River or Mountain View Creek. Streamflow measurements for the Stillwater River are obtained from the U.S. Geological Survey (USGS) gauging station (06202510) located near Nye, Montana. Between 1980 and 1991, the mean annual streamflow at this location averaged 373 cubic feet per second (cfs). The maximum instantaneous discharge recorded was 6,400 cfs and the minimum was 16 cfs (DEQ and USFS 1998a). SMC measures streamflow at nine monitoring sites on the Stillwater River and its tributaries (Figure 3-1). The Stillwater River streamflow ranged from 38 to 212 cfs between 2000 and 2007 (SMC 2008a).

3.1.2.1.2 Hertzler Ranch

Surface Water Quality

The Stillwater River water quality near the Hertzler Ranch is generally good. The Stillwater River water has a neutral to slightly basic pH and low salts (DEQ and USFS 1998a). SMC has monitored the Stillwater River water quality upstream (SMC-12) and downstream (SMC-13) of the Hertzler Ranch tailings impoundment, as well as in the West Fork Stillwater River (SMC-14) (Figure 3-1). Between 1995 and 2008, salts concentrations at SMC-13 ranged from 10 to 115 mg/L TDS with a median salts concentration of 66 mg/L TDS (SMC 2008a). The salts concentrations in the Stillwater River exhibit a general downward trend and are higher at the downstream monitoring location when compared to the upstream monitoring location (Figure 3-12). The recent salts concentrations are consistent with the baseline (pre-1999) monitoring period (Figure 3-12 and Appendix C, Surface Water Quality at SMC-13 Figure, DEQ 2009).

Concentrations of nitrogen at SMC-13 ranged from less than 0.15 to 0.67 mg/L TIN between 1995 and 2008. Total nitrogen concentrations in the Stillwater River at SMC-13 exhibit an increasing trend that is due to the organic nitrogen component (Appendix C, Total Nitrogen at SMC-13 Figure, DEQ 2009) (Figure 3-13). Nitrogen concentrations are below both the Stillwater River total nitrogen limit of 1.0 mg/L TIN used by the agencies and the Montana numeric water quality standard for protection of human health of 10 mg/L TIN (DEQ 2006).

Surface Water Quantity

The Hertzler Ranch tailings impoundment and LAD system are located directly northeast of the West Fork Stillwater River and the Stillwater River confluence. The Stillwater River flows recorded from 1970 to 1976, measured at the USGS monitoring station 06202600 near Nye, indicated a mean annual streamflow of 640 cfs. The maximum instantaneous discharge of 8,710 cfs was recorded in June 1974 (USGS 2006). The streamflow is higher at the USGS monitoring station than at the mine (Figure 3-1). The SMC monitors streamflow at several sites on the Stillwater River. The 2008 Stillwater River streamflow measured by SMC increased from 148 cfs at SMC-1A to 271 cfs at SMC-13 downstream of the Hertzler Ranch (SMC 2009).

The West Fork Stillwater River is a fourth-order tributary draining 122 square miles. It joins the Stillwater River just upstream of the Hertzler Ranch. Baseline flow monitoring between June 1980 and June 1981 documented flows ranging from 23 to 514 cfs (CDM 1981, as cited in DEQ and USFS 1998a). SMC monitors streamflow at one site on the West Fork Stillwater River. The 2008 Stillwater River streamflow at SMC-14 was measured at 75 cfs (SMC 2009).

3.1.2.2 East Boulder Mine

3.1.2.2.1 East Boulder Mine

Affected surface water resources near the East Boulder Mine include the East Boulder River. The headwaters of the East Boulder River lie in the Beartooth Range at an elevation of more than 10,000 feet. Stream channel gradients range from about 100 feet per mile at the headwaters, to about 1,000 feet per mile in the middle reaches, and 200 feet per mile in the lower reaches (DSL et al. 1992b). Adjacent to and downstream of the East Boulder Mine, the river is characterized by successive cascades interrupted by small pools. The mine is the uppermost man-made impact within the East Boulder River watershed.

Surface Water Quality

Baseline surface water quality data measured between 1981 and 1991 indicate good quality water with neutral to slightly alkaline pH and low concentrations of salts (70 to 128 mg/L TDS). Salts concentrations vary seasonally and are inversely proportional to flow. Concentrations are higher during the low-flow seasons of winter and early spring and lower during the rest of the year. Baseline nitrogen concentrations average less than 0.14 mg/L TIN (DSL et al. 1992b).

Since 2000, SMC has monitored water quality at several surface water locations on the East Boulder River and on Dry Fork Creek, upstream of the East Boulder Mine (Figure 3-6). Monitoring indicates that the East Boulder River nitrogen and salts concentrations are consistent with baseline values. The downstream East Boulder River monitoring stations EBR-004 and EBR-004A show concentrations of nitrogen and salts approximately equal to the upstream monitoring station EBR-003 (Figure 3-14). These data indicate that there is no measurable operational increase in nitrogen and salts concentrations among EBR-003 and EBR-004 and EBR-004A on the East Boulder River.

SMC conducted aquatic resource sampling within the East Boulder River from 1998 through 2004 (Advent Environ 2005). Physical and biological parameters

were sampled and evaluated including temperature, dissolved oxygen, pH, streamflow, metals, nitrogen, periphyton, and macroinvertebrates. Findings include:

- Visual evaluations of habitats indicated that the stream morphology, physical characteristics, and quality of habitat at the nine East Boulder River sample sites were consistent over the monitoring period.
- Field-based measurements of water quality (temperature, pH, specific conductivity, and dissolved oxygen) indicated slightly alkaline waters with normal diurnal and seasonal fluctuations in temperature and near-saturated concentrations of dissolved oxygen.
- Reported concentrations for all major ions were typical for mountain streams. Variations in total hardness, alkalinity, and specific conductivity appear to be related to water flowing into the East Boulder River from tributaries in the upper basin and to withdrawals of irrigation water in the lower basin.
- Mean concentrations of nitrogen averaged 0.06 mg/L TIN at all sites in the upper East Boulder River basin. These values were at or below baseline concentrations. The East Boulder River nitrogen concentration decreased to 0.02 mg/L downstream at the confluence with the Boulder River.
- Additional information is disclosed in Section 3.2.2 pertaining to periphyton and macroinvertebrates.

Section 303(d) of the federal Clean Water Act (CWA) requires states to identify water bodies that do not meet state water quality standards. Under the Montana Water Quality Act, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data show that the water body or stream segment is failing to achieve compliance with applicable water quality standards (Section 75-5-103(211), MCA).

In 1996, the full reach of the East Boulder River was listed on the 303(d) list as a “threatened” water body due to nutrient contamination. In the 2006 303(d) list, the East Boulder River was divided into three segments. The segment where the mine is located, MT43B004_143, was classified as fully supporting all designated beneficial uses. Downstream reaches from the Gallatin National Forest (GNF) boundary to the confluence with the Boulder River, MT43B004_141 and MT43B004_142, were identified as “impaired” due to siltation/sedimentation and changes to the chlorophyll *a* community (DEQ 2007).

The East Boulder Mine is located upstream within segment MT43B004_143 and the permitted discharges from the mine operation represent potential nutrient sources to downstream receiving water bodies (MT43B004_141 and MT43B004_142). DEQ data for instream nutrient water chemistry and biology indicate that the segment containing the East Boulder Mine is fully supporting its beneficial uses, and instream nitrogen levels are not elevated above naturally occurring levels (DEQ 2007).

Surface Water Quantity

Peak streamflow in the East Boulder River valley results from direct precipitation and runoff. Average annual precipitation varies from 20 inches at the northern boundary of the GNF to about 40 inches at Iron Mountain (DSL et al. 1992b). Baseflow is the year-round contribution of ground water to the East Boulder River. The USGS does not maintain recording flow gauges on the East Boulder River near the mine. Historic data from a USGS gauging station (06197800) located below the confluence of Dry Fork Creek indicate streamflow varied from a low of 5 cfs in March 1982 to a high of 588 cfs in late June of the same year (DSL et al 1992b).

SMC monitors streamflow in Dry Fork Creek upstream of its confluence with the East Boulder River and at locations on the East Boulder River (Figure 3-6). During 2007, flows in the East Boulder River varied seasonally from 2.0 cfs at low-flow conditions to 32.5 cfs during the highest flow conditions. Flows in East Boulder River are typically highest during the spring runoff and lowest during the winter and early spring (SMC 2008b).

3.1.2.2.2 Boe Ranch

The Boe Ranch is located 20 miles south of Big Timber, Montana and is upstream of the confluence of the Boulder and East Boulder rivers. The East Boulder River flows within one mile of the proposed Boe Ranch LAD system (Figure 3-9). The flow path of surface water is approximately 1.5 miles to the East Boulder River. The Boe Ranch LAD area has several ephemeral drainages that have been influenced by glacial activity and uplifted bedrock. Shallow ground water discharges as springs downslope of the proposed LAD area near the East Boulder River. SMC has identified 11 springs downslope of the proposed LAD area (Figure 3-9).

Elevation has a strong influence on local climatic conditions. Temperatures typically decrease and precipitation generally increases with increasing elevation. Estimates of annual precipitation range between 12 and 24 inches (Knight and Piésold 2000c).

Surface Water Quality

Between 2000 and 2004, salts concentrations at the East Boulder River downstream sampling location EBR–008 ranged from 82 to 375 mg/L TDS. Nitrogen concentrations ranged from 0.06 to 0.02 mg/L TIN (Appendix C, Surface Water Quality at EBR-008 Figure, DEQ 2009).

Surface Water Quantity

The Mason Ditch is located between the proposed Boe Ranch LAD area and the East Boulder River (Figure 3-9). The Mason Ditch is used between April and November and diverts approximately 2 cfs of water to downstream ranches for irrigation (Knight Piésold 2000c).

In February 2000, the East Boulder River streamflow at EBR-008 downstream of the Boe Ranch was 11 cfs, more than twice as much flow as the upstream monitoring station near the East Boulder Mine. Flow at EBR–008 had decreased to 1.7 cfs in August 2000 (Knight Piésold 2000c).

3.2 Wildlife and Aquatic Resources

This wildlife discussion focuses on the Boe Ranch, where some of the alternatives could alter existing wildlife habitats. Effects to high interest species, species of special concern and sensitive species, management indicator species (MIS), and threatened and endangered species (TES) at the Stillwater and the East Boulder mines have been addressed in past environmental analyses (DEQ and USFS 1998a; DSL et al.1992b) and were updated based on new listings. Wildlife at the Stillwater Mine and the Hertzler Ranch are not considered further in this analysis.

3.2.1 Wildlife Resources

3.2.1.1 High Interest Species

High-interest species potentially present at the Boe Ranch include mule deer, white-tailed deer, elk, and moose. Mule deer are the most abundant large mammals in the area. Although they are present in the general area year-round, they are most common during the winter when they concentrate on winter range. The Boe Ranch is located in an area identified as mule deer winter range. In the early 1980s, about 150 to 200 mule deer wintered in the lower East Boulder River drainage, but their numbers declined during the 1990s. By the early 2000s, the number of mule deer increased to 300 to 350 (Paugh 2006). Although population counts conducted in 2005 suggest that the number of mule deer had decreased to about 150, Montana Department of Fish, Wildlife, and Parks (FWP) suspects the actual population is higher than 150 (Paugh 2006).

White-tailed deer are found year-round along the lower East Boulder River. During summer and fall, white-tailed deer can be found along the East Boulder River as far up river as Dry Fork Creek. Overall, the number of white-tailed deer has increased in the area, and FWP estimates that there are 150 to 200 white-tailed deer year-round in the East Boulder River drainage (Paugh 2006). Within the GNF, white-tailed deer are closely associated with stream bottoms in riparian zones that offer good cover for security and productive foraging areas.

The GNF has designated elk as a management indicator species for big game. Although the Boe Ranch lies within the Absaroka Elk Management Unit where elk numbers have increased dramatically (FWP 2004), elk are generally uncommon within the drainage of the East Boulder River (DSL et al. 1992b). An estimated 100 to 150 elk use the Green Mountain area and sometimes drop into the East Boulder River drainage (Paugh 2006). The Boe Ranch does not encompass any designated summer or winter elk range (DSL et al. 1992b). There are no defined elk migration corridors within the Boe Ranch site.

Small numbers of moose are present near the East Boulder Mine permit area. Generally, moose are confined to the drainage of Dry Fork Creek (located northwest of the East Boulder Mine). There is some evidence that moose may use areas along the East Boulder River that contain narrow bands of spruce trees (DSL et al. 1992b). FWP estimates that fewer than six moose occasionally move through the East Boulder River over the course of the year (Paugh 2006). The Boe Ranch does not provide high quality moose habitat. The Boe Ranch is

dominated by a grass/forb vegetation community and does not contain extensive stands of deciduous hardwood species favored by moose. Moose use of the Boe Ranch has not been documented, although it may occur.

3.2.1.2 Species of Special Concern and Sensitive Species

The Montana Natural Heritage Program (NHP) was contacted to identify species of special concern and sensitive species that occur near the drainage of the East Boulder River (NHP 2006). The search of the NHP database identified 17 species of concern or sensitive species (See Table 3-1).

Table 3–1 Species of Special Concern and Sensitive Species near the East Boulder River Drainage

Common Name	Species
Birds	
Bald eagle	*Haliaeetus leucocephalus*
Black-backed woodpecker	*Picoides arcticus*
Flammulated owl	*Otus flammeolus*
Harlequin duck	*Histrionicus histrionicus*
Northern goshawk	*Accipiter gentilis*
Peregrine falcon	*Falco peregrinus*
Trumpeter swan	*Cygnus buccinator*
Mammals	
Grizzly bear	*Ursus arctos horribilis*
Gray wolf	*Canis lupus*
Western big-eared bat	*Corynorhinus townsendii*
Wolverine	*Gulo gulo*
Fish and Mollusks	
Montana arctic grayling	*Thymallus articus*
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*
Striate disc	*Discus shimekii*
Reptiles and Amphibians	
Northern leopard frog	*Rana pipiens*
Boreal toad	*Bufo boreas*

3.2.1.2.1 Bald Eagle

The bald eagle is listed as a sensitive species by the GNF and the Custer National Forest (CNF). Bald eagles are known to nest along the Yellowstone and the Boulder rivers. Bald eagles have also been observed near the Boe Ranch along the East Boulder River north of the GNF boundary during the winter. The East Boulder River is likely used only as a foraging area because the availability of prey is limited and human activity in the area is abundant (See also Section 3.2.1.3.2). This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.2.2 Black-backed Woodpecker

The black-backed woodpecker is listed as a sensitive species by the GNF and as a species of concern by the NHP. Habitats for the black-backed woodpecker include mature and overmature lodgepole pine, Douglas-fir, and spruce forests. Although black-backed woodpeckers occur on the GNF, they are rarely observed. Black-backed woodpeckers were observed in a burned stand on the south end of the Madison Arm of Hebgen Lake (50 miles away from the project area) in 1996, 1997, 1998, and 2004 (NHP 2006). The Boe Ranch is primarily comprised of grassland and sagebrush and does not provide suitable habitat for black-backed woodpeckers. Because black-backed woodpeckers would not be affected by construction and operation of the LAD system, they are not considered in detail in Chapter 4.

3.2.1.2.3 Flammulated Owl

The flammulated owl is listed as a sensitive species by the GNF and as a species of concern by NHP. Flammulated owls breed in montane forests of western North and Central America from southern British Columbia to the highlands of Mexico and Guatemala. Suitable habitats typically consist of old-growth mature ponderosa pine and Douglas-fir forests, often mixed with mature aspen (Andrews and Righter 1992). Flammulated owls nest in abandoned woodpecker cavities. Although the owls show an affinity for yellow pines, particularly ponderosa pine, they may also use dry, open Douglas-fir forests as nesting habitat. The Boe Ranch does not encompass flammulated owl nesting habitat; however, flammulated owls may use the open grassland and sagebrush as foraging habitats. Detailed effects analysis for this species will not be contained in Chapter 4.

3.2.1.2.4 Harlequin Duck

GNF lists the harlequin duck as a sensitive species. The NHP lists the harlequin duck as a species of concern. This species occurs in forest-dominated riparian communities (Merrill et al. 1996). Nest sites include rocky islands, the banks of undisturbed rivers, and braided mountain streams with many riffles and rapids (Cassirer et al. 1993). This species requires relatively undisturbed, high-gradient streams with dense (more than 50 percent) streamside shrub cover, and woody debris.

Within the GNF, harlequin ducks have been recorded only on the upper Boulder River (NHP 2006). These sightings are located 10 miles southwest of the East Boulder Mine site, which is approximately 17 miles from the Boe Ranch. Individual harlequin ducks have been observed elsewhere in the GNF, but presumably are migratory.

Harlequin ducks have not been observed on the East Boulder River (DSL et al. 1992b, NHP 2006). Surveys of the entire GNF indicated that the East Boulder River contains habitat that may be suitable to support harlequin ducks (DSL et al. b). Harlequin ducks use local fast-flowing streams during migration stopovers, but they are not expected to nest locally. Due to the developed nature of the riparian corridor along the East Boulder River downstream of the GNF boundary, it is not likely that harlequin ducks use the Boe Ranch area. This species will not be further discussed in detail in this analysis.

3.2.1.2.5 Northern Goshawk

The northern goshawk is listed as a species of concern by the NHP. The northern goshawk is also listed as a management indicator species for old-growth Douglas-fir forests by the GNF and CNF. This species occurs from Alaska through the Rocky Mountains to New Mexico and in the mountains and forests of Washington, Oregon, and interior California (Udvardy 1977).

The northern goshawk typically occupies montane forests during the spring and summer and then moves to lower foothills and valleys during the winter (Terres 1980). In the western states, it tends to nest in conifers and, occasionally, in aspen trees. The northern goshawk uses old-growth habitats, such as successional dry conifer stands. Spruce grouse, ruffed grouse, snowshoe hare, and red squirrel make up the four basic foods of the goshawk in boreal forests east of the Rocky Mountains.

No suitable nesting habitats exist for northern goshawks at the Boe Ranch. The site is composed of grassland/sagebrush habitats, not montane forests. The Boe Ranch may serve as occasional foraging habitat for the northern goshawk. Goshawks will be further discussed in Chapter 4.

3.2.1.2.6 Peregrine Falcon

The peregrine falcon was removed from the threatened and endangered species list in 1999 (USFWS 1999a); however, GNF lists it as a sensitive species. The American peregrine falcon nests from central Alaska, the central Yukon Territory, and northern Alberta and Saskatchewan, east to the Maritime Provinces and south (excluding coastal areas north of the Columbia River in Washington and British Columbia) throughout western Canada and the United States to Baja California, Sonora, and the highlands of central Mexico (USFWS 1999a). Peregrine falcons nest on high cliffs that are usually located within one mile of a stream.

Historically, peregrine falcons were known to inhabit the East Boulder Mine area. Potentially suitable habitats exist along the Boulder and the East Boulder rivers. Even though habitats are available on the East Boulder River, no recent observations of peregrines in or near the area have been documented.

A historic aerie is located approximately 8 miles west of the Boe Ranch, just west of the Boulder River. Although it is unoccupied, this site is listed as having a high potential for reoccupancy (NHP 2002).

A documented hack site is located 5 miles from the Boe Ranch. Peregrine chicks were reportedly hacked at this location in 1989, 1990, and 1991 (DSL et al. 1992b). The last year peregrine falcons were released from the hack site was 1992, and the last time a peregrine falcon was observed at the site was in 1993 (NHP 2002; NHP 2006). This species will be further discussed in Chapter 4.

3.2.1.2.7 Trumpeter Swan

The trumpeter swan is listed as a sensitive species by the GNF and as a species of concern by the NHP. Trumpeter swans breed in southern Alaska, northern British Columbia, western Alberta, Oregon, Idaho, Montana, and Wyoming. Because of the destruction of their habitats and overhunting, this species was near

extinction. Careful management and reintroduction practices have helped return the population to several thousand individuals.

Suitable habitat for this species includes lakes and ponds with developed aquatic vegetation for feeding and nesting materials (Terres 1980). Suitable habitat must include approximately 100 yards or more of open water for takeoff from the water's surface. Trumpeter swans do not occur at the Boe Ranch because of the lack of suitable habitat and are not considered further in this analysis.

3.2.1.2.8 Grizzly Bear

The grizzly bear is listed as a species of special concern by the NHP. The Boe Ranch is located north of the Primary Conservation Area (PCA) for the grizzly bear in the Yellowstone Ecosystem. The PCA is the old Yellowstone Grizzly Bear Recovery Zone as identified in the 1993 Grizzly Bear Recovery Plan (Interagency Conservation Strategy Team 2003). Occasional sightings of grizzly bear, mostly unconfirmed, have been reported in the East Boulder Mine area. These sightings indicate that transient grizzly bears may use the area on a limited basis. The Boe Ranch and the surrounding areas contain habitat types favored by the grizzly bear, according to habitat maps developed by the GNF.

The Boe Ranch is not included in the area identified as occupied grizzly bear habitat (DEQ and USFS 1998a), nor is it part of any Grizzly Recovery Zone. See also Section 3.2.1.3.1. This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.2.9 Gray Wolf

The gray wolf is listed as a species of special concern by the NHP. Wolves occur near the Boe Ranch. The Moccasin Lake wolf pack occurs in the Dry Fork Creek and Elk Creek areas east of the East Boulder Mine (Trapp 2006). Although the primary range for this pack does not include the Boe Ranch, it is possible that an individual wolf may travel through the area on occasion (Trapp 2006). This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.2.10 Western Big-eared Bat

The Western (Townsend's) big-eared bat is listed as a sensitive species by the GNF and as a species of concern by the NHP. This species is most common throughout the western half of North America and occurs south into central Mexico. Suitable habitats include desert shrublands, piñon-juniper woodlands, and dry coniferous forests. Typical day and night roosts, maternity roosts, and hibernacula in the western states include caves, abandoned mines, and lava tubes (Barbor and Davis 1969).

There are no known habitats suitable for day or night roosting within the Boe Ranch. Western big-eared bats may use Boe Ranch for foraging, but the lack of roost sites limits the potential for this species to occur in the area. The western big-eared bat is not considered further in this analysis.

3.2.1.2.11 Wolverine

The wolverine is listed as a sensitive species by the GNF and CNF and as a species of concern by the NHP. The distribution of the wolverine is boreo-arctic,

with southward extensions along major mountain ranges. Wolverines prefer mature forests, followed by ecotones and rocky areas on timbered benches. Wolverines tend to avoid clearcuts, dense young stands of timber, recent burns, and wet meadows. Wolverines generally use high elevations during the summer, big game winter ranges in the winter, and riparian areas during spring (Hash 1987).

Wolverines have been observed in remote areas of the Hebgen Lake Ranger District, Beaver Creek, and Earthquake Lake in the Madison River drainage. Historical trapping records indicate that wolverines have been harvested in the Taylor Fork, Beaver Creek, and Grayling Creek drainages. Because wolverines typically occur at higher elevations and are closely associated with elk winter range, they are not expected to occupy the Boe Ranch. Although wolverines may use the Boe Ranch as a dispersal or travel corridor to access more desirable habitats, they would not be affected by the construction and operation of the Boe Ranch LAD system and are not considered further in this analysis.

Wolverines were not covered in previous analyses for the Stillwater and the East Boulder mine sites. They are unlikely to occur near these sites, due to current levels of noise and disturbance.

3.2.1.2.12 Montana Arctic Grayling

The Montana arctic grayling is listed as a sensitive species by the GNF. Grayling primarily forage on aquatic insects and crustaceans. Arctic Grayling are not endemic to the project area and are not found in the upper Yellowstone drainage. They are native to the upper Missouri drainage. Because the Montana arctic grayling would not be affected by construction and operation of the Boe Ranch LAD system, they are not considered further in this analysis.

3.2.1.2.13 Westslope Cutthroat Trout

The westslope cutthroat trout is listed as a sensitive species by the GNF and as a species of concern by the NHP. The historical range of the westslope cutthroat trout consisted of the upper Missouri River drainage to below Great Falls, Montana. The subspecies is not native to the Yellowstone River drainage. The current distribution of westslope cutthroat trout is restricted to a few isolated populations. Only three genetically pure populations of westslope cutthroat trout are known on the GNF: they are located in the Madison and the Gallatin River drainages. No known genetically pure populations of westslope cutthroat trout occur in the East Boulder River. Because westslope cutthroat trout would not be affected by construction and operation of the LAD system, they are not considered further in this analysis.

3.2.1.2.14 Yellowstone Cutthroat Trout

The GNF, CNF, and State of Montana list the Yellowstone cutthroat trout as a sensitive species. Suitable habitats include rivers, creeks, beaver ponds, and large lakes. Optimum water temperature is generally between 39 and 60ºF, but the fish probably tolerate much warmer temperatures in larger rivers.

The East Boulder Yellowstone cutthroat trout population is not indigenous to the area. Yellowstone cutthroat trout are currently present above a natural fish barrier on the East Boulder River near Brownlee Creek (DSL et al. 1992b). This

population is considered genetically pure. Yellowstone cutthroat trout can and do move downstream of the natural fish barrier into the lower East Boulder River (MFWP, Woods, 2009 pers. comm.). Although current Yellowstone cutthroat trout inhabitants are not indigenous, the East Boulder drainage is within their historic range and is considered a possible future Yellowstone cutthroat trout restoration area.

Effects to Yellowstone cutthroat trout will be addressed in Chapter 4 of this document in the effects disclosure provided for wild trout. Yellowstone cutthroat trout and other wild trout require the same biological and physiological parameters in relation to water quality and aquatic habitat requirements.

3.2.1.2.15 Striate Disc

The striate disc is listed as a sensitive species by the NHP. The striate disc is a small terrestrial snail that is typically found in montane areas under rocks and dead wood. There is one known occurrence of striate disc along the Boulder River within the GNF. Striate disc are found on limestone rocks and falls at this location. This species is not expected to occur at the Boe Ranch due to the lack of available habitat. This species will not be further discussed in Chapter 4.

3.2.1.2.16 Northern Leopard Frog and Boreal Toad

Both the northern leopard frog and the boreal toad are listed as sensitive species by the GNF and CNF and as species of concern by the NHP. The range of the northern leopard frog extends from Canada south to Massachusetts in the east to northern Nebraska, then south to New Mexico and Arizona, and west to Nevada and up through parts of Idaho and most of Montana. Documented populations of northern leopard frog are known to occur within the drainage of the Madison and Missouri rivers.

Populations of the boreal toad have been divided into two sub-populations: the southern Rocky Mountain and the northern Rocky Mountain. The southern Rocky Mountain population, which is located in the Medicine Bow National Forest and the Southern Rockies in Colorado and New Mexico, was withdrawn as a candidate for listing under the Endangered Species Act (ESA) in 2005. The northern Rocky Mountain population of the western boreal toad is not currently a candidate for listing under the ESA. Boreal toads are known to inhabit western Montana and the Yellowstone National Park. Boreal toads occupy a diverse range of habitat types, ranging from wetlands and aquatic environments to sagebrush meadows and forested areas. Although some potentially suitable habitat exists at and adjacent to the Boe Ranch, no occurrences of northern leopard frogs or boreal toads have been documented nearby.

Boreal toads and leopard frogs were not covered in previous analyses for the Stillwater or the East Boulder mine sites. There are no known records of them occurring near either of these sites (NHP 2008). Further discussions related to potential effects to these two species will not be contained in Chapter 4.

3.2.1.3 Management Indicator Species

Management Indicator Species (MIS) are designated species that serve as an indicator of potential effects to a group of wildlife species that use similar habitats. In general, MIS are selected because they fall into one of the following three categories: an ecological indicator, a species commonly hunted or that has ecological significance, or a threatened or endangered species. MIS for the GNF are identified in Table 3-2.

Table 3–2 Management Indicator Species for GNF

Species	Management Indicator
Grizzly bear	Federally threatened
Bald eagle	Delisted federally threatened
Elk	Big game species
Wild trout	Cold water fisheries
Northern goshawk	Old-growth forest dependent species, dry Douglas-fir sites
Pine marten	Old-growth forest dependent species, moist spruce sites

3.2.1.3.1 Grizzly Bear

The grizzly bear is included as a MIS because it is listed as federally threatened. Grizzly bears present on the GNF and the CNF are part of the Greater Yellowstone Ecosystem population. In addition, the Boe Ranch is not included in the area identified as occupied grizzly bear habitat (DEQ and USFS 1998a), nor is it part of any Grizzly Recovery Zone. See also Section 3.2.1.2.8. This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.3.2 Bald Eagle

The bald eagle is a MIS. The bald eagle was previously listed as federally threatened but was delisted in 2007. Bald eagles are known to nest along the Yellowstone and Boulder rivers. Bald eagles have been observed during the winter near the Boe Ranch along the East Boulder River and north of the GNF boundary. The East Boulder River provides foraging area and has limited human activity. See also Section 3.2.1.2.1. This species will be further discussed in Chapter 4.

3.2.1.3.3 Wild Trout

The MIS designation for wild trout includes all naturally reproducing Yellowstone cutthroat, rainbow, brown, and brook trout populations. GNF uses wild trout as indicators for cold-water fisheries. Wild trout found in the East Boulder River both upstream and downstream of the Boe Ranch and the East Boulder Mine include Yellowstone cutthroat, rainbow, brown, and brook trout. Potential effects to these species will be further discussed in Chapter 4, Aquatic Resources Section 4.2.2.

3.2.1.3.4 Northern Goshawk

The northern goshawk is a MIS for the GNF for old-growth Douglas-fir forests. There is no suitable nesting habitat for northern goshawks at the Boe Ranch because the site is composed of grassland and sagebrush habitat. The Boe Ranch may serve as occasional foraging habitat for northern goshawk. This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.3.5 Pine Marten

The pine marten is a MIS for the GNF for old-growth spruce forests. More than a 30 percent canopy cover of coniferous trees is thought to be necessary for suitable marten habitat, with an optimum of 40 to 60 percent for resting and foraging (Fitzgerald et al. 1994). There is no suitable denning habitat for pine martens at the Boe Ranch because the site is composed of grassland and sagebrush habitats. The Boe Ranch may serve as occasional foraging habitat for pine martens. This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.4 Threatened and Endangered Species

The gray wolf is the only endangered species that was identified as potentially present at the Boe Ranch or in adjacent areas. Canada Lynx and grizzly bear are the two endangered species that are potentially present at the Boe Ranch or in adjacent areas. The bald eagle was recently delisted. The status of this species is described in the previous sections. The status of grizzly bear, the gray wolf, and Canada lynx and their potential to occur within the assessment area are discussed below.

3.2.1.4.1 Gray Wolf

The gray wolf is a federally listed endangered species. Wolves occur near the Boe Ranch. The Moccasin Lake wolf pack occurs in the Dry Fork Creek and Elk Creek areas east of the East Boulder Mine (Trapp 2006). Although the primary range for this pack does not include the Boe Ranch, it is possible that an individual wolf may travel through the area on occasion (Trapp 2006). This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.4.2 Grizzly Bear

The grizzly bear is a federally listed threatened species. The Boe Ranch is located north of the Primary Conservation Area (PCA) for the grizzly bear in the Yellowstone Ecosystem. The PCA is the old Yellowstone Grizzly Bear Recovery Zone as identified in the 1993 Grizzly Bear Recovery Plan (Interagency Conservation Strategy Team 2003). Occasional sightings of grizzly bear, mostly unconfirmed, have been reported in the East Boulder Mine area. These sightings indicate that transient grizzly bears may use the area on a limited basis. The Boe Ranch and the surrounding areas contain habitat types favored by the grizzly bear, according to habitat maps developed by the GNF.

The Boe Ranch is not included in the area identified as occupied grizzly bear habitat (DEQ and USFS 1998a), nor is it part of any Grizzly Recovery Zone. See also Section 3.2.1.3.1. This species will be carried forward and briefly discussed in Chapter 4.

3.2.1.4.3 Canada Lynx

The USFWS has listed the Canada lynx as a threatened species in the contiguous United States (USFWS 2000). Lynx occur throughout the forests of Canada and Alaska and extend into the United States around the Great Lakes and mountainous areas of the west. The distribution and abundance of lynx in northern latitudes is associated with the snowshoe hare (Koehler and Aubry 1994; USFS and USFWS 2000).

Most lynx habitat in the western United States is subalpine fir, Engelmann spruce, lodgepole pine, or aspen forests at middle to high elevations (Koehler and Aubry 1994). Lynx appear to prefer early successional forests that support high densities of prey and late-successional forests with multiple structural layers and abundant downed wood for denning and rearing young. Lynx typically use ridgelines and forested creek bottoms as travel corridors (Butts 1992; USFS and USFWS 2000). Other important features of denning habitat include minimal human disturbance, proximity to early successional foraging habitat, and secure travel areas that allow females to move kittens to alternate den sites (Koehler and Aubry 1994).

Many lynx habitats in the Rocky Mountains occur as islands of coniferous forest surrounded by shrub-steppe habitats. Movement patterns between forested habitats are not well documented. Various management agencies met during 2001 and 2002 to define linkage zones for the lynx. The closest linkage zone is about 15 miles west of the Boe Ranch (USFS No Date). The occasional availability of abundant alternative prey, such as jackrabbits or ground squirrels, may attract lynx into shrub-steppe habitats such as those found near the East Boulder Mine.

In 2005, the USFWS published a proposed rule that defines critical habitat for the lynx. The proposed critical habitat closest to the East Boulder Mine area is the Northern Rockies Unit, which is northwest of Helena, Montana (USFWS 2005a). Although the area does not occur near or within any proposed critical habitat, it is located near the GNF, which does encompass areas that are identified as potential lynx habitat (USFS No Date).

Two surveys have reported evidence of lynx on the GNF. Lynx tracks were observed and verified by the FWP in the Tepee Creek area in 1995 and 1996. A separate survey identified probable lynx tracks in the Buck Creek drainage. No lynx have been observed near the Boe Ranch (NHP 2007). Lynx may occasionally occur in the area. This species will be carried forward and briefly discussed in Chapter 4.

3.2.2 Aquatic Resources

3.2.2.1 Stillwater Mine and Hertzler Ranch

The Project Area aquatic resources have been reviewed and discussed in previous documents, including the following:

- *Anaconda Stillwater Project, 12-Month Environmental Baseline Report. Volume: I, II, and III.* (CDM 1981).
- *Final Environmental Impact Statement, Stillwater Project, Stillwater County, Montana.* (DSL and USFS 1985).
- *Decision Notice and Finding of No Significant Impact for the Stillwater Mining Company's Proposed East Side Adit.* (DSL and USFS 1989)
- *Final Environmental Impact Statement for the Stillwater Mine Revised Waste Management Plan and Hertzler Tailings Impoundment.* (DEQ and USFS 1998a)

The Stillwater River is characterized by clear, cold, high-quality water. Within the Project Area, it is considered ideal habitat for spawning and rearing game fish that live in the lower Stillwater and Yellowstone rivers. Factors that contribute to the quality of habitats in the Stillwater River include the nature of the gravel substrate, the shallow side channels, flow regimens, water quality, and stream gradient.

The Stillwater River is considered an excellent wild trout fishery and has been designated an outstanding fishery by the FWP. The FWP has established instream flow reservations on the Stillwater River to maintain flow regimes and to protect fisheries. The FWP has established a daily harvest limit for the Stillwater River of two trout. Only one fish can measure more than 13 inches (FWP 2006a).

A number of nongame and game fish occur within the Stillwater River. Nongame fish present throughout the river include the longnose sucker (*Catostomus catostomus*), mountain sucker (*Catostomus platyrhynchus*), longnose dace (*Rhinichthys cataractae*), and white sucker (*Catostomus commersoni*). Game fish include the brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*), and mountain whitefish (*Prosopium williamsoni*). The composition of game fish in the Stillwater River varies seasonally, depending largely on the spawning times of each species. Brown trout and whitefish are the most common fish in the Stillwater River during fall spawning. Rainbow trout increase in number during the spring. A baseline 1980 to 1981 survey indicated that the yearlong average composition of species in the Stillwater River was 35 percent brown trout, 33 percent mountain whitefish, 27 percent rainbow trout, and 5 percent brook trout (CDM 1981).

Overall, the 2007 spring estimate for the Stillwater River near the Moraine Fishing Access Site suggests that the fish population is down somewhat from the 2005 estimate. FWP still considers the population in excellent shape (FWP 2007a). Although the fish population is doing well, drought remains an issue for the Stillwater River. In both 2006 and 2007, FWP had to implement measures under the Montana Drought Response Plan to protect the fish population. These measures included restrictions on fishing (FWP 2007b; FWP 2007c).

Baseline aquatic invertebrate sampling was conducted in the Stillwater River in 1980 and 1981 (CDM 1981). This study of the Stillwater River indicated a diverse periphyton community (CDM 1981). Several species collected are indicators of good water quality. Many of the most abundant species of periphyton found are indicators of high concentrations of dissolved oxygen, high water velocity, and cool temperatures. The dominance of diatoms at most stations indicated that the aquatic ecosystem is largely undisturbed.

A reconnaissance study conducted during 1996 concluded that although large-scale changes in aquatic community population richness and distribution have not occurred, several small-scale changes are evident along the Stillwater River. These changes include the continued development of the Stillwater Mine and an increase in the number of homes along the Stillwater River and the West Fork Stillwater River. Development has resulted in an increase in fishing pressure on

the Stillwater River as well as nutrient loading. Abundant filamentous green algae were observed at a station 20 miles downstream of the Stillwater Mine. The presence of algae at this location indicates that point and nonpoint sources that are not related to the mine are altering the river's nutrient load. Septic systems and agricultural runoff are the likely sources of these nutrients (DEQ and USFS 1998a).

A separate study of periphyton and limiting nutrients suggests that primary production (algal growth) in the Stillwater River is limited within the Stillwater Mine area (DEQ and USFS 1998a). This conclusion was supported by water quality data, which indicate that the Stillwater River contains low concentrations of macronutrients and micronutrients. Nitrogen is not limiting in the Stillwater River, but phosphorus, possibly in conjunction with micronutrients, may be limiting to algal growth.

The SMC sampled the aquatic environment of the Stillwater River between August 1998 and September 2002 (Advent Group, Inc. 2003). Physical and biological parameters were sampled and evaluated, including temperature, dissolved oxygen, pH, flow, metals, nitrogen, periphyton, and macroinvertebrates. Several key findings from the 5 years of sampling and analysis included:

- Assemblages of benthic macroinvertebrates consist of taxa common to clean, cold water mountain streams, including Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Coleoptera: Elmidae (riffle beetles), and a few species of Diptera (true flies)
- Benthic macroinvertebrate bioassessment scores indicate full support of designated water quality uses in each year of the study, with the exception of 2001. The September 2001 collection was lower in both taxa richness and organism abundance. The summer 2002 samples confirmed that the condition was temporary.
- Periphyton samples were dominated by diatoms and included other algae representative of cold, clean, mountain streams.
- Diatom bioassessment results based on general criteria for mountain streams in Montana indicate excellent biotic integrity and no impairment of water quality or habitat at all sample sites.
- Mean chlorophyll *a* concentration showed a trend to increase downstream. These differences were not statistically significant. Although the higher mean chlorophyll *a* concentration at the downstream sample site corresponds with a pattern shown by nitrogen concentrations, the magnitude of the chlorophyll *a* concentration value is not characteristic of nutrient enrichment.

Results of biological monitoring conducted in 2005 were consistent with the results and findings of the 1998 to 2002 monitoring (Advent Environ 2006). Overall, existing water quality within the Stillwater River indicates support of designated beneficial uses.

3.2.2.2 East Boulder Mine

Aquatic resources have been reviewed and discussed in previous documents, including the following:

- *Final Environmental Impact Statement, East Boulder Mining Project, Sweet Grass County, Montana*. (DSL et al. 1992b)

A variety of microhabitat types have been documented for the East Boulder River, including riffles, runs, and pools. In general, the width of the East Boulder River has historically ranged from 13 feet (4 meters) to 39 feet (12 meters), with a gradient of 1 to 4 percent, and a river and pool depth of ⅓ foot (0.1 meters) to 1.5 feet (0.5 meters) (DSL et al. 1992b). Channel stability has been considered good to excellent, bank stability has been considered good, and stream shade cover ranges from poor to good (DSL et al. 1992b). The section of river adjacent to the East Boulder Mine has been characterized as boulder-strewn, with pocket water for fish holding habitat.

Brown trout and rainbow trout have been documented as the most abundant species in the East Boulder River. Brown trout are the more abundant fish in lower portions of the river, and rainbow trout are more abundant upstream. Small populations of genetically pure Yellowstone cutthroat trout are present above a natural fish barrier on the East Boulder River near Brownlee Creek (located upstream of the East Boulder Mine) and individuals are occasionally found adjacent to or downstream of mine facilities.

Other species found on the river include mountain whitefish, cutthroat trout, cutthroat X rainbow hybrids, and brook trout. Whitefish and brook trout have been found on the lower portions of the river. Cutthroat trout and cutthroat X rainbow hybrids have been found above and downstream of the East Boulder Mine. The Boulder River and lower portion of the East Boulder River appear to be an important spawning area for brown trout (DSL et al. 1992b). Rainbow trout spawn in localized areas of the East Boulder River (DSL et al. 1992b). Little spawning habitat can be found in the stretch of river adjacent to the mine (DSL et al. 1992b).

FWP has designated the upper portion of the East Boulder River as an outstanding fishery, and the lower portion as a substantial fishery resource. Tributaries to the East Boulder River, including Dry Fork Creek, Brownlee Creek, and Canyon Creek, have limited local importance and were considered to be lower-quality dispersed fishing (DSL et al. 1992b). Fishing pressure on the East Boulder River was minor when compared with fishing pressure on the Boulder River (DSL et al. 1992b).

Baseline surveys for periphyton and benthic macroinvertebrates in the East Boulder River were completed in 1982. Diatoms were the dominant periphyton at all stations. The abundance of diatoms is considered an indicator of good water quality. The East Boulder River supports a diverse macroinvertebrate community. In 1982, the lower reaches of the river supported a more abundant and diverse macroinvertebrate community when compared with the upper reaches.

Most of the benthic macroinvertebrates collected were considered indicators of a clean and healthy stream environment (DSL et al. 1992b).

Since 1992, aquatic resources, including fish, macroinvertebrate and periphyton communities, have been described for the East Boulder River in numerous studies. These studies generally supported the conclusions documented in the 1992 EIS for the East Boulder Mine Plan of Operations approval.

SMC sampled the aquatic environment of the East Boulder River between April 1998 and September 2006 (Advent Environ 2007). Physical and biological parameters were sampled and evaluated including temperature, dissolved oxygen, pH, flow, metals, nitrogen, periphyton, and macroinvertebrates. Several key findings from the 8 years of sampling and analysis include:

- Assemblages of benthic macroinvertebrates consist of taxa common to clean, cold-water mountain streams including Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddis flies), Coleoptera: Elmidae (riffle beetles), and a few species of Diptera (true flies).
- Macroinvertebrate Bioassessment Index values show little variation in the upper basin and indicate predominantly "Full Support" (no impairment) conditions from upstream to below the East Boulder Mine.
- Macroinvertebrate Bioassessment Index values indicate "Partial Support" (minor impairment) in the lower reaches of the East Boulder River to the confluence with the Boulder River. Seasonal changes in the macroinvertebrate community suggest that biological impairment in the lower East Boulder River during late summer is partially caused by stream dewatering and problems with sedimentation associated with bank degradation.
- The spatial and temporal results in the macroinvertebrate bioassessment do not indicate impairment of water quality or biological integrity in the East Boulder River due to operation of the East Boulder Mine.
- The East Boulder River periphyton was dominated by an expansive and characteristic macroscopic growth of the stalked diatom *Didymosphenia geminata* both upstream and downstream of the mine.
- The Diatom Bioassessment Index results indicate generally "excellent" biotic integrity (no impairment) for all sampling sites on the East Boulder River. A classification of excellent implies no impairment of water quality or physical habitat relative to the in-stream reference section. The results do not indicate impairment of water quality or biological integrity in the East Boulder River due to operation of the East Boulder Mine.

3.2.2.3 Boe Ranch

The East Boulder River is located north and east of the Boe Ranch. Surface water near the Boe Ranch includes the Mason Ditch, which is an irrigation ditch that diverts water out of the East Boulder River. Ground water is expressed as numerous seeps and springs located between the Boe Ranch LAD area and the East Boulder River. Baseline conditions of the East Boulder River, including aquatic

resources, are discussed in detail in the previous section. No aquatic sampling was conducted in the Mason Ditch on the Boe Ranch.

3.3 Irrigation Practices

This section focuses on resources potentially affected by the Boe Ranch irrigation practices. LAD practices in use at the Stillwater Mine and the Hertzler Ranch have been addressed in previous analyses and will not be discussed any further.

3.3.1 Vegetation

The Boe Ranch grassland habitats include native range grasses, naturalized and introduced grasses, interspersed shrubs, and a variety of forbs. Two dominant native grassland habitat types include Idaho fescue/bluebunch wheatgrass and Idaho fescue/western wheatgrass.

The Idaho fescue/bluebunch wheatgrass habitat type is the dominant plant community at the Boe Ranch and is found on benches, ridges, and flat or convex slopes (Westech 2001). Dominant species in the Idaho fescue/bluebunch wheatgrass habitat type include Idaho fescue, bluebunch wheatgrass, needle-and-thread grass, western needlegrass, prairie junegrass, Sandberg bluegrass, common yarrow, Hood's phlox, and dense clubmoss. Canopy cover within the Idaho fescue/bluebunch wheatgrass habitat type ranges from 55 to 65 percent, with a high amount of litter accumulation and limited bare ground. Annual production of this grassland community ranges from 655 to 1,300 pounds per acre dry weight.

The Idaho fescue/western wheatgrass habitat type occurs on concave slopes and swales. Dominant species include Idaho fescue, western wheatgrass, western needlegrass, and bearded wheatgrass. Several naturalized introduced species are also present including Kentucky bluegrass, timothy, and smooth brome. These species have been introduced to the area by non-native hay or intentional seeding to establish pasture. Canopy cover within the Idaho fescue/western wheatgrass habitat type ranges from 75 to 85 percent. Total production and litter accumulation is generally higher than in the Idaho fescue/bluebunch wheatgrass habitat type (Westech 2001).

3.3.1.1 Sensitive Plant Species and Species of Special Concern

Several plants, which are listed by the GNF as sensitive and/or are listed by the NHP as species of special concern, have the potential to occur at the Boe Ranch. The GNF list of sensitive plant species was evaluated at the privately owned Boe Ranch. Application of these GNF federal requirements is not appropriate for private lands.

The evaluation of species of special concern and sensitive plant species for the Stillwater Mine and the East Boulder Mine sites has been previously considered and disclosed. No further discussion related to these species will be presented in this document.

3.3.1.1.1 Short-styled columbine (Aquilegia brevistyla)

Short-styled columbine is listed as a sensitive species by the GNF and as a species of special concern by the NHP. This columbine typically is found at elevations ranging between 5,000 feet and 6,200 feet in meadows, rock crevices, and open soils. Short-styled columbine has been reported in the Little Belt Mountains, as well as the Absaroka Mountains in the GNF. Based on habitat requirements for this species, occurrence at the Boe Ranch is not reasonable. Further discussions and effects analysis will not be presented.

3.3.1.1.2 Small-winged Sedge (Carex stenoptila)

Small-winged sedge is listed by the NHP as a species of special concern. This sedge occurs in dry, often rocky soil of grasslands and open forests in the montane and subalpine zones. Small-winged sedge is also found in moist soil along valley streams. Small-winged sedge has been recorded in the GNF near Contact Mountain. Based on habitat requirements for this species, occurrence at the Boe Ranch is not reasonable. Further discussions and effects analysis will not be presented.

3.3.1.1.3 Small Yellow Lady's Slipper (Cypripedium parviflorum)

Small yellow lady's slipper is listed as a sensitive species by the GNF and as a species of concern by the NHP. This orchid is found in fens, damp mossy woods, seepage areas, and moist meadows in valleys to lower montane zones. Known occurrences of small yellow lady's slipper include mountain ranges in northwestern Montana. Historical occurrences include the Absaroka-Beartooth Mountains, Bridger Mountains, Garnet Range, Little Belt Mountains, and the Madison Range. There are no known occurrences of the small yellow lady's slipper orchid within the Big Timber Ranger District of the GNF. Based on habitat requirements for this species, occurrence at the Boe Ranch is not reasonable. Further discussions and effects analysis will not be presented.

3.3.1.1.4 Beaked spikerush (Eleocharis rostellata)

Beaked spikerush is listed as a sensitive species by the GNF and as a species of special concern by the NHP. Beaked spikerush is a grasslike perennial that occurs in wet, often alkaline soils associated with warm springs or fens in valleys and foothills zones. There is one recorded occurrence of beaked spikerush in the GNF, approximately 2 miles southwest of the East Boulder Mine. Based on habitat requirements for this species, occurrence at the Boe Ranch is not reasonable. Further discussions and effects analysis will not be presented.

3.3.1.1.5 Eaton's Daisy (Erigeron eatonii ssp. eatonii)

Eaton's daisy is listed by the NHP as a species of special concern. Eaton's daisy is a taprooted perennial that occurs in mountain and foothill zones, at elevations ranging from 2,900 feet to 8,825 feet. There is one known occurrence of Eaton's daisy in the Absaroka-Beartooth Mountains of the GNF. Eaton's daisy was not identified in the baseline vegetation studies conducted for the Boe Ranch (Westech 2001). Based on habitat requirements for this species, occurrence at the Boe Ranch is not likely. Further discussions and effects analysis will not be presented.

3.3.1.2 Noxious Weeds

Noxious weeds present in the Boe Ranch area include Canada thistle, houndstongue, leafy spurge, and spotted knapweed. SMC has an approved Sweet Grass County weed control plan. The weed control plan is applicable for all the SMC-controlled properties in the East Boulder Valley, including the Boe Ranch and leased State of Montana Trust Lands.

3.3.2 Soils

In 2000, Cascade Earth Sciences (CES) evaluated soils present at the Boe Ranch (Knight Piésold 2000c). For use of the site for LAD of mine wastewaters, important soil properties, including the following, need to be evaluated: slope, rock content, texture, structure, depth, existence and depth of impervious layers, infiltration, permeability, organic matter content, and potential for surface runoff (CES 2008). Soil evaluation involved excavating 41 test pits (Figure 3-15). The discussion below summarizes the descriptions of the soil profiles and the results of chemical and physical testing, including infiltration and permeability.

Three soil units were identified in the LAD area (Knight Piésold 2000c). Soil Unit B covers most of this area (61 percent). Soil Unit A covers about 38 percent of the area, and Soil Unit C covers a minor portion of the area (1 percent). The soil profile for Soil Unit C is not described, and its physical and chemical properties were not analyzed because of its limited extent.

Soil Unit A generally correlates to the Shambo soil series and Unit B generally correlates to the Bridger soil series. Descriptions of the soil profiles for Soil Units A and B are provided in CES 2008. Natural Resource Conservation Service (NRCS) Soil Units are depicted on Figure 3-15.

3.3.2.1 Infiltration and Permeability Testing

Infiltration is important for evaluating the performance and potential impacts of the proposed Boe Ranch LAD system. Infiltration determines how much water from rainfall and LAD enters the soil and how much becomes runoff. It is an important factor in erosion because runoff can transport sediment.

Seven tests were used to estimate the saturated infiltration rates of Soil Units A and B (Knight Piésold 2000c; CES 2008). The average rate of infiltration was 1.6 inches/hour for Soil Unit A and 2.3 inches/hour for Soil Unit B. NRCS (2005) classifies these infiltration rates as moderate to moderately rapid.

Infiltration was evaluated at ten additional soil pits. Three pits (TP99BR-4, 5, and 6) were located within potential sites for the center-pivots of the Boe Ranch LAD system and are located within Soil Unit B (CES 2008). Infiltration of soils at test pits TP99BR-4 and 5 was estimated (Knight Piésold 2000c).

Based on the infiltration tests, the measured infiltration rate in the top 2 feet was 2.98 and 4.25 inches/hour (KP 2000c). Infiltration in the top 2 feet of soil is moderately rapid to rapid (NRCS 2005). The measured infiltration rate at a depth of 2 to 4 feet was 0.82 and 0.98 inches/hour, which is considered moderate.

Laboratory permeability tests were performed on soil from test pits TP99BR-4 and 6 (KP 2000c). Tests indicated permeability of the top 2 feet of soil was 0.37 inches/hour (slow). From 2 to 4 feet in the soil profile, permeability was 0.32 and 2.63 inches/hour (slow to moderately slow) (NRCS 2005).

3.3.2.2 Chemical Properties of Soils

The chemical properties of soils affect the growth of plants. Plants, in turn, affect soil chemistry. Many factors affect the suitability of soils as a growth medium for plants. These factors include pH, EC, which is the indirect measure of the concentration of salts in soil water, and the sodium adsorption ratio (SAR).

The presence of excessive salts in soil can be detrimental to plant growth. High concentrations of salts can reduce the availability of water for root absorption and increase accumulation of harmful substances in plant tissues. Water absorption by roots decreases as the concentration of salts increases.

The detrimental aspects associated with salinity depend on climatic conditions, soil characteristics, and landscape position. In arid climates where evaporation exceeds precipitation, salts leach slowly and may accumulate in soil. In addition, soils derived from the weathering of sandstones and marine shales may contain high concentrations of salts. Salts may accumulate in soils irrigated with water high in soluble salts.

The proposed Boe Ranch LAD system would be constructed on upland glacial terraces that are approximately 300 to 700 feet above the East Boulder River. The Boe Ranch LAD area soils predominately have developed in glacial till and shallow sedimentary bedrock units. These deposits are composed of different parent materials (granitic materials of mixed origin and sandstone, mudstone, and shale). The soils are well-drained with limited soluble salts. Annually, snow accumulates on the soil surface, melts in the spring, and leaches through or runs off the soil surface. These site conditions flush accumulated salts. This situation is promoted by downward leaching in the spring, with shorter periods of upward migration of salts in mid to late summer. Salts have not accumulated in the soils at the proposed Boe Ranch LAD area to a degree that inhibits normal plant growth.

Grasses, shrubs, and trees require 16 essential elements for normal growth and development. The proportion of each element required by plants varies. Elements needed in relatively large amounts are called macronutrients and include (in order of the plant tissue concentration considered adequate) carbon, oxygen, hydrogen, nitrogen, potassium, calcium, phosphorus, magnesium, and sulfur. Nitrogen, phosphorus, and potassium fertilizers are added to soil to increase the availability of these nutrients to plants. Important micronutrients (in order of the plant tissue concentration considered adequate) include iron, chloride, manganese, zinc, boron, copper, and molybdenum.

Nitrogen is the most important essential element for plant growth. Relative to other elements such as phosphorus, potassium, and calcium, plants require a large amount of nitrogen. A deficiency of nitrogen slows, stunts, or prohibits the plant growth and reproduction. If other factors are favorable, an adequate supply of

nitrogen in soil promotes growth. Excess nitrogen can cause water pollution and changes in the structure and composition of plant communities.

In undisturbed or unfertilized plant communities, an equilibrium exists between the supply and demand for nitrogen. When nitrogen is applied as fertilizer, plant production increases, especially in grasses. Such an increase in production can produce changes in plant communities and increase the amount of nitrogen in the soil. Soils and plants have a fixed ability to use or store nitrogen. If excess nitrogen is added to nitrogen-saturated soil, and plants cannot use the added nitrogen, then it could flush to the ground water system.

The Boe Ranch LAD area soils are non-sodic and have a SAR of less than 12 (CES 2008). The soils are non-saline with an EC of less than 4 µmhos/cm. The surface of the soil is neutral with a pH of 6.5 to 7.5, whereas the lower portion of the soil profile is slightly alkaline with a pH of 7.5 to 8.5. Concentrations of nitrogen are generally higher at soil depths from 12 to 24 inches. Below 24 inches, nitrogen compounds decline with depth.

Soil organic matter (OM) is an important soil characteristic. Most soils contain approximately 1 to 5 percent OM, although this varies widely. OM increases soil porosity, improves the transfer of water and air in soils, and reduces wind and water erosion. In uncultivated soils, OM supplies the majority of necessary plant nutrients. OM is constantly being created and decomposed in the soil. At the Boe Ranch LAD area, OM content is approximately 4.0 percent in surface samples and declines to 0.3 percent below 36 inches in Soil Units A and B.

3.3.2.3 Physical Properties of Soils

The Boe Ranch LAD area soils predominately have developed in glacial till and shallow sedimentary bedrock units. These deposits are composed of different parent materials (granitic materials of mixed origin and sandstone, mudstone, and shale). These various depositional environments and rock types have affected the physical properties and development of the soils over time. These soils have developed since the last ice age, approximately 10,000 years ago. Soil Units A and B consist of rolling hills with large rocks at the surface (Figure 3-16).

Texture is the relative proportion of sand (coarse size), silt (medium size) and clay (fine size) particles in soil. Texture is an important soil property because it determines water infiltration rates, soil water storage, availability of water to plants, and in part, the amount and frequency of water that may be land applied. It influences soil fertility and salts movement through soil. Texture of Soil Units A and B varies from a fine texture that is dominated by silt- and clay-sized particles to a coarse texture that is dominated by sand and silt-sized particles (CES 2008).

A soil horizon is a layer of soil material that differs from an adjacent soil layer with a differing set of properties. Soil horizon textural differences affect movement of water through soil. The A-horizon is the organically enriched layer near the surface. The B-horizon accumulates constituents such as clay, iron, aluminum, humus, and calcium carbonate due to downward movement of water

through the soil profile. The C-horizon is the zone of bedrock weathering and decomposition. It has minimal soil formation.

The textures of the A-, B-, and C-horizons at the proposed Boe Ranch LAD area vary. The textures of the A-horizon are classified as loams, silt loams, and sandy loams. Soils in the B-horizon are classified as gravelly loams, sandy loams, silt loams, and clays. Soils in the C-horizon vary from silt loams to gravel. Soils develop structure over time that can influence the ability of the soil to drain when irrigated. The soils at the Boe Ranch are classified as well-drained.

The amount of water that can be stored in the soil for use by plants is based on several soil properties, including texture, OM content, slope, and depth. The amount of water relatively available to plants is called the available water holding capacity (AWHC) and is based on testing the upper five feet of soil. The higher the AWHC, the more the soil can hold. As plant roots extract moisture from soil, water is drawn from progressively finer grained soil. Soil water can be held so tightly that plants cannot extract water from the soil. Soils with low AWHC are not as good for LAD and require a lot of water to keep a plant community actively growing.

The AWHC of two soil profiles in the LAD Area ranged from 7.9 to 11.6 inches of water. If the soil is saturated during the spring, even if no more moisture falls during the rest of the growing season, this is enough water to typically grow dry-land wheat and grass hay. The average AWHC is 0.19 and 0.13 inch per inch (in/in) and ranges from 0.12 to 0.22 in/in. The volume of water held in the Boe Ranch soils makes them well suited for use as a LAD location.

3.4 Cultural Resources

The cultural resources discussion only focuses on the Boe Ranch. No Stillwater or East Boulder mine alternatives, nor the Boe Ranch LAD System No Action Alternative 1C would result in physical disturbance at the Stillwater Mine, the Hertzler Ranch, the East Boulder Mine, or the Boe Ranch. Effects of the Stillwater Mine, the Hertzler Ranch, and the East Boulder Mine on cultural resources have been disclosed in previous analyses. Cultural resources at the Stillwater Mine, the Hertzler Ranch, and the East Boulder Mine are not considered further in this analysis.

If the Boe Ranch LAD System Proposed Action Alternative 2C or the Boe Ranch LAD System Agency-Mitigated Alternative 3C were selected, new disturbances would result that have not been analyzed in past environmental documents.

The Boe Ranch LAD area is located in the East Boulder River drainage. The river valley consists of folded and faulted Precambrian metamorphic rocks, igneous materials, and Middle Cambrian through Late Cretaceous sedimentary rocks. It is sculpted by glaciation and mantled with terraces, moraines, and outwash deposits. Vegetation is a mix of prairie sagebrush grassland and forbs, as well as grasses common to mountain flanks. Areas of riparian woodlands are located along watercourses. The varied topography and resources provided excellent seasonal resources for small populations of mobile hunter-gatherers. On the

other hand, the abundance of cobbles, boulders, and rock outcrops make much of the terrain undesirable for cultivation. Field notes by land surveyors in this area during the 1890s comment on the thousands of piles of boulders left by the Indians (Lahren et al. 2001). The following sections provide information on prehistoric and historic use of the area and on the results of the recent investigations for cultural resources.

3.4.1 Prehistoric

The Boe Ranch is in the Northwestern Plains culture area, which encompasses the southern half of Alberta and Saskatchewan, three-quarters of Montana, and the northern half of Wyoming. Known human occupation of the region spans more than 11,000 years, beginning shortly after the retreat of the Wisconsinan glaciation. The history of the prehistoric culture in the region conventionally is divided into six periods: (1) Paleoindian (ca. 11,500 to 8,000 years ago); (2) Early Plains Archaic (ca. 8,000 to 5,000 years ago); (3) Middle Plains Archaic (ca. 5,000 to 3,000 years ago); (4) Late Plains Archaic (ca. 3,000 to 1,500 years ago); (5) Late Prehistoric (ca. 1,500 to 500 years ago); and (6) Protohistoric (ca. 500 to 200 years ago) (Frison 1991). Many prehistoric sites can be assigned to one or more periods of occupation or use by the presence of distinctive chipped or ground stone tools, the use of distinctive stone materials from distant sources, or the presence of distinctive types of hearths, storage pits, or stone structures. Paleoindian sites also may contain the bones of extinct species of animals.

3.4.2 Historic

According to native tradition, the Hidatsa people of the Middle Missouri region split in the 1600s: the Absarokee group migrated west to the Montana-Wyoming region, while the others remained in the Middle Missouri area near the Mandan and Arikara. In the Boe Ranch area, the range of the Absarokee overlapped with other tribes that regularly used the region in the early historic period. These other tribes included Minnetaries, Blackfeet, Piegan, Bloods, Gros Ventres, Flatheads, Pend Oreilles, Bannock, Nez Perces, and Sheepeater Shoshoni. The Lakota also made forays into this area in the late 1800s.

The Fort Laramie Treaty of 1868 established a newly defined Crow (Absarokee) reservation that extended from a line parallel to the eastern boundary of the present reservation along the 107th degree of longitude westward to the Yellowstone River. This reservation, which was reduced by cessions in 1882, 1891, and 1904, included the current Boe Ranch area. The area of the reservation identified in the Fort Laramie Treaty of 1851 had been substantially larger, extending south into the Big Horn Basin, north to the Musselshell River, and east to the Powder River. The cessions made in the Treaty of 1868, as well as later cessions, resulted partially from Lakota claims, but were primarily in response to clashes between the Absarokee and Anglo prospectors and settlers.

Prospecting had begun in the region in the mid-1860s, but the early finds in this region were overshadowed by larger gold rushes in other regions. Nonetheless, prospecting and railroads in the 1860s through the 1880s produced the first sustained Euroamerican populations in the region. Among the first permanent towns

in the Boulder region were Livingston and Big Timber. Railroad tie manufacturing operations in the Boulder River drainage were extensive. Large-scale ranching began in the region as early as 1877. By 1910, the environmental impacts of grazing were evident, and limited grazing permits were issued to decrease the pressure. Mining in the region developed slowly and sporadically until the late 1880s, followed by several small booms through the 1890s. Interest in mining was again sporadic after 1901. Prospecting and mining brought many of the early settlers into the area. The same settlers who filed mineral claims also were responsible for many of the early homestead entries.

3.4.3 Cultural Resource Investigations

A series of archaeological investigations was conducted by the SMC in the spring and summer of 2000 (Lahren et al. 2001). Approximately 960 acres in and around the Boe Ranch LAD area in Sweet Grass County were investigated. One historical stockherding camp, 77 cultural features, and two isolated finds were identified. The camp and features were grouped into 12 sites plus the two isolated finds. The features consisted of 52 cairns or stone piles, seven stone walls, three historic foundations, five stone rings, three stone lines, three boulders, two stone features, a cairn alignment or drive line, and an unlined historic irrigation ditch. Four of the historic sites are recommended as not eligible for the National Register of Historic Places, and the remaining eight sites are unevaluated.

3.5 Stability of the Boe Ranch LAD Storage Pond

3.5.1 Surficial Geology

Surface material at the Boe Ranch includes glacial till and weathered bedrock. Most of the landforms are glacial in origin. Five areas were reviewed for suitability for land application and disposal of mine water (Knight Piésold 2000c). Test pits were excavated in areas identified with mass movement potential (Figure 3-17).

Soil particle size varies. Landslides were observed within the glacial till at the southeast entrance of the Boe Ranch. Shale outcrops within the property and weathers rapidly to clay. The shale bedrock units act to retard downward water infiltration at the junction of the glacial till and bedrock unit. This results in accumulation of ground water and potential for mass movement.

3.5.2 Bedrock Geology

The Stillwater Complex consists of layered mafic igneous rock of Precambrian age. It is partially exposed and extends 77 miles along the northern margin of the Beartooth Mountains. It has been uplifted, tilted, faulted, intruded, and eroded since it was formed.

Sedimentary rocks of Cambrian through Cretaceous age overlie the Complex. Overlying sedimentary units are composed of sandstone, shale, limestone, siltstone, and dolomite. Outcrops of Cretaceous Kootenai, Thermopolis-Mowry, Frontier, and Cody Shale have been observed at the Boe Ranch.

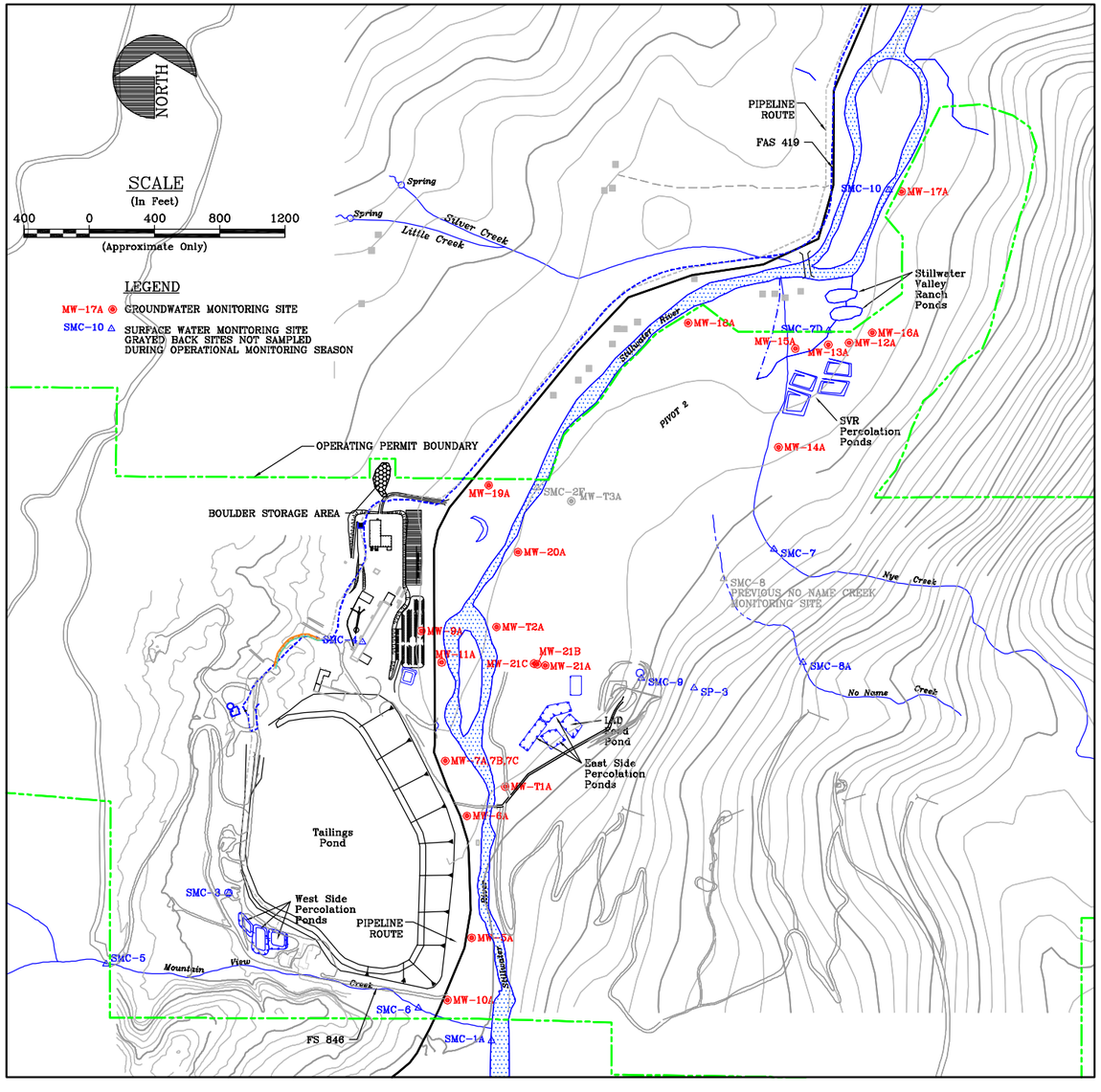
3.5.3 Mass Movement Features

SMC conducted an analysis of mass movement potential in the Boe Ranch area (KP 2000c). Seven specific areas of concern were identified at the Boe Ranch (Figure 3-17). Areas of concern have the following characteristics: slope gradients that exceed 15 percent, underlying shale layers with similar slope aspect, and bedrock that dips in the same direction as the surface slope.

- *Area 1*. A potentially problematic area is the north-facing, heavily gullied shale and shale-derived soil north of all proposed LAD facilities that drain to the Boulder River drainage system. The slope differs by 45 degrees from the orientation of the shale bedding.
- *Area 2*. This area is north of all Boe Ranch LAD facilities in adjoining Section 8 and drains to the Boulder River. It appears that most of the surficial material has slipped and that more material may be sliding.
- *Area 3*. This area is north of all LAD facilities in adjoining Section 8 and drains to the East Boulder River. The slope gradient is 15 to 20 percent, and aspect is similar to the orientation of the shale bedding. Instability was not observed.
- *Area 4*. This area is east of the LAD facilities in Sections 3, 10, 15, and 16. Small slumps and shallow surface slides were observed along riverbanks. The slope failures generally occur where gradients exceed 50 percent. It is expected that shale underlies the soil in this area. Moderately well-graded glacial till with 45 to 50 percent fines was observed in all outcrops.
- *Area 5*. Shale or fine-grained rocks may underlie this area, which is located west of LAD center pivots P9 and P10.
- *Area 6*. A large historical mass movement and runout zone from an earth slump-flow that is still active is evident in this area, which is located south of the LAD center pivots and would discharge to the East Boulder River. The slope gradient of the historic slide is 20 percent in the initiation zone; whereas, the slope gradient in the runout zone is 11 to 14 percent. Slickensided (polished and grooved surfaces that are produced by one soil mass sliding past another) and reworked soil of silt and clay were encountered when the test pits were excavated.
- *Area 7*. An earth slump-flow continues to move in this area which is south of the proposed LAD facilities. Irregular hummocky surfaces and parallel ridges were observed and indicate slow-moving flows. Exposed soil was observed in minor scarps.

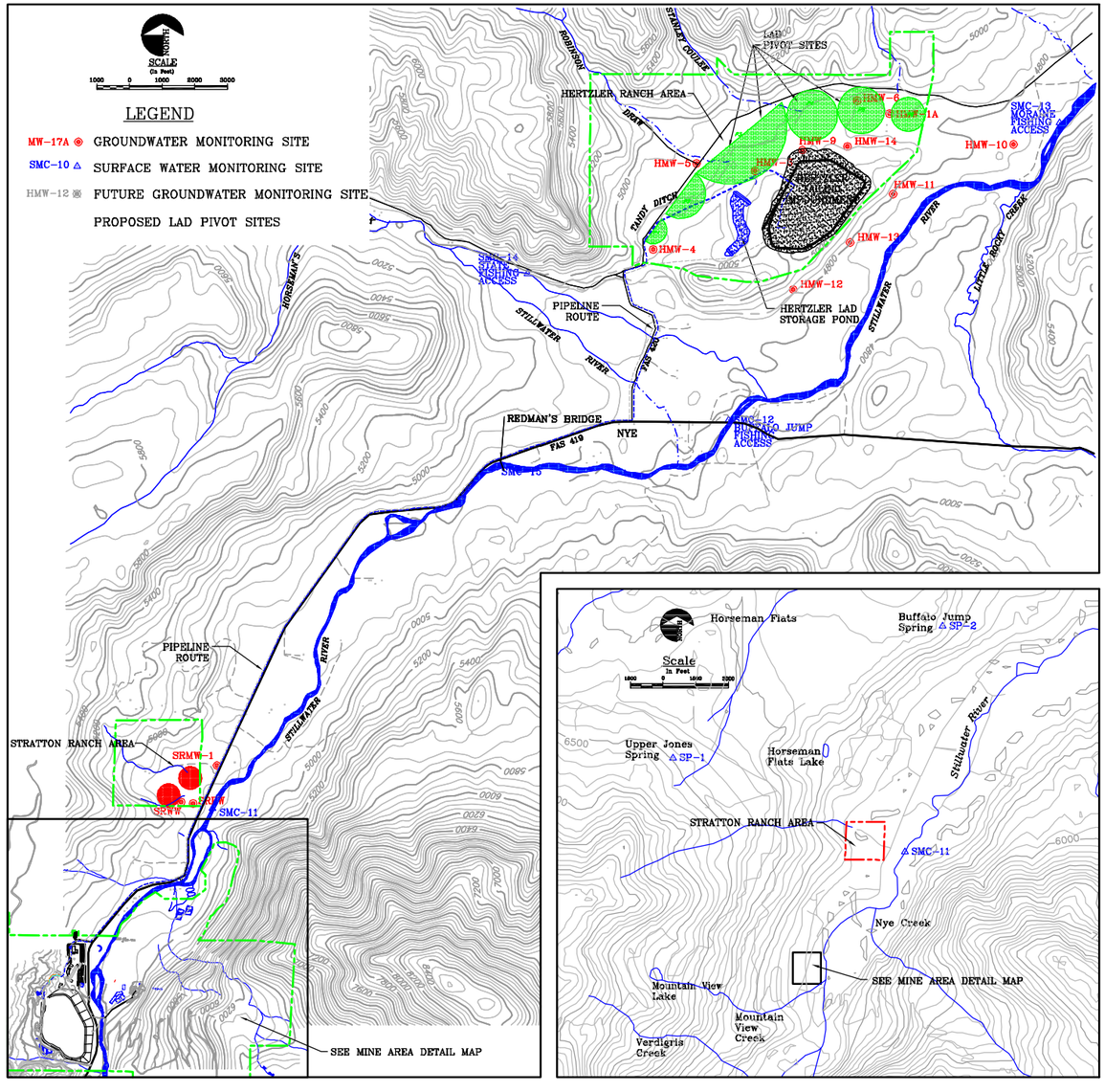
3.5.4 Ground Water Discharge Features

Ground water discharges in the Boe Ranch area are evident as springs and seeps. These features are primarily located outside of proposed areas of disturbance, on the lower bench of Section 9 centered near the Boe Ranch homestead (Figure 3-18). The ground water discharges are in glacial till underlain by shale (Knight Piésold 2000c).



MINE AREA DETAIL MAP

SCALE: 1"=500'



SAMPLING SITES LOCATION MAP

SCALE: 1"=2000'

ADDITIONAL SAMPLING SITES

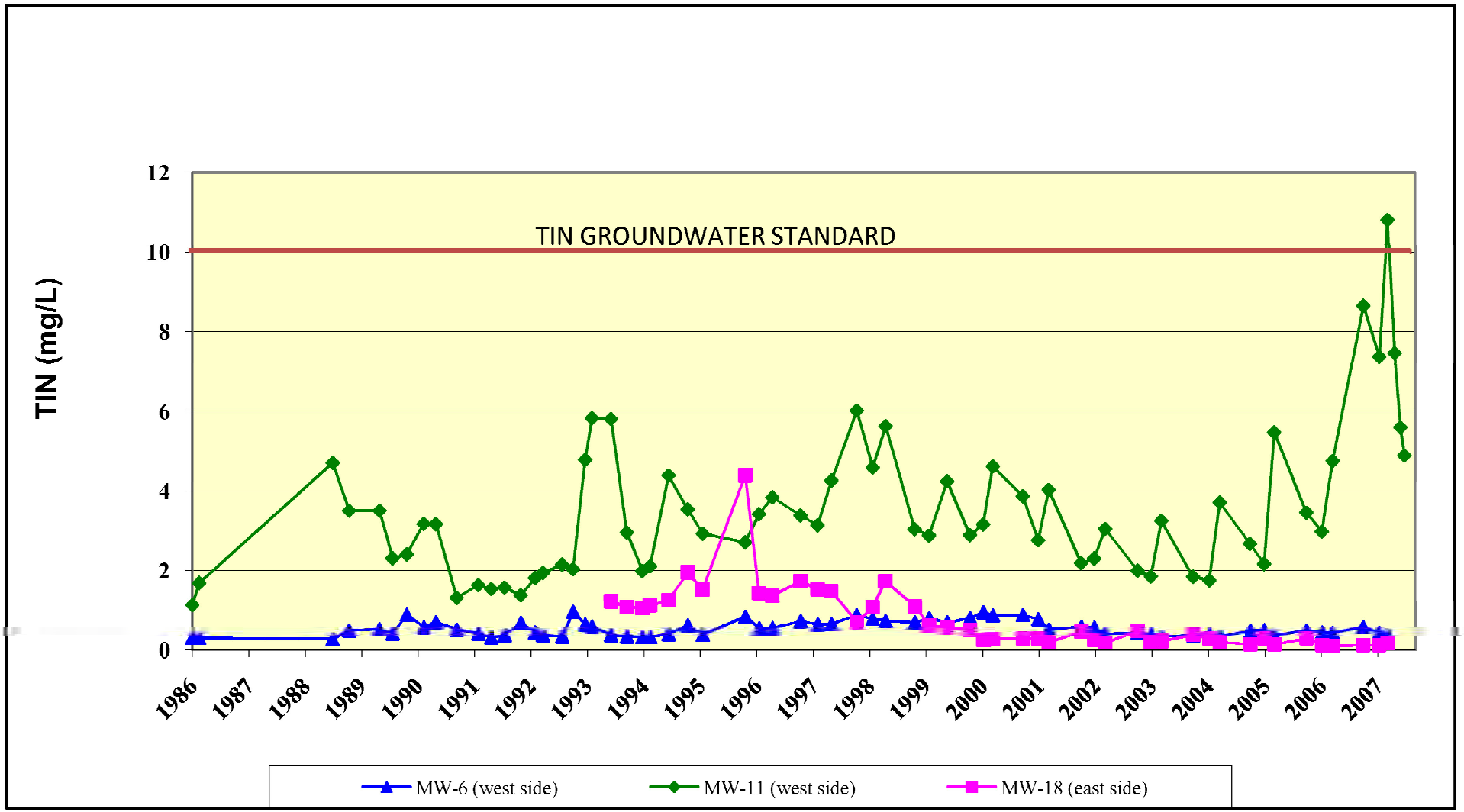
SCALE: 1"=3000'

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WATER MONITORING SITES AT THE STILLWATER MINE

DWG:Figure 3-1.dwg		LAYOUT:3-1	FIGURE 3-1
DRAWN BY:ETC	PREPARED BY:JH	DATE:6/18/2008	

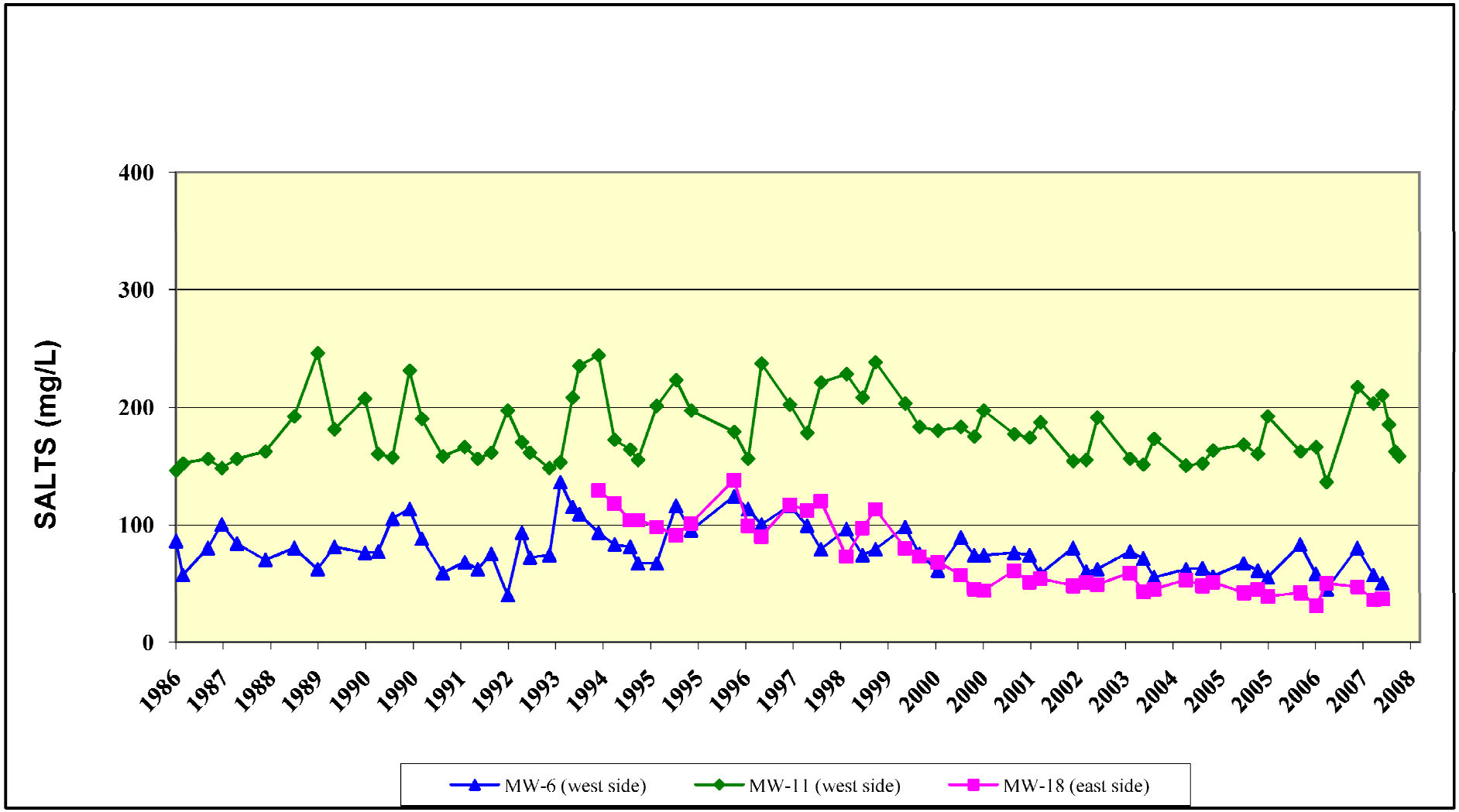
Source: Hydrometrics, Inc.



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TIN CONCENTRATIONS IN STILLWATER MINE MONITORING WELLS

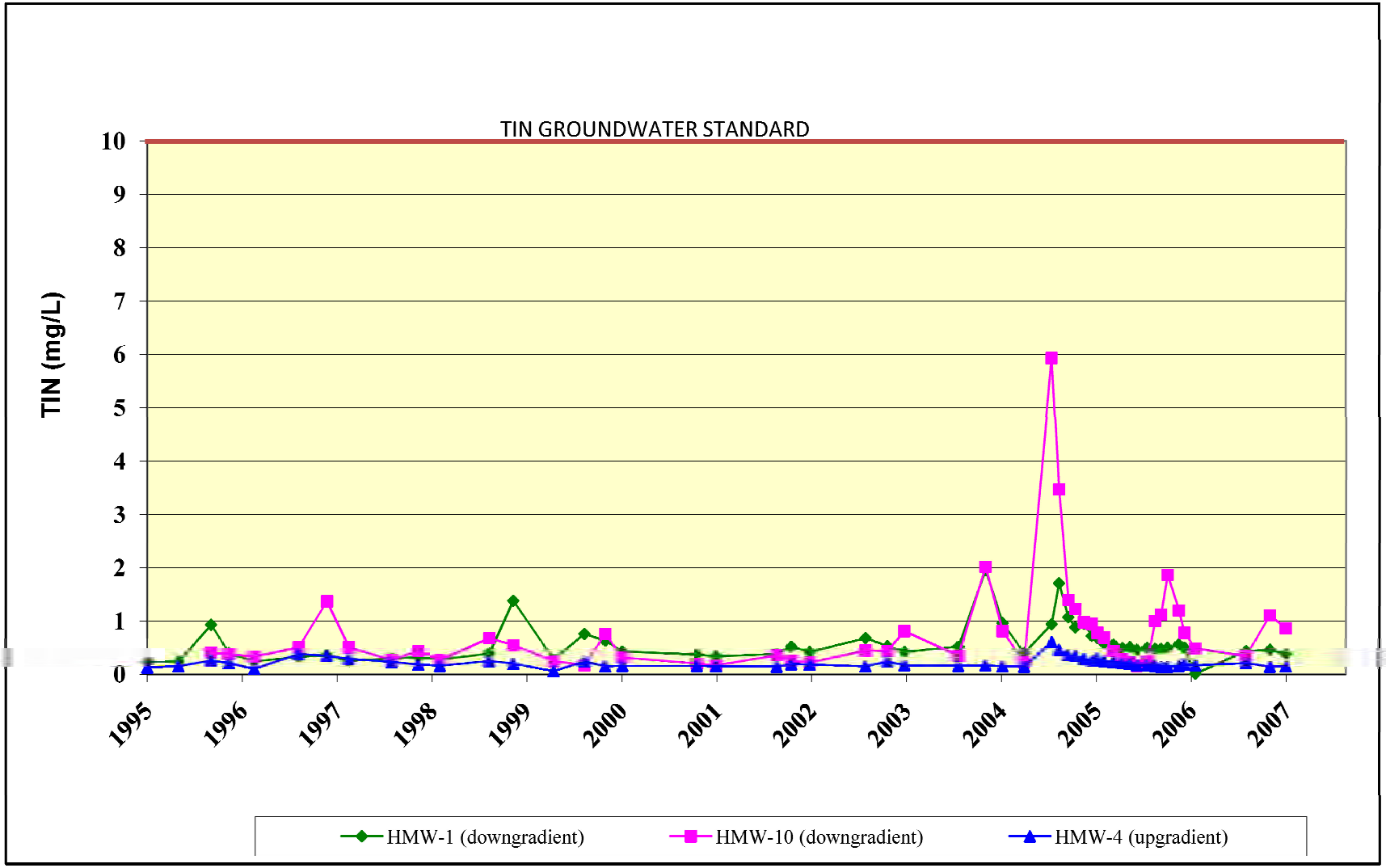
DWG:Edited 1200graphs.dwg		LAYOUT:3-2	FIGURE **3-2**
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/13/2009	



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SALTS CONCENTRATIONS IN STILLWATER MINE MONITORING WELLS

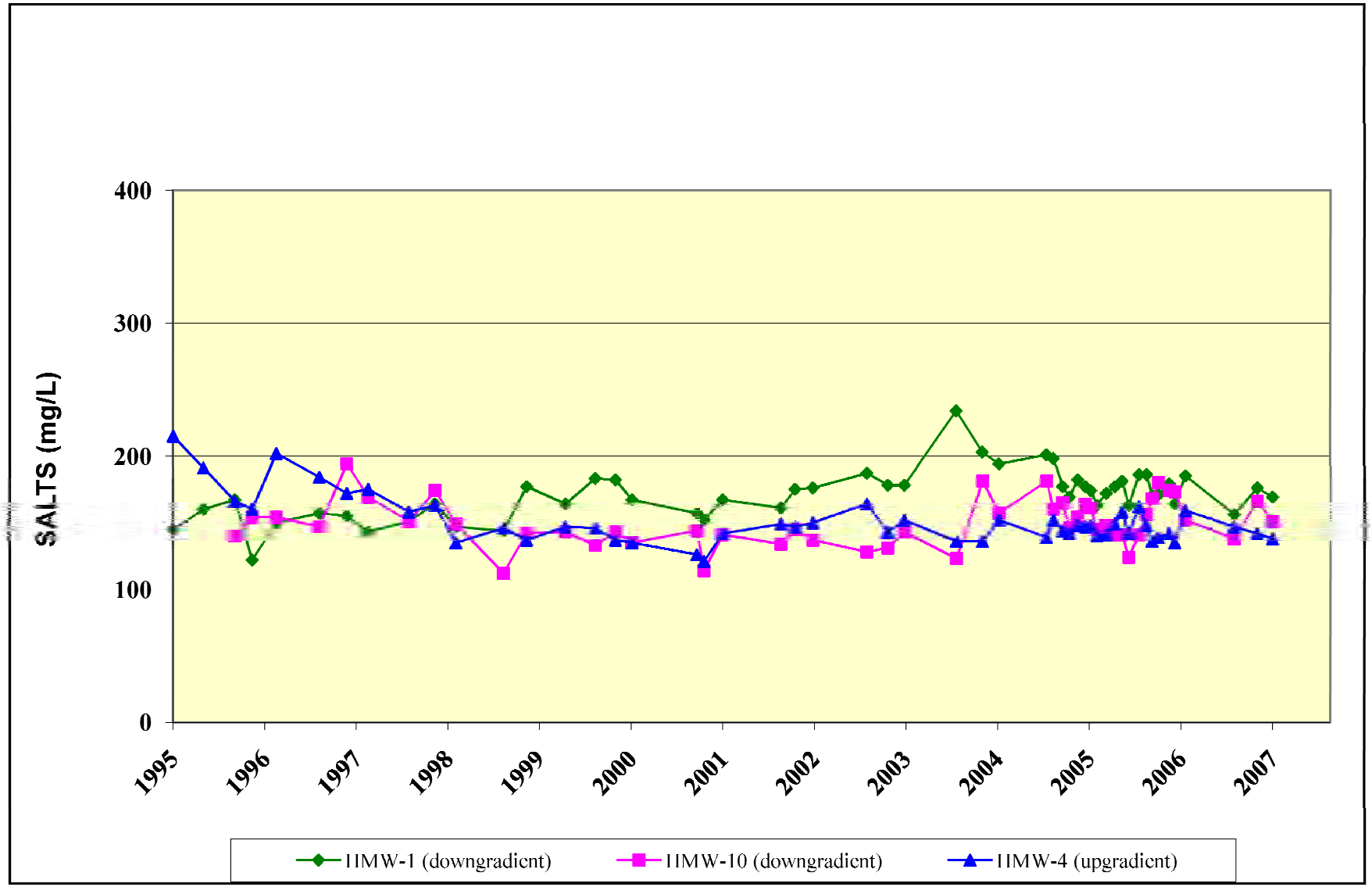
DWG:Edited 1200graphs.dwg		LAYOUT:3-3	FIGURE **3-3**
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/13/2009	



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TIN CONCENTRATIONS IN HERTZLER RANCH MONITORING WELLS

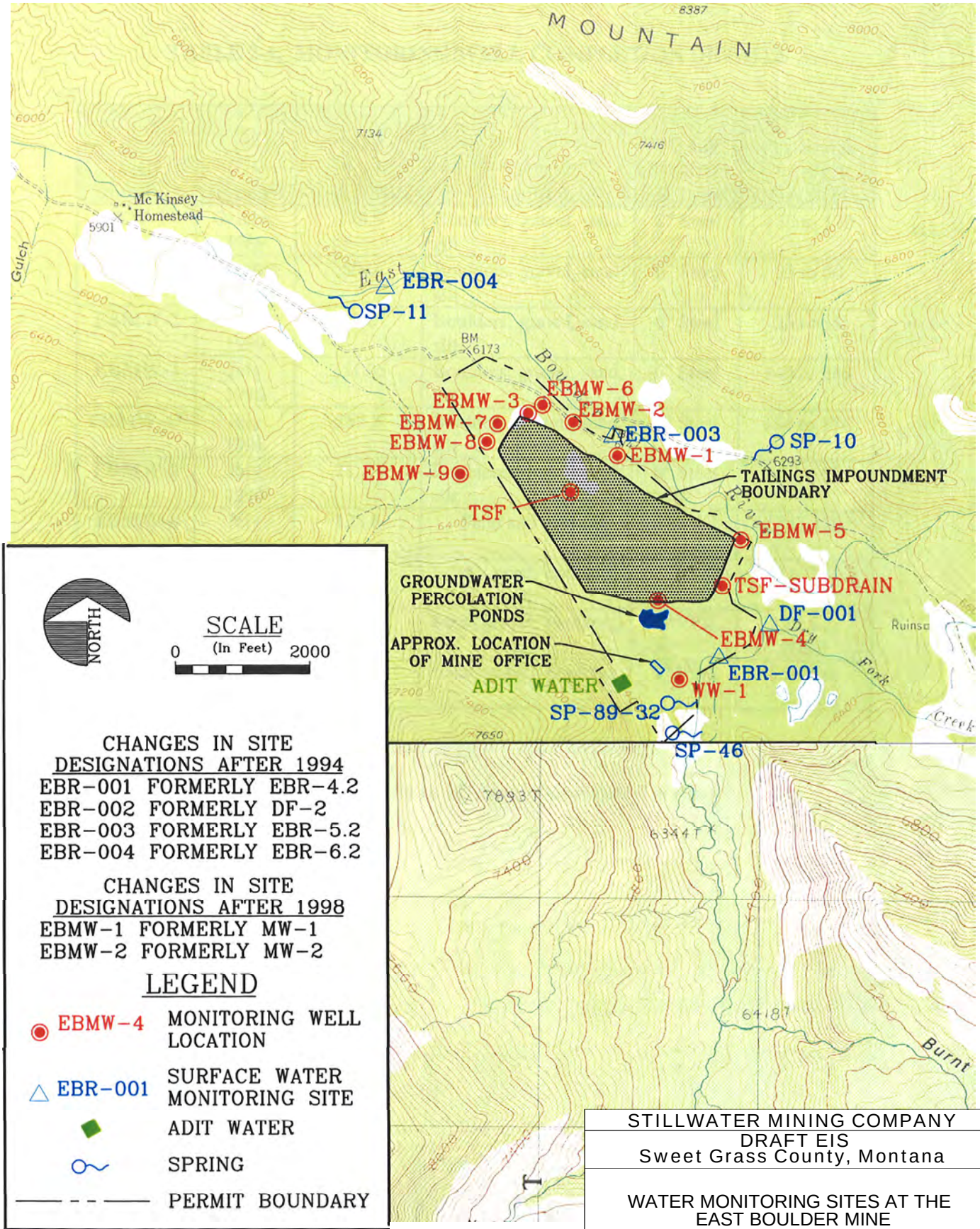
DWG:Edited 1200graphs.dwg		LAYOUT:3-4	FIGURE 3-4
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/16/2009	



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SALTS CONCENTRATIONS IN HERTZLER RANCH MONITORING WELLS

DWG:Edited 1200graphs.dwg		LAYOUT:3-5	FIGURE 3-5
DRAWN BY:ETC	PREPARED BY:JH	DATE:3/16/2009	

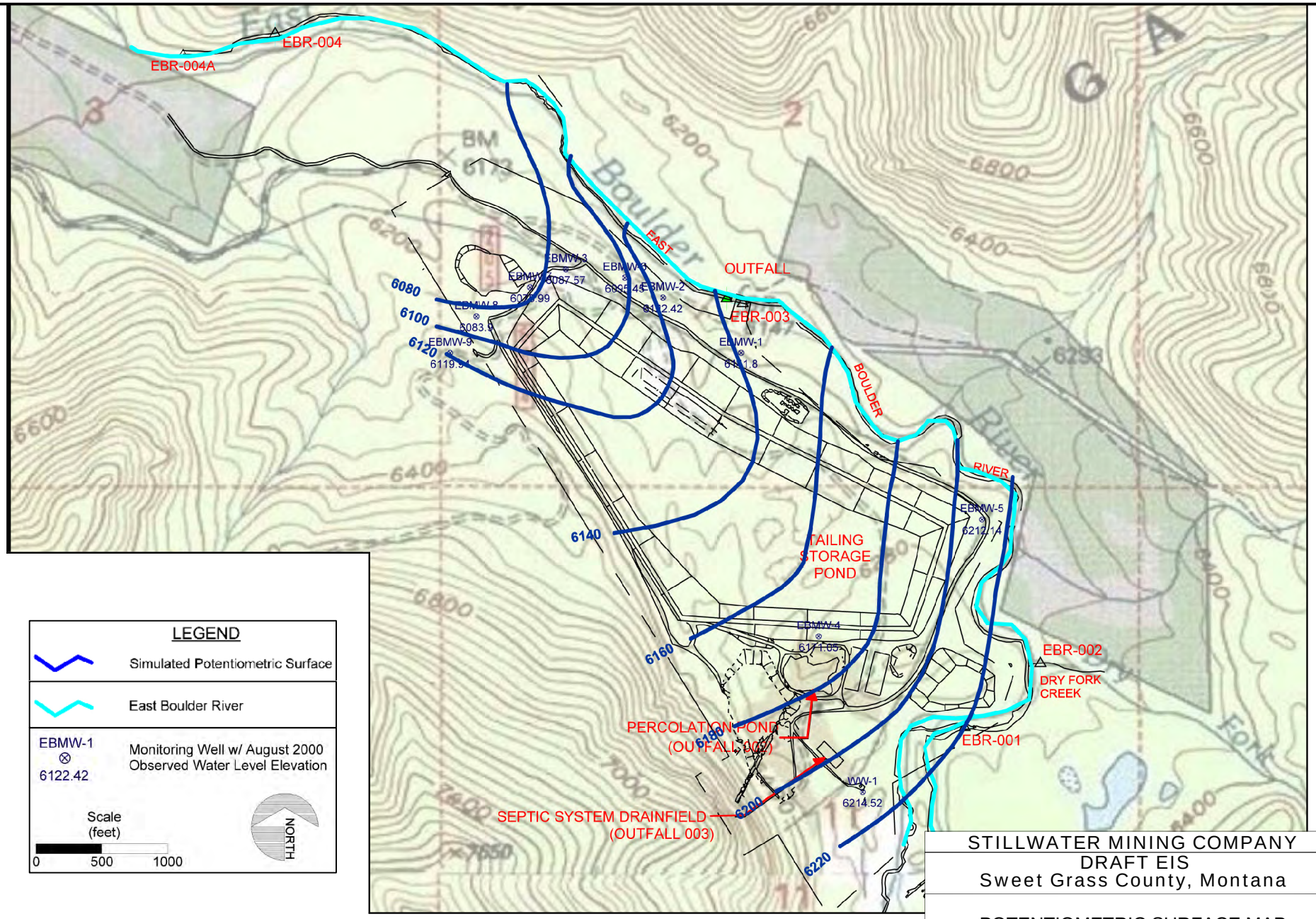


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WATER MONITORING SITES AT THE EAST BOULDER MINE

DWG:1200 MontWell.dwg		LAYOUT:001	FIGURE 3-6
DRAWN BY:ETC	PREPARED BY: DMC	DATE:06/16/2008	

Source: Hydrometrics, Inc. 2005



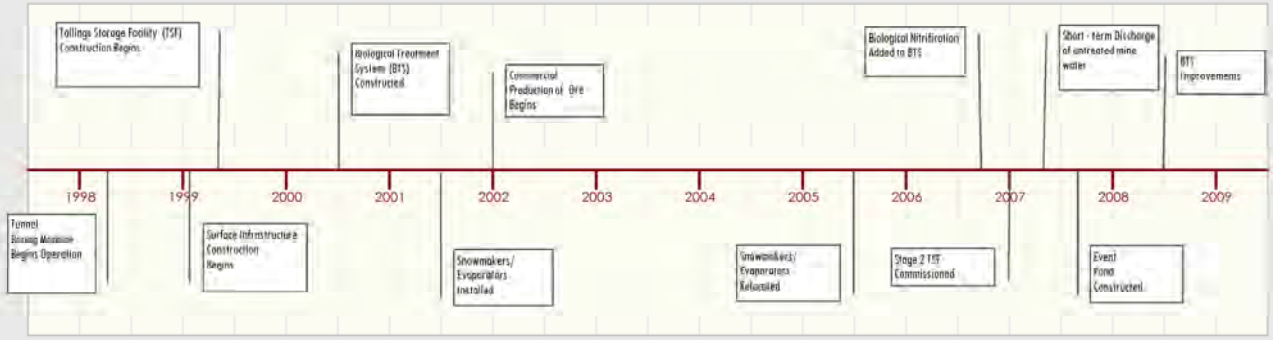
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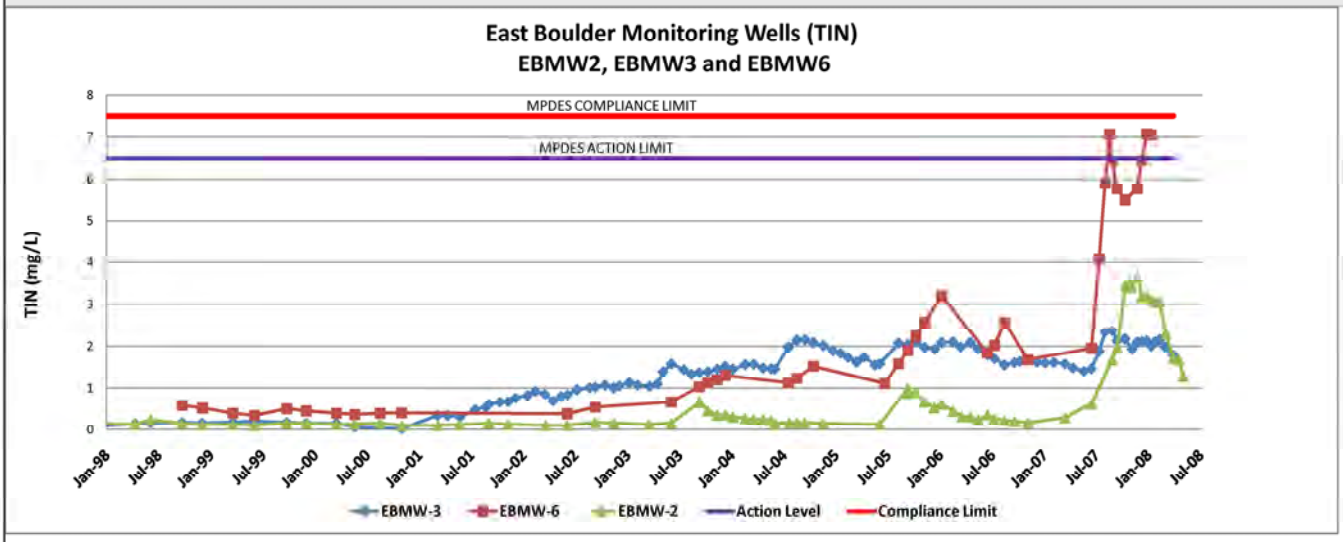
POTENTIOMETRIC SURFACE MAP
AT THE EAST BOULDER MINE

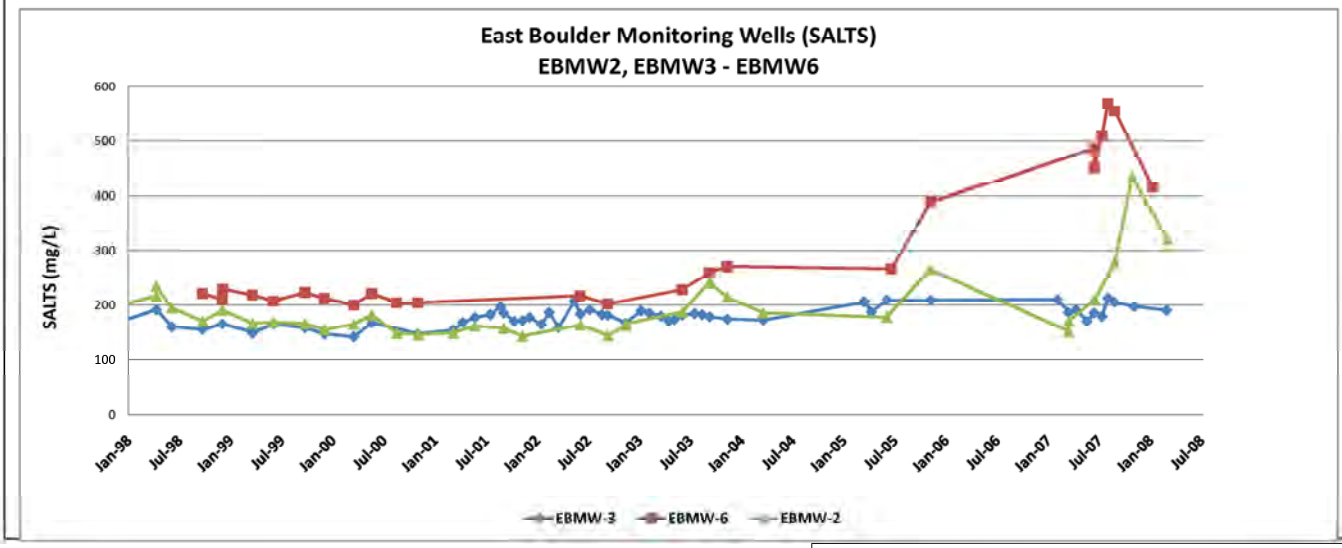
DWG:1200 Graphs.dwg		LAYOUT:3-7	FIGURE 3-7
DRAWN BY:ETC	PREPARED BY:JH	DATE: 8/12/2008	

Source: Hydrometrics, Inc. 2008

East Boulder Mine Water Management Timeline



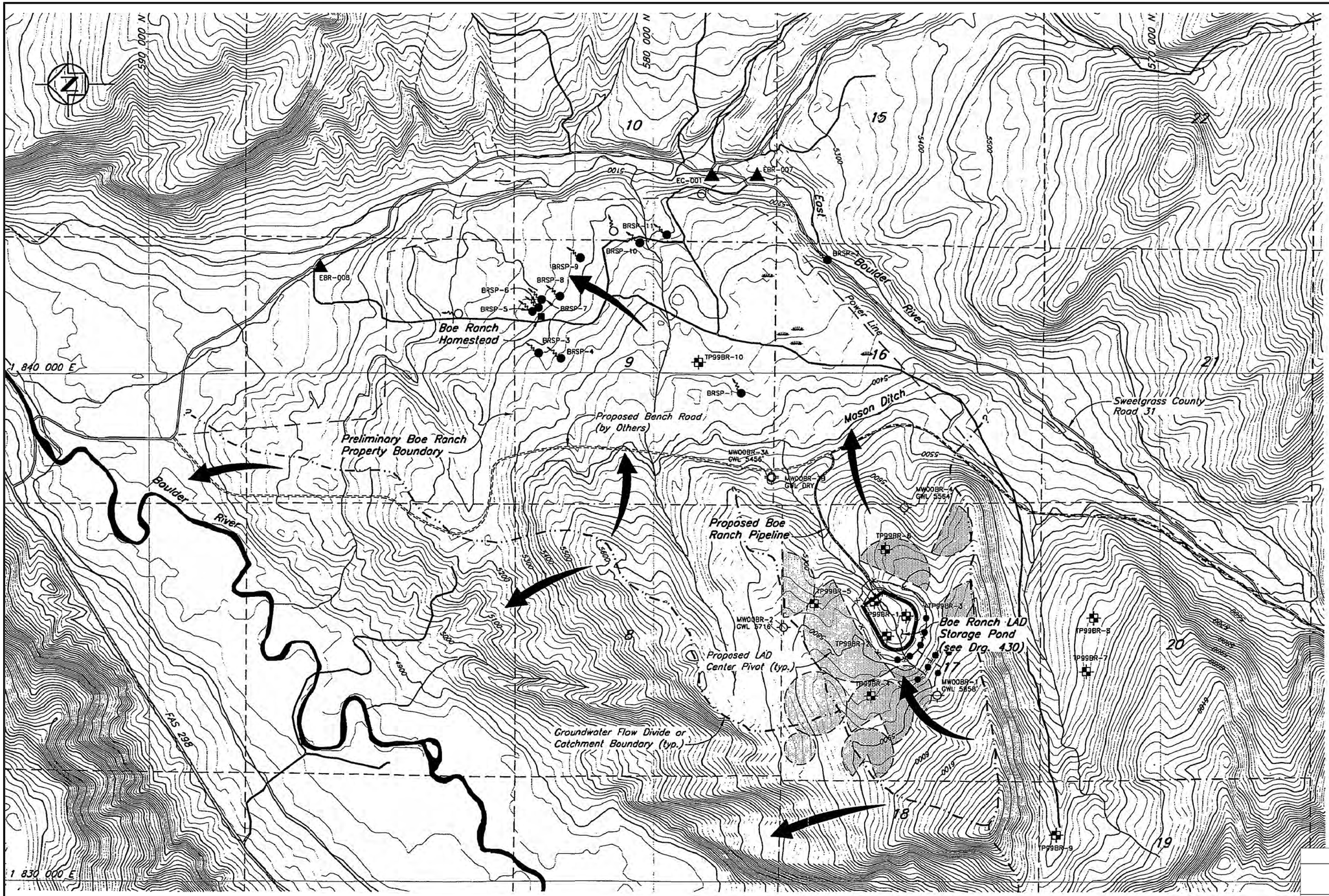




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TIN AND SALTS CONCENTRATIONS AT THE EAST BOULDER MINE MONITORING WELLS

DWG:Edited 1200graphs.dwg		LAYOUT:3-8	FIGURE **3-8**
DRAWN BY:ETC	PREPARED BY:JH	DATE:03/16/2009	



Source: Knight Piesold

NOTES

1. *Contours, roads and public land boundaries were obtained from the USGS Geographical Data Download site. Contours and public land boundaries were generated from 1:24,000 scale Digital Elevation Model and Digital Line Graph data. The roads and rivers were obtained from the 1:100,000 scale Digital Line Graph data. The information was translated from UTM NAD27 Zone 12 to the Montana State Coordinate System – Southern Zone (NAD 27).*
2. *Site Investigation locations shown are preliminary.*
3. *The groundwater flow divides have been estimated using water level monitoring data and assuming that the groundwater surface is a subdued image of the topography.*

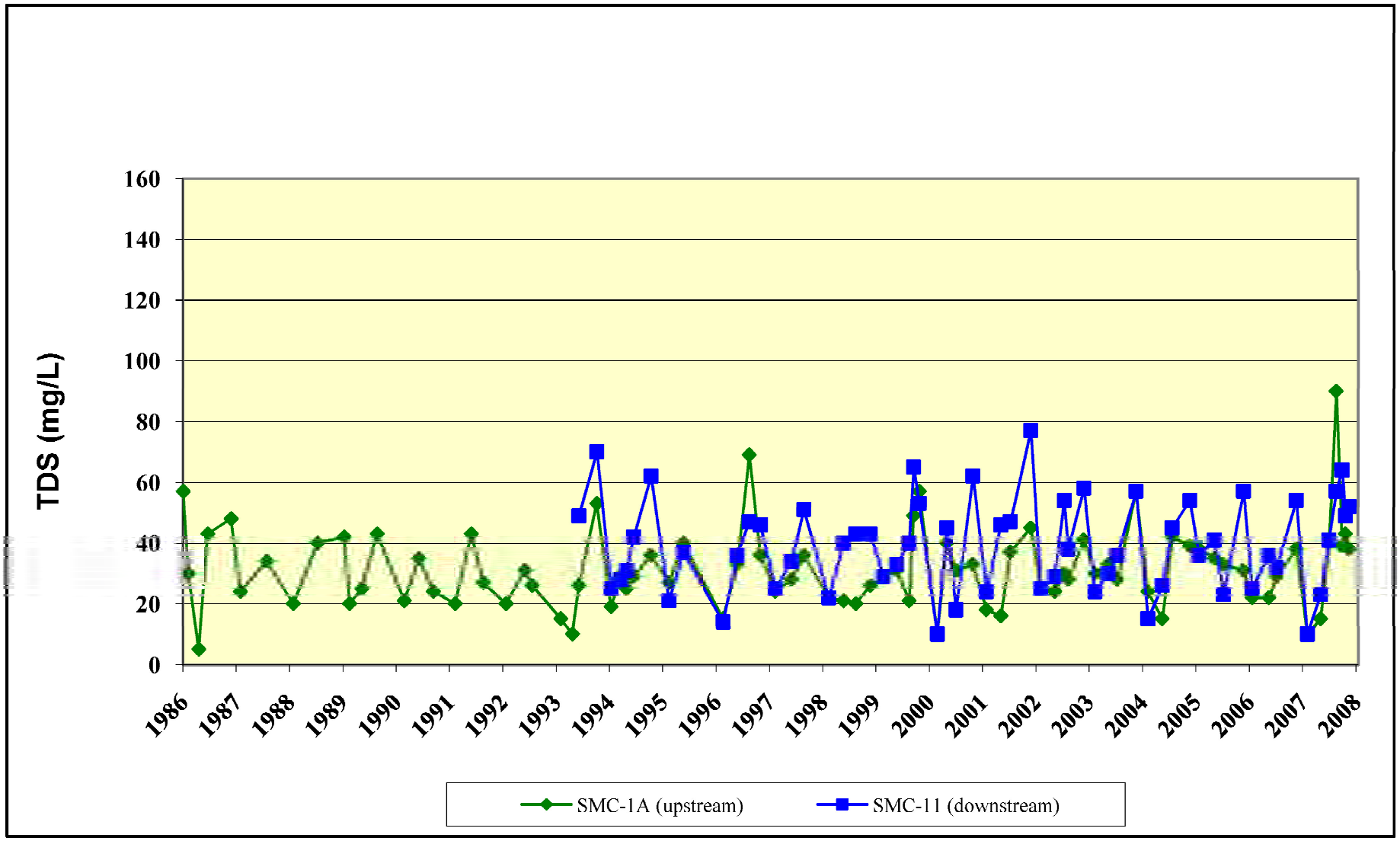
LEGEND

- TP99BR-1 — *Test pit locations*
- MW00BR-1 GWL 5858' — *Monitoring well locations and groundwater elevation*
- BRSP-1 — *Groundwater Seeps*
- *Seep*
- *Surface Water Monitoring Site*
- *Marsh*
- *Road*
- 19 — *Section Number*
- *Section boundary*
- *Local and intermediate groundwater flow direction*

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WATER RESOURCES AT BOE RANCH

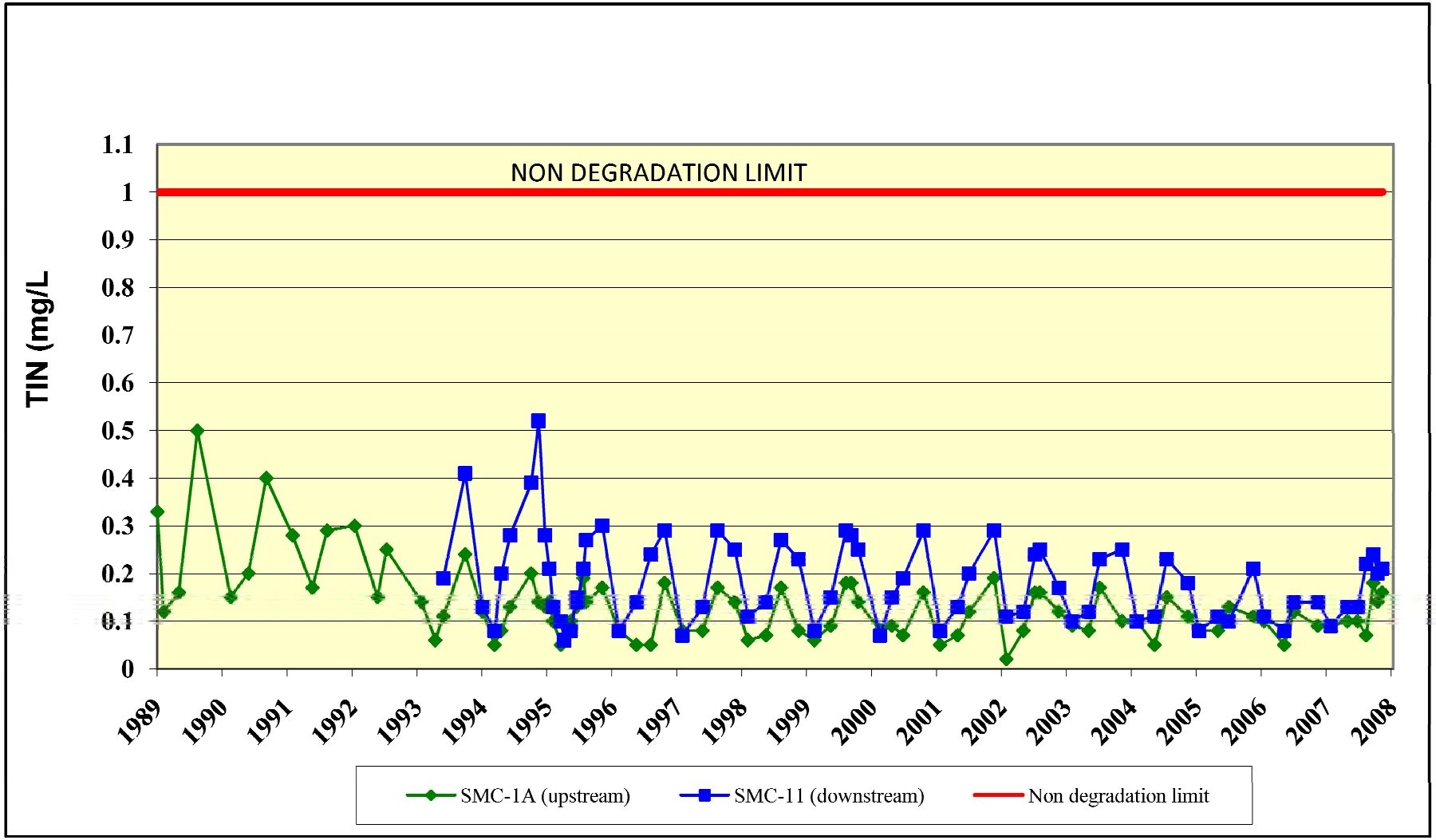
DWG:Figure 3-9.dwg		LAYOUT:3-9	FIGURE 3-9
DRAWN BY: ETC	PREPARED BY: JH	DATE: 8/12/2008	



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TDS CONCENTRATIONS IN THE STILLWATER RIVER

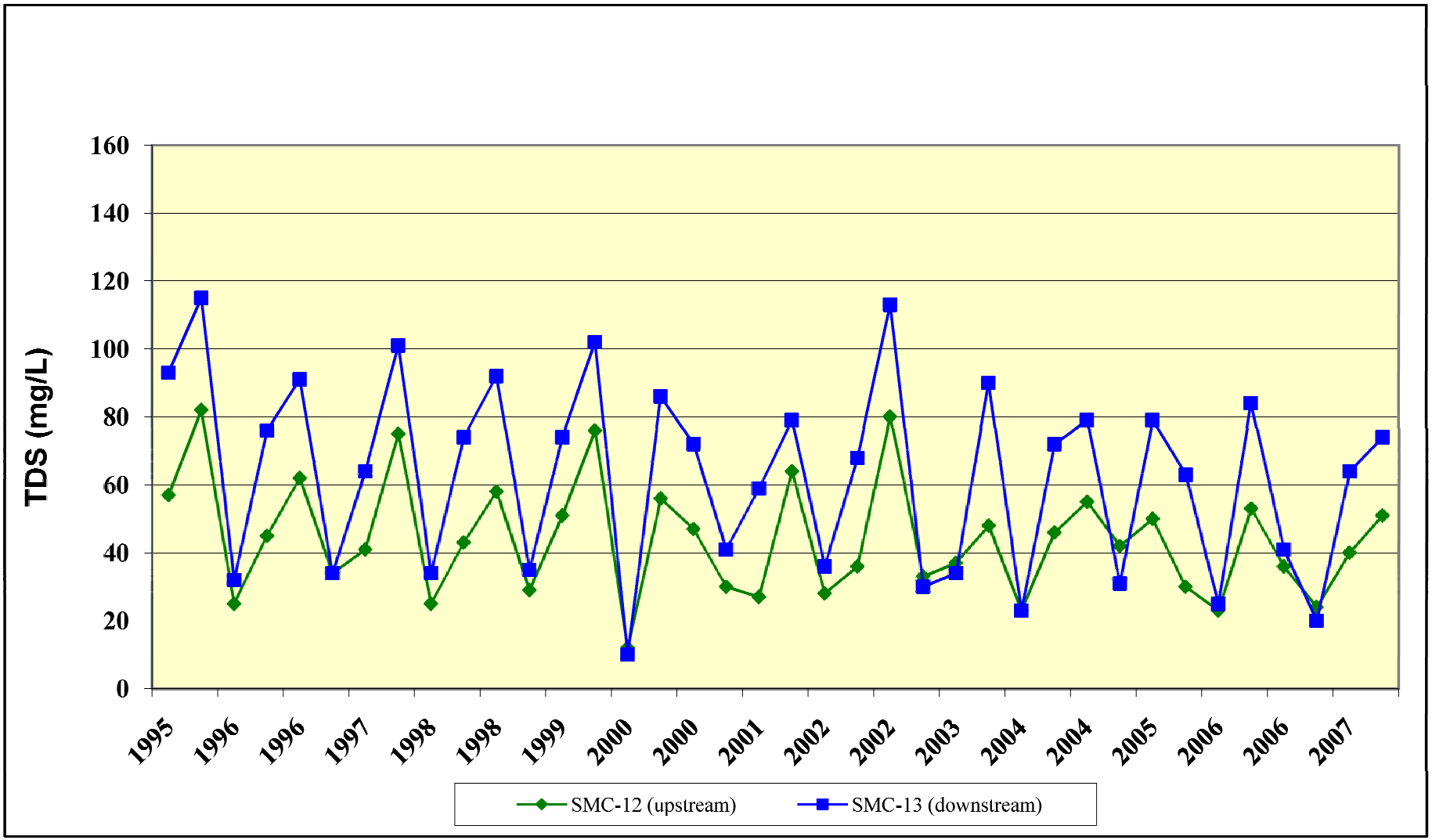
DWG:Edited 1200graphs.dwg		LAYOUT:3-10	FIGURE **3-10**
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/16/2009	



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TIN CONCENTRATIONS IN
THE STILLWATER RIVER

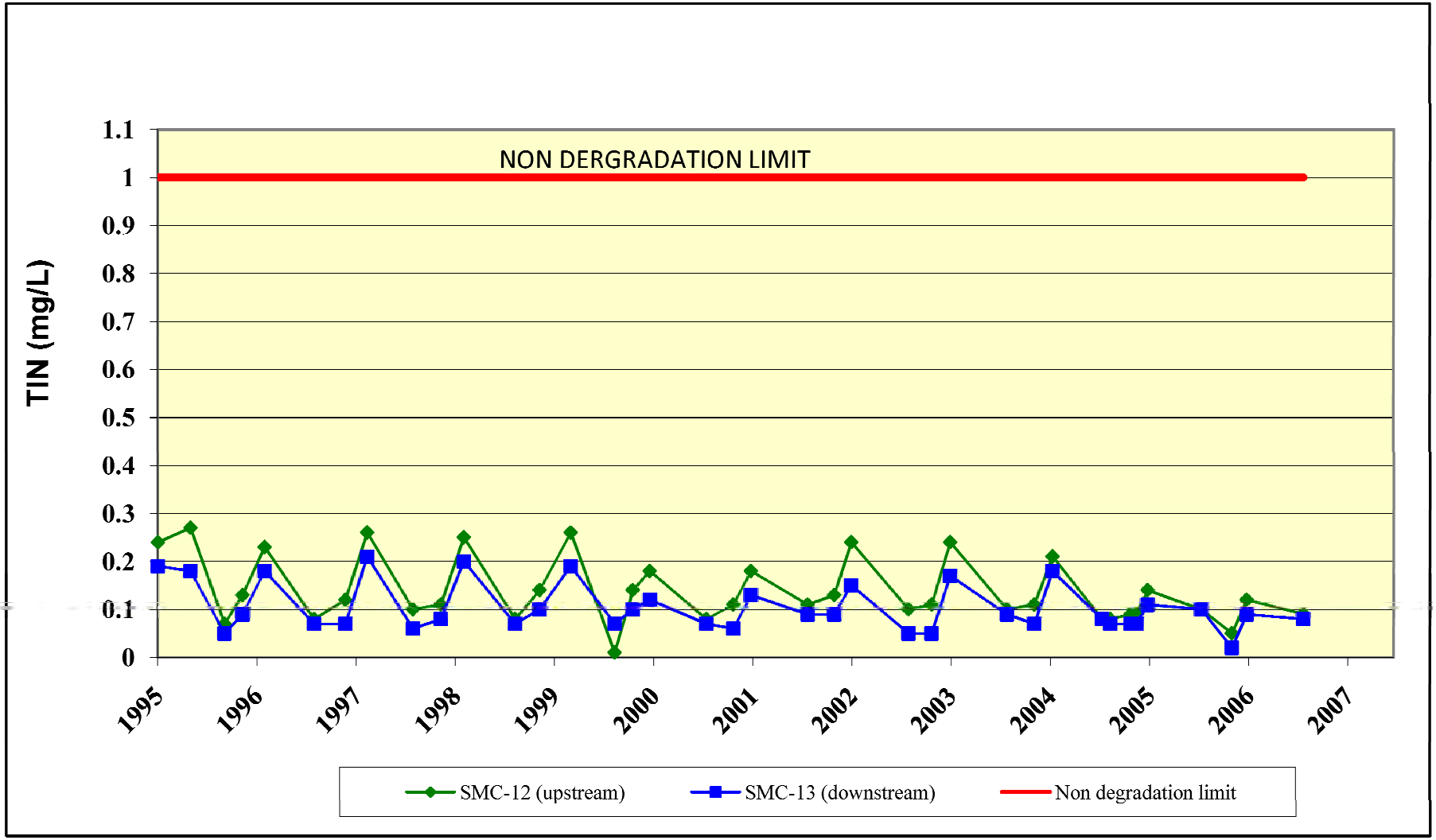
DWG:Edited 1200graphs.dwg		LAYOUT:3-11	FIGURE 3-11
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/16/2009	



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TDS CONCENTRATIONS IN THE STILLWATER RIVER NEAR HERTZLER RANCH

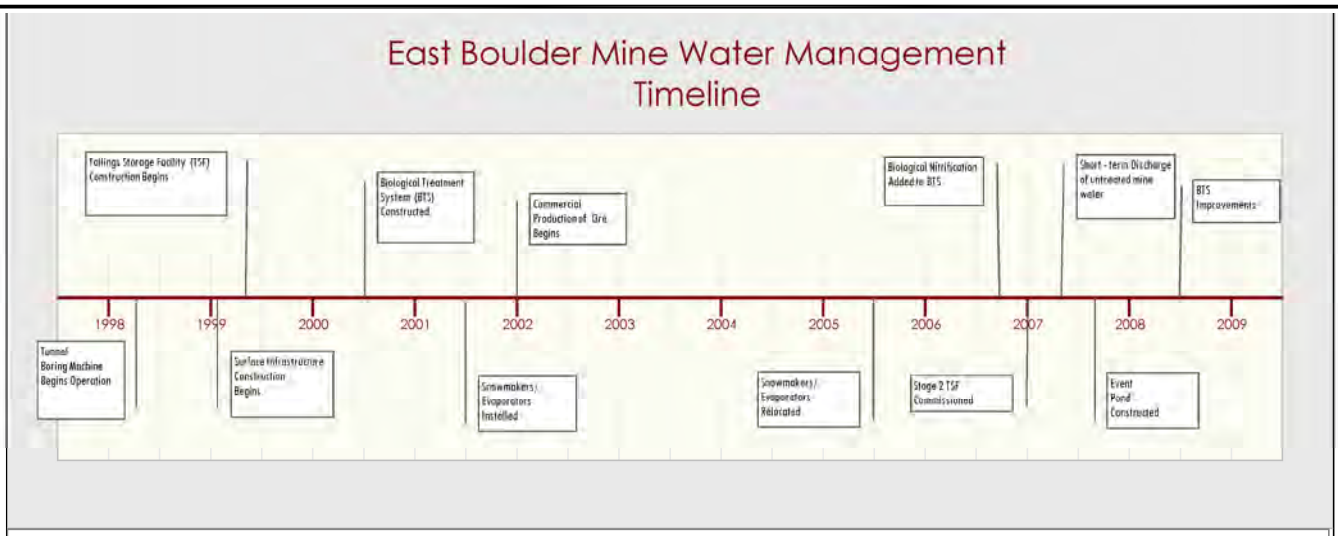
DWG:Edited 1200graphs.dwg		LAYOUT:3-12	FIGURE 3-12
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/16/2009	

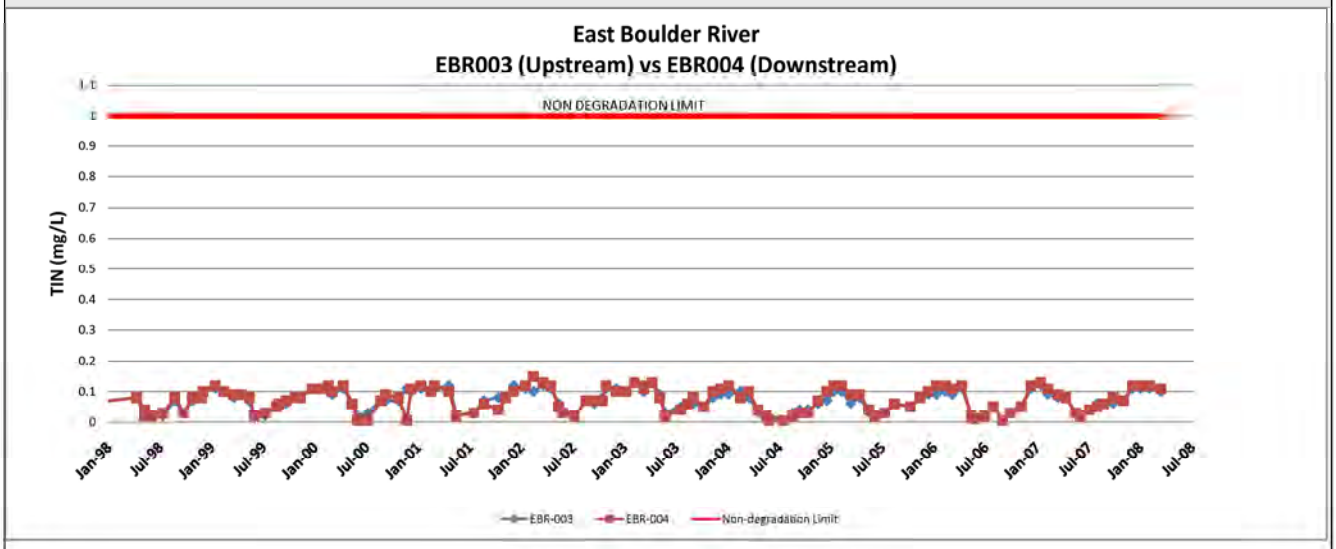


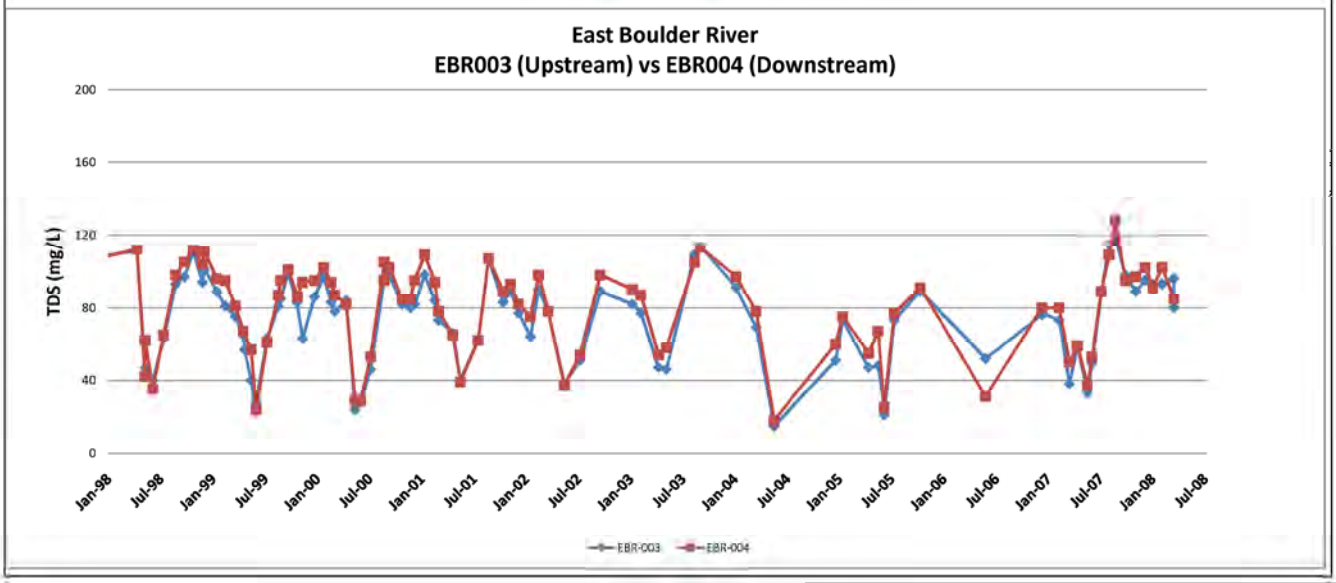
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TIN CONCENTRATIONS IN THE STILLWATER RIVER NEAR HERTZLER RANCH

DWG:Edited 1200graphs.dwg		LAYOUT:3-13	FIGURE 3-13
DRAWN BY:ETC	PREPARED BY:JH	DATE: 3/16/2009	



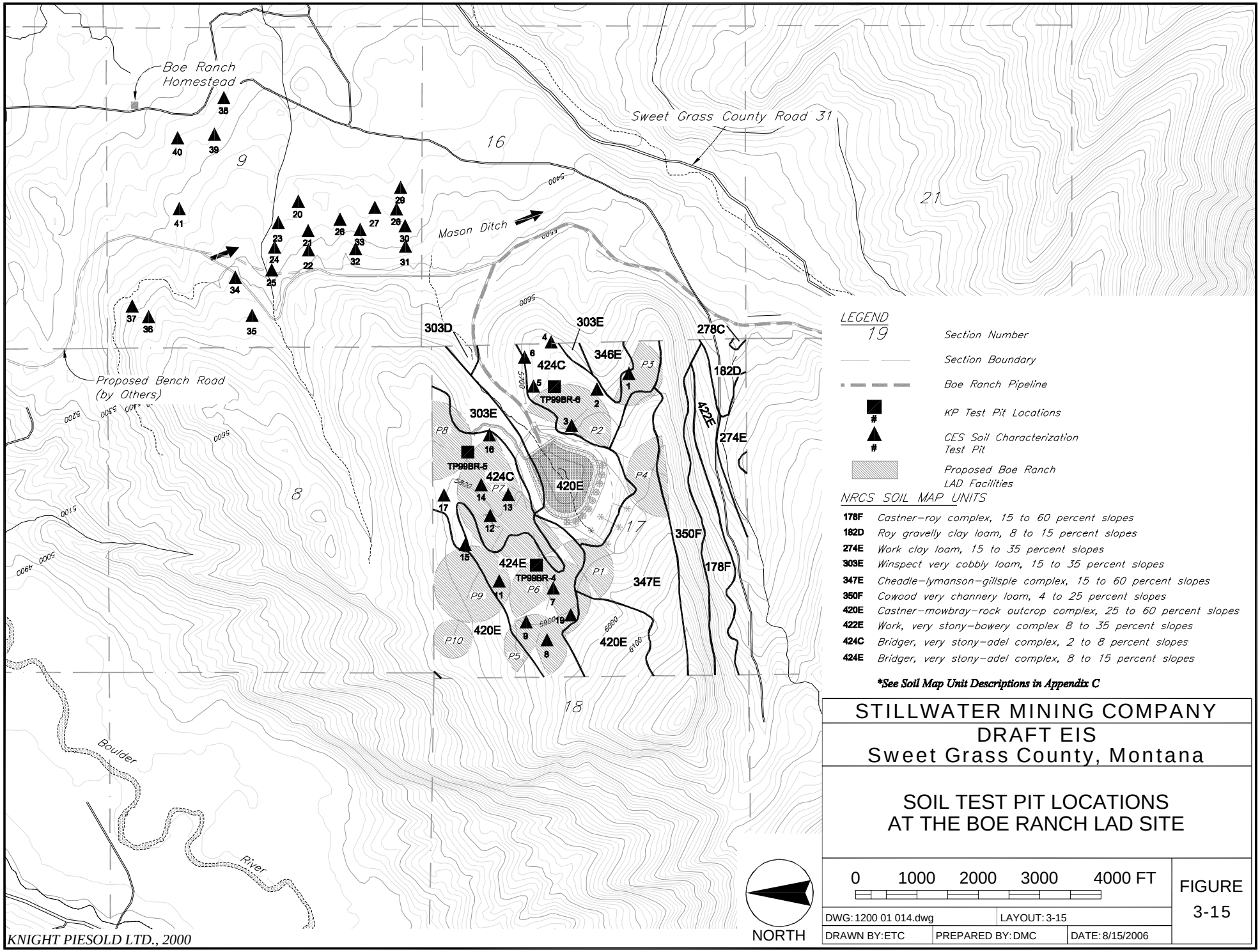




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TIN AND TDS CONCENTRATIONS
IN THE EAST BOULDER RIVER

DWG:Edited 1200graphs.dwg		LAYOUT:3-14	FIGURE **3-14**
DRAWN BY:ETC	PREPARED BY:JH	DATE:03/16/2009	



LEGEND

19	Section Number
	Section Boundary
	Boe Ranch Pipeline
#	KP Test Pit Locations
#	CES Soil Characterization Test Pit
	Proposed Boe Ranch LAD Facilities

NRCS SOIL MAP UNITS

178F	Castner–roy complex, 15 to 60 percent slopes
182D	Roy gravelly clay loam, 8 to 15 percent slopes
274E	Work clay loam, 15 to 35 percent slopes
303E	Winspect very cobbly loam, 15 to 35 percent slopes
347E	Cheadle–lymanson–gillsple complex, 15 to 60 percent slopes
350F	Cowood very channery loam, 4 to 25 percent slopes
420E	Castner–mowbray–rock outcrop complex, 25 to 60 percent slopes
422E	Work, very stony–bowery complex 8 to 35 percent slopes
424C	Bridger, very stony–adel complex, 2 to 8 percent slopes
424E	Bridger, very stony–adel complex, 8 to 15 percent slopes

See Soil Map Unit Descriptions in Appendix C

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SOIL TEST PIT LOCATIONS AT THE BOE RANCH LAD SITE

0 1000 2000 3000 4000 FT

FIGURE 3-15

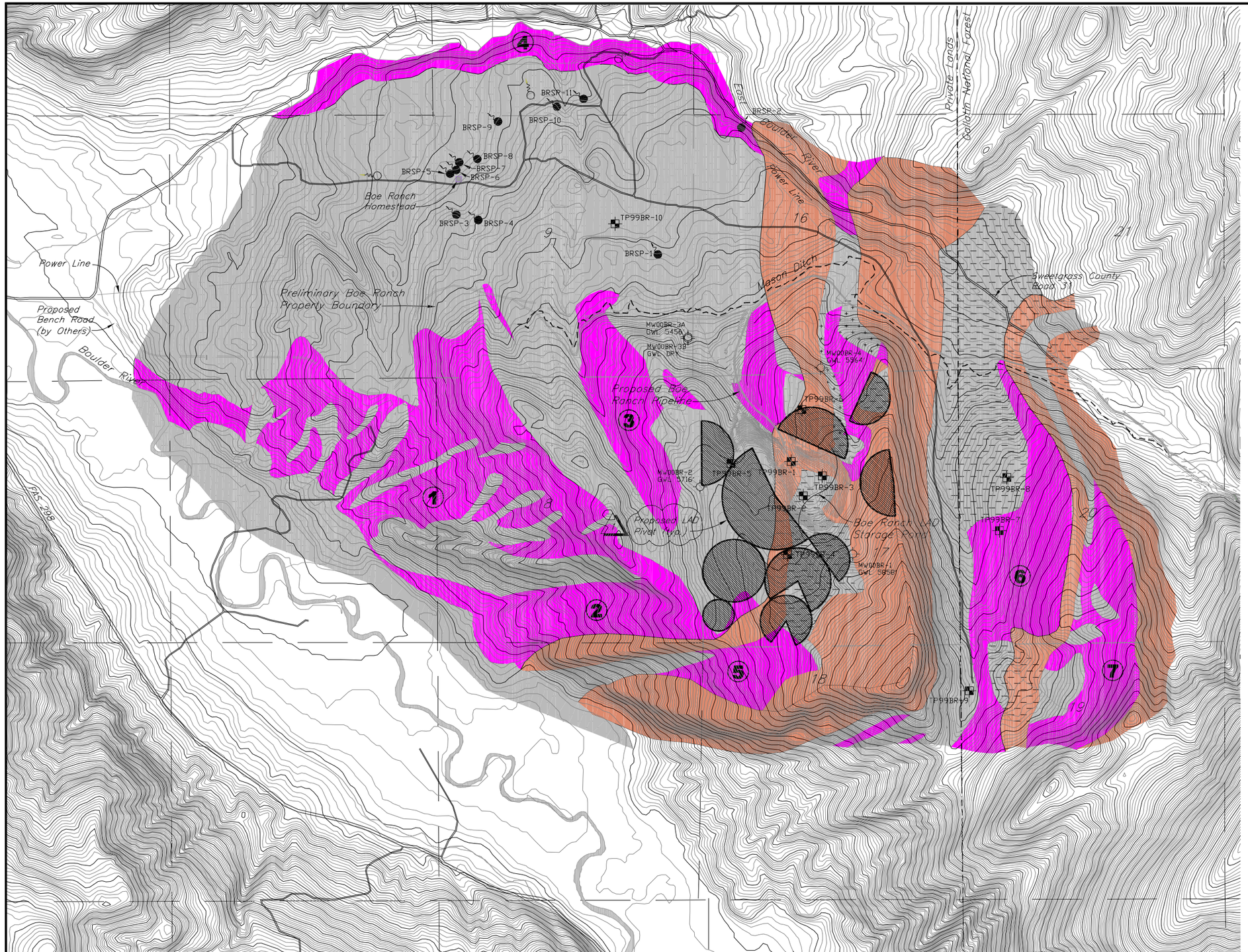
DWG: 1200 01 014.dwg | LAYOUT: 3-15

DRAWN BY: ETC | PREPARED BY: DMC | DATE: 8/15/2006

KNIGHT PIESOLD LTD., 2000



Figure 3–16 Photograph of the Proposed Boe Ranch LAD Site



LEGEND

- TP99BR-1 — *Test Pit Locations*
- MW00BR-1 GWL 5858' — *Monitoring Well Locations*
- BRSP-1 — *Groundwater Spring*
- *Seep*
- *Center Pivot Irrigation*
- *Sandstone (Frontier and Kootenai Formations)*
- *Shale (or claystone, mudstone and/or siltstone) – Recessive, potentially problematic units*
- *Where shale slope aspect is different from shale bedding orientation by greater than 45°*
- *Where shale or sandstone slope gradient is less than or equal to 15% (9°)*
- (1) *Areas of concern due to mass movement potential*

NORTH

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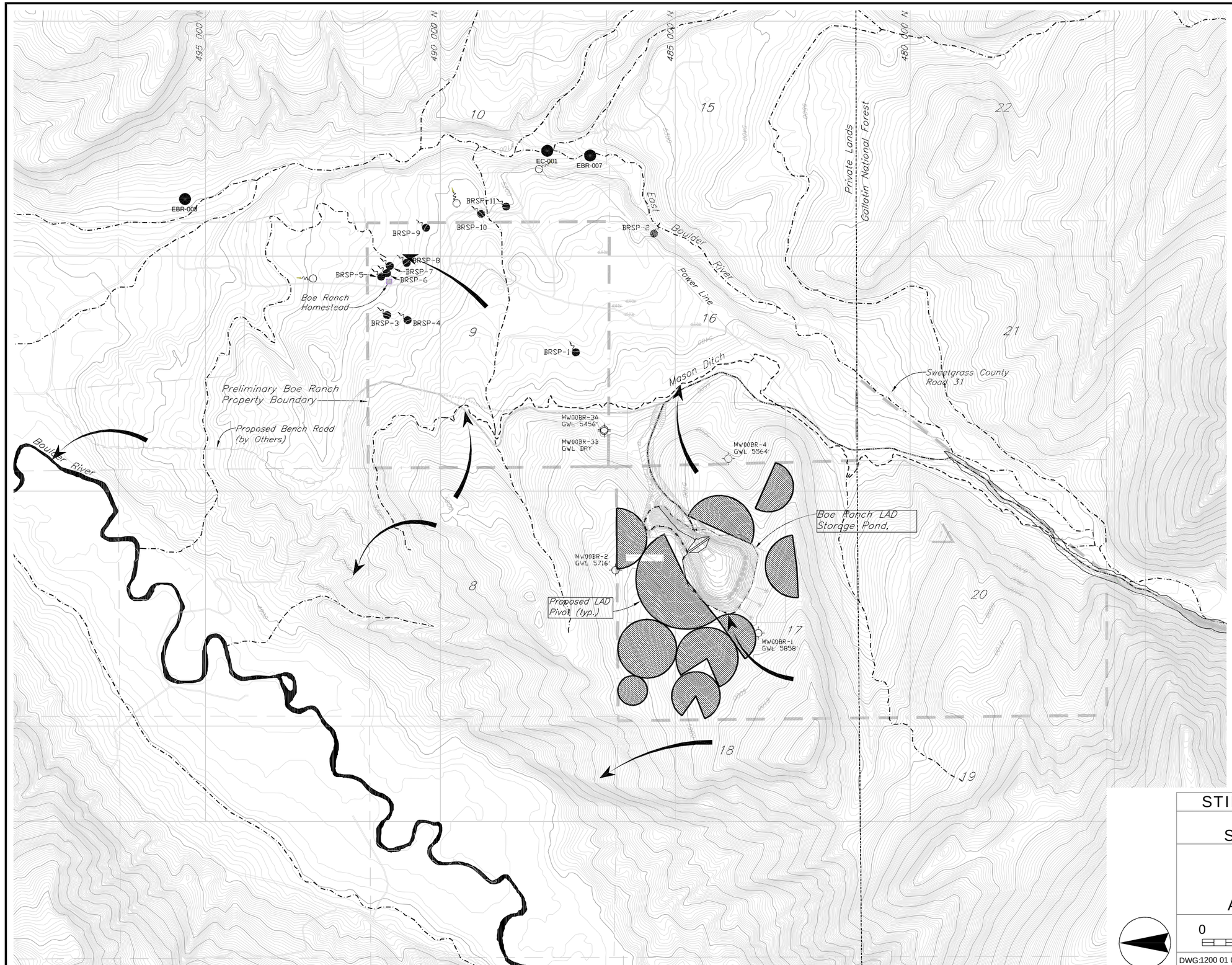
BOE RANCH BEDROCK GEOLOGY
MASS MOVEMENT POTENTIAL

0 1000 2000 3000 4000 FT

FIGURE 3-17

DWG:**1200 01 015.DWG**	LAYOUT:**3-5**	
DRAWN BY:ETC	PREPARED BY:HS	DATE:02/27/07

KNIGHT PIESOLD LTD., 1996



LEGEND

- MW00BR-1 GWL 5858' — Monitoring Well Locations
- BRSP-1 — Groundwater Springs
- Seep
- Marsh
- Proposed Center Pivot Irrigation
- Road
- Local and Intermediate groundwater flow direction
- # — Surface Water Monitoring Site
- Irrigation Ditch
- Streams
- Boe Ranch Pipeline

KNIGHT PIESOLD LTD., 1996

NORTH

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WATER RESOURCES
AT BOE RANCH LAND
APPLICATION DISPOSAL SITE

0 1000 2000 3000 4000 FT

FIGURE 3-18

DWG:1200 01 017.dwg	LAYOUT:3-18	
DRAWN BY:ETC	PREPARED BY:DMC	DATE:2/27/2007

Chapter 4 — Environmental Consequences

This chapter describes the potential effects of each of the alternatives described in Chapter 2. Data and analyses from previous environmental reviews (see synopses in Appendix A) also were incorporated into this analysis. The intent of this chapter is to provide the scientific and analytical basis for the comparison of alternatives presented in Chapter 2. The discussion in this chapter includes direct, indirect, and cumulative effects from implementation of the Proposed Actions and alternatives. The chapter discusses measures that are part of existing operations at Stillwater Mining Company's (SMC's) facilities and additional mitigation measures that would be considered for the new plans and facilities.

In this analysis, an environmental effect is defined as any change from the present condition of any resource or issue that may result as a consequence of the agencies' decision to implement a Proposed Action or an alternative to the Proposed Action. An environmental effect may be adverse, beneficial, or both. Effects are analyzed by considering the impact of an action on a resource. For the environmental effects analysis, the following definitions were applied:

- Beneficial effect – a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
- Adverse effect – in the context of most resources, an adverse effect refers to a change that moves the resource away from a desired condition or detracts from its appearance or condition.
- Direct effect – occurs at the same time and place as the action that triggers the effect.
- Indirect effect – occurs at a different location or later time than the action that triggers the effect.
- Short-term impact – an impact that within a short period would no longer be detectable as the resource is returned to its pre-disturbance condition or appearance.
- Long-term effect – a change in a resource or its condition that does not return the resource to pre-disturbance condition or appearance and, for all practical purposes, is considered permanent.
- Irreversible and irretrievable loss – those effects that are not eliminated by mitigation.

This chapter includes an analysis of the following issues identified during the scoping process:

- **Issue 1: Water Quality and Quantity**

  Project scoping identified concerns that implementation of the Proposed Actions might change the existing quality and quantity of water around the Stillwater Mine, the East Boulder Mine, the East Boulder Boe Ranch Land Application Disposal (LAD) area, or all three. Water effects relative to the three Proposed Actions are discussed in Section 4.1.

- **Issue 2: Wildlife and Aquatic Resources**

  Project scoping indicated that implementation of portions of the Proposed Actions might affect wildlife and aquatic life near both mines at closure and post-closure, and aquatic life on and near the Boe Ranch during operations. Wildlife issues relative to the Boe Ranch are discussed in Section 4.2.1. Potential effects to aquatic life relative to the three Proposed Actions are discussed in Section 4.2.2.

- **Issue 3: Irrigation Practices**

  Concerns were identified related to implementation of the Boe Ranch LAD System Proposed Action, which could affect natural resources on the Boe Ranch. Irrigation practices and potential effects at the Boe Ranch are discussed in Section 4.3.

- **Issue 4: Cultural Resources**

  Public and agency comments indicated that implementation of the Boe Ranch LAD system Proposed Action might adversely affect cultural resources on the property. The potential effects to cultural resources at the Boe Ranch are discussed in Section 4.4.

- **Issue 5: Stability of the Boe Ranch LAD Storage Pond**

  Implementation of the Boe Ranch LAD System Proposed Action would result in construction and long-term use of a 32-acre LAD storage pond to store treated mine waste waters before routing to the Boe Ranch LAD center pivots. The geology of the Boe Ranch and potential effects of irrigation practices on LAD storage pond stability are discussed in Section 4.5.

Chapter 4 also includes a review of cumulative effects. The following table summarizes projects in the analysis area with potential cumulative effects and under which issues the cumulative effect will be discussed.

Table 4-1 Actions with Potential to Contribute to Cumulative Effects

Action	Stillwater Mine	East Boulder Mine	Boe Ranch	Applicable Issue	Comments
Oil and Gas Exploration and Development	Yes (Dean Dome)	N/A[1]	N/A	1[2]	Present and Reasonably Foreseeable
Hard Rock Mineral Exploration	Yes (Small scale hard rock mineral exploration projects)	Yes (Small scale hard rock mineral exploration projects)	N/A	1	Past, Present, and Reasonably Foreseeable
Historic Mining	Yes (Mountain View and Mouat Mines)	N/A	N/A	1, 2[3], 4[4]	Past (Pre-SMC)
Wildland Fire	Yes (Approximately 30 thousand acres within last decade)	Yes (Approximately 200 thousand acres within last decade)	N/A	1, 2, 4	Past
Future Wildland Fire	Unknown	Unknown	Unknown	1, 2, 4	Reasonably Foreseeable
Subdivisions	Yes (from newly developing subdivisions)	No	Yes	1, 2, 4	Past, Present, and Reasonably Foreseeable
Agriculture (grazing and hay production)	Yes	No	Yes	1, 2, 3[5]	Past, Present, and Reasonably Foreseeable
Invasive Species (*Didymosphenia geminata*)	Yes	Yes	No	1, 2	Past, Present, and Reasonably Foreseeable
Invasive Species (Noxious Weeds)	Yes	Yes	Yes	1, 2	Past, Present, and Reasonably Foreseeable
Mass Wasting due to LAD Practices	No	No	Yes	1,2,3,5[6]	Past, Present, and Reasonably Foreseeable
USFS Travel Management Plan Implementation	Yes	Yes	No	1,2,4	Present and Reasonably Foreseeable

[1] Not Applicable
[2] Issue 1: Water Quality and Quantity
[3] Issue 2: Wildlife and Aquatic Resources
[4] Issue 4: Cultural Resources
[5] Issue 3: Irrigation Practices
[6] Issue 5: Stability of the Boe Ranch LAD Storage Pond

4.1 Water Quality and Quantity Effects

This section summarizes the results of the analyses of effects to ground and surface water resources (Appendix C, DEQ 2010). SMC handles three waste water streams from its operations at the Stillwater and East Boulder mines. One stream is adit water, which is intercepted ground water and any make-up water needed for operations underground. The second stream is process water, which reports to the tailings impoundments, and is also called tailings waters. This stream includes water that has been used in the milling and concentrating circuits and for slurrying tailings. The third stream is storm water.

During project scoping, specific concerns related to water quality and quantity were raised. From those concerns, an issue statement was composed to articulate how the No Action Alternatives (1A, 1B, and 1C), Proposed Action Alternatives (2A, 2B, and 2C), and Agency-Mitigated Alternatives (3A, 3B, and 3C) might change the quality and quantity of water around the Stillwater and East Boulder mines and/or the East Boulder River valley at and surrounding the Boe Ranch LAD area. Most of these concerns relate to potential effects caused by nitrates discharged into water from the mines during operations, closure, and post-closure. Specific issues identified included the following:

- Discharges of waters containing nitrates, salts, heavy metals, or sediment from mine adits or storm water discharged during closure and post-closure;
- Discharges of tailings impoundment waters associated with impoundment dewatering during closure, which could vary in quality and quantity depending on how water would be routed. Water quality and quantity differences could result from treatment and disposal of tailings waters (comprised of supernatant water, which is free standing water on the tailings mass, and tailings mass water), liner leakage, open or plugged underdrains, and/or seepage through the reclamation cover at closure and post-closure;
- Inadequate treatment of nitrates during snowmaking at the Boe Ranch during operations and closure;
- Effects to the East Boulder River from uncontrolled discharges of adit water containing elevated nitrate levels that could result from a ruptured pipeline feeding the Boe Ranch LAD system from the East Boulder Mine during operations and closure;
- Discharges of adit and tailings impoundment waters used to irrigate the Boe Ranch, which contain low concentrations of nitrates or other contaminants, to ground and surface water. This discharge could result from the Boe Ranch LAD facilities if inappropriate application rates are used during operations and closure; and
- Post-closure discharges of water from the adits, tailings impoundments, and storm water runoff discharged directly to surface or ground water.

Existing data from both mines and scientific calculations based on the data were used to determine the potential for effects associated with the concerns listed above (Appendix C, DEQ 2010). Maximum permitted and current operational adit flows were evaluated to provide the total possible range of effects. Specific analyses included the following:

- Environmental effects were estimated through analyses of potential changes in water chemistry, operational experience at both mines, the results of monitoring conducted since operations began at each mine, and professional interpretation of site-specific data and conditions.
- Water balances at both mines were evaluated to identify all sources of water at each mine.
- Mine water volume estimates, ground water flow rates, and mine waste water quality data were used to evaluate the volume and quality of water discharged during operations, closure, and post-closure.
- Mine waste water treatment time frames were also evaluated. As necessary, changes to the monitoring programs at both mines were considered.

Scoping conducted for this EIS identified potential concerns related to salt discharge during closure, which had not been raised in past analyses. The agencies reviewed adit and tailings waters data and concluded that salts could potentially affect water quality during operations and closure. The agencies assessed potential salt effects in these analyses.

For these analyses, the agencies have used the standard Montana Pollutant Discharge Elimination System (MPDES) permit analysis method used by the DEQ and approved by the U.S. Environmental Protection Agency (EPA) for predicting effects to ground and surface water. The disclosure of water quality and quantity effects is based on the premise that adherence to the MPDES permits and surface and ground water quality standards are protective of downstream beneficial uses. SMC has various options for disposal of adit and tailings waters during operations and closure to meet water quality standards (For the Stillwater Mine, see Figures 2-1, 2-4, 2-8, and 2-14. For the East Boulder Mine, see Figures 2-18, 2-19, 2-22, 2-25, and for the Boe Ranch LAD, see Figures 2-28, 2-29, and 2-33).

For the nitrogen analyses, which were based on operational adit water data, the agencies used historical maximum nitrogen loads after treatment in the Biological Treatment System (BTS) at the Stillwater Mine and the BTS/Anox (nitrification) treatment system at the East Boulder Mine. A load represents the total amount of a contaminant in a waste water stream and is calculated by multiplying the flow rate times the concentration. In these analyses, nitrogen concentrations in adit water were determined by dividing the maximum historical load after treatment by the adit flow rate. As the adit flow rate increased, the nitrogen concentration decreased. As the adit flow rate decreased, nitrogen concentrations increased. In these analyses, the agencies used a constant nitrogen concentration for tailings waters.

In the salts analyses, which were based on operational adit water data, the agencies used a constant salts concentration for adit water because an increase or decrease in adit water flow rate does not have as great an effect on the salts concentration as the nitrogen concentration. Salts are not treated in the BTS or Anox systems at the mines. The agencies used the median adit and tailings waters salts concentrations in the analyses.

Total dissolved solids (TDS) is a measure of mineral salts dissolved in water. Electrical conductivity (EC) is a measure of water salinity and is directly related to the TDS content of the water. As TDS increases, EC increases. The EC value in water is calculated by multiplying the TDS concentration times 1.56. Both TDS and EC are important measures in these analyses. The terms TDS and salts are used interchangeably in this document. Salinity concentrations differ between adit and tailings waters. There are no standards or MPDES permit limits for salts in ground or surface water. For these analyses, the agencies used 250 milligrams per liter (mg/L) TDS in surface water as a conservative recommendation to identify any potential effects to trout eggs (DEQ-7, Custer National Forest and Gallatin National Forest 2009). The agencies remind the reader that the 250 mg/L TDS concentration used is not a regulatory limit but an analysis goal.

Montana has established classes of ground water based on electrical conductivity (EC) to ensure that beneficial uses are protected (Montana Ground Water Pollution Control System Subchapter 10, Administrative Rules of Montana (ARM) 17.30.1006). Class I ground water has an EC of less than 1,000 micromhos per centimeter (µmhos/cm). Class II ground water has an EC of greater than 1,000 and less than 2,500 µmhos/cm. In these analyses, the agencies have used these EC class guidelines to limit impairment to future beneficial uses at each site.

For these analyses, the agencies developed spreadsheets to evaluate the preferred disposal option by alternative to ensure that the hydraulic load of water needing treatment and disposal could be managed (*i.e.* BTS design capacity, LAD storage pond capacity, percolation pond percolation capacity, LAD system design capacity and LAD maximum application rate) (Appendix C, DEQ 2010). If the preferred disposal option by alternative was hydraulically limiting, the agencies assumed another non-prescriptive disposal option to evaluate at least one reasonable operation, closure, or post-closure disposal option. If the hydraulic load of the water treatment and disposal system was not limiting, the agencies conducted nitrogen and salts loading analyses. In the future, these spreadsheets can be modified as new data are collected and used throughout mine life to verify predictions made in these analyses and to guide future decision making.

SMC has many water management options during operations and closure to limit effects from adit and tailings waters disposal at the two mines and the proposed Boe Ranch LAD area. These options include but are not limited to**:**

- improving housekeeping in the underground workings to limit nitrogen and salts concentrations in adit water;
- improving treatment efficiency in the BTS at both mines and the Anox system at the East Boulder Mine;

- implementing an Anox system at the Stillwater Mine;
- using percolation ponds at either mine, as needed, to dispose of water when LAD is not possible;
- running center pivots for 24 hours per day rather than 12 hours per day if appropriate;
- adding more center pivots;
- disposing of some adit and/or tailings waters in the underground workings if needed at the Stillwater Mine;
- disposing of tailings slimes underground to accelerate closure of the Stillwater tailings impoundment;
- disposing of tailings slimes in the LAD storage ponds to accelerate closure of the Hertzler Ranch and/or the East Boulder tailings impoundments;
- applying for a ground water mixing zone at the Hertzler Ranch or at the Boe Ranch;
- separating unaltered ground water in the underground mines so the water does not need to go through the BTS or Anox system;
- adding more evaporators or snowmakers if needed;
- bleeding off some of the tailings waters periodically during operations and replacing them with adit water, which has a lower nitrogen and salts content;
- implementing an operational microfiltration system to reduce nitrogen and salts content in tailings waters, if needed;
- extending the time to dewater the tailings impoundments which would allow for application of tailings waters at slower rates to limit nitrogen and salts effects at closure; and
- using evaporation in the tailings impoundments as described in the No Action alternatives to limit salts effects to ground water, surface water; vegetation, and soils.

4.1.1 Stillwater Mine Closure and Post-Closure Water Management Plan Alternatives 1A, 2A, and 3A

The effects analyses for the Stillwater Mine Closure and Post-Closure Water Management Plan (WMP) Alternatives 1A, 2A, and 3A are supported by data collected since operations began in 1986 at the Stillwater Mine. These data have been used in various modeling exercises undertaken by both SMC and the agencies to make projections about water quality and quantity effects to ground and surface water at the mine during operations, closure, and post-closure (Appendix C, DEQ 2010). Although there is ample information about the quality and quantity of adit and tailings waters during operations, past analyses and environmental documents have not thoroughly evaluated the effects to ground and surface water from adit and tailings waters disposal during the closure and post-closure phases of mining operations.

The Stillwater Mine's MPDES permit has established an allowable average mine water discharge flow rate of 2,000 gpm and an averaged monthly discharge load of 100 lbs/day for total nitrogen from all mine water sources. The MPDES permit sets a maximum nitrogen concentration limit of 1 mg/L total nitrogen (TN) in surface water. The ground water quality standard for nitrogen is 10 mg/L. All nitrogen modeling conducted for the following analyses use these limits to evaluate the effectiveness of the water management proposed in these alternatives. It is assumed that these limits are protective of water quality and the environment.

For input variables, information has been drawn from site specific data, threshold limits contained in the MPDES permit, and the Montana Numeric Water Quality Standards (DEQ-7). Common to all of the analyses is the requirement to stay within the limits prescribed by the MPDES permit. The principle constituent of concern at the Stillwater Mine is nitrogen. There are also elevated levels of salts in both the adit and tailings waters. The salts effects on ground and surface water have not been evaluated in previous environmental documents for the Stillwater Mine.

This evaluation includes other input variables based on observed and projected water quality and quantity parameters. To evaluate the nitrogen and salts effects, the agencies have examined the closure and post-closure conditions using the following assumptions:

- Adit discharge rates of 650 gpm and 2,020 gpm (approved adit discharge rate under the Operating Permit)
- Nitrogen load contributed by the adit discharge after treatment equals 50 lbs/day
- Tailings waters nitrogen concentration equals 50 mg/L (TN)

- Tailings waters nitrogen concentration post-BTS treatment equals 10 mg/L (TN)
- TDS recommendation of 250 mg/L in surface water at the Stillwater Mine site to minimize effects to trout eggs
- EC limit of 1,000 µmhos/cm in Class I ground water to protect beneficial uses
- 80 percent nitrogen concentration reduction credit for plant uptake during summer LAD
- 80 percent nitrogen concentration reduction for winter snowmaking
- 30 percent reduction in water volume during summer and winter LAD

All of the modeling exercises account for flow, load, and concentration of nitrogen and salts. The ability to meet MPDES permit limits and DEQ-7 water quality criteria depends on the efficiency of treatment provided by the disposal options available in the Stillwater Mine WMP, including summer LAD, winter snowmaking, percolation, and direct discharge. The modeling presented in Appendix C and summarized in the following sections examines combinations of discharge rates and disposal locations to assess whether the mine waste water streams can be treated and discharged within an assumed one-year closure time frame while satisfying the applicable water quality criteria.

4.1.1.1 Operational Nitrogen and Salts Effects to Water Quality and Quantity at the Stillwater Mine and the Hertzler Ranch

4.1.1.1.1 Nitrogen Effects

Adit water picks up nitrogen from blasting compounds as it moves through the underground mine workings. SMC's treatment process includes primary treatment in the BTS and secondary treatment using LAD. Since 2001, the BTS has consistently achieved an average of 94 percent reduction in influent nitrate plus nitrite concentrations of adit water. The average concentration of nitrate plus nitrite in the pre-treatment adit water is 30 mg/L. The BTS reduces the concentration to less than 10 mg/L in the post-treatment adit water and, as designed, can treat more than 1,000 gallons per minute (gpm).

The Stillwater Mine BTS cannot treat ammonia. Ammonia, as well as the remaining nitrate plus nitrite in the adit water, would be treated using LAD at the Hertzler Ranch after being discharged from the BTS.

Operational disposal options for adit water at the Stillwater Mine include the Hertzler Ranch LAD area and mine percolation ponds. SMC receives a nitrogen

treatment credit in its MPDES permit for summer LAD. No nitrogen treatment credit is allowed for mine waste waters discharged to the percolation pond. SMC has used these disposal options since operations began.

In 2009, the Stillwater Mine intercepted an average of 650 gpm of ground water (250 gpm from the east-side workings and 400 gpm from the west-side workings). The 250-gpm flow on the inactive east side contains 0.2 mg/L nitrogen and is disposed of in the east-side percolation ponds without treatment, producing a load of less than 1 lb/day. The 400-gpm flow on the active west side is treated and preferentially land applied at the Hertzler Ranch LAD area.

SMC maximizes recycling of adit water during operations. Up to 500 gpm are treated and discharged to the Hertzler Ranch LAD area during operations. No mine waste waters, except spills, have been disposed of on the Stillwater Mine west side since 2003 when the west-side percolation ponds were lined. Water has not been disposed of in the Stillwater Valley Ranch percolation ponds for years.

No violations of the MPDES permit, which limits the average annual nitrogen discharge to 100 pounds per day (lbs/day) total nitrogen (TN), or the surface water standard (1 mg/L) have occurred since operations began in 1986. Ground and surface water effects from discharging mine waste waters are minimal at the Stillwater Mine. No downstream beneficial uses have been compromised. During operations and closure, SMC would be required to comply with its approved storm water management plan.

Excess adit water not recycled in the mine is being treated and routed to the Hertzler Ranch LAD area. Since the BTS has been commissioned, the maximum load of nitrogen disposed of in treated adit water at the Hertzler Ranch has not exceeded 50 lbs/day.

SMC has discharged nitrogen at the Hertzler Ranch to ground water since 1999. No nitrogen violations of the ground water standard (10 mg/L) or the Stillwater River standard (1 mg/L) used in the Stillwater Mine MPDES permit have occurred since operations began at the Hertzler Ranch. The only operational increases in ground water nitrogen levels have occurred after leaks from the Hertzler Ranch tailings impoundment and Hertzler Ranch LAD storage pond. Leaks have been repaired, and the nitrogen in ground water has been flushed out of the ground water system. Ground and surface water effects from discharging adit water at the Hertzler Ranch during operations are minimal. No downstream beneficial uses have been compromised.

4.1.1.1.2 Salts Effects

TDS can be used to compute a total salts load applied to a site and can be a helpful indicator in surface water of suitability for trout habitat. EC is the measure used for the State of Montana's beneficial use criteria in ground water. EC can also be measured in soil: it is used to monitor salts buildup and to compute the need to apply excess water to prevent salts from accumulating in soil. As salts are flushed from soils, TDS and EC increase in ground water and

can increase in surface water. Salts are mobile and are readily flushed from soils when water moves through the soil profile.

Salts concentrations in mine water are increased by several mining processes. The milling process grinds up the ore and liberates salts. Reagents used in the milling process add salts to tailings waters. Grouting in the underground workings adds salts to adit water. Adit water flushes salts from tailings backfill in the mine, which increases the adit water salts level. BTS treatment, summer LAD, winter snowmaking, and percolation do not reduce the salts load in adit and tailings waste water streams.

Evaporation from LAD and snowmaking operations increases salinity in mine waste waters. Soil salts management for LAD areas may require soil flushing to move salts beyond the root zone. SMC must balance the amount of nitrogen removal achieved from LAD operations with the potential to increase the salts concentration in land-applied waste water and in soils. SMC may need to land apply mine waste waters at rates that flush accumulated salts from soil and minimize salts buildup in the root zone. Mine percolation ponds have had surface soils removed to expose the Stillwater River alluvium. Percolation pond discharges minimize evaporation and ensure salts are flushed below the root zone.

Deep percolation through LAD area soils may occur naturally in the spring each year from snowmelt and rainfall as soils become saturated and soil water discharges *(i.e.* percolates) through the unsaturated zone to ground water. Some salts in the soils can leach to ground water from LAD during the growing season. The LAD rate must exceed the soil water-holding capacity in order to flush salts from soil. In the spring, the remaining salts stored in the soil can leach with snowmelt and precipitation through the soil profile below the plant root zone into the ground water system. Assuming zero percent of the salts are used in the soil by plants, 100 percent of the salts are available to leach to ground water. SMC has never exceeded the Class I ground water EC level (1,000 µmhos/cm) at the Stillwater Mine from use of the percolation pond or LAD system.

Mining on the east side ended before 2003. The 250-gpm flow of east-side adit water contains 250 mg/L TDS and is disposed of in the east-side percolation ponds without treatment, producing a load of 3,100 lbs/day salts. The Stillwater Mine MPDES permit does not contain a discharge limit for salts. No increased discharge from mining is planned in the foreseeable future on the east side; therefore, no changes in untreated adit water salts loads on the east side are foreseen for the rest of mine life.

Since 2000, all west-side treated adit water has been discharged at the Hertzler Ranch LAD area. SMC has discharged salts at the mine to ground water since mine operations began over 20 years ago. No additional salts effects at the Stillwater Mine are anticipated during operations because all treated adit water is preferentially discharged at the Hertzler Ranch site. Ground and surface water effects from discharging mine waste waters at the Stillwater Mine during operations should continue to be minimal. No downstream beneficial uses have been compromised.

Adit water is treated and routed to the Hertzler Ranch LAD storage pond where it is stored until it can be disposed of during the growing season. SMC treats and disposes up to 500 gpm of adit water with an average post-BTS concentration of 491 mg/L salts. SMC does not have an MPDES permit at the Hertzler Ranch and has no regulatory salts limit. During the growing season, SMC must dispose of all mine waste waters stored in the Hertzler Ranch LAD storage pond, as well as the excess operational adit water not recycled in the mine. SMC has been discharging salts to ground water at the Hertzler Ranch for almost 10 years.

The Class I ground water EC level (1,000 µmhos/cm) has not been exceeded since operations began at the Hertzler Ranch. Discharging treated adit water at the Hertzler Ranch during operations has had minimal effects on ground and surface water salts concentrations. No downstream beneficial uses have been compromised.

4.1.1.1.3 Other Effects

Tailings waters remain in the Stillwater and Hertzler Ranch tailings impoundments during operations unless excess tailings waters need to be disposed of at the Hertzler Ranch LAD area. Under all alternatives, SMC would have the option to dispose of tailings waters operationally if needed. Previous environmental documents examined effects from 1 gpm of tailings impoundment liner leakage from the Stillwater and Hertzler Ranch tailings impoundments during operations. The Stillwater tailings impoundment has no underdrain. No effects from underdrain seepage at the Hertzler Ranch tailings impoundment occur during operations because the underdrain seepage is recycled back into the tailings impoundment.

4.1.1.2 Closure Nitrogen and Salts Effects to Water Quality and Quantity at the Stillwater Mine and the Hertzler Ranch

Potential effects to water quality and quantity at closure may result from the following: adit water, tailings supernatant water, and tailings mass water disposal; tailings impoundment liner leakage; tailings impoundment underdrain seepage from the Hertzler Ranch tailings impoundment; and/or seepage through the reclamation cover in both tailings impoundments.

During closure, SMC would be required to meet the average monthly MPDES permit nitrogen limit (100 pounds per day lbs/day) at the Stillwater Mine site, as during operations. SMC would be required to treat adit and tailings waters disposed of at the mine at closure until the mine waste waters meet the MPDES permit effluent limits without treatment.

4.1.1.2.1 Adit Water

Flows of adit water from the Stillwater Mine would continue after mining ceases. During closure, the flow rate of adit water would be similar to that occurring at the mine during operations (650 to 2,020 gpm, which includes 250 gpm from the east-side workings and 400 to 1,770 gpm from the west-side workings). Based on results of SMC's long-term water monitoring and management practices (*i.e.*

grouting), the potential would be limited for an increase in adit discharge up to the permitted rate of 2,020 gpm. SMC would have to continue to pump and/or treat adit water until decommissioning of the underground workings and other surface closure activities are completed. The time frame for decommissioning the underground workings would vary from six weeks under the Proposed Action Alternative 2A to 12 weeks under the Agency-Mitigated Alternative 3A.

As previously discussed, a maximum rate of 50 lbs/day nitrogen has been discharged after BTS treatment to date. At closure, blasting would cease, removing the source of nitrogen to adit water. With the nitrogen source gone, concentrations of nitrogen in the adit water would begin to decline. This conclusion is based on SMC's previous experience and experience at other mines (Appendix C, DEQ 2010). For these analyses, the agencies have chosen to use the maximum nitrogen discharge rate (50 lbs/day) for the closure period. This is a conservative analysis approach.

At closure, tailings backfilling would cease at the Stillwater Mine, and salts levels should decline as salts flush from the tailings backfill. This conclusion is based on SMC's previous experience and experience at other mines. For these analyses, the agencies have used a recommended concentration of 250 mg/L TDS to minimize surface water effects at the Stillwater Mine during closure. Unlike the nitrogen analyses, no dilution of the salts concentration has been credited in the analyses as the adit flow increases.

4.1.1.2.2 Tailings Waters

Up to 35 million gallons (MG) of Stillwater tailings waters and 45 MG of Hertzler Ranch tailings waters would be disposed of at closure. Tailings waters contain higher nitrogen concentrations than adit water. Between 2000 and 2008, nitrogen concentrations ranged from 28.5 mg/L to 59.8 mg/L nitrogen in tailings waters, with an average concentration of 42.6 mg/L. For these analyses, the agencies used 50 mg/L, a conservative nitrogen concentration for tailings waters. Tailings waters also contain higher salts concentrations than adit water. For the tailings waters analyses, the agencies used 1,870 mg/L TDS, a median salts concentration for tailings waters.

Under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, tailings supernatant and tailings mass waters would be evaporated over the tailings mass and would not contribute any nitrogen and salts effects to ground and surface water quality. Nitrogen and salts would remain in the tailings mass and would eventually be covered by the reclamation cover system. Under this approved tailings impoundment dewatering plan, the length of time to dewater and place the reclamation cover is potentially problematic. Climatic conditions, especially during the winter and early spring, would increase tailings wind erosion potential and ultimately increase the time required for impoundment capping. It would take at least two years to dewater the tailings impoundments using evaporation. This is unacceptable to the agencies and the mining company.

Under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A and Agency-Mitigated Alternative 3A, tailings waters (80 MG) would be actively pumped from both tailings impoundments to shorten the closure time frame. The Stillwater Mine closure time frame would vary from 12-months under the Proposed Action Alternative 2A to 18 months under the Agency-Mitigated Alternative 3A and at least two years under the No Action Alternative 1A.

4.1.1.2.3 Disposal Options

For these analyses, water quality effects at closure were evaluated for adit water discharge rates of 2,020 gpm, the maximum permitted adit flow, and 650 gpm, the average rate during operations. The BTS can treat up to 1,000 gpm. The agencies have assumed that as adit flow increases during operations, SMC would increase treatment capacity to ensure compliance with the Stillwater Mine MPDES permit average annual nitrogen limit (100 lbs/day), surface water standards in the Stillwater River, and ground water standards at the Hertzler Ranch. These treatment and disposal facilities would be in place at the time of closure. Salts concentrations and loads would not be reduced by treatment in the BTS at closure.

At closure, SMC has a number of permitted disposal options for adit and tailings waters that could be used under the No Action Alternative 1A, the Proposed Action Alternative 2A, or the Agency-Mitigated Alternative 3A, including evaporation over the tailings impoundments, use of the Stillwater Mine percolation ponds, the Hertzler Ranch LAD area, and direct discharge to the Stillwater River. Treated adit and tailings waters could be disposed of in the mine percolation ponds as long as the MPDES permit nitrogen limit (100 lbs/day) is not exceeded. As during operations, all west-side treated adit water (up to 1,770 gpm) could be discharged to the Hertzler Ranch LAD area. SMC would prefer not to discharge directly to the Stillwater River until post-closure.

Under the Proposed Action Alternative 2A and the Agency-Mitigated Alternative 3A, adit water would be mixed with the Stillwater Mine and Hertzler Ranch tailings impoundment waters and treated in the BTS. SMC has tested treating mixed adit and tailings waters. Results of the test indicated that the BTS can effectively treat the nitrogen in the mixed waters without upsetting or impairing the organisms in the BTS plant (SMC 2006b).

4.1.1.2.4 Nitrogen Effects

For the Stillwater Mine alternatives 1A, 2A, and 3A, the agencies analyzed several closure disposal options for adit flow (650 and 2,020 gpm) and tailings waters. In all options analyzed, the nitrogen load discharged to the Stillwater River at the Stillwater Mine would be less than the 100 lbs/day MPDES permit limit (Figure 4-1). The nitrogen concentration in ground water at the Stillwater Mine and the Hertzler Ranch would be less than the 10 mg/L total nitrogen ground water standard (Figure 4-2). Under the Agency-Mitigated Alternative 3A, if the entire nitrogen load from 80 MG of tailings waters is disposed of in one 120-day LAD season at the Hertzler Ranch, then the nitrogen concentration in ground water would exceed the trigger limit (2 mg/L above background levels)

for the Hertzler Ranch LAD area. SMC has other disposal options available and could route some treated adit and Stillwater impoundment tailings waters to the Stillwater Mine percolation ponds to avoid this problem.

Figure 4-1. Stillwater Mine and Herzler Ranch LAD Closure Projected Nitrogen Load to the Stillwater River by Alternative and Adit Flow Rate

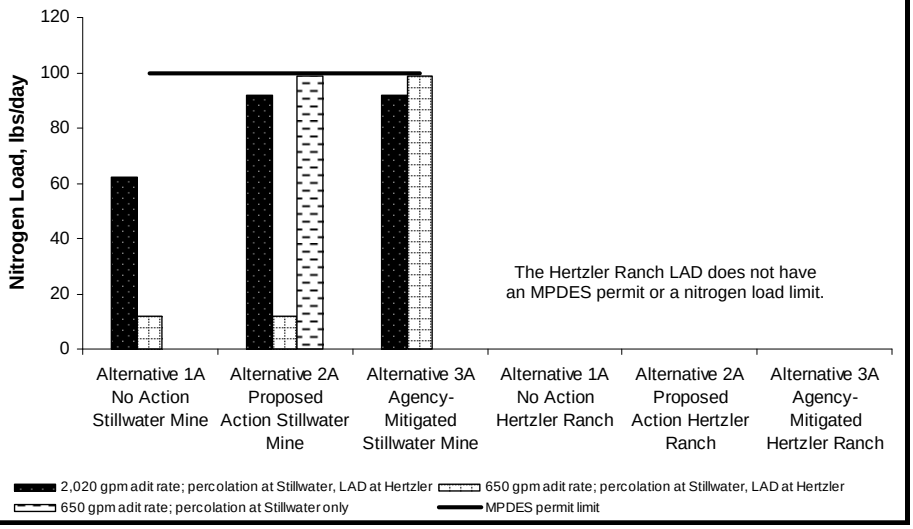
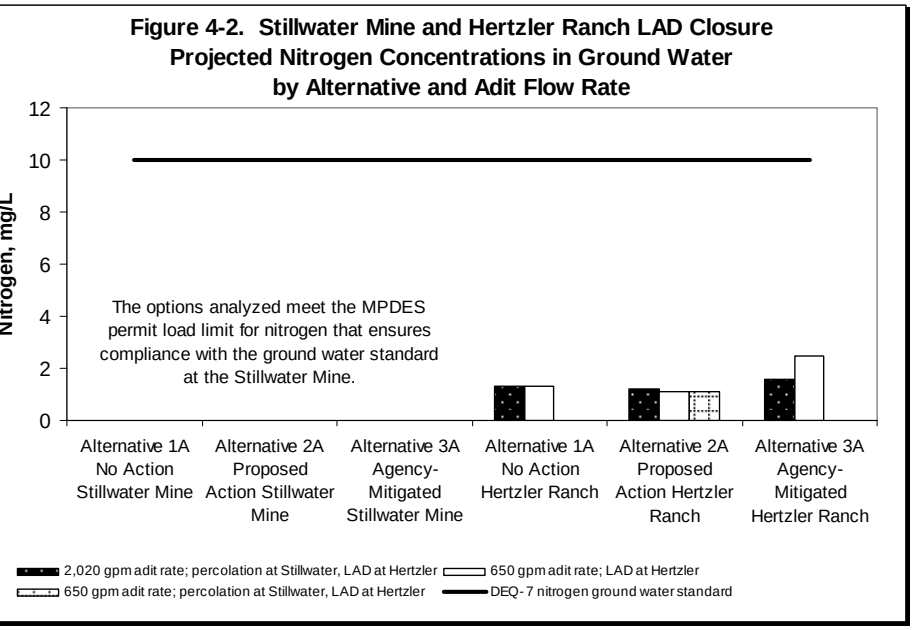


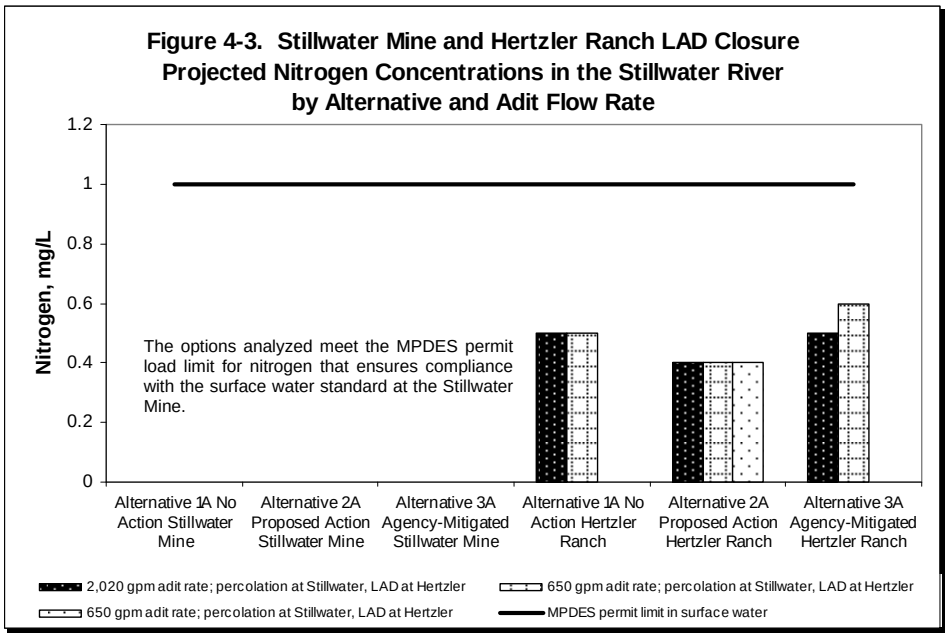
Figure 4-2. Stillwater Mine and Hertzler Ranch LAD Closure Projected Nitrogen Concentrations in Ground Water by Alternative and Adit Flow Rate



In all options analyzed under the Stillwater Mine alternatives 1A, 2A, and 3A, the projected nitrogen concentrations in the Stillwater River at the Stillwater Mine and at the Hertzler Ranch would be less than the surface water standard (1 mg/L) used for the Stillwater Mine MPDES permit (Figure 4-3). Ground and surface water at the Stillwater Mine and Hertzler Ranch would continue to show

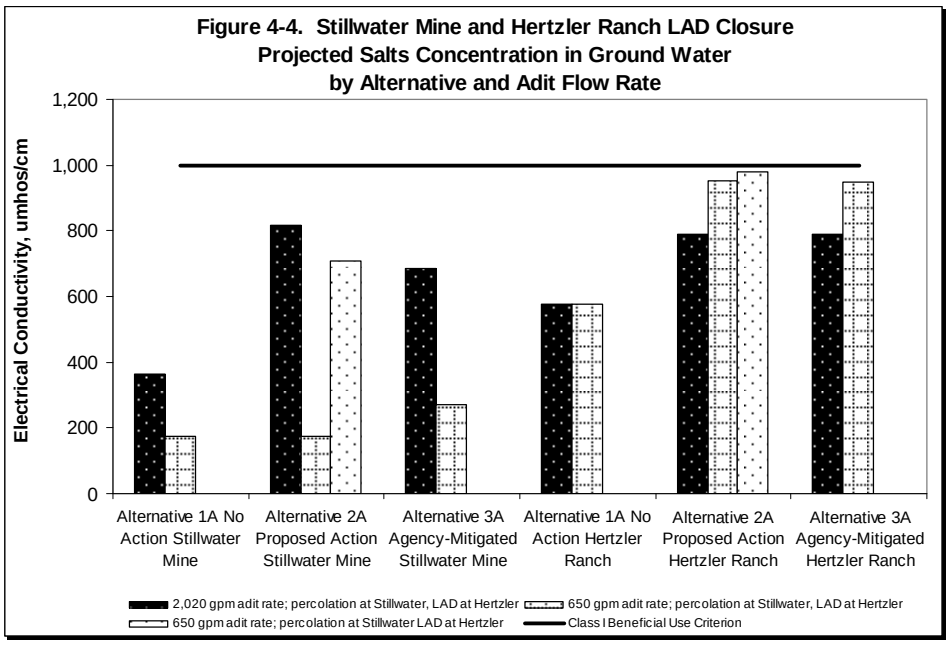
minimal effects from nitrogen that has been disposed of at the mine since 1986. No downstream beneficial uses would be compromised.

Figure 4-3. Stillwater Mine and Hertzler Ranch LAD Closure Projected Nitrogen Concentrations in the Stillwater River by Alternative and Adit Flow Rate

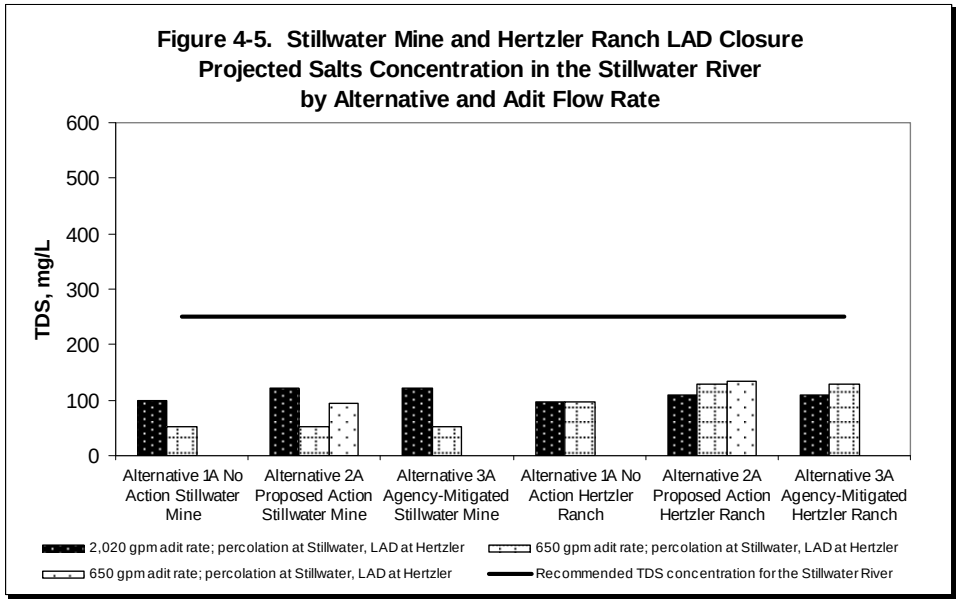


4.1.1.2.5 Salts Effects

For the Stillwater Mine alternatives 1A, 2A, and 3A, the agencies analyzed several closure disposal options for adit flow (650 and 2,020 gpm) and tailings waters. Because of the presence of Colorado shale, an exceedance of the Class I ground water standard (1,000 µmhos/cm EC) occurs in ground water in the vicinity of the Hertzler Ranch tailings impoundment for all alternatives. For all disposal options analyzed for these alternatives, the EC concentration in ground water at the Stillwater Mine and the Hertzler Ranch would be less than the EC ground water standard at the respective compliance points (Figure 4-4).



For all disposal options analyzed for these alternatives, the salts concentration in surface water at the Stillwater Mine and the Hertzler Ranch would be less than the recommended TDS water quality criteria (250 mg/L) used in the agencies' analyses (Figure 4-5). Ground and surface water at the Stillwater Mine and Hertzler Ranch would continue to show minimal effects from salts that have been disposed of at the mine since 1986. No downstream beneficial uses would be compromised.



4.1.1.2.6 Other Effects

Other effects could occur from tailings impoundment liner leakage, seepage from underdrains, seepage through the reclamation cover, and storm water. Previous environmental documents examined effects from tailings impoundment liner leakage (1 gpm) from the Stillwater and Hertzler Ranch tailings impoundments during operations. Effects from liner leakage would be the same at closure. The Stillwater tailings impoundment has no underdrain, so no effects from underdrain seepage would occur. At the Hertzler Ranch tailings impoundment, no effects from underdrain seepage would occur during closure because the underdrain seepage would be recycled back into the tailings impoundment. There would be minimal seepage through the covers at the Stillwater Mine and Hertzler Ranch tailings impoundments during closure since the reclamation covers would not be completed until well into the closure period. During closure, but prior to completion of the reclamation covers, storm water falling on the tailings impoundments would be managed as tailings waters, as it is during mine operations.

4.1.1.3 Post-Closure Nitrogen and Salts Effects to Water Quality and Quantity at the Stillwater Mine and the Hertzler Ranch

Tailings backfill and waste rock placed underground during operations would be the primary source of nitrogen and salts at post-closure. Ground water inflows into the mine workings would be expected to flush some nitrogen and salts over a longer time frame than if the workings had not been backfilled. After the closure period in each alternative, SMC would not have to treat adit water if the discharge complies with the MPDES permit nitrogen load limit and ground and surface water analyses criteria. During post-closure, some or all of the inflows into the Stillwater Mine could be used to flood the underground workings. No time frame for flooding the mine workings was estimated in previous environmental documents.

4.1.1.3.1 Adit Water

Analyses were conducted to evaluate water quality effects from three adit water disposal options during post-closure: percolation to ground water, direct discharge to surface water, and the use of some ground water inflows in the mine to accelerate mine flooding. In the first analyses for all Stillwater Mine alternatives, the agencies assumed adit water treatment would continue for one year during closure. At post-closure, no further adit water treatment would be available.

Effects from Percolation to Ground Water

2,020 gpm Flow Rate. After one year, disposal of untreated adit water (2,020 gpm) to the mine percolation ponds would result in projected ground and surface water nitrogen concentration exceedances of the DEQ-7 ground and surface water quality standards. Based on the Stillwater Mine Projected Nitrogen Concentration Decline Curve Figure in Appendix C, it could take up to 3 years to meet the ground and surface water nitrogen standards. Even at a 2,020 gpm percolation rate, the Class I ground water EC beneficial use criterion or surface water TDS recommendation would not be exceeded at closure.

To minimize post-closure effects from percolation of adit water (2,020 gpm) to ground and surface water, SMC could do the following: treat and/or land apply at the Hertzler Ranch until water quality standards could be met, route some of the adit water flow underground, or implement other water management options to comply with water quality standards. Under all Stillwater Mine alternatives, SMC has many options at post-closure to minimize water quality effects.

650 gpm Flow Rate. Under all Stillwater Mine alternatives, disposal of untreated adit water (650 gpm) to the mine site percolation ponds would not result in projected ground water nitrogen and salts concentration exceedances of ground and surface water standards and recommendations. No downstream beneficial uses are expected to be compromised at closure.

Effects from Direct Discharge to Surface Water

Up to 2,020 gpm (4.5 cubic feet per second (cfs)) of adit water could discharge from the shaft to the Stillwater River at post-closure. At a low flow of 31 cfs within the Stillwater River, the addition of 4.5 cfs of adit water would contribute less than 15 percent to the base flow of the river. No adverse effects to the Stillwater River water quantity would be expected from this additional quantity of water discharged to the river.

Effects from Routing Adit Water Underground

Some or all adit water could be routed underground as soon as underground decommissioning and/or treatment are no longer needed. SMC developed several post-closure nitrogen effects scenarios (Hydrometrics 2004 and SMC 2009a). The agencies looked at other mine flooding options. According to these analyses, it may take from 4-38 years for adit water to discharge depending on adit flow rates. Under all analysis options, there would not be any water quality criteria exceeded when the water discharges from the Stillwater Mine. For Agency-Mitigated Alternative 3A, the agencies conclude that ground water would exit the mine shaft rather than the 5000-foot elevation mine adits since the shaft is lower than the adits. Mitigations are included under the Agency-Mitigated Alternative 3A to develop a channel, which would be designed as a trout stream, from the shaft to the Stillwater River to handle the discharge.

4.1.1.3.2 Tailings Waters

Depending on the alternative, three sources of tailings waters would exist at the Stillwater and Hertzler Ranch tailings impoundments at post-closure. These include liner leakage, underdrain seepage, and seepage through the reclamation cover. Liner leakage volumes and effects would be minimal for all alternatives (less than 0.6 and 0.4 gpm for the Stillwater and the Hertzler Ranch tailings impoundments, respectively). Tailings waters that pass through the tailings mass are denitrified by naturally existing bacteria, similar to the process occurring in the BTS. This *in situ* denitrification results in an average underdrain nitrogen concentration of 4 mg/L TN. The salts concentration in the underdrain seepage is the same as the concentration in the tailings waters, 897 mg/L TDS (1,399 µmhos/cm EC). Underdrain seepage effects at the Hertzler Ranch tailings impoundment would be minimal for all alternatives, even if the underdrain is left open at post-closure.

After the reclamation covers are placed on both the Stillwater and the Hertzler Ranch tailings impoundments, the approved reclamation plans assume that the majority of precipitation would flow across the reclamation covers as storm water or do one of the following: seep through the reclamation covers, percolate into the tailings masses, collect above the liners, and/or report in liner leakage.

The majority of seepage through the cover would not report as underdrain seepage or liner leakage. Analyses have shown that seepage through the cover would collect along the interface between the more permeable reclamation cover material and the underlying, less permeable tailings before preferentially discharging laterally from the tailings impoundment surface. During post-closure, flows of seepage through the cover would vary by season in response to precipitation and evapotranspiration. Analyses have shown that seepage through the cover reporting off the impoundments would have minimal effects to water quality and quantity regardless of the flow rate.

Effects from Reclamation Cover Design

The approved Stillwater tailings impoundment reclamation cover (No Action Alternative 1A) consists of 42 inches of waste rock or borrow material and 8 inches of soil. This is the same cover system analyzed in Agency-Mitigated Alternative 3A. SMC proposed reducing the thickness of the cover system to 24 inches of waste rock or borrow with 8 inches of soil/borrow in Proposed Action Alternative 2A. Under all Stillwater Mine alternatives, the tailings would be deposited to route water to the northwest end of the impoundment. The cover system would be placed to route storm water and seepage through the cover to the northwest end as well.

Under the No Action Alternative 1A and the Agency-Mitigated Alternative 3A, the Hertzler Ranch tailings impoundment reclamation cover would be 48 inches of borrow, 12 inches of subsoil, and 12 inches of soil. Under the No Action Alternative 1A, the approved reclamation cover system would be mounded, and seepage through the cover would discharge with storm water over the edges of the embankment. The agencies believe the approved Hertzler Ranch tailings impoundment reclamation plan (No Action Alternative 1A) is not practicable. Tailings impoundments which contain slurried tailings are not conducive to creating a mounded surface unless tailings are deposited in the center of the facility. Operational tailings deposition has resulted in a tailings surface that slopes towards the south end. In the Proposed Action Alternative 2A and the Agency-Mitigated Alternative 3A, the reclamation cover system would be placed on the sloping tailings surface, and storm water and seepage through the cover would be routed to the south end of the impoundment.

Settling of the tailings surface would occur over time. In the No-Action Alternative 1A, SMC would be required to place more cover material on the reclaimed impoundments to maintain positive drainage of storm water. The agencies analyzed effects of this settlement on revegetation success for the Proposed Action Alternative 2A and the Agency-Mitigated Alternative 3A.

Some potential exists for salts in the tailings mass to wick to the surface and effect reclamation soils. Although waste rock would produce a capillary break that limits potential wicking, borrow material may have enough fines to allow wicking to occur. Over time, some small areas of salt-affected soils would result in the loss of planted species and would promote establishment of species tolerant of saline soil conditions.

Even if the salt-affected soil areas were unvegetated and the Stillwater River valley winds blew the soil away, the rock content in the 24-48 inches of waste rock and borrow material in the reclamation cover systems on both impoundments would not expose the tailings. The agencies believe the salt-affected areas would be small and not produce a major long-term effect to the revegetated impoundment surface. These areas would produce microclimates and diversity on the reclaimed impoundment surfaces. The agencies concluded that the reduction in waste rock and borrow cover thicknesses of the reclamation covers would produce minimal changes to revegetation success.

Nitrogen and Salts Effects

The agencies conducted their own independent analyses of nitrogen and salts effects from seepage through the cover during post-closure at the Stillwater Mine and at the Hertzler Ranch tailings impoundment. The agencies have assumed that when seepage through the cover exits the outlet structure it would have the same nitrogen and salts concentrations as tailings waters. SMC would have to treat these pulses of seepage through the cover, especially after storm events, until the averaged monthly MPDES permit nitrogen load limit of 100 lbs/day is met at the mine. There is no MPDES permit or nitrogen load limit at the Hertzler Ranch. SMC would have to meet the ground water DEQ-7 nitrogen standard of 10 mg/L. As long as SMC complies with these nitrogen limits, minimal nitrogen effects to ground and surface water quality and quantity would be anticipated.

SMC may have to collect and treat seepage through the cover until it does not exceed the Class I ground water salts standard of 1,000 µmhos/cm EC. The salts and nitrogen concentrations would eventually decrease over time as more precipitation flushes the available salts and nitrogen on the tailings mass surface from the system. The agencies conclude that the nitrogen and salts loads discharging from the impoundments during the post-closure period would be less than the operational and/or closure loads discharged from the impoundments.

4.1.1.3.3 Storm Water

For all alternatives, storm water would percolate through the reclamation cover systems and report as seepage through the cover or run off the reclaimed surface of the tailings impoundments. Storm water from the tailings impoundments would not contain contaminants other than sediment, since it would not be in contact with tailings. Sediment within this storm water would be minimal once the two tailings impoundments are reclaimed and vegetated. Sediment would filter out in the sediment retention pond at the Stillwater Mine. The storm water would percolate and would not affect ground water.

Some storm water would be mixed with seepage through the cover. The elevated salts content in seepage through the cover would be diluted by storm water. The potential exists for small salt-affected areas to develop where seepage through the cover is routed with storm water from the tailing impoundments. The agencies have concluded that these small areas would not negatively affect reclamation and would provide diversity in the reclaimed plant communities.

4.1.1.4 Cumulative Effects

Selection and implementation of the Stillwater Mine Closure and Post-Closure WMP alternatives (No Action 1A, Proposed Action 2A, and Agency-Mitigated 3A) would not contribute additional operational cumulative effects to water quality and quantity within or adjacent to the Stillwater Mine and the Hertzler Ranch over those effects disclosed and approved in previous environmental documents.

Implementation of any of the alternatives would not result in additional disturbances within the mine permit areas other than those previously approved. All facilities necessary for the collection, treatment, routing, and disposal of mine waters are currently in place or have been previously approved and would be implemented on lands which have been approved for disturbance.

Cumulative effects to water quality and quantity could result from oil and gas development on the Dean Dome, hard rock mineral exploration, historic mining, wildland fires, subdivisions, agriculture, invasive species, and the Custer National Forest travel management plan implementation (Appendix C, DEQ 2010).

4.1.1.5 Unavoidable Adverse Effects

Selection and implementation of the Stillwater Mine Closure and Post-Closure WMP alternatives (No Action 1A, Proposed Action 2A, and Agency-Mitigated 3A) would not result in additional operational unavoidable adverse effects over those analyzed in previous environmental documents. Unavoidable adverse effects from disposal of adit and tailings waters on water quality and quantity at closure were not disclosed in previously environmental documents. These closure effects would include short-term increases in nitrogen and salts in ground and surface water.

4.1.1.6 Relationship between Short-term Uses and Long-term Productivity

Selection and implementation of the Stillwater Mine Closure and Post-Closure WMP alternatives (No Action 1A, Proposed Action 2A, and Agency-Mitigated 3A) would not change the existing relationship between short-term use of the Stillwater Mine and the Hertzler Ranch and the long-term maintenance and enhancement of the ground and surface water quality and quantity in the Stillwater River drainage.

In general, short-term refers to the life of the mine and long-term effects are defined as those that would extend beyond mine life. Decisions have been made

previously that balance short-term uses of the human environment and the maintenance and enhancement of long-term productivity in the area surrounding the Stillwater Mine and the Hertzler Ranch. Selection of any of the Stillwater Mine alternatives would result in the same operational effects previously disclosed for effects to ground and surface water quality and quantity. After the mine closes and all reclamation and mine-related activities cease at post-closure, the long-term productivity of the Stillwater Mine area and the Hertzler Ranch would improve as water quality and quantity return to pre-mine conditions.

4.1.1.7 Irreversible and Irretrievable Commitments of Resources

Implementation of any of the Stillwater Mine alternatives would not result in additional irretrievable or irreversible commitments of resources within or adjacent to the mine area and the Hertzler Ranch in excess of those previously considered and approved in past environmental analyses.

4.1.2 East Boulder Mine Closure and Post-Closure Water Management Plan Alternatives 1B, 2B, and 3B

The effects analyses for these alternatives are supported by data collected over 10 years of operations at the East Boulder Mine. These data have been used in various modeling exercises undertaken by both SMC and the agencies to make projections about water quality and quantity effects to ground and surface water at the mine during operations, closure, and post-closure (Appendix C, DEQ 2010). Although there is ample information about the quality and quantity of adit and tailings waters during operations, past analyses and environmental documents have not thoroughly evaluated the effects to ground and surface water from adit and tailings waters disposal during the closure and post-closure phases of mining operations.

The MPDES permit has established an allowable average mine water discharge flow rate of 737 gpm and an averaged monthly discharge load of 30 lbs/day total inorganic nitrogen (TIN) from all mine water sources. There is also a TIN concentration limit of 7.5 mg/L for ground water within the percolation pond mixing zone in the MPDES permit. The MPDES permit sets a maximum nitrogen concentration limit of 1 mg/L TIN in surface water. The ground water quality standard for nitrogen is 10 mg/L. All nitrogen modeling conducted for the following analyses used these limits to evaluate the effectiveness of the water management proposed for the East Boulder Mine closure and Post-Closure WMP Alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigation 3B). It is assumed that these limits are protective of water quality and the environment.

For input variables, information has been drawn from site specific data, threshold limits contained in the MPDES permit, and the Montana Numeric Water Quality Standards (DEQ-7). Common to all of the analyses is the requirement to stay within the limits prescribed by the MPDES permit. The principle constituent of concern at the East Boulder Mine is nitrogen. There are also elevated levels of salts in both the adit and tailings waters. The salts effects on ground and surface water have not been evaluated in previous environmental documents for the East Boulder Mine.

This evaluation includes other input variables based on observed and projected water quality and quantity parameters. To evaluate the nitrogen and salts effects, the agencies have examined the closure and post-closure conditions using the following assumptions:

- Adit discharge rates of 150 gpm and 737 gpm
- Nitrogen load contributed by the adit discharge equals 20 lbs/day after treatment
- Tailings waters nitrogen concentration equals 50 mg/L (TIN)

- Tailings waters nitrogen concentration post-BTS treatment equals 10 mg/L (TIN)
- TDS recommendation of 250 mg/L in surface water at the East Boulder Mine site to minimize effects to trout eggs
- EC limit of 1,000 µmhos/cm in Class I ground water to protect beneficial uses
- 80 percent nitrogen concentration reduction credit for plant uptake during summer LAD
- 80 percent nitrogen concentration reduction for winter snowmaking
- 30 percent reduction in water volume during summer and winter LAD

All of the modeling exercises account for flow, load, and concentration of nitrogen and salts. The ability to meet MPDES permit limits and DEQ-7 water quality criteria depends on the efficiency of treatment provided by the disposal options available in the East Boulder Mine WMP, including summer LAD, winter snowmaking, percolation, and direct discharge. The modeling presented in Appendix C examined combinations of discharge rates and disposal locations to assess whether the mine waste water streams could be treated and discharged within an assumed one-year closure time frame while satisfying the applicable water quality criteria.

4.1.2.1 Operational Nitrogen and Salts Effects to Water Quality and Quantity at the East Boulder Mine

The primary difference between the BTS at the East Boulder Mine and the BTS at the Stillwater Mine is the additional use of a nitrification circuit (Anox system) to treat ammonia. At the East Boulder Mine, ammonia, which has accumulated due to recycling of mine waters during operations, is nitrified under aerobic conditions to nitrate plus nitrite and then denitrified under anaerobic conditions in the BTS. By converting the ammonia to a form which can be treated by the BTS, additional nitrogen is removed from the adit water stream.

Use of the Anox system decreases the ammonia level to less than 1 mg/L, resulting in a total nitrogen concentration of less than 5 mg/L TIN in BTS-treated water. Minimizing the concentrations of nitrate plus nitrite and ammonia in adit water before disposal maximizes the amount of adit water that can be land applied or percolated at the mine without violating the East Boulder Mine MPDES permit nitrogen load limit of 30 lbs/day.

4.1.2.1.1 Nitrogen Effects

SMC has discharged nitrogen-bearing adit water to ground water at the East Boulder Mine for 10 years. Although the BTS design flow capacity is 1,000 gpm, far lower flows have been treated through the system since its installation.

Adit water discharge has averaged approximately 250 gpm since operations began, and in 2008, the flow averaged less than 150 gpm. The agencies have reviewed adit discharge data from 1999-2008. From 2001 to 2008, the average nitrogen load discharged to ground water from the treatment system was 7 lbs/day. For this analysis, the agencies have used a conservative 20 lbs/day nitrogen load in the water quality and quantity affects analyses.

Operational disposal options for adit water at the East Boulder Mine include the mine LAD areas and percolation pond. Similar to the Stillwater Mine, SMC receives a treatment credit in its MPDES permit for summer LAD and winter snowmaking. No nitrogen treatment credit is allowed for mine waste waters discharged to the percolation pond. SMC has used all three disposal options since operations began.

Since operations began at the East Boulder Mine, nitrogen levels in ground water have slowly increased at monitoring sites. This increase is attributed to the discharge of BTS-treated adit water to the percolation pond. While the concentration of nitrogen in the BTS-treated water is low (< 10 mg/L TIN), it is above the natural background level in ground water (0.15 mg/L TIN). A spill of untreated adit water in the spring of 2007 and other sources of nitrogen resulted in a spike in nitrogen levels above ground water standards during late summer and fall of 2007 that remained elevated into 2010. As a result of the spill, the nitrogen concentration in ground water increased above the DEQ-7 ground nitrogen water quality standard (10 mg/L) and the MPDES permit limit (7.5 mg/L TIN) at the end of the mixing zone.

SMC has subsequently made improvements to the operational water management system in an attempt to reduce nitrogen discharges and to prevent further exceedances of ground water standards. The nitrogen in ground water from the spill is being flushed out of the ground water system. No surface water effects have occurred and no downstream beneficial uses have been compromised.

4.1.2.1.2 Salts Effects

The East Boulder Mine BTS and Anox system do not reduce the salts concentration in adit water. The MPDES permit does not have a salts load or concentration limit, and a salts treatment credit is not allowed for mine waste waters discharged to the East Boulder Mine percolation pond or LAD area.

SMC has discharged salt-bearing adit water to ground water at the mine for 10 years. The agencies have reviewed operational adit discharge data from 1999-2008 and have used the median adit concentration (858 µmhos/cm EC) for these analyses. Salts concentrations within ground water downgradient of the percolation pond have increased slightly since mining began; although, there was a noticeable spike in EC as a result of an untreated adit water spill in spring 2007. SMC has never exceeded the Class I ground water EC concentration for salts at the East Boulder Mine from use of the percolation pond or LAD system. Surface water has not shown a corresponding EC increase to date. Collected data indicate that ground and surface water salts concentrations have not been impacted by operational adit water discharge from the East Boulder Mine. No downstream beneficial uses have been compromised.

4.1.2.1.3 Other Effects

During operations, SMC is required to comply with its approved storm water management plan. Tailings waters remain in the East Boulder tailings impoundment during operations unless excess tailings waters need to be disposed. Under all alternatives, SMC has the option to dispose of tailings waters operationally if needed. Previous environmental documents examined effects from 1 gpm of tailings impoundment liner leakage from the East Boulder tailings impoundment during operations. No effects from underdrain seepage at the East Boulder tailings impoundment occur during operations because the underdrain seepage is recycled back into the tailings impoundment.

4.1.2.2 Closure Nitrogen and Salts Effects to Water Quality and Quantity at the East Boulder Mine

As with the Stillwater Mine, potential effects to water quality and quantity at the East Boulder Mine during closure may result from the following: disposal of adit water, tailings supernatant water, and tailings mass water; tailings impoundment liner leakage; tailings impoundment underdrain seepage from the East Boulder tailings impoundment; and/or seepage through the reclamation cover from the tailings impoundment.

During closure, the adit water flow rate would be similar to that occurring at the mine on the last day of operations. SMC would manage adit and tailings waters using operational systems until the water meets the averaged monthly MPDES permit TIN effluent limit (30 lbs/day) at the East Boulder Mine without treatment. Once the limit is met, SMC would discharge adit water directly to the East Boulder River.

4.1.2.2.1 Adit Water

Flows of adit water from the East Boulder Mine would continue after mining ceases. During closure, the flow rate of adit water would be similar to that occurring at the mine during operations (150 to 737 gpm). Based on results of SMC's long-term water monitoring and management practices (*i.e*. grouting), the potential would be limited for an increase in adit discharge up to the permitted rate of 737 gpm. SMC will have to continue to pump and/or treat adit water until decommissioning of the underground workings and other closure activities are complete. The time frame for decommissioning the underground workings would vary from six weeks under the East Boulder Mine Closure and Post-closure WMP Proposed Action Alternative 2B to 12 weeks under the Agency-Mitigated Alternative 3B.

At closure, blasting would cease, removing the source of nitrogen to adit water. With the nitrogen source gone, concentrations of nitrogen in the adit water would begin to decline. This conclusion is based on SMC's previous experience and experience at other mines (Appendix C, DEQ 2010). For these analyses, the agencies have chosen to use a 20 lbs/day nitrogen discharge rate for the closure period. This is a conservative rate that is well above the historic 6 lbs/day average discharge rate from the mine.

4.1.2.2.2 Tailings Waters

Up to 40 MG of East Boulder tailings waters would be disposed of at closure. Tailings waters contain higher nitrogen concentrations than adit water and have averaged approximately 40 mg/L TIN over the past several years. For these analyses, the agencies used a conservative 50 mg/L nitrogen concentration for tailings waters. Tailings waters also contain higher salts concentrations than adit water. For the tailings waters analyses, the agencies used a median tailings waters salts concentration of 897 mg/L TDS (1,399 µmhos/cm EC).

At closure, tailings backfilling would cease at the East Boulder Mine and salts levels should decline as salts flush from the tailings backfill. This conclusion is based on SMC's previous experience and experience at other mines. For these analyses, the agencies used a concentration of 250 mg/L TDS to minimize surface water effects at the East Boulder Mine during closure. This TDS concentration is not a regulatory standard, but a recommended concentration that is protective of trout eggs. Unlike the nitrogen analyses, no dilution of the salts concentration has been credited in the analyses as the adit flow increases.

Under the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, tailings supernatant and tailings mass waters would be evaporated over the tailings mass and would not contribute any nitrogen and salts effects to ground and surface water quality. The nitrogen and salts would end up in the tailings mass and would eventually be covered with the reclamation cover system. A potential implication of this alternative, which is the approved tailings impoundment dewatering plan, is the length of time to dewater and place the reclamation cover. Climatic conditions, especially during the winter, would increase the potential for wind erosion of tailings and, ultimately, the time required for impoundment capping. It would take at least two years to dewater the tailings impoundments using evaporation. This is unacceptable to the agencies and the mining company.

Under the East Boulder Mine Closure and Post-closure Proposed Action Alternative 2B or the Agency-Mitigated Alternative 3B, 40 MG of tailings waters would be actively pumped from the tailings impoundment to shorten the closure time frame. The East Boulder Mine closure time frame would vary from 12-months under the Proposed Action Alternative 2B, to 18 months under the Agency-Mitigated Alternative 3B, and up to 3 years under the No Action Alternative 1B.

4.1.2.2.3 Disposal Options

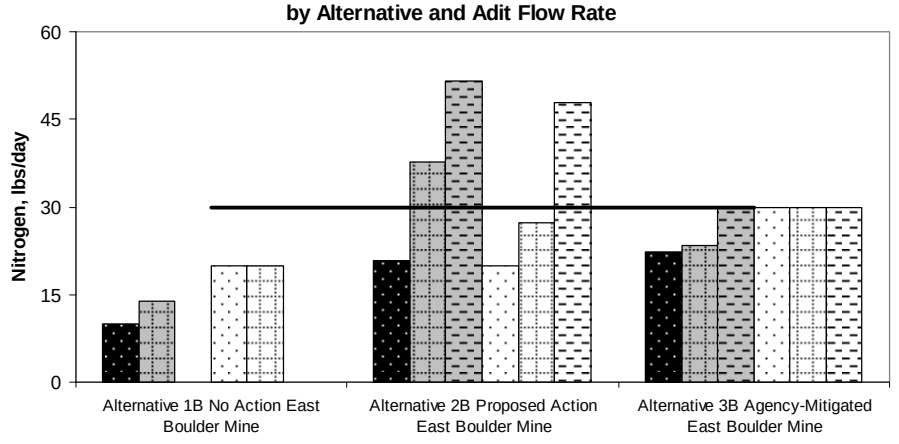
For these analyses, water quality effects at closure were evaluated for two adit water discharge rates: 737 gpm, the maximum permitted adit flow, and 150 gpm, the average rate during operations. The BTS can treat up to 1,000 gpm. The treatment and disposal facilities would be in place at the time of closure. Salts concentrations and loads would not be reduced by treatment in the BTS/Anox system at closure. SMC has a number of permitted disposal options for adit and tailings waters that could be used under the East Boulder Closure and Post-Closure WMP No Action 1B, Proposed Action 2B, or Agency-Mitigated 3B alternatives at closure, including use of the East Boulder Mine percolation pond, the mine LAD areas, and direct discharge to the East Boulder River. Treated adit

and tailings waters could be disposed of in the mine percolation ponds as long as the MPDES permit nitrogen limit (30 lbs/day) is not exceeded. As during operations, any excess adit water could be discharged to the LAD areas. SMC would prefer not to discharge directly to the Stillwater River until post-closure.

Under the Proposed Action Alternative 2B or the Agency-Mitigated Alternative 3B, adit water would be mixed with the East Boulder Mine tailings impoundment waters and treated in the BTS. SMC has tested treating mixed adit and tailings waters (SMC 2006b). Results of the test indicated that the BTS can effectively treat the nitrogen in the mixed waters without upsetting or impairing the organisms in the BTS plant.

The agencies analyzed several adit water closure disposal options for the No Action Alternative 1B and several mixed adit and tailings waters closure disposal options for the Proposed Action Alternative 2B and the Agency-Mitigated Alternative 3B. For all alternatives, except three options analyzed under the Proposed Action Alternative 2B, the nitrogen load to the East Boulder River at the East Boulder Mine would be less than the MPDES permit load limit (30 lb/day TN) (Figure 4-6). The three options under the Proposed Action Alternative 2B that exceed the nitrogen load limit utilize percolation, which does not provide any credit for nitrogen reduction. SMC has other closure water management options, such as LAD, to reduce the nitrogen load to less than 30 lbs/day and to prevent related effects.

Figure 4-6. East Boulder Mine Closure Projected Nitrogen Load to the East Boulder River by Alternative and Adit Flow Rate



4.1.2.2.4 Nitrogen Effects

Under all closure options analyzed for the East Boulder Mine alternatives, the nitrogen concentration in ground water (Figure 4-7) and the East Boulder River (Figure 4-8) at the East Boulder Mine would be less than the 10 mg/L ground water and 1.0 mg/L surface water quality standards for nitrogen.

Figure 4-7. East Boulder Mine Closure
Projected Nitrogen Concentration in Ground Water
by Alternative and Adit Flow Rate

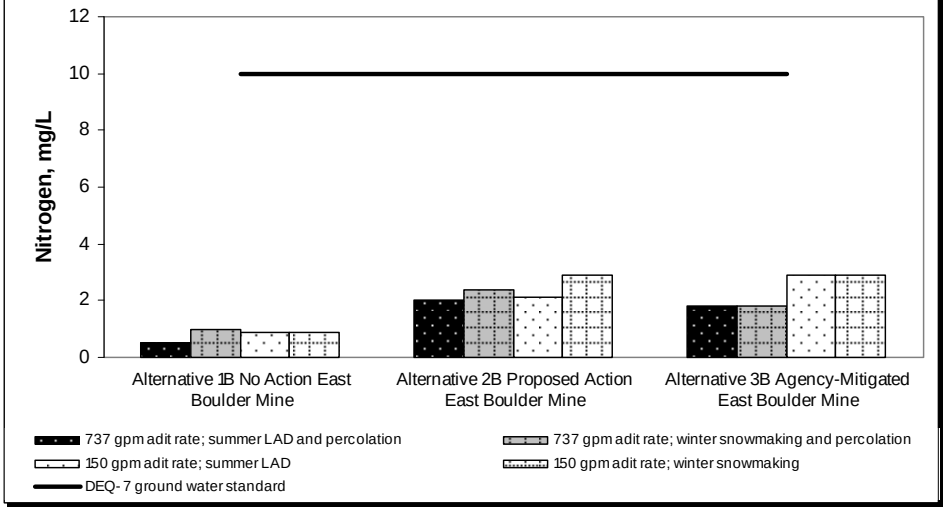
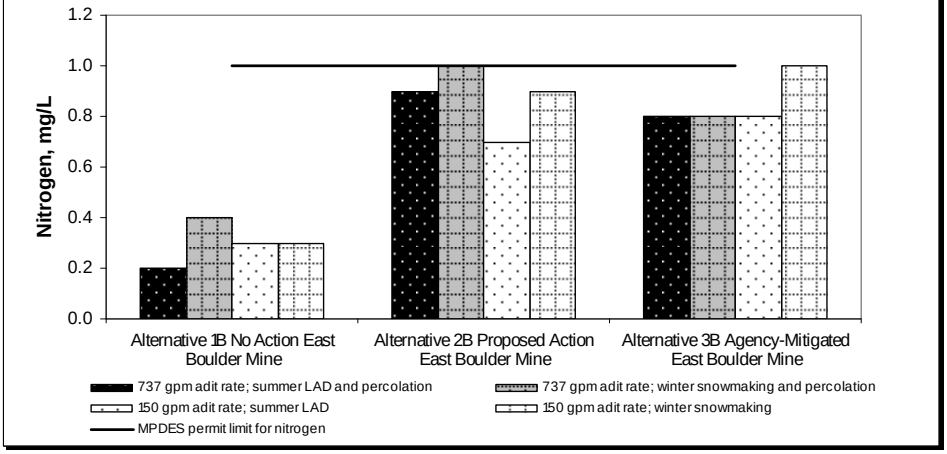


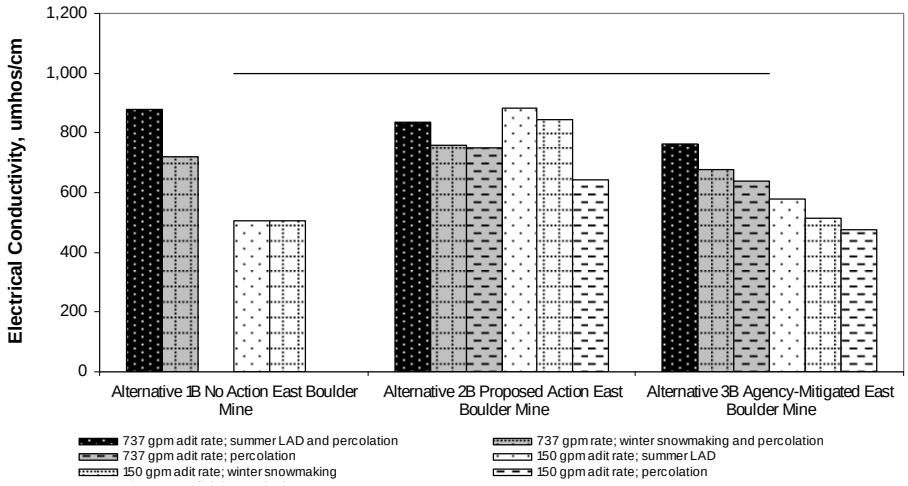
Figure 4-8. East Boulder Mine Closure
Projected Nitrogen Concentration in the East Boulder River
by Alternative and Flow Rate



4.1.2.2.5 Salts Effects

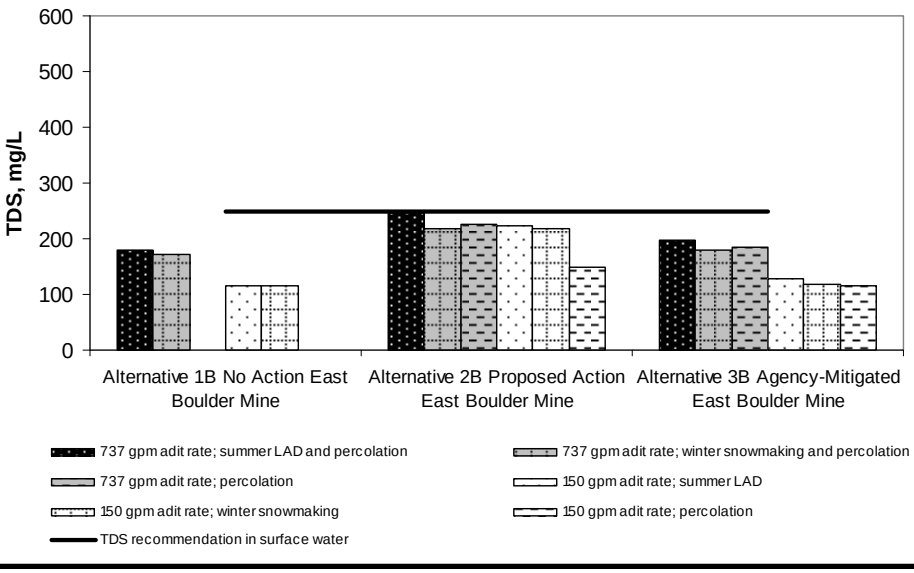
In all closure disposal options analyzed for all East Boulder Mine alternatives, the EC concentration in ground water at the East Boulder Mine would be less than the 1,000 µmhos/cm Class I beneficial use criterion (Figure 4-9).

Figure 4-9. East Boulder Mine Closure
Projected Salts Concentration in Ground Water
by Alternative and Adit Flow Rate



In all closure disposal options analyzed for all East Boulder Mine alternatives, the salts concentration in the East Boulder River at the East Boulder Mine would be less than the recommended 250 mg/L TDS surface water concentration (Figure 4-10). Ground and surface water at the East Boulder Mine would continue to show minor effects from nitrogen and salts disposed of at the mine. No downstream beneficial uses would be compromised.

Figure 4-10. East Boulder Mine Closure
Projected Salts Concentration in the East Boulder River
by Alternative and Adit Flow Rate



4.1.2.2.6 Other Effects

Other effects could occur from tailings impoundment liner leakage, seepage from underdrains, seepage through the reclamation cover, and storm water. Previous environmental documents examined effects from 1 gpm of liner leakage from the East Boulder tailings impoundment during operations. The effect would be the same at closure. No effects from underdrain seepage at the East Boulder tailings impoundment would occur during closure because the underdrain seepage is recycled back into the tailings impoundment. There is no seepage through the cover at the East Boulder tailings impoundments until after closure since the reclamation cover would not be completed. During closure, prior to reclamation cover completion, storm water falling on the tailings impoundment would be managed as tailings waters, as during mine operations.

4.1.2.3 Post-Closure Nitrogen and Salts Effects to Water Quality and Quantity at the East Boulder Mine

Tailings backfill and waste rock placed underground during operations would be the primary source of nitrogen and salts at post-closure. Ground water inflows into the mine workings would be expected to flush some nitrogen and salts over a longer time period than if the workings had not been backfilled. After the closure period in each alternative, SMC would not have to treat adit water if the discharge complied with the MPDES permit nitrogen load limit and other ground and surface water analysis criteria.

4.1.2.3.1 Adit Water

At post-closure, untreated adit water would be routed around the percolation pond in a constructed channel from the adit to the East Boulder River. There would be no discharge of adit water to ground water during post-closure other than seepage through the bottom of the unlined channel. The anticipated adit water discharge rate to the East Boulder River is expected to be the same rate as on the last day of operations. Analyses were conducted to evaluate water quality effects from two adit water discharge rates at post-closure: 737 gpm, the maximum permitted adit flow, and 150 gpm, the average rate during operations (Appendix C, DEQ 2010).

Two adit water disposal options were analyzed for post-closure: percolation to ground water and direct discharge to surface water. In the first analyses for all alternatives, the agencies assumed adit water treatment would continue for one year during closure. At post-closure, no further adit water treatment would be available.

Effects from Percolation to Ground Water

SMC estimates the post-closure nitrogen loading from direct discharge of untreated adit water (at a 150 gpm flow rate) to the East Boulder River would be 27 lbs/day within one year of closure (Knight Piésold 2000b). The agencies conducted independent analyses that generally agree with SMC's estimate; however, the agencies estimate two years would be necessary to achieve a nitrogen load of 27 lbs/day at an adit flow rate of 150 gpm (Appendix C, DEQ 2010). Based on the agencies' projections, no further adit water treatment would

be needed after two years in order to comply with the MPDES permit nitrogen limit (30 lbs/day). The nitrogen load would be the same at a 737 gpm adit flow rate.

To minimize nitrogen effects to ground and surface water from percolation of adit water, regardless of rate, SMC would have to treat and/or land apply until water quality standards could be met. SMC could also implement other water management options to comply with water quality standards. Under all East Boulder Mine alternatives, SMC has options at post-closure to minimize water quality effects.

Salts concentrations are anticipated to decline by about 40 percent within two years after closure (East-Side Adit Water Electrical Conductivity Figure, Appendix C, DEQ 2010). The salts contribution from adit water to ground water and to the East Boulder River during post-closure is anticipated to decrease as the salts levels in adit water decline. Regardless of the percolation rate, neither the Class I ground water EC beneficial use criterion or the surface water TDS recommendation (250 mg/L) would be exceeded at post-closure. No downstream beneficial uses are expected to be compromised at closure.

Any increase in nitrogen and salts concentrations in ground water that occur during operations and closure would decrease over time as clean ground water moving through the aquifer flushes out the remaining concentrations.

At post-closure, up to 737 gpm (1.6 cfs) of adit water could discharge from the East Boulder Mine to the East Boulder River. When the East Boulder is at low flow (5 cfs), the addition of 1.6 cfs of adit water would contribute more than 32 percent to the base flow of the river. To limit impacts of discharge to river temperature and other factors, the East Boulder Mine MPDES permit requires that discharge not increase the flow of the East Boulder River by more than 15 percent during low flows. During low flows, 346 gpm would be the maximum adit flow that could be discharged directly to the East Boulder River and not increase the East Boulder River flow by 15 percent. At a high flow of 588 cfs, a 1.6 cfs discharge of adit water into the river would increase flow by less than one percent. No adverse effects to the East Boulder River water quantity would be expected from this additional quantity of water discharged to the river.

4.1.2.3.2 Tailings Waters

Depending on the alternative, three sources of tailings waters would exist at the East Boulder tailings impoundment during closure. These include liner leakage, underdrain seepage, and seepage through the reclamation cover. Liner leakage volumes at post-closure would be less than 1 gpm for all alternatives, and effects to water quality would be minimal. Tailings waters that pass through the tailings mass are denitrified by naturally existing bacteria, similar to the process occurring in the BTS. This *in situ* denitrification results in an average underdrain nitrogen concentration of 4 mg/L TIN. The salts concentration in the underdrain seepage is the same as the tailings water, 897 mg/L TDS (1,399 µmhos/cm EC). Underdrain seepage effects would be minimal for all alternatives, even if the underdrain was left open at post-closure.

Effects from Reclamation Cover Design

The approved East Boulder Mine reclamation cover (No Action Alternative 1B) consists of 48 inches of waste rock, borrow material, and/or boulders; 22 inches of subsoil; and 6 inches of topsoil for a total thickness of 76 inches. This is the same cover system analyzed for the Agency-Mitigated Alternative 3B. SMC proposes reducing the thickness of the cover system by eliminating 24 inches of waste rock or borrow in Proposed Action Alternative 2B.

Under the No-Action Alternative 1B, the reclamation cover system would be mounded, and seepage through the cover would discharge with storm water over the edges of the embankment. The agencies believe the approved East Boulder tailings impoundment reclamation plan is not practicable. Tailings impoundments which contain slurried tailings are not conducive to creating a mounded surface unless tailings are deposited in the center of the facility. SMC's operational tailings deposition has resulted in a tailings surface that slopes towards the south end. Under the Proposed Action Alternative 2B and the Agency-Mitigated Alternative 3B, the reclamation cover system would be placed on the sloping tailings surface. Storm water and seepage through the cover would be routed to the south end of the impoundment.

Settling of the tailings surface would occur over time. The agencies analyzed effects of this settlement on revegetation success for the Proposed Action Alternative 2B and the Agency-Mitigated Alternative 3B. Some potential exists for salts in the tailings mass to wick to the surface and effect reclamation soils. Although waste rock would produce a capillary break that limits potential wicking, borrow material may have enough fines to allow wicking to occur. Over time, some small areas of salt-affected soils would result in the loss of planted species and establishment of species tolerant of saline soil conditions.

Even if the salt-affected soil areas were unvegetated and the soils blew away, the rock content in the 24-48 inches of waste rock and borrow material in the impoundment's reclamation cover system would prevent tailings exposure. The agencies believe the salt-affected areas would be small and not produce major, long-term effects to the revegetated impoundment surface. Instead, these areas would produce microclimates and diversity on the reclaimed impoundment surface.

After the reclamation cover system is constructed, seepage through the reclamation cover would vary by season in response to precipitation and evapotranspiration. Seepage through the cover would report to the south end of the impoundment, discharge with storm water through the seepage outlet structure, and then be routed to the East Boulder Mine percolation pond. The agencies conclude that the reduction in proposed waste rock or borrow cover thickness, as under Proposed Action Alternative 2B, would produce minimal effects to revegetation success.

Nitrogen and Salts Effects

The agencies conducted their own independent analyses of nitrogen and salts effects from seepage through the cover during post-closure. The agencies have assumed that when seepage through the cover exits the outlet structure it would

have the same nitrogen and salts concentrations as tailings waters. SMC would have to treat these pulses of seepage through the cover, especially after storm events, until the averaged monthly MPDES permit load limit (30 lbs/day) would be met. As long as SMC complies with the MPDES permit nitrogen limit, minimal nitrogen effects to ground and surface water quality and quantity would be anticipated. SMC may have to collect and treat seepage through the cover until it does not exceed the agencies' ground water salts standard (1,000 µmhos/cm EC). The salts and nitrogen concentrations would eventually decrease over time as more precipitation flushes the available salts and nitrogen on the tailings mass surface from the system.

4.1.2.3.3 Storm Water

At post-closure after the reclamation cover is in place, in all alternatives, storm water would percolate through the reclamation cover system and report as seepage through the cover or runoff the reclaimed surface of the tailings impoundment. Tailings impoundment storm water runoff would not contain contaminants except sediment, since it would not be in contact with tailings. Sediment within this storm water would be minimal once the tailings impoundment is reclaimed and vegetated. Sediment would filter out in the sediment retention pond at the East Boulder Mine. The storm water would percolate and would not affect ground water.

Some storm water would be mixed with the seepage through the cover. The elevated salts content in seepage through the cover would be diluted by the storm water. The potential exists for small salt-affected areas to develop where seepage through the cover is routed with storm water from the tailing impoundments. The agencies have concluded that these small areas would not negatively affect reclamation and would provide diversity in the reclaimed impoundment plant communities.

4.1.2.4 Cumulative Effects

Selection and implementation of any of the East Boulder Mine Closure and Post-Closure WMP alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B) would not contribute additional operational cumulative effects to water quality and quantity within or adjacent to the East Boulder Mine other than those effects disclosed and approved in previous environmental documents.

Implementation of any of the alternatives would not result in additional disturbances within the mine permit area other than those previously approved. All facilities necessary for the collection, treatment, routing, and disposal of mine waters are currently in place or have been previously approved and would be implemented on lands which have been approved for disturbance.

Cumulative effects to water quality and quantity could result from hard rock mineral exploration, wildland fires, invasive species, and the Gallatin National Forest travel management plan implementation (Appendix C, DEQ 2010).

4.1.2.5 Unavoidable Adverse Effects

Selection and implementation of any of the East Boulder Mine Closure and Post-Closure WMP alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B) would not result in additional operational unavoidable adverse effects over those analyzed in previous environmental documents. Unavoidable adverse effects from disposal of adit and tailings waters on water quality and quantity at closure and post-closure were not disclosed in previously environmental documents. These closure and post-closure effects would include short-term increases in nitrogen and salts in ground and surface water.

4.1.2.6 Relationship between Short-term Uses and Long-term Productivity

Decisions have been made previously that balance short-term uses of the human environment and the maintenance and enhancement of long-term productivity in the area surrounding the East Boulder Mine. Selection and implementation of any of the East Boulder Mine Closure and Post-Closure WMP alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B) would result in the same operational effects to ground and surface water quality and quantity in the East Boulder River drainage as previously disclosed in other environmental documents. After the mine closes and all reclamation and mine-related activities cease at post-closure, the long-term productivity of the mine area would improve as water quality and quantity return to pre-mine conditions.

4.1.2.7 Irreversible or Irretrievable Commitments of Resources

Selection and implementation of any of the East Boulder Mine Closure and Post-Closure WMP alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B) would not result in additional irretrievable or irreversible commitments of resources within or adjacent to the mine area in excess of those previously considered and approved in past environmental analyses.

4.1.3 Boe Ranch LAD System Alternatives 1C, 2C, and 3C.

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be constructed. SMC would continue to manage water at the East Boulder Mine as described for the East Boulder Mine Closure and Post-Closure WMP No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B alternatives. Any effects associated with adit water, tailings waters, and storm water management during closure and post-closure would be the same as those identified for the East Boulder Mine alternatives.

Under the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C, SMC could construct and use the Boe Ranch LAD system, if needed. If constructed, the Boe Ranch LAD system would be the preferred method of secondary treatment and disposal for treated adit water and tailings waters to reduce nitrogen concentrations in ground water. Primary treatment of nitrogen in mine waste waters and disposal using LAD and percolation may still occur at the East Boulder Mine as permitted.

During operations, both the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C alternatives would involve piping treated adit water and, if needed, treated adit and tailings waters from the East Boulder Mine to SMC's Boe Ranch. Mine waste waters could be stored there over fall, winter, and early spring seasons. During the growing season, which is generally April through October, waste waters would be land applied at the Boe Ranch, as is done at the Stillwater Mine and the Hertzler Ranch.

The Boe Ranch LAD system would also include growing season evaporation over the LAD storage pond and winter snowmaking capabilities. During operations when the weather is cold or when LAD at the Boe Ranch is not possible, excess adit water and tailings waters would be routed to the Boe Ranch LAD storage pond, which could store up to 108 MG. During the growing season, stored waste waters would be routed from the storage pond to center pivots for land application.

Under Proposed Action Alternative 2C, the Boe Ranch LAD irrigation system would consist of 10 center pivots with a maximum LAD discharge rate of almost 1,500 gpm during a 12-hour application day. The 10 center pivots would be on 194.1 acres and operated at agronomic rates to minimize the potential for deep percolation. Excessive application rates at the Boe Ranch LAD area could result in increased runoff, ponding, and potential for mass wasting on some identified steep and susceptible sites in the LAD area.

Under the Agency-Mitigated Alternative 3C, the Boe Ranch LAD system could be operated at greater than agronomic rates on 187 acres to flush salts from soils, if needed. During operations, the Boe Ranch center pivot P10 would not be used due to mass wasting concerns. The Boe Ranch center pivots P4 and P9 would

require additional monitoring of the LAD application rate due to concerns related to mass wasting.

The Boe Ranch LAD system is designed as a "no-leaching" facility. Some ground water percolation would occur when soils are saturated in the spring from snowmelt and precipitation. The Boe Ranch LAD system operation could result in the release of treated waters containing nitrogen and salts to the ground water system. Mixed LAD-area percolation and ambient ground water would flow towards the East Boulder River. Ground water recharge from the Mason Ditch, a historic irrigation ditch downgradient of the Boe Ranch LAD area, would mix with LAD area percolation and reduce potential effects on downgradient ground and surface water quality.

4.1.3.1 Construction Effects at the Boe Ranch

Under the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C, a new 11,700-foot pipeline extension, access road, and Boe Ranch LAD storage pond would be constructed. Construction activities may increase sedimentation and erosion and effects from accidental spills and leaks. Sediment generated through construction activities would not be expected to leave the immediate construction area due to implementation of best management practices (BMPs) and standard engineering practices. Construction would have negligible impacts on ground and surface water quality.

4.1.3.2 Operational Nitrogen and Salts Effects to Water Quality and Quantity at the Boe Ranch and the East Boulder Mine

For the Proposed Action Alternative 2C, SMC analyzed different operational options to predict potential nitrogen loading rates to the East Boulder River from the Boe Ranch LAD system. All options met narrative water quality standards for nitrogen in the East Boulder River (Knight Piésold 2000b). SMC concluded that there would be no major operational water quality effects to the East Boulder River from the operation of the Boe Ranch LAD system. SMC did not evaluate the effects of salts in ground water and the East Boulder River. Under this alternative, SMC would monitor water quality during LAD system operations to confirm their water quality predictions, to monitor water quality compliance, and to adjust the LAD application rates. SMC did not propose trigger values for nitrogen in ground water in the Boe Ranch LAD area that would require additional monitoring and mitigation measures during operations. Also, a salts monitoring program was not included in the Proposed Action Alternative 2C.

Under Agency-Mitigated Alternative 3C, a more detailed water quality and soils monitoring program at the Boe Ranch would be established during operations to provide early detection of increased nitrogen and salts concentrations in soil and ground water that could affect the nitrogen and salts loads moving toward the East Boulder River (Appendix B). Monitoring would include new downgradient seeps and springs above the Mason Ditch during the irrigation season and expanded soil sampling to assess fate and transport of nitrogen and salts. The results of monitoring would be compared to the following trigger levels set by

the agencies for total concentration of nitrogen and salts. SMC would have to implement additional monitoring and mitigating measures if ground water concentrations of nitrogen increased 2 mg/L above the ambient 0.1 mg/L TIN concentration in ground water at the Boe Ranch LAD area. Similarly, SMC would have to implement additional monitoring and mitigating measures if the ambient ground water EC concentration downgradient of the Mason Ditch (1,017 µmhos/cm) increased 20 percent to 1,220 µmhos/cm EC. Implementation of this monitoring program and associated trigger levels would reduce the potential for adverse effects to ground water and eventually to the East Boulder River.

4.1.3.2.1 Adit Water

For the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, operational adit water management would be similar to the East Boulder Mine Closure and Post-Closure WMP Alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B), except treated adit water would be preferentially routed to the Boe Ranch LAD system, if constructed, for disposal. Operationally, SMC would still have to comply with ground and surface water quality nitrogen standards, as well as the Class I ground water beneficial use EC criteria, in the East Boulder Mine area.

Agency Analyses

For the Boe Ranch LAD System Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C, the agencies conducted independent operational and closure water quality and quantity analyses, including the effects of reduced nitrogen and salts loading at the East Boulder Mine (Appendix C, DEQ 2010). The East Boulder River below the Boe Ranch has a flow of 5 cfs that decreases to 2 cfs during the irrigation season. The agencies used this range of flows to predict effects to the East Boulder River.

For analysis of Proposed Action Alternative 2C, the agencies assumed that all 10 center pivots on the 194-acre LAD area would be developed for use during operations. For the Agency-Mitigated Alternative 3C analyses, similar assumptions were used. To be conservative, the agencies assumed that center pivots P4 and P9 would not be used; neither would P10, which was eliminated due to mass wasting concerns. The agencies also assumed that the remaining seven center pivots would only operate on about 166-acres during operations and closure.

The Boe Ranch LAD area does not have an MPDES permit and would not have a nitrogen load limit. However, SMC must comply with the 10mg/L ground water standard. In the analyses for Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C, the agencies used the same MPDES permit surface water quality nitrogen limit (1 mg/L) used at the mine site. This is not a regulatory limit below the Boe Ranch. For salts, SMC would have to comply with the Class II ground water EC criterion of less than 2,500 µmhos/cm at the Boe Ranch. The agencies could not use the 250 mg/L TDS surface water quality recommendation for the Boe Ranch alternatives analyses because the background TDS concentration in the East Boulder River below the ranch is 340 mg/L.

The agencies analyzed several closure adit water disposal options for the No Action Alternative 1C and several mixed adit and tailings waters closure disposal options for the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C. For all alternatives, the nitrogen load to the East Boulder River at the East Boulder Mine would be less than the MPDES permit load limit (30 lb/day TN) (Figure 4-11). The Boe Ranch LAD would not have an MPDES permit or a nitrogen load limit.

Ground Water Effects at the Boe Ranch. For all operational options analyzed for the Boe Ranch under the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, the predicted nitrogen concentration in ground water would be less than the 10 mg/L TN ground water standard (Figure 4-12) and the Class II EC beneficial use ground water criterion (Figure 4-13).

Figure 4-11. East Boulder Mine and Boe Ranch LAD Operations Projected Nitrogen Load by Alternative and Adit Flow Rate

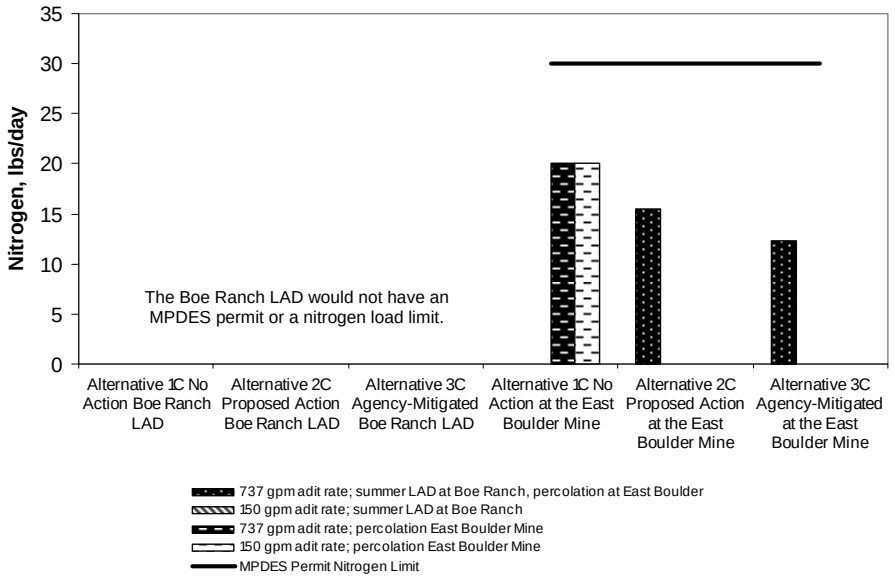


Figure 4-12. East Boulder Mine and Boe Ranch LAD Operations Projected Nitrogen Concentration in Ground Water by Alternative and Adit Flow Rate

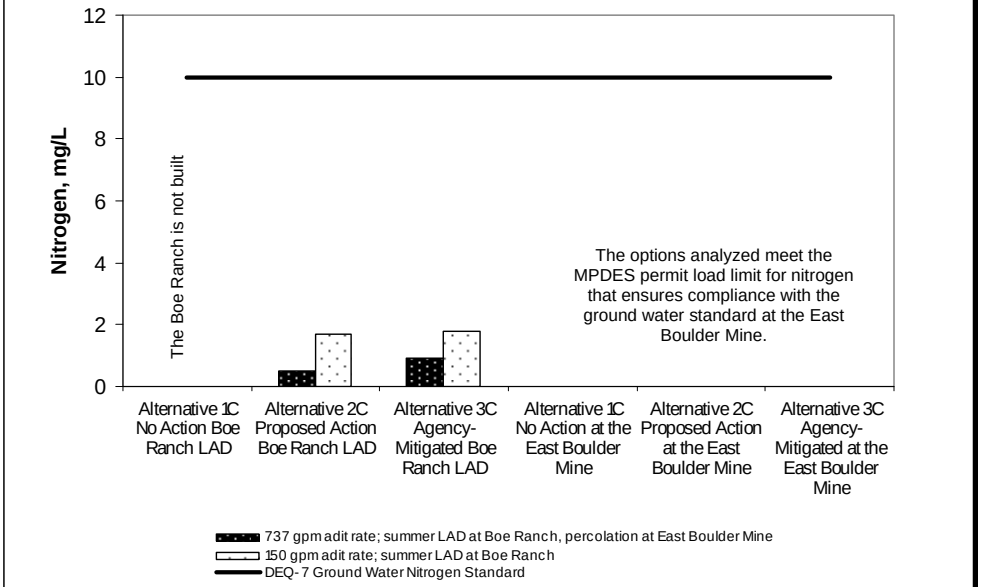
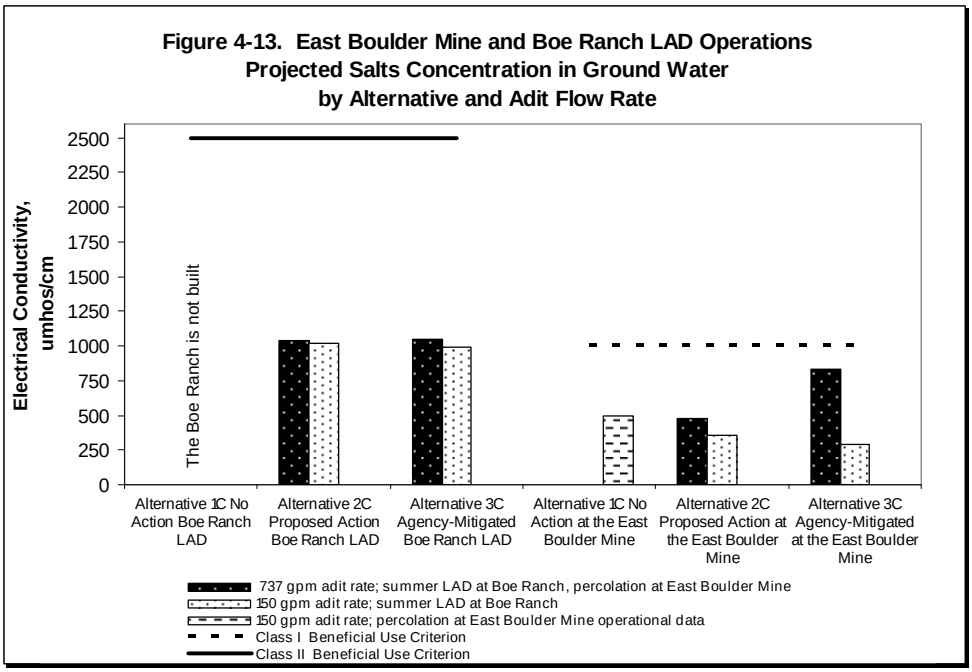


Figure 4-13. East Boulder Mine and Boe Ranch LAD Operations Projected Salts Concentration in Ground Water by Alternative and Adit Flow Rate



Surface Water Effects at the Boe Ranch. For all operational options analyzed for the Boe Ranch under the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, SMC would exceed the 340 mg/L ambient TDS surface water concentration in the East Boulder River below the Boe Ranch (Figure 4-14). Depending on adit water flow rates, the TDS concentrations in the

East Boulder River would increase from 8 to 35 percent above ambient levels during operations. This increase could incrementally affect trout eggs during the operational period.

Figure 4-14. East Boulder Mine and Boe Ranch LAD Operations Projected Salts Concentration in the East Boulder River by Alternative and Adit Flow Rate

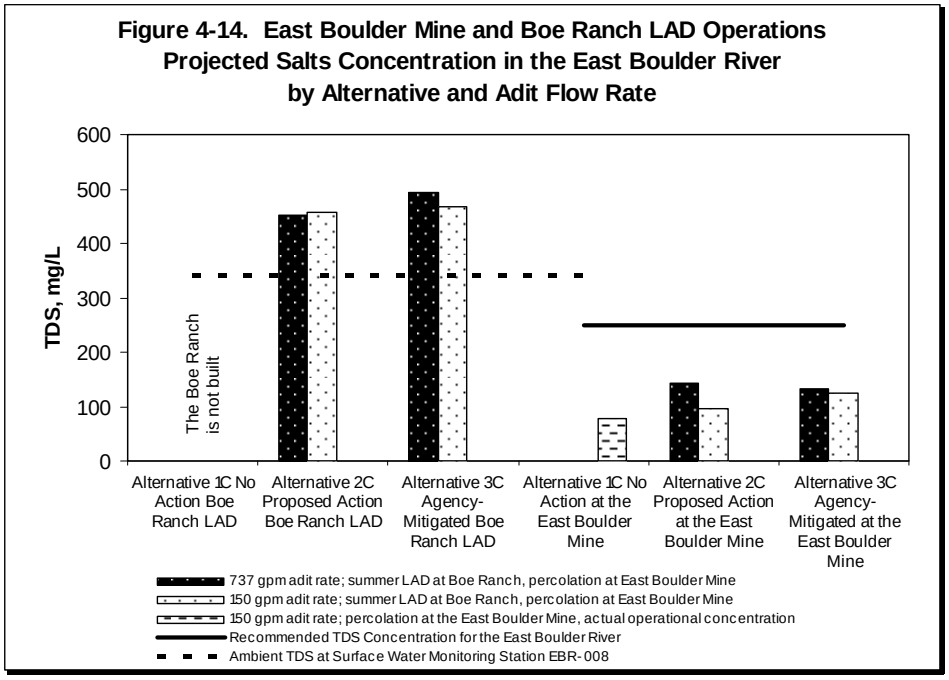


Figure 4-14 note: This figure depicts the maximum projected salts concentration that would occur in the East Boulder River. Maximum salts concentrations would occur when the streamflow is at the 7Q10 low value then reduced further by irrigation season withdrawals (2.0 cfs remaining streamflow).

To reduce salts increases in the East Boulder River below the Boe Ranch during operations, SMC could implement other options to reduce operational salt concentrations in adit and tailings waters, such as managing adit flows to reduce salts concentrations or implementing additional salts treatment measures.

For all operational options analyzed for the Boe Ranch under the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, SMC would comply with the 1 mg/L nitrogen surface water criteria used by the agencies in analyses for the East Boulder River (Figure 4-15).

Figure 4-15. East Boulder Mine and Boe Ranch LAD Operations Projected Nitrogen Concentration in the East Boulder River by Alternative and Adit Flow Rate

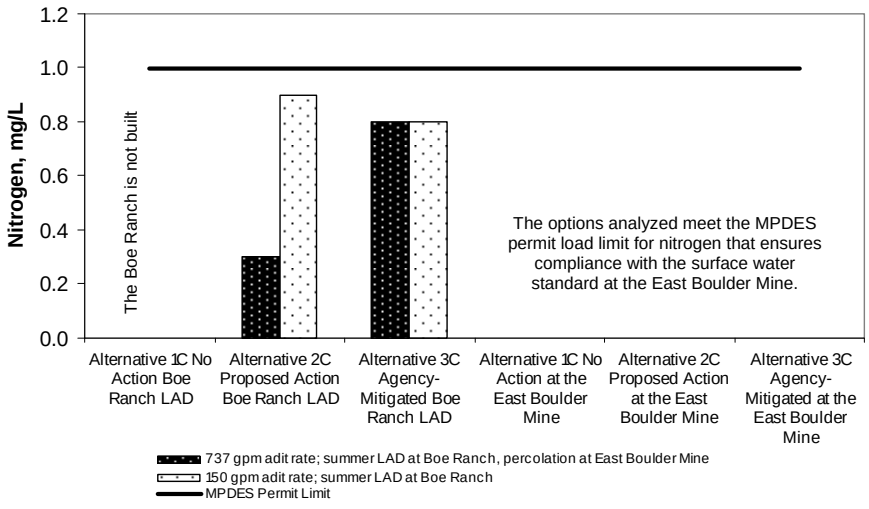


Figure 4-15 note: This figure depicts the maximum projected nitrogen concentration that would occur in the East Boulder River. Maximum nitrogen concentrations would occur when the streamflow is at the 7Q10 low value then reduced further by irrigation season withdrawals (2.0 cfs remaining streamflow).

Nitrogen and Salts Effects at the East Boulder Mine. For all operational options analyzed for the Boe Ranch under the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, SMC would not exceed the MPDES permit nitrogen load limit (30 lbs/day) at the East Boulder Mine. Under either of these alternatives less water would be disposed of at the East Boulder Mine than under the Proposed Action Alternative 2B or the Agency-Mitigated Alternative 3B, minimizing effects to ground and surface water (Figure 4-11).

For all operational options analyzed for the Boe Ranch under the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, SMC would not exceed the Class I ground water EC beneficial use criterion (Figure 4-13) or the surface water 250 mg/L TDS recommendation used in the analyses by the agencies at the East Boulder Mine (Figure 4-14). Under either of these alternatives, less water would be disposed of at the East Boulder Mine than under the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B or the Agency-Mitigated Alternative 3B

Effects of a Pipeline Failure on the East Boulder River. Water quality effects during operations and closure may result from leaks within the pipeline conveying treated mine waters. If the treated adit water pipeline breaks near the East Boulder Mine during operations at an adit flow rate of 150 gpm, adverse downstream short-term effects would be expected from the 180,000 gallon pipeline volume discharge, which is assumed to contain 11.1 mg/L nitrogen and 550 mg/L TDS, to the East Boulder River. The surface water nitrogen concentration in the river would increase up to 3.3 mg/L. The 250 mg/L TDS recommendation would be exceeded. Based on the volume and velocity of the

East Boulder River, these water quality effects would last less than one month (Freeze and Cherry 1979).

4.1.3.2.2 Tailings Waters

Under the Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C, tailings waters would remain in the East Boulder tailings impoundment during operations unless excess tailings waters need to be disposed of at the East Boulder Mine or at the Boe Ranch. Operational tailings waters disposal effects to ground and surface waters at the East Boulder Mine are disclosed in Section 4.1.2.1.2. Effects from a portion of operational tailings waters disposal under the Boe Ranch LAD System Proposed Action Alternative 2C or Agency-Mitigated Alternative 3C would be less than those disclosed below in the closure section when all tailings waters would be disposed of at the Boe Ranch.

4.1.3.2.3 Storm Water

No changes have been proposed for operational storm water management at the East Boulder Mine under either the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C. Effects of operational storm water management on ground and surface water quality and quantity at the East Boulder Mine would be the same as for the East Boulder Mine WMP No Action alternatives (1B, 2B, or 3B).

A storm water pollution prevention plan (SWPPP) would be required at the Boe Ranch LAD area during construction where there is potential for storm water runoff containing sediment to discharge off site. Minimal storm water would report to the Mason Ditch, which is located below the LAD area. Runoff from the access road and pipeline construction would also be minimal.

An operational SWPPP after construction is completed may not be required at the Boe Ranch for the Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C because there would be limited storm water runoff from the Boe Ranch LAD Area. Most storm water runoff would drain into the Boe Ranch LAD storage pond (Figure 2-35). Because storm water would be contained and would have limited potential to mix with treated adit water disposed of during operations, no measurable adverse effects related to ground water quality would be anticipated at the Boe Ranch LAD area. During operations, effects to water quality in the East Boulder River would not be anticipated since existing riparian vegetation and implementation of BMPs would preclude sediment from reaching surface water. The Boe Ranch LAD system facilities are located approximately one mile from the East Boulder River. Most storm water would infiltrate to ground water, eliminating the potential for sediment to reach the river.

4.1.3.3 Closure Nitrogen and Salts Effects to Water Quality and Quantity at the Boe Ranch and the East Boulder Mine

The agencies' analyses for the Boe Ranch LAD System Proposed Action Alternative 2C demonstrate the need to balance nitrogen and salts treatment and disposal in order to maintain compliance with applicable water quality criteria at

closure. With the 12-month closure period specified in the SMC's Boe Ranch LAD System Proposed Action Alternative 2C, there is potential for unforeseen problems that might affect the closure treatment start date or for problems due to system inefficiency or malfunction.

For the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the closure period would be extended from 12 to 18 months to provide flexibility in disposal options. The agencies have also identified the need for a modified LAD management program based on 10 years of operating results from the Stillwater Mine Hertzler Ranch LAD system. At the Hertzler Ranch, mine waste waters have been applied at greater than agronomic rates during the LAD season. During this time period, there has been no appreciable build up of salts in the soil above the salts concentration in the applied mine waste waters (see *Irrigation Practices* Section 4.3.4.4). This lack of salts buildup suggests that the increased application rate is flushing salts through the soil horizon rather than concentrating them.

Monitoring at the Hertzler Ranch has documented that the nitrogen concentration in ground water also has not appreciably increased above ambient levels. This lack of nitrogen buildup in ground water indicates that plant uptake is occurring at a rate protective of ground water. As a result of the Hertzler Ranch LAD experience, the LAD application rate could be applied at greater than agronomic rates under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, if needed.

The Boe Ranch LAD application rates would be set to ensure that all mine waste waters stored in the Boe Ranch LAD storage pond over winter would be disposed of during the LAD season. Over-application of water could result in increased runoff, ponding, and potential for mass wasting on susceptible sites. For more information on mass wasting potential from Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, see sections 4.3.3.10 and 4.3.4.9, respectively.

Under the Boe Ranch LAD System Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C, water quality data from ground water monitoring wells, springs, and surface water monitoring locations would be collected and analyzed during closure to verify whether potential deep percolation is affecting overall ground water quality. Application rates would have been adjusted as necessary as part of the Boe Ranch operations. Potential long-term impacts to soil from operation of the Boe Ranch LAD to soils are discussed in *Irrigation Practices* sections 4.3.3.19 (for Alternative 2C) and 4.3.4.18 (for Alternative 3C).

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, SMC would be required to implement several measures to minimize the nitrogen and salt effects to ground and surface water identified for the Proposed Action Alternative 2C. A more complete operational and closure ground water and soil monitoring program would be implemented to provide early detection of increased nitrogen and salts concentrations in ground water that could affect the nitrogen and salts loads moving toward the East Boulder River (Appendix B).

4.1.3.3.1 Mixed Adit and Tailings Waters

Under the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, adit water would be mixed with East Boulder Mine tailings impoundment waters and treated in the BTS/Anox system at the East Boulder Mine. Up to 40 MG of tailings waters would be discharged with up to 737 gpm of adit water. SMC has tested treating mixed adit and tailings waters. As much as 100 percent tailings waters can be treated through the BTS without toxic effects to the organisms (SMC 2006b).

Under the Proposed Action Alternative 2C, during the 12-month closure period, adit and tailings waters would be mixed and treated in the BTS/Anox system prior to disposal at the Boe Ranch LAD area (Figure 2-29). Under the Agency-Mitigated Alternative 3C, the agencies would extend the closure period to 18-months and use alternate routing to maximize LAD area use over percolation pond use whenever possible (Figures 2-28 and 2-33).

Agency Analyses

For both the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C analyses, the agencies based their effects calculations on the following regulatory requirements: the Montana Water Quality Act, its rules and regulations, and the federal Clean Water Act for ground water mixing zones. Other assumptions are listed in Appendix C under the Boe Ranch LAD System Proposed Action 2C and Agency-Mitigated Alternative 3C Operation and Closure Nitrogen and Salts Spreadsheets (DEQ 2010).

The agencies analyzed several closure mixed adit and tailings waters disposal options. Effects to ground and surface water resources from the Boe Ranch LAD system operations would be similar for both alternatives.

Ground Water Effects at the Boe Ranch. For all closure options analyzed for the Boe Ranch LAD System Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C, the nitrogen concentration in ground water would be below the 10 mg/L water quality standard (Figure 4-16), and the salts concentration would be below the 2,500 µmhos/cm Class II EC beneficial use criterion (Figure 4-17).

Figure 4-16. East Boulder Mine and Boe Ranch LAD Closure Projected Nitrogen Concentration in Ground Water by Alternative and Adit Flow Rate

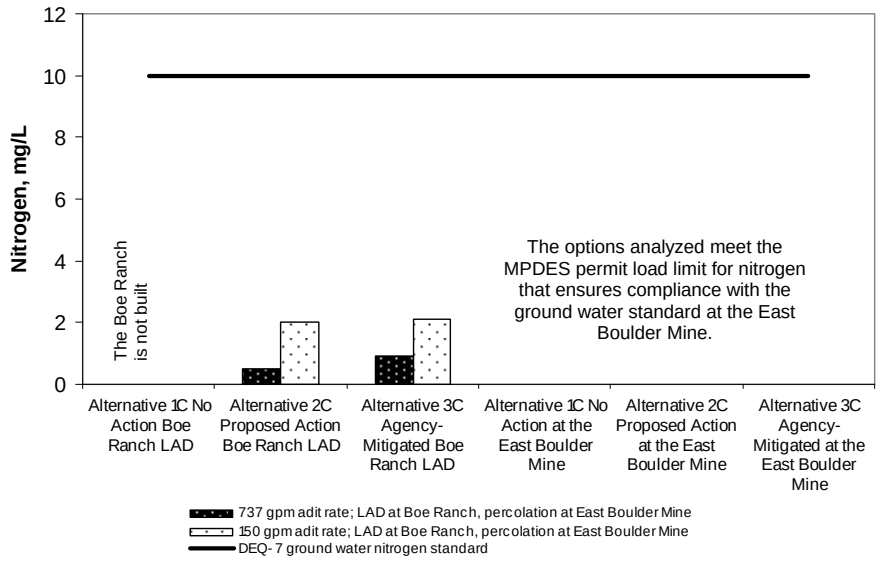
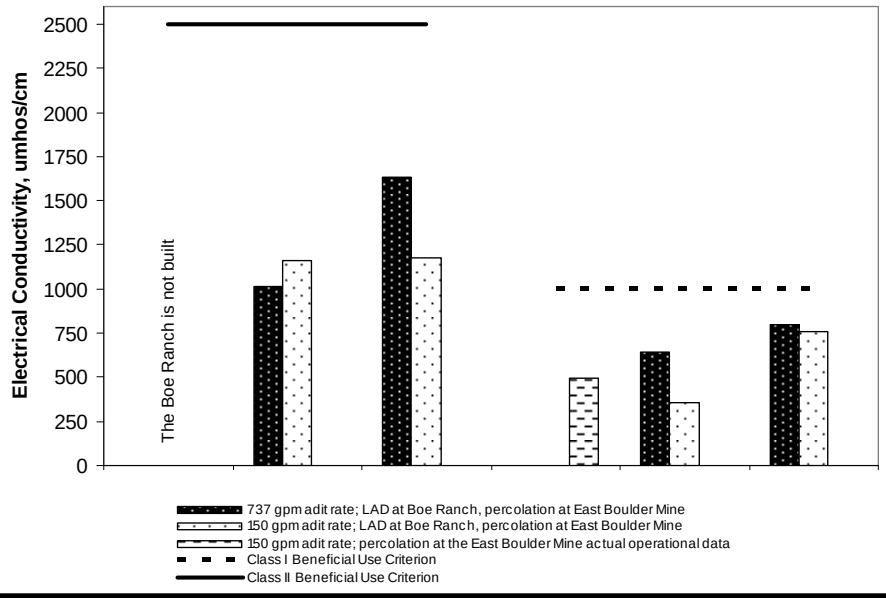


Figure 4-17. East Boulder Mine and Boe Ranch LAD Closure Projected Salts Concentration in Ground Water by Alternative and Adit Flow Rate



Surface Water Effects at the Boe Ranch. For all but one of the closure options analyzed for the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, the nitrogen concentration in surface water would be below the 1 mg/L water quality criterion used by the agencies in their analyses (Figure 4-18). In the 150-gpm adit flow option analyzed for the Proposed Action Alternative 2C, disposal of 40 MG of tailings waters in a 12-month closure period would cause the surface water quality to reach 1.2 mg/L TIN in the East Boulder River below the Boe Ranch. This increase in nitrogen would only occur if the flow in the East Boulder River below the Boe Ranch is below a 3 cfs flow rate. A 1.2 mg/L TIN concentration could cause short-term adverse effects to the East Boulder River below the Boe Ranch. If the Proposed Action Alternative 2C is selected, SMC would have to use other water management options to avoid this increase.

Figure 4-18. East Boulder Mine and Boe Ranch LAD Closure Projected Nitrogen Concentration in the East Boulder River by Alternative and Adit Flow Rate

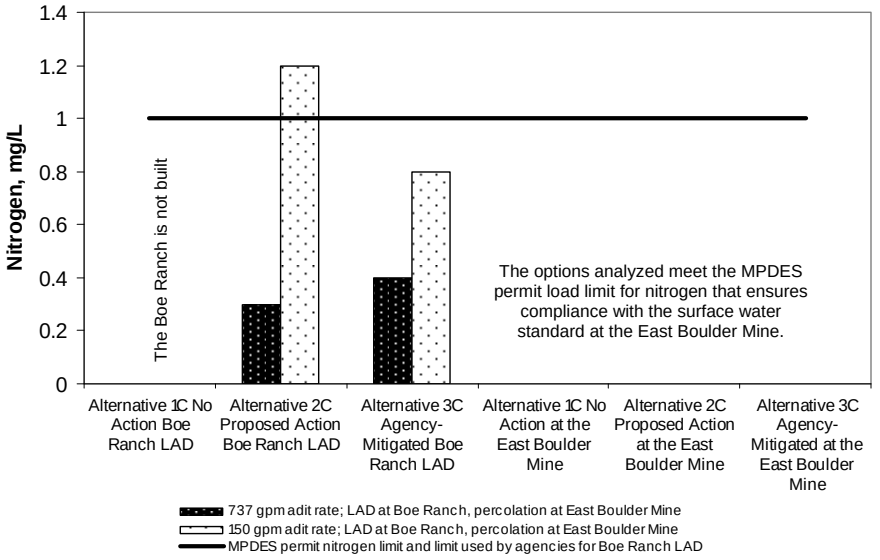


Figure 4-18 note: This figure depicts the maximum projected nitrogen concentration that would occur in the East Boulder River. The maximum nitrogen concentration would occur when the streamflow is at the 7Q10 low value then reduced further by irrigation season withdrawals (2.0 cfs remaining streamflow).

For all closure options analyzed for the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, SMC would exceed the 340 mg/L ambient TDS surface water concentration in the East Boulder River below the Boe Ranch (Figure 4-19). Depending on adit flow rates, the TDS concentrations in the East Boulder River would increase from 8 to 56 percent above ambient levels during closure. This increase could incrementally affect trout eggs during the closure period.

Figure 4-19. East Boulder Mine and Boe Ranch LAD Closure Projected Salts Concentration in the East Boulder River by Alternative and Adit Flow Rate

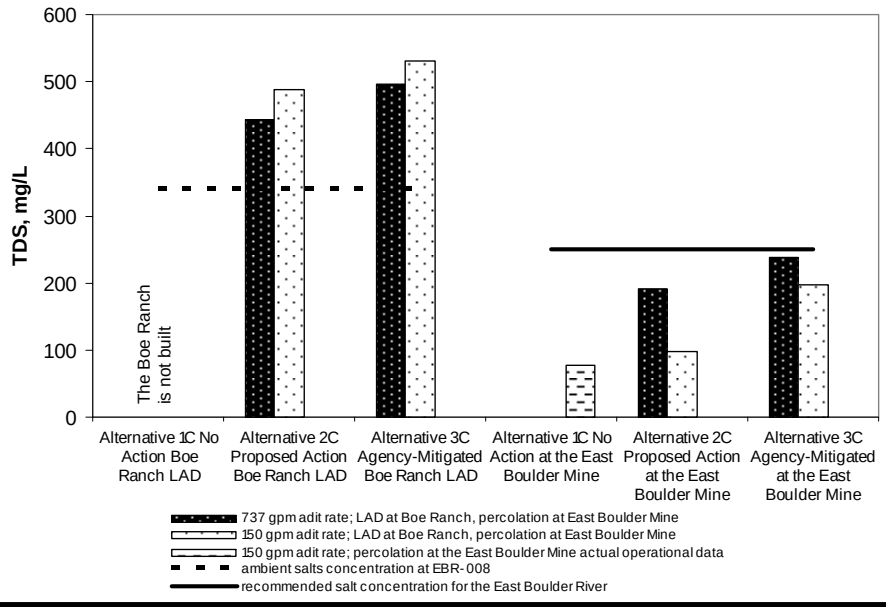
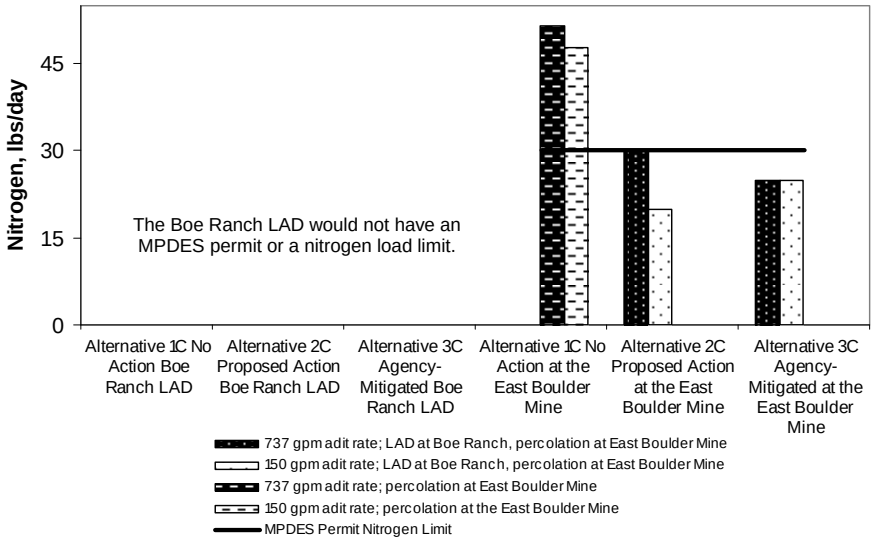


Figure 4-19 note: This figure depicts the maximum projected salts concentration that would occur in the East Boulder River. The maximum salts concentration would occur when the streamflow is at the 7Q10 low value then reduced further by irrigation season withdrawals (2.0 cfs remaining streamflow).

Under the Agency-Mitigated Alternative 3C, the agencies would require SMC to implement measures to reduce salt concentrations in adit and tailings waters during operations, such as managing adit flows to reduce salts concentrations or implementing additional salts treatment measures, in order to reduce salts increases in the East Boulder River below the Boe Ranch during closure. Also, under this alternative, SMC could spread the salts load over two LAD seasons to reduce salts effects in the East Boulder River.

Nitrogen and Salts Effects at the East Boulder Mine. For all closure disposal options analyzed for the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, the nitrogen load to the East Boulder River at the East Boulder Mine would be less than MPDES permit nitrogen load limit (30 lb/day TN) (Figure 4-20) and would have minimal effects on ground (Figures 4-16 and 4-17) and surface water quality (Figures 4-18 and 4-19).

Figure 4-20. East Boulder Mine and Boe Ranch LAD Closure Projected Nitrogen Load by Alternative and Adit Flow Rate



For all closure disposal options analyzed, the nitrogen concentration in ground water at the East Boulder Mine would be less than the 10 mg/L water quality standard (Figure 4-16).

Similarly, the salts concentration in ground water at the East Boulder Mine would be less than the Class I EC beneficial use criterion (1,000 µmhos/cm) for all closure disposal options analyzed (Figure 4-17). The salts concentration in surface water at the East Boulder Mine would be less than the 250 mg/L TDS surface water quality recommendation (Figures 4-19).

Under both the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, ground and surface water at the East Boulder Mine would continue to show minor effects from nitrogen and salts disposed of at the mine. No downstream beneficial uses would be compromised.

4.1.3.3.2 Other Effects

Previous environmental documents examined effects from 1 gpm of tailings impoundment liner leakage from the East Boulder tailings impoundment during operations. Effects would be the same at closure.

At closure, SMC would reclaim the East Boulder tailings impoundments as described in Section 2.4.5.2. No effects from underdrain seepage at the East Boulder tailings impoundment occur during closure because the underdrain seepage is recycled back into the tailings impoundment. There is no seepage through the cover at the East Boulder tailings impoundments until after closure since the reclamation cover would not be completed. Potential effects to water quality and quantity may result from tailings supernatant water and tailings mass

water disposal at the Boe Ranch and the East Boulder Mine as discussed above in Section 4.1.3.3.1.

4.1.3.3.3 Storm Water

During closure, the East Boulder Mine storm water would be managed as it is during operations and as described in the East Boulder Mine SWPPP (SMC 2007b). During closure and prior to reclamation cover completion, storm water falling on the East Boulder tailings impoundment would be managed as tailings waters and directed to the BTS/Anox system.

Storm water would be managed during closure at the Boe Ranch the same as it is managed during operations. There would be no reclamation of the Boe Ranch LAD facilities at closure, except for removal of snowmakers and evaporators around the Boe Ranch LAD storage pond. All other LAD facilities would be left for future use by the landowner.

4.1.3.4 Post-Closure Nitrogen and Salts Effects to Water Quality and Quantity at the Boe Ranch and the East Boulder Mine

The Boe Ranch LAD facilities would not be used during post-closure to dispose of mine waste waters. Under the Boe Ranch LAD System Proposed Action Alternative 2C or Agency-Mitigated Alternative 3C, mine waters would be managed during post-closure as described for the East Boulder Closure and Post-Closure WMP Proposed Alternative 2B or Agency-Mitigated Alternative 3B, respectively.

4.1.3.4.1 Adit and Tailings Waters

Under the Boe Ranch LAD System Proposed Action Alternative 2C or Agency-Mitigated Alternative 3C, the quantity and quality of adit water disposed of at the East Boulder Mine at post-closure would be the same as described for the East Boulder Mine WMP alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B) and the Boe Ranch LAD System No Action Alternative 1C. SMC proposes to decommission and reclaim the BTS/Anox system and the East Boulder Mine LAD system when all water discharges to ground water or to the East Boulder River meet MPDES permit nitrogen limits. At post-closure, untreated adit water would be routed around the percolation pond and to the East Boulder River in a constructed channel from the adit.

Water Quality Effects

If the Boe Ranch LAD area is constructed under Proposed Action Alternative 2C or Agency-Mitigated Alternative 3C, it would be the primary disposal site for treated adit water during operations and for treated adit and tailings waters during closure. After 12 months of closure under the Boe Ranch LAD System Proposed Action Alternative 2C or 18 months of closure under the Agency-Mitigated Alternative 3C, effects to ground and surface water quality would be less than the other alternatives that rely on the East Boulder Mine alone for adit and tailings waters disposal (1B, 2B, 3B and 1C).

Water Quantity Effects

For Boe Ranch LAD System Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C, post-closure water quantity effects at the East Boulder Mine would be the same as described for the East Boulder Mine WMP alternatives (No Action 1B, Proposed Action 2B, and Agency-Mitigated 3B) and the Boe Ranch LAD System No Action Alternative 1C.

4.1.3.4.2 Storm Water

Under the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, effects to ground and surface waters from post-closure tailings impoundment storm water are the same as described for the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B or Agency-Mitigated Alternative 3B, respectively.

Storm water would be managed during post-closure at the Boe Ranch the same as it is managed during operations and closure.

4.1.3.5 Cumulative Effects

Implementation of either the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would result in new disturbances at the Boe Ranch. All facilities necessary for the collection, treatment, routing, and disposal of mine waters there are not currently in place, have not been previously approved, and would be implemented on private lands (the Boe Ranch) that have not been approved for disturbance.

Conversely, implementation of either the Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would not result in additional disturbances on public land within the East Boulder Mine permit area over those previously approved. All facilities necessary for the collection, treatment, routing, and disposal of mine waters are currently in place at the mine or have been previously approved and would be implemented on public lands that have been approved for disturbance.

4.1.3.5.1 Cumulative Effects during Operations and Closure

Selection and implementation of either the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would potentially increase cumulative effects to ground and surface water quality and quantity within or adjacent to the Boe Ranch area during operations and closure. Nitrogen and salts in mine waste waters applied at the Boe Ranch LAD would increase nitrogen and salts loading and concentrations in ground and surface water over ambient concentrations, adding to increases from human land uses and natural events in the East Boulder River valley below the Boe Ranch. Most effects from operation of the Boe Ranch LAD system would be short-term increases in nitrogen. Disposal of mine waste waters during operations would decrease salts concentrations in ground water downgradient of the Mason Ditch because adit water contains lower salts concentrations than ground water. During closure, disposal of mine waste waters would increase salts concentrations in ground water downgradient of the Mason Ditch because mixed adit and tailings waters

contain more salts than ground water (Appendix C, Boe Ranch LAD System Proposed Action Alternative 2C and Agency-Mitigated Alternative 3C Operation and Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). Expanded monitoring of the ground water at the Boe Ranch could address potential cumulative nitrogen and salts loading effects in ground water and the East Boulder River.

Selection and implementation of either the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would reduce cumulative effects to water quality and quantity within or adjacent to the East Boulder Mine during operations and closure, as compared to the East Boulder Mine WMP alternatives (1B, 2B, and 3B) or the Boe Ranch LAD System No Action Alternative 1C.

4.1.3.5.2 Cumulative Effects at Post-Closure

At post-closure, all mine waste waters would be discharged at the East Boulder Mine. Water quality and quantity effects at post-closure would be the same as the East Boulder Mine WMP alternatives (1B, 2B, 3B).

4.1.3.5.3 Other Land Use Activities

Cumulative effects to water quality and quantity could result from hard rock mineral exploration, wildland fires, invasive species, subdivisions, and implementation of the Gallatin National Forest (GNF) travel management plan.

Hard rock mineral exploration is a past, present, and reasonably foreseeable activity in the Stillwater Complex. Several small-scale hard rock exploration projects have been conducted with minimal impacts to water quality.

Past and reasonably foreseeable wildland fires would affect water quality. Approximately 200,000 acres have burned in the East Boulder River and the Boulder River drainages in the last decade. Water quality data gathered by SMC have shown some small increases in nitrogen in the river as a result of the fires. These water quality effects were short-term. Future wildland fires would likely produce similar effects.

Other past, present, and reasonably foreseeable land use activities, including subdivisions, and recreational use of roads, could cumulatively add to water quality effects in the East Boulder River drainage. Major effects would include increased sediment production and the spread of noxious weeds. Chemical treatment of noxious weeds could also result in leaching of weed control chemicals into ground and surface waters. The GNF Travel Management Plan implementation could reduce some of the seasonal sediment effects from road use on public lands in the drainage. There would be no seasonal controls on private roads in subdivisions.

Any of the activities listed above could cumulatively degrade water quality and, consequently, promote the spread of aquatic nuisance species, such as *Didymosphenia geminata.* Cumulative effects to aquatic resources from implementation of the Boe Ranch LAD System Proposed Action Alternative 2C

or the Agency-Mitigated Alternative 3C are discussed in sections 4.2.2.5.2 and 4.2.2.7.2, respectively.

4.1.3.6 Unavoidable Adverse Effects

Selection and implementation of the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would result in additional, unavoidable short-term adverse effects to water quantity and quality at the Boe Ranch during operations and closure. Disposal of mine waste waters at the Boe Ranch would increase the volume of ground and surface water in the Boe Ranch area and increase loads and concentrations of nitrogen and salts in those waters. Based on operational East Boulder Mine water quality monitoring data, the agencies expect nitrogen and salts in ground and surface water to flush within two years of cessation of water disposal at the Boe Ranch (Appendix C, Figures EBMW-2, EBMW-3, EBMW-6, EBMW-7, spring SP-11, EBR-004 and EBR-004A, DEQ 2010). These effects would continue during operations and closure and decrease during post-closure.

Selection and implementation of the Boe Ranch Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would result in reduced unavoidable, short-term adverse effects at the East Boulder Mine during operations over those analyzed in previous environmental documents. The transfer of water from the mine to the Boe Ranch would decrease the volume of ground and surface water near the East Boulder Mine. Unavoidable adverse effects include the transfer of water from the East Boulder Mine area to the Boe Ranch. This decrease in flow at the mine area could have the effect of increasing the concentrations of nitrogen and salts in mine area ground and surface water. These effects would continue during operations and closure and decrease during post-closure.

4.1.3.7 Relationship between Short-term Use and Long-term Productivity

As compared to effects disclosed for the East Boulder Mine WMP alternatives (1B, 2B, and 3B), selection and implementation of the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would result in reduced effects to ground and surface water at the East Boulder Mine area during operations and closure.

No decisions have been made previously regarding use of the Boe Ranch area. Selection of the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would result in new operational and closure effects to ground and surface water quality and quantity at the Boe Ranch other than those previously disclosed for the East Boulder Mine alternatives (1B, 2B, and 3B). The short-term use of the Boe Ranch during operations and closure would increase disposal of mine waste waters at the Boe Ranch, which would reduce effects from disposal of mine waste waters at the East Boulder Mine.

After the East Boulder Mine closes and all reclamation and mine-related activities cease at post-closure, the long-term productivity of the mine area would improve as water quality returns to pre-mine conditions. Similarly, after the Boe Ranch LAD system in no longer used for mine waste water disposal, the long-

term productivity of Boe Ranch area would improve as water quality and quantity return to pre-mine and pre-LAD conditions.

Decisions have been made previously that balance short-term human uses of the environment and the maintenance and enhancement of long-term productivity in the area surrounding the East Boulder Mine. Selection and implementation of Boe Ranch LAD System Agency-Mitigated Alternative 3C would still make use of the mine waste water management facilities and would not change the relationship between short-term use of the East Boulder Mine and the long-term maintenance and enhancement of the ground and surface water quality and quantity in the East Boulder River drainage.

4.1.3.8 Irreversible or Irretrievable Commitments of Resources

Selection and implementation of either the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would reduce the irreversible or irretrievable commitments of water resources at the East Boulder Mine, as compared to the East Boulder Mine WMP alternatives (1B, 2B, and 3B). The transfer of water from the mine area to the Boe Ranch and the evaporative loss of water from use of SMC's high pressure irrigation systems at the Boe Ranch would be irreversible or irretrievable commitments of water resources.

4.2 Wildlife and Aquatic Resources

Project scoping indicated that implementation of the Proposed Action alternatives for the Stillwater Mine, East Boulder Mine, and Boe Ranch LAD system (2A, 2B, and 2C, respectively) or the Agency-Mitigated alternatives for the Stillwater Mine, East Boulder Mine, and Boe Ranch LAD system (3A, 3B, and 3C, respectively) might affect aquatic resources near both mines during closure and post-closure, as well as wildlife and aquatic resources on and near the Boe Ranch during operations, closure, and post-closure. Specific concerns are detailed in the description of Issue 2 (Section 2.2.1) and include the following:

- Increases in the numbers of deer and elk that winter on the Boe Ranch and surrounding lands due to greater forage production and increased wildlife carrying capacity that would result from application of treated mine waste waters under the Boe Rand LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C;
- Adverse consequences to threatened, endangered, or sensitive species that would occur potentially in the Boe Ranch area if either the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C is implemented; and
- Possible adverse effects to aquatic resources in the East Boulder and/or Stillwater rivers resulting from treatment and disposal of mine waste waters from the Stillwater and East Boulder mines during closure. Adverse effects could also result from disposal of untreated adit water, storm water, and liner leakage or impoundment underdrain discharges during post-closure. Mine waste waters would be discharged to ground water and eventually would be incorporated into either the Stillwater or East Boulder rivers under the Proposed Action alternatives for the Stillwater Mine, East Boulder Mine, and Boe Ranch LAD system (2A, 2B, and 2C, respectively) or the Agency-Mitigated alternatives for the Stillwater Mine, East Boulder Mine, and Boe Ranch LAD system (3A, 3B, and 3C, respectively).

The analyses below address issues regarding effects to high-interest (game) species at the Boe Ranch, threatened or endangered species (TES) at the Boe Ranch, species of special concern at the Boe Ranch, and aquatic resources, including management indicator species (MIS), in the Stillwater and East Boulder rivers. Methods for evaluating potential impacts included the following:

- Wildlife effects were estimated through professional interpretation of Montana Department of Fish, Wildlife, and Parks (FWP) data, including migratory patterns, local winter range use by deer and elk, and hunting pressure, as well as predicted effects to vegetation from irrigation practices.
- Effects to aquatic resources from discharges of adit water, tailings impoundment waters, and storm water to the Stillwater and East Boulder rivers during operations, closure, and post-closure were estimated

through professional ground water system modeling and interpretations of water quality and biomonitoring data.

The following section presents the findings of these analyses.

4.2.1 Wildlife Resources

4.2.1.1 Stillwater Mine Closure and Post-Closure Water Management Plan No Action Alternative 1A and East Boulder Mine Closure and Post-Closure Water Management Plan No Action Alternative 1 B

4.2.1.1.1 Direct and Indirect Effects

Effects to high interest species (deer and elk), species of special concern, sensitive species, management indicator species, and threatened or endangered species at the Stillwater and East Boulder mines have been addressed in past environmental analyses (DSL and USFS, 1985 and 1989, DEQ and USFS 1998a; DSL et al. 1992b). No additional adverse effects are predicted for any of these species under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A or the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B. No new disturbances at either the Stillwater or East Boulder mines would take place under these alternatives. Mine-related human activity at either mine site would not increase under these alternatives. At closure, facilities would be removed and mine reclamation would result in the establishment of grasses and forbs. The elimination of mine facilities and activities during post-closure, except at the Hertzler Ranch LAD area, as well as the reestablishment of habitat and forage, would have beneficial effects for all wildlife species that had been previously displaced. Trees that were removed during the construction of the mine and other facilities would take several decades to reestablish.

4.2.1.1.2 Cumulative Effects

Selection and implementation of either the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A or the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B would not contribute cumulative effects to wildlife resources within or adjacent to the project areas.

4.2.1.1.3 Unavoidable Adverse Effects

Selection and implementation of either the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A or the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B would not result in unavoidable adverse effects.

4.2.1.1.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Decisions have been made previously that strike a balance between the short-term human uses of the environment and the maintenance and enhancement of long-term productivity in the area surrounding the Stillwater and East Boulder mines. Selection of either the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A or the East Boulder Mine Closure and Post-Closure

WMP No Action Alternative 1B would result in the same effects related to wildlife resources as either the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B. After the mines close and all reclamation and mine-related activities cease at post-closure, the long-term productivity of both mine areas would return for wildlife resources.

4.2.1.1.5 Irreversible and Irretrievable Losses

There would be no irreversible or irretrievable commitments of wildlife resources at either the Stillwater or East Boulder mines under either the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A or the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B.

4.2.1.2 Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2A and East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B

4.2.1.2.1 Direct and Indirect Effects

Effects to High Interest Species, Effects to Species of Special Concern and Sensitive Species, and Effects to Management Indicator Species

Effects to high interest species (deer and elk), species of special concern, sensitive species, and management indicator species at the Stillwater and East Boulder mines have been addressed in past environmental analyses (DSL and USFS, 1985 and 1989, DEQ and USFS 1998a; DSL et al. 1992b). No additional adverse effects are predicted for any of these species under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B. No new disturbances at either the Stillwater or East Boulder mines would take place under these alternatives. Mine-related human activity at either mine would not increase under these alternatives. At closure, facilities would be removed and mine reclamation would result in the establishment of grasses and forbs. The elimination of mine facilities and activities during post-closure, except at the Hertzler Ranch LAD area, as well as the reestablishment of habitat and forage, would have beneficial effects for all wildlife species previously displaced. Trees that were removed during the construction of the mine and other facilities would take several decades to reestablish.

Effects to Threatened and Endangered Species

Effects to threatened or endangered species at the Stillwater and East Boulder mines have been addressed in past environmental analyses (DSL and USFS, 1985 and 1989, DEQ and USFS, 1993 and 1998, DEQ and USFS 1998a; DSL et al. 1992b). No adverse effects are predicted for wildlife species listed as either threatened or endangered. Under either the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B, no new ground disturbance would occur, and the level of human activity at the mine sites would not increase. During mine closures, existing disturbances would be reclaimed to grasses and forbs. This would result in forage and seasonal habitat for deer and elk, which would help maintain prey for gray wolves.

Regardless of reclamation conditions at post-closure, it is not anticipated that the mine areas are capable of providing appropriate habitat conditions for lynx since necessary vegetation communities are not found within the project areas. Selection of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not affect threatened or endangered species within or adjacent to the project areas.

4.2.1.2.2 Cumulative Effects

Implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not result in additional disturbances within the mine permit areas other than those previously approved. All facilities necessary for the collection, treatment, routing, and disposal of mine waste waters are currently in place or have been previously approved and would be implemented on lands that have been approved for disturbance.

Listed projects or activities (Table 4-1) that have potential to cumulatively effect wildlife resources within or adjacent to the existing mine sites were considered. Some of these activities, such as the spread of noxious weeds or the occurrence of wildfire, would cumulatively affect wildlife within the Stillwater and the East Boulder river drainages. Additional adverse cumulative effects to wildlife resources within or adjacent to the mine would not be anticipated if the Proposed Action Alternative for either the Stillwater Mine (2A) or the East Boulder Mine (2B) is selected. Wildlife species, which may have experienced short-term displacement from lands occupied by either mine, are expected to use the area again at post-closure. Selection of either the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B may serve to reduce slightly the overall cumulative effects to wildlife resources within the project area by enabling the affected areas to return to a more natural, non-industrial condition in a one or two year shorter timeframe than proposed under the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A and the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B.

4.2.1.2.3 Unavoidable Adverse Effects

Implementation of the Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B would not result in any new area disturbances at the mines other than those previously considered and approved. All facilities necessary for the collection, treatment, routing, and disposal of mine waste waters are currently in place or have been previously approved for construction. Selection and implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not contribute unavoidable adverse effects to wildlife species within or adjacent to the mines other than those considered in previous environmental analyses.

4.2.1.2.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Implementation of either the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not result in any new disturbances other than those considered and approved in past environmental

analyses. The long-term wildlife productivity of both mines areas would return at post-closure.

Selection and implementation of either the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not change the existing relationship between short-term use of the mine areas and the long-term maintenance and enhancement of the mine sites' wildlife productivity.

4.2.1.2.5 Irreversible and Irretrievable Losses

Implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A or the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not result in additional irretrievable or irreversible commitments of resources within or adjacent to the mine sites in excess of those previously considered and approved in past environmental analyses.

4.2.1.3 Stillwater Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3A and East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B

4.2.1.3.1 Direct and Indirect Effects

Effects to high interest species, species of special concern and sensitive species, management indicator species, and threatened and endangered species at the Stillwater and East Boulder mines have been addressed in past environmental analyses (DEQ and USFS 1998a; DSL et al. 1992b). Selection of the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would result in effects similar to those under the No Action alternatives and the Proposed Action alternatives described above in sections 4.2.1.1 and 4.2.1.2, respectively. Under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A and the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B, the adits would be closed with bat-friendly gates, opening up the adits as potential bat habitat.

No additional adverse effects are predicted for any of these species under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B, since no new disturbances at the Stillwater or East Boulder mines would occur under these alternatives. Mine-related human activity at either mine site would not increase. At closure, the facilities would be removed and mine reclamation would result in the establishment of grasses and forbs. The reclamation of the Stillwater Mine facilities during post-closure would reestablish habitat and forage and have beneficial effects for all wildlife species that had been displaced previously. Trees removed in the disturbance of constructing the mine and other facilities would take several decades to reestablish.

4.2.1.3.2 Cumulative Effects

Projects or activities that have potential to cumulatively affect wildlife resources within or adjacent to the existing mine sites were considered (See Table 4-1). No new areas of disturbance within or adjacent to the two mine sites would take place under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B. Cumulative effects would be similar to those previously considered and approved under past environmental analyses.

Implementation of the Stillwater Mine and the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated alternatives 3A and 3B would not result in additional cumulative effects to wildlife resources, as compared to the Proposed Action alternatives 2A and 2B.

4.2.1.3.3 Unavoidable Adverse Effects

Unavoidable adverse effects to wildlife resources due to selection and implementation of the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would not result in any new disturbance at the mines. There would be no additional unavoidable adverse effects to wildlife resources at either mine other than those that have been previously considered and approved.

4.2.1.3.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

The relationship between short-term uses of the human environment and the maintenance and enhancement of long-term productivity would be similar to those for the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A and the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B.

4.2.1.3.5 Irreversible and Irretrievable Losses

No additional irreversible and irretrievable losses of wildlife resources would be anticipated under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B, as compared to the Proposed Action alternatives 2A and 2B.

4.2.1.4 Boe Ranch LAD System No Action Alternative 1C

4.2.1.4.1 Direct and Indirect Effects

Effects to High Interest Species, Species of Special Concern, and Sensitive Species

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be built. No new disturbances related to mine activities within or adjacent to the Boe Ranch would take place. No mine-related effects to wintering deer or elk would occur at the Boe Ranch. Existing agricultural, recreational, or residential disturbances to wildlife resources would continue to occur within the area adjacent to the Boe Ranch.

Effects to Management Indicator Species

MIS are species that the United States Forest Service Gallatin National Forest (GNF) uses to gauge effects resulting from management actions. The Boe Ranch consists of private lands and contains no National Forest System Lands. Therefore, evaluation of MIS is not required.

Effects to Threatened and Endangered Species

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be built. No effects to threatened or endangered species would occur at the Boe Ranch.

4.2.1.4.2 Cumulative Effects

Selection and implementation of the Boe Ranch LAD System No Action Alternative 1C would preclude additional mine-related cumulative effects to wildlife resources within or adjacent to the Boe Ranch. Ongoing agricultural, recreational, or residential disturbances would continue to cumulatively affect wildlife resources that use the Boe Ranch.

4.2.1.4.3 Unavoidable Adverse Effects

Selection and implementation of the Boe Ranch LAD System No Action Alternative 1C would preclude additional disturbances at the Boe Ranch. No unavoidable adverse effects associated with mining activities or operation of the Boe Ranch LAD system would take place.

4.2.1.4.4 Relationship between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

Selection and implementation of the Boe Ranch LAD System No Action Alternative 1C would preclude construction and operation of the Boe Ranch LAD system. Short-term use of the Boe Ranch lands would not take place. The long-term productivity of the land and associated wildlife resources would be available for future use and would not be changed from present conditions.

4.2.1.4.5 Irreversible and Irretrievable Losses

Selection and implementation of the Boe Ranch LAD System No Action Alternative 1C would preclude construction and operation of the Boe Ranch LAD system. No irreversible or irretrievable commitment of wildlife resources would take place.

4.2.1.5 Boe Ranch LAD Proposed Action Alternative 2C

The Boe Ranch is private land. Guidelines related to GNF designated sensitive species or management indicator species do not apply to private land. Project effects analyses did consider these wildlife resources. Several of the listed species have potential to occur at the Boe Ranch or near the East Boulder River drainage.

4.2.1.5.1 Direct and Indirect Effects

Effects to High Interest Species

As stated in Section 2.2.1, concern was expressed during scoping regarding effects to wintering deer and elk at the Boe Ranch and surrounding lands as a result of the increases in the property's forage values and carrying capacity that would result from land application of treated mine waste waters.

The Boe Ranch LAD System Proposed Action Alternative 2C includes construction of temporary and permanent access roads, a pipeline, the LAD storage pond, center pivots, and other associated infrastructure. The Boe Ranch LAD storage pond would be fenced during operations and enclosed to prevent wildlife access to the pond and damage to the high-density polyethylene (HDPE) liner. Short-term loss of wildlife habitat would occur during construction and prior to reclamation of the pipeline corridor and the pipeline access road. Long-term loss and fragmentation of wildlife habitat would occur from use of the access road and other LAD infrastructure that would not be reclaimed at closure. Areas not reclaimed would represent permanent habitat loss. The largest permanent loss of wildlife habitat at Boe Ranch would occur from the 36-acre LAD storage pond construction and use.

Construction and operation of the Boe Ranch LAD system would have positive and negative effects on habitat for deer and elk. As stated in Section 3.2.1.1, the Boe Ranch currently provides mule deer winter range. FWP estimates the mule deer population is more than 150 animals (Paugh 2006).

The Boe Ranch is not an important elk use area. Elk are generally uncommon in the East Boulder River drainage (DSL et al. 1992b). An estimated 100 to 150 elk use the Green Mountain area and sometimes use the East Boulder River drainage (Paugh 2006). The Boe Ranch does not encompass any designated summer or winter elk range (DSL et al. 1992b). There are no defined elk migration corridors within the Boe Ranch area.

Specific effects to vegetation community composition and productivity within the Boe Ranch LAD area are discussed in *Irrigation Practices* Section 4.3.3.7. If the Boe Ranch LAD system is constructed and operated, existing native vegetation communities would change during mine life and would become dominated by introduced and more water-loving native plant species that can respond to the increased moisture and nitrogen. Overall forage quantity and quality would increase during mine life for some wildlife species. Based on experience at the Hertzler Ranch, productivity could double. This means the productivity of the Idaho fescue/bluebunch wheatgrass and Idaho fescue/western wheatgrass communities could increase to upper limits of 2,600 and 3,000 pounds per acre dry weight, respectively.

The improvement in forage availability during operations may increase use of the Boe Ranch by deer and may establish use of the Boe Ranch by elk. Irrigation and nitrogen fertilization at the Boe Ranch would provide available green forage later in the growing season compared to surrounding native rangeland habitat, which would not be receiving irrigation and nitrogen treatments. Deer and elk would use the Boe Ranch LAD area later in the growing season as native plants in surrounding areas become desiccated. The lack of hunter access at the Boe Ranch would concentrate big game species within the area especially during the hunting season.

Noxious weeds would become established and would increase within and adjacent to the Boe Ranch LAD area. Construction and operational vehicle traffic would introduce weed seeds into disturbed locations. The SMC has a noxious weed management plan for the East Boulder Mine. The Boe Ranch area would be incorporated into the noxious weed plan, and the area would be periodically monitored and treated for noxious weeds. Despite these efforts, noxious weeds and indirect effects to native plants from weed control chemicals would adversely affect wildlife habitats and foraging potential.

Construction and operation of the Boe Ranch LAD facilities would result in short-term and long-term changes in wildlife use patterns. Operation of the Boe Ranch LAD system would increase big game wildlife use of the area as a result of improved forage availability. Construction activity would most likely occur during summer and would not disrupt wildlife winter use.

After irrigation and fertilization stop, plant community production would decrease and more closely resemble pre-LAD operation levels. LAD area plant communities would not recover their original native species composition or diversity. Noxious weeds would persist on site during post-closure. These are unavoidable effects from irrigating, fertilizing, and controlling weeds on native rangeland.

At post-closure, if the future landowner continues to irrigate portions of the LAD area with water from the East Boulder River in the Mason Ditch, then forage production increases would continue and effects of improved forage would continue over the long-term. If forage within the Boe Ranch LAD continued to be of higher quality during post-closure compared to surrounding areas, this change could represent a beneficial effect to wildlife resources.

Although the Boe Ranch LAD System Proposed Action Alternative 2C would cause habitat loss, this loss would be partially mitigated through site reclamation and improved forage production from LAD area irrigation and fertilization during mine life. Permanent habitat loss, decreased forage production, and loss of native species diversity on the 194-acre Boe Ranch LAD area at post-closure would not be a major loss due to regional availability of suitable habitat.

Effects to Threatened and Endangered Species, Species of Special Concern, and Sensitive Species

A summary of potential effects to threatened and endangered species, species of special concern, and sensitive species that potentially could be found within the project area is provided in Table 4-2. This table was created based on conversations with GNF personnel (Sparks 2002), information provided by the Montana Natural Heritage Program (NHP 2008), and information from the US Fish and Wildlife Service (USFWS 2002). Effects to aquatic resources are discussed below in *Aquatic Resources* Section 4.2.2.5.

Bald eagles are not known to nest in the vicinity of the Boe Ranch. Bald eagles winter on both the Boulder and East Boulder rivers. The Boe Ranch LAD System Proposed Action Alternative 2C would have negligible adverse effects on bald eagles because its operation is not expected to have an effect on the prey of bald eagles, which is primarily fish. In addition, bald eagle use of the area would be highest during winter months when the LAD system would not be in use.

Peregrine falcons may occasionally use the Boe Ranch area; however, there are no known nest sites in the immediate vicinity of the ranch. The Boe Ranch LAD System Proposed Action Alternative 2C would not adversely affect peregrine falcons due to their limited use of the area and their large foraging ranges.

Northern goshawks have been observed in the vicinity of the East Boulder River and may use the Boe Ranch as a foraging area. The Boe Ranch LAD System Proposed Action Alternative 2C would result in limited loss of northern goshawk foraging habitat. This limited habitat loss would not adversely affect foraging ranges of the northern goshawk.

Grizzly bear use of the Boe Ranch area has not been documented. The Boe Ranch may serve as a temporary foraging area. In the event that the Boe Ranch LAD system is developed, increased human occupation and activity would occur during construction and operation of the LAD system. It is anticipated that grizzly bears would avoid the Boe Ranch area during operations and closure.

No established populations of gray wolf are known to occur at or in the vicinity of the Boe Ranch. LAD operations would increase forage for deer and elk, which in turn might increase prey for gray wolves. Because gray wolves may occasionally use the area, and the prey base would increase, beneficial effects to the gray wolf are possible.

Table 4-2 Potential Effects to Threatened and Endangered Species, Species of Special Concern, and Sensitive Species from the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B and the Boe Ranch LAD System Proposed Action Alternative 2C

Common Name	Potential Effect(s)
Birds	
Bald eagle	No effects; bald eagles are known to nest along the Yellowstone and Boulder rivers. The East Boulder River is likely used as a foraging area because of the availability of prey and lack of human activity.
Black-backed woodpecker	No effects; black-backed woodpecker is a fire-dependent species and has no occurrence records in the area. The Boe Ranch does not contain appropriate habitat for this species.
Flammulated owl	No effects; the only record of flammulated owl use is in the Bridger Mountains north of Bozeman. The Boe Ranch does not contain appropriate habitat.
Harlequin duck	No effects; harlequin ducks may occasionally use the East Boulder River but the only known breeding population is located on the upper Boulder River.
Northern goshawk	Known nesting sites on the East Boulder River; potential loss of foraging habitat.
Peregrine falcon	Historic activity within the last 10 years at Baker and Tepi mountains; potential loss of foraging habitat.
Trumpeter swan	No effects; does not occupy the area. The Boe Ranch does not contain appropriate habitat for this species.
Mammals	
Gray wolf	Although the primary range for nearby wolf packs does not include the Boe Ranch, it is possible that an individual wolf may travel through on occasion
Grizzly bear	No effects; Boe Ranch is not included in the area identified as occupied grizzly bear habitat nor is it part of any Grizzly Recovery Zone.
Lynx	No effects; Boe Ranch is located within an area designated as potential habitat. Within the GNF, lynx typically occur at elevations higher than the Boe Ranch (5,500 to 9,500 feet). The East Boulder Mine site is in lynx habitat.
Western big-eared bat	No effects; there are no known records of western big-eared bat at or in the vicinity of the Boe Ranch or the East Boulder Mine.
Wolverine	No effects; there are no historic records of wolverine at or in the vicinity of the Boe Ranch or the East Boulder Mine. Wolverines typically occur at higher elevations and are associated with elk winter range. The nearest records of wolverine are in the Crazy Mountains and the upper Boulder River.
Fish and Mollusks	
Montana arctic grayling	No effects; Montana arctic grayling do not occur in the East Boulder River.
Westslope cutthroat trout	No effects; there are no known populations in the East Boulder River.

Common Name	Potential Effect(s)
Yellowstone cutthroat trout	No effects; Yellowstone cutthroat trout are occasionally found adjacent to and downstream from the East Boulder Mine and the proposed Boe Ranch LAD area
Striate disc	No effects; the only known population occurs along the Boulder River.
Reptiles and Amphibians	
Northern leopard frog	No effects; there are no known occurrences at the Boe Ranch. Surveys have not identified any populations in the Boulder River drainage.
Boreal toad	No effects; there are no known occurrences at the Boe Ranch. Surveys have not identified any populations in the Boulder River drainage.

The Canada lynx is potentially present at the Boe Ranch or in adjacent areas. GNF personnel state that Canada lynx habitat within the GNF is located between 5,500 and 9,500 feet (Sparks 2002). The Boe Ranch is mostly below this elevation and may represent marginal Canada lynx habitat. Fir- and spruce-dominated forests are the preferred lynx habitat. The Boe Ranch does not contain any fir/spruce forest and is dominated by grass/shrub/forb vegetation communities. Because Canada lynx may only occasionally use the area, and required habitat components are not found within the Boe Ranch, it is anticipated that selection of the Boe Ranch LAD System Proposed Action Alternative 2C would have no adverse effects.

Effects to Management Indicator Species

Management indicator species that are not covered in other sections in this document are the pine marten and wild trout. Effects to wild trout will be considered in Section 4.2.2.5. There is no suitable denning habitat for pine martens at the Boe Ranch because the site is occupied by grassland and sagebrush habitats. The Boe Ranch may serve as occasional foraging habitat for pine martens. The Boe Ranch LAD System Proposed Action Alternative 2C would result in limited loss of occasional pine marten foraging habitat. No adverse effects to pine martens are anticipated.

4.2.1.5.2 Cumulative Effects

Projects with the potential to contribute cumulative effects to the project area of the Boe Ranch were reviewed (Table 4-1). Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would contribute effects to wildlife resources within and adjacent to the Boe Ranch. The use of this area for the construction and operation of the Boe Ranch LAD system would result in increased human use of the area and changes in existing wildlife use patterns and plant communities. These additional effects should be relatively short term. Increased forage value and availability may increase the area's attractiveness to deer and elk. After mine-related irrigation stops and another private landowner controls the land, cumulative effects related to mining activities would cease. Other development in the valley would continue to represent the largest impact to wildlife resources, as wildlife habitats would be lost to residential and other land use development. Noxious weed establishment and spread would continue to cumulatively affect wildlife habitat within the area.

4.2.1.5.3 Unavoidable Adverse Effects

The Boe Ranch LAD System Proposed Action Alternative 2C would disturb 246 new acres for mine-related land application facilities in areas previously used for livestock grazing. Unavoidable adverse effects include a reduction of wildlife habitat, displacement of wildlife species that currently use the area, and alterations to native plant communities.

4.2.1.5.4 Relationship between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

Short-term wildlife habitat and forage values found at the Boe Ranch would be affected due to implementation of the Boe Ranch LAD System Proposed Action Alternative 2C. The use of the Boe Ranch for construction and operation of a mine waste water land application disposal system would enable beneficial use of water in an agricultural setting. Increases in vegetation community productivity would occur because of the application of nitrogen-containing mine waste waters at the Boe Ranch during operations for up to 30 years. Vegetation production would decrease to near pre-mining conditions following closure of the Boe Ranch LAD system if irrigation ceases. Native plant communities would not become reestablished. Wildlife use of the area would be expected to return to near pre-LAD conditions at post-closure.

4.2.1.5.5 Irreversible and Irretrievable Losses

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would result in the construction of the Boe Ranch LAD storage pond, center pivot irrigators, and an access road on the Boe Ranch. The disturbance associated with these facilities would represent an irretrievable change in habitats for wildlife. The loss of native-vegetation dominated communities would take place. No other irretrievable or irreversible commitments of resources would occur.

4.2.1.6 Boe Ranch LAD System Agency-Mitigated Alternative 3C

Disturbances from the Boe Ranch LAD System Agency-Mitigated Alternative 3C are similar to those described for the Boe Ranch LAD System Proposed Action Alternative 2C, but there are several differences, including the following: the length of time that mine waste waters could be land applied by the Boe Ranch center pivots, the elimination of center pivot P10 due to mass wasting considerations, increased monitoring associated with center pivots P4 and P9, and relocation of soil and unsuitable material stockpiles out of the drainage bottom downgradient of the LAD storage pond.

4.2.1.6.1 Direct and Indirect Effects

Effects during operations, closure, and post-closure under the Boe Ranch LAD System Agency-Mitigated Alternative 3C would be similar to those disclosed under the Proposed Action Alternative 2C. The Agency-Mitigated Alternative 3C would require that the wildlife fence be maintained around the LAD storage pond during post-closure. Maintaining the wildlife fence following mine closure would limit the potential for future wildlife mortalities and damage to the liner.

4.2.1.6.2 Cumulative Effects

The cumulative effects of implementation of the Boe Ranch LAD System Agency-Mitigated Alternative 3C to wildlife resources would be similar to those under the Proposed Action Alternative 2C.

4.2.1.6.3 Unavoidable Adverse Effects

Unavoidable adverse effects associated with the Boe Ranch LAD System Agency-Mitigated Alternative 3C would be similar to those disclosed for the Proposed Action Alternative 2C.

4.2.1.6.4 Relationship between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

The relationship between short-term use and long-term productivity of the Boe Ranch would be similar to that described for the Boe Ranch LAD System Proposed Action Alternative 2C.

4.2.1.6.5 Irreversible and Irretrievable Losses

Implementation of the Boe Ranch LAD System Alternative 3C would be similar to implementation of the Proposed Action Alternative 2C. The disturbance associated with relocating soil and unsuitable material stockpiles would represent an irretrievable change in habitats for wildlife, but the loss of productivity of soils and vegetation would be less than the acres disturbed in the drainage bottom as part of the Boe Ranch LAD System Proposed Action Alternative 2C. No other irretrievable or irreversible commitments of resources would occur.

4.2.2 Aquatic Resources

4.2.2.1 Introduction

Project scoping indicated that implementation of portions of the Proposed Actions for the Stillwater Mine (2A), East Boulder Mine (2B), and Boe Ranch AD system (2C) might affect aquatic resources near the Stillwater and the East Boulder Mines at closure and post-closure, as well as aquatic resources downgradient of the Boe Ranch during operation, closure, and post-closure. Effects could include:

- Adverse effects to aquatic resources in the Stillwater and/or the East Boulder rivers from operations, closure, and post-closure mine waste water discharges to ground and surface water.

Effects to aquatic resources from adit, tailings impoundment, and storm water discharges to ground water and the Stillwater and East Boulder rivers during operations, closure, and post-closure were modeled. Estimates of water quality were compared with MPDES permit nitrogen limits, DEQ-7 nitrogen water quality standards, agency-assumed TDS recommendations for surface water, the Class I ground water beneficial use criterion for electrical conductivity, previously collected biomonitoring data, and referenced literature.

4.2.2.2 Stillwater Mine Closure and Post-Closure Water Management Plan No Action Alternative 1A, East Boulder Mine Closure and Post-Closure Water Management Plan No Action Alternative 1B, and Boe Ranch LAD System No Action Alternative 1C

4.2.2.2.1 Direct and Indirect Effects

Effects to Aquatic Resources in the Stillwater and the East Boulder Rivers

Selection of the No Action alternatives 1A, 1B, or 1C would not result in adverse effects during operations to aquatic resources in either the Stillwater or the East Boulder rivers other than those previously disclosed under past environmental analyses. Adherence to MPDES permit nitrogen discharge limits at the Stillwater Mine (100 lbs/day) and the East Boulder Mine (30 lbs/day) would ensure that water quality supports cold-water fisheries and aquatic resource health within both river systems.

Closure and post-closure reclamation activities would follow approved plans. Tailings waters would be disposed of through evaporation over the impoundments and would not be discharged to either ground or surface water. During reclamation, it is possible that unforeseen releases of nitrogen and salts may occur as a result of liner puncture or equipment and operator accidents. This is true for all alternatives. No adverse effects to aquatic resources in the

Stillwater or East Boulder rivers would be anticipated since all nitrogen and salts would be confined within the impoundment at closure and post-closure.

The agencies' analyses indicate that salt concentrations within the East Boulder River downgradient of the mine may exceed 250 mg/L TDS if an adit discharge of 737 gpm was realized during operations and closure (Appendix C, East Boulder Mine Alternative 1B and 1C Salts Spreadsheet and Summary of Water Quality by Alternative Table, DEQ 2010). Although a value of 250 mg/L TDS within the East Boulder River would not constitute a violation of standards, a literature review of TDS effects to trout indicates that TDS values in excess of 250 mg/L may adversely affect egg fertilization and development (USFS 2009).

Selection of No Action alternatives 1A, 1B, or 1C would increase the length of time that closure activities would occur (*e.g.* tailings impoundment dewatering, consolidation, and reclamation cap placement). It is anticipated it would take over two years to reclaim the tailings impoundments under the No Action alternatives 1A, 1B, and 1C.

Effects to Threatened, Endangered, Sensitive, and Management Indicator Species in the Stillwater and East Boulder Rivers

Adherence to MPDES permit nitrogen discharge limits at the Stillwater Mine (100 lbs/day) and the East Boulder Mine (30 lbs/day) would ensure that water quality would support existing healthy macroinvertebrate communities and cold-water fisheries within both river systems.

There are no aquatic threatened or endangered species in the Stillwater River adjacent to or downstream of the Stillwater Mine (Section 3.2.1.4 and Table 4-2). The Stillwater River, adjacent to or downstream of the Stillwater Mine, does occasionally contain Yellowstone cutthroat trout. This species is listed as a State of Montana sensitive species and a Custer National Forest designated management indicator species. Implementation of the Stillwater Mine WMP Closure and Post-Closure No Action Alternative 1A would not be expected to result in effects to threatened, endangered, sensitive, or management indicator species unless an unforeseen event that resulted in tailings waters discharge were to occur.

There are no aquatic threatened or endangered species in the East Boulder River adjacent to or downstream of the East Boulder Mine. Wild trout, including Yellowstone cutthroat trout, are included as management indicator species for the Gallatin National Forest as indicators for cold-water fisheries. Yellowstone cutthroat trout are listed as a State of Montana sensitive species. Wild trout are found throughout the East Boulder River drainage. Selection of the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B and the Boe Ranch LAD System No Action Alternative 1C would not result in any additional site disturbances within the mine area other than those previously disclosed. Tailings waters would be disposed of through evaporation over the tailings impoundment, thereby containing nitrogen and salts within the impoundment. Adit and storm waters would be routed for BTS treatment and then percolated on site. Adverse effects would not be anticipated as long as the previously analyzed and approved MPDES permit nitrogen discharge limit of 30 lbs/day at the East

Boulder Mine is met. Implementation of the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B would not be expected to result in effects to threatened, endangered, sensitive, or management indicator species unless an unforeseen event that resulted in tailings waters discharge were to occur.

Selection of the Boe Ranch LAD System No Action Alternative 1C would preclude construction and operation of the proposed LAD system. Sediment generation and potential water quality effects to threatened, endangered, sensitive, or management indicator species would not be anticipated.

4.2.2.2.2 Cumulative Effects

Implementation of the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, the East Boulder Mine Closure and Post-Closure Water Management Plan No Action Alternative 1B, or the Boe Ranch LAD System No Action Alternative 1C would not result in new area disturbances other than those that have been considered and approved during past environmental analyses. All facilities necessary for the collection, treatment, routing, and disposal of mine waters are currently in place or have been previously approved and would be implemented on lands which have been disturbed.

Projects or activities (Table 4-1) that have potential to cumulatively affect the Stillwater and the East Boulder rivers were considered. Some of these activities, such as the spread of noxious weeds, aquatic nuisance species (*Didymosphenia geminata*), and increased recreational fishing pressure due to development of residential subdivisions, would continue to cumulatively affect aquatic resources within the Stillwater and the East Boulder river drainages. Selection of any of the No Action alternatives (1A, 1B, or 1C) would not contribute additional cumulative effects to aquatic resources within the Stillwater and the East Boulder rivers.

4.2.2.2.3 Unavoidable Adverse Effects

Implementation of the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, or the Boe Ranch LAD System No Action Alternative 1C would not result in unavoidable adverse effects other than those previously considered and approved in past environmental documents. All mine site facilities necessary for the collection, treatment, routing, and disposal of mine waters are currently in place or have been previously approved for construction and operation. Previously analyzed and approved mine reclamation plans would be implemented at closure. Selection and implementation of the No Action alternatives (1A, 1B, and 1C) would not contribute unavoidable adverse effects to aquatic species within either the Stillwater or the East Boulder rivers in excess of those previously considered and approved. Resultant water quality effects are projected to meet the ground and surface nitrogen and salts water quality criteria used in the agencies' analyses (Appendix C, Summary of Water Quality by Alternative Table, DEQ 2010).

4.2.2.2.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Implementation of the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, or the Boe Ranch LAD System No Action Alternative 1C would not result in new disturbances at the respective mines or at the Boe Ranch. Site disturbances associated with operations, closure, and post-closure activities have previously been considered and approved. Short-term use of the Boe Ranch would not take place under the No Action Alternative 1C. Boe Ranch's long-term productivity would remain unchanged from current conditions.

Selection and implementation of any of the No Action Alternatives (1A, 1B, or 1C) would not change the existing relationship between short-term use of the mine areas and the long-term maintenance and enhancement of the areas' productivity, which has been previously analyzed and disclosed.

4.2.2.2.5 Irreversible and Irretrievable Losses

Implementation of the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B, or the Boe Ranch LAD System No Action Alternative 1C would not result in additional irretrievable or irreversible commitments of resources. No new disturbances within or adjacent to the mine sites would take place under either the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A or the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B.

Selection of the Boe Ranch LAD System No Action Alternative 1C would preclude construction and operation of the LAD system. No irreversible and irretrievable losses would be expected to take place within or adjacent to the Boe Ranch area.

4.2.2.3 Stillwater Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2A

4.2.2.3.1 Direct and Indirect Effects

Effects to Aquatic Resources in the Stillwater River

As discussed in Section 3.2.2.1, SMC sampled the aquatic environment of the Stillwater River between August 1998 and September 2002 (Advent Group, Inc. 2003). Key analyses and findings included:

- Assemblages of benthic macroinvertebrates consist of taxa common to clean, cold water mountain streams, including Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Coleoptera: Elmidae (riffle beetles), and a few species of Diptera (true flies).
- Benthic macroinvertebrate bioassessment scores indicate full support of designated water quality uses in each year of the study, with the exception of 2001. The September 2001 collection was lower in both taxa richness and organism abundance. The summer 2002 samples confirmed that the condition was temporary and related to climatic regional drought.
- Periphyton samples were dominated by diatoms and included other algae representative of cold water, clean, mountain streams.
- Diatom bioassessment results based on general criteria for mountain streams in Montana indicate excellent biotic integrity and no impairment of water quality or habitat at all sample sites.
- Mean chlorophyll *a* concentration showed a trend to increase downstream. These differences were not statistically significant. Although the higher mean chlorophyll *a* concentration at the downstream sample site corresponds with nitrogen concentrations, the magnitude of the chlorophyll *a* concentration values is not characteristic of nutrient enrichment.

Results of biological monitoring conducted in 2005 were consistent with the results and findings of the 1998 to 2002 monitoring, and SMC concluded there were no adverse effects to aquatic species or habitat (Advent Environ 2006).

Under the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A, MPDES permit nitrogen limits would continue during operations and closure. There is no MPDES permit limit for salts. Treatment of adit water would continue for up to one year during closure, at which time, untreated adit water quality is anticipated to decrease to approximately 2 mg/L TN or less. The salts concentration would decrease but not as rapidly as the nitrogen concentration. Treated adit water would be discharged to ground water using Stillwater Mine percolation ponds for untreated east-side adit water or the Hertzler Ranch LAD area for the treated west-side adit water (Figure 2-8).

During closure, both the Stillwater and the Hertzler Ranch tailings impoundments would require active dewatering and disposal of tailings waters. Thirty-five million gallons of Stillwater impoundment tailings waters would be treated through the BTS with west-side adit water and routed either to the Hertzler Ranch or Stillwater Mine percolation ponds for disposal, depending on the amount of adit flow at closure. An additional 45 MG of untreated Hertzler Ranch tailings impoundment waters would be mixed with treated west-side adit water and/or treated Stillwater impoundment tailings waters, depending on the closure adit flow rate, and disposed of at the Hertzler Ranch LAD area.

As discussed in *Water Quality and Quantity* Section 4.1.1, percolation or land application of these mine waste waters would result in a temporary increase in nitrogen and salts concentrations in ground water at the Stillwater Mine and Hertzler Ranch LAD area (Appendix C, Stillwater Mine Alternative 2A Closure TN and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). According to the agencies' analyses, nitrogen would increase regardless of the adit flow rate but would remain below the DEQ-7 ground water standard (10 mg/L) at the Stillwater Mine and the Hertzler Ranch. Salts would also increase regardless of the adit flow rate but would be below the Class I ground water beneficial use criterion (1,000 µmhos/cm) at the Stillwater Mine and the Hertzler Ranch.

Percolation or land application of these mine waste waters would also result in a temporary increase in nitrogen and salts concentrations in surface water at the Stillwater Mine and Hertzler Ranch LAD area (Appendix C, Stillwater Mine Alternative 2A Closure TN and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). According to the agencies' analyses, nitrogen would increase regardless of the adit flow rate but would remain below the surface water standard (1 mg/L TN) for the Stillwater Mine and the Hertzler Ranch. Salts would also increase regardless of the adit flow rate but would be below the surface water TDS recommendation (250 mg/L) that the agencies believe to be protective of wild trout egg fertilization and development.

Due to SMC's underground grouting practices, a 2,020 gpm ground water mine inflow is not expected. Ground and surface water analyses conducted based on present intercepted Stillwater Mine underground inflows indicate that exceedance of the MPDES nitrogen limit (100 lbs/day) or exceedance of the surface water standard (1 mg/L TN) is not likely. As determined through previous MPDES permit analyses, which specifically consider water quality effects to aquatic communities, a possible gain in nitrogen but to a concentration less than 1 mg/L TN within the Stillwater River would not result in adverse effects to aquatic life.

Other mine waste water streams would be incorporated into ground and surface water during closure and post-closure. These include storm water, seepage through the reclamation cover, and liner leakage. Underdrain seepage would also be incorporated into the ground water system at the Hertzler Ranch tailings impoundment during closure. These waste water streams were considered during water quality effects analyses in *Water Quality and Quantity* Section 4.1.1. Minor effects to water quality were predicted.

Minor increases in sediment loading to the Stillwater River may occur during reclamation of mine facilities. The implementation of erosion control measures and successful revegetation of disturbed areas would minimize potential sediment loading to the Stillwater River. No substantial effects to aquatic resources from increased sedimentation would be expected during closure or post-closure. In summary, the resultant water quality in both ground and surface water if the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A is selected would not adversely affect aquatic resources within the Stillwater River.

Effects to Threatened, Endangered, Sensitive, and Management Indicator Species in the Stillwater River

There are no aquatic threatened or endangered species in the Stillwater River adjacent to or downstream of the Stillwater Mine. Adverse affects to threatened and endangered species would not occur.

Occasionally, the Custer National Forest management indicator species, the Yellowstone cutthroat trout, may be located adjacent to or downstream of the Stillwater Mine. Based on the projected concentrations of nitrogen and salts derived from the agencies' analyses, adverse effects to State of Montana sensitive species and Yellowstone cutthroat trout are not anticipated.

Unlike the Stillwater Mine Closure and Post-Closure WMP No Action Alternative 1A, the Proposed Action Alternative 2A would accelerate tailings impoundment closure by actively dewatering the tailings impoundments at closure. SMC believes it can dewater and reclaim the Stillwater and Hertzler Ranch tailings impoundments in 12 months under the Proposed Action Alternatives 2A. As discussed above, the agencies believe that the water quality criteria used in their analyses may be met in most options analyzed under the Proposed Action Alternative 2A; however, the 12-month timeframe leaves little room for unforeseen problems at closure (Appendix C, Stillwater Mine Alternative 2A Closure TN and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

4.2.2.3.2 Cumulative Effects

Implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A would not result in new area disturbances other than those previously considered and approved during past environmental analyses. All facilities necessary for the collection, treatment, routing, and disposal of mine waste waters are currently in place or have been previously approved and would be implemented on lands which have been disturbed.

Projects or activities (Table 4-1) that have the potential to cumulatively affect aquatic resources within or adjacent to the Stillwater Mine were considered. Some of these activities, such as the spread of noxious weeds and aquatic nuisance species (*Didymosphenia geminata*), increased recreational fishing pressure, and continued development of residential subdivisions, would cumulatively affect aquatic resources within the Stillwater River drainage. Selection of this alternative would not contribute cumulative effects in addition to those previously considered and approved.

4.2.2.3.3 Unavoidable Adverse Effects

Implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A would result in additional tailings waters nitrogen and salts loads discharged into ground and surface water as compared to the No Action Alternative 1A. These additional nitrogen and salts loads are not anticipated to produce adverse effects to aquatic resources within the Stillwater River.

All facilities necessary for the collection, treatment, routing, and disposal of mine waste waters are currently in place or have been previously approved for construction and operation. Although new or modified mine waste water routing facilities may be proposed, these facilities would be constructed in areas currently disturbed by mining operations. Selection and implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A would not contribute unavoidable adverse effects to aquatic resources within the Stillwater River in excess of those previously considered and approved.

4.2.2.3.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A would not result in new area disturbances at the Stillwater Mine or the Hertzler Ranch. Mine-related disturbances associated with operations, closure, and post-closure activities have previously been considered and approved. Previously approved short-term uses of the Stillwater Mine or the Hertzler Ranch would not change under this alternative.

Selection and implementation of the Stillwater Mine Closure and Post-Closure Proposed Action Alternative 2A would not change the existing relationship between short-term use of the mine and the long-term maintenance and enhancement of the area's productivity.

4.2.2.3.5 Irreversible and Irretrievable Losses

Implementation of the Stillwater Mine Closure and Post-Closure WMP Proposed Action Alternative 2A would not result in irretrievable or irreversible commitments of aquatic resources. All disturbances within or adjacent to the mine would take place on currently disturbed areas.

4.2.2.4 East Boulder Mine Closure and Post-Closure Water Management Plan Proposed Action Alternative 2B

4.2.2.4.1 Direct and Indirect Effects

Effects to aquatic resources in the East Boulder River

As discussed in Section 3.2.2.2, SMC sampled the aquatic environment of the East Boulder River between April 1998 and September 2006 (Advent Environ 2007). Key analyses and findings included:

- Assemblages of benthic macroinvertebrates consist of taxa common to clean, cold water mountain streams including Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddis flies), Coleoptera: Elmidae (riffle beetles), and a few species of Diptera (true flies).
- Macroinvertebrate Bioassessment Index values show little variation in the upper basin and indicate predominantly "Full Support" (no impairment) conditions from upstream to below the East Boulder Mine.
- Macroinvertebrate Bioassessment Index values indicate "Partial Support" (minor impairment) in the lower reaches of the East Boulder River to the confluence with the Boulder River. Seasonal changes in the macroinvertebrate community suggest that biological impairment in the lower East Boulder River during late summer is at least partially caused by stream dewatering and problems with sedimentation.
- The spatial and temporal results in the macroinvertebrate bioassessment do not indicate impairment of water quality or biological integrity in the East Boulder River coincident with operation of the East Boulder Mine.
- The East Boulder River periphyton was dominated by the stalked diatom *Didymosphenia geminata*.
- The Diatom Bioassessment Index results indicate generally "excellent" biotic integrity (no impairment) for all sampling sites on the East Boulder River. A classification of excellent implies no impairment of water quality or physical habitat relative to the in-stream reference. The results do not indicate impairment of water quality or biological integrity in the East Boulder River coincident with operation of the East Boulder Mine.

As disclosed in *Water Quality and Quantity* Section 4.1., SMC has a number of options available for mine waste waters management during closure. Under the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B, the MPDES permit nitrogen limits would continue in effect during operations and closure. There are no MPDES permit limits for salts. For the purposes of these analyses, the Boe Ranch LAD system is assumed to not be constructed and all mine waste waters would be disposed of at the mine. As discussed in *Water Quality and Quantity* Section 4.1.2.2., treated adit and tailing waters would be

managed and disposed of at the mine percolation pond and LAD system during a 12-month closure period.

During the 12-month closure period, SMC predicts the untreated adit water nitrogen concentration to decrease to approximately 2 mg/L TIN or less within six months. The salts concentration would decrease but not as rapidly as nitrogen. The East Boulder Mine tailings impoundment would require active dewatering and disposal of tailings waters. Forty MG of tailings waters would be treated through the BTS/Anox system with adit water and routed to the mine percolation pond and/or mine LAD areas for disposal, depending on the amount of adit flow at closure.

As disclosed in *Water Quality and Quantity* Section 4.1.2.2, percolation or land application of these mine waste waters would result in a temporary increase in nitrogen and salts concentrations in ground water at the East Boulder Mine (Appendix C, East Boulder Mine Alternative 2B Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). According to the agencies' analyses, nitrogen would increase regardless of the adit flow rate but would be below the DEQ-7 ground water standard (10 mg/L) at the East Boulder Mine. Salts would also increase regardless of the adit flow rate but would be below the Class I ground water beneficial use criterion of 1,000 µmhos/cm at the East Boulder Mine.

Percolation or land application of these mine waste waters would also result in a temporary increase in nitrogen and salts concentrations in surface water at the East Boulder Mine (Appendix C, East Boulder Mine Alternative 2B Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). Analyses indicated that nitrogen surface water quality could range between 0.2 mg/L to 1.4 mg/L TIN depending on the time of year when closure takes place and the volume of water exiting the adits. Due to SMC's underground grouting practices, the attainment of a 737 gpm ground water East Boulder Mine inflow does not seem reasonable.

Exceedance of the 1 mg/L TIN surface water standard is possible (Appendix C, Summary of Water Quality by Alternative Table, DEQ, 2010). In the event that nitrogen additions exceed the MPDES permit limit of 30 lbs/day, effects to aquatic resources could take place. Initial changes to the integrity of the East Boulder River could include increased algae growth and a reduction in macroinvertebrates such as mayflies, caddis flies, and stoneflies. These changes in cold-water macroinvertebrates ultimately may affect East Boulder River trout population levels.

Salts would also increase regardless of the adit flow rate but would be below the surface water TDS recommendation of 250 mg/L that the agencies believe to be protective of wild trout egg fertilization and development. The resultant water quality in both ground and surface water is not expected to adversely affect aquatic communities.

Other mine waste water streams would be incorporated into ground and surface water during closure and post-closure. These include storm water, seepage

through the reclamation cover, and liner leakage. Underdrain seepage would also be incorporated into the ground water system at the East Boulder tailings impoundment during closure. These waste water streams were considered during water quality effects analyses in *Water Quality and Quantity,* Section 4.1.2.2. Minor effects to water quality were predicted.

Minor increases in sediment loading to the East Boulder River may occur during reclamation of mine facilities. Implementation of erosion control measures and successful revegetation of disturbed areas would minimize potential sediment loading to the East Boulder River. No substantial effects to aquatic resources from increased sedimentation would be expected during closure or post-closure. Selection of the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not adversely affect aquatic resources within the East Boulder River.

At post-closure, untreated adit water would be routed to the East Boulder River. Any gains in nitrogen or salts concentrations within the East Boulder River are anticipated to be short-term and would flush over time. The East Boulder River nitrogen and salts concentrations would be anticipated to return to near baseline levels within a couple of years at post-closure. No adverse effects to aquatic resources within the East Boulder River would be expected in the long term.

4.2.2.4.2 Effects to Threatened, Endangered, Sensitive, and Management Indicator Species in the East Boulder River

There are no threatened or endangered aquatic species in the East Boulder River adjacent to or downstream of the East Boulder Mine. Adverse effects to threatened and endangered species would not occur.

Occasionally the Custer National Forest management indicator species, the Yellowstone cutthroat trout, may be located adjacent to or downstream of the East Boulder Mine. If nitrogen additions exceed the MPDES permit limit of 30 lbs/day, effects to aquatic resources in the East Boulder Mine could take place. Initial changes to the integrity of the East Boulder River could include increased algae growth and a reduction in macroinvertebrates such as mayflies, caddis flies, and stoneflies. These changes in cold-water macroinvertebrates ultimately may affect the East Boulder River trout population levels. If the salts concentration within the East Boulder River exceeds 250 mg/L TDS, minor adverse effects to State of Montana sensitive species and the Yellowstone cutthroat trout may be anticipated. For analysis purposes, the agencies utilized 250 mg/L TDS as a recommended limit for salts concentrations in order to be protective of trout eggs.

Under the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B, all mine waste waters would be disposed of at the East Boulder Mine water management facilities. Depending on adit flow rates, disposal of East Boulder Mine waters at the mine site during closure may contribute some potential adverse effects to aquatic resources. Contributing factors include the limitations of the East Boulder Mine site related to LAD capacity, distance to the receiving East Boulder River, and the transmissivity of the underlying ground

water system. During post-closure, the ground water system would be expected to flush nitrogen additions over time (Hydrometrics, Inc. 2008)

The East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternatives 2B would accelerate tailings impoundment closure by actively dewatering the East Boulder tailings impoundment at closure. SMC believes it can dewater and reclaim the tailings impoundment in 12 months under this alternative. As discussed above, the agencies' water quality analyses indicate that water quality criteria used in the analyses may be met in most options analyzed under this alternative; however, the 12-month timeframe leaves little room for unforeseen problems at closure (Appendix C, East Boulder Mine Alternative 2B Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

4.2.2.4.3 Cumulative Effects

Implementation of the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would contribute short-term cumulative effects to aquatic resources within the East Boulder River. A list of projects or activities that have potential to contribute additional cumulative effects to aquatic resources within the East Boulder River were considered (Table 4-1). Some of these activities, such as the spread of noxious weeds or aquatic nuisance species (*Didymosphenia geminata)*, increased recreational fishing pressure, and continued development of residential subdivisions, would cumulatively affect aquatic resources within the East Boulder River drainage.

4.2.2.4.4 Unavoidable Adverse Effects

Implementation of the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B may result in unavoidable short-term adverse effects to ground water and the East Boulder River, which would affect aquatic resources if the MPDES permit nitrogen limit of 30 lbs/day, the Class I ground water beneficial use criterion of 1,000 µmhos/cm EC, or the agencies' assumed 250 mg/L TDS recommendation were exceeded. As discussed above, the disposal of mine waste waters may increase nitrogen and salts concentrations in the East Boulder River. If concentrations increased, minor adverse short-term effects to the river macroinvertebrate community integrity and composition may take place.

4.2.2.4.5 Relationship between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

Implementation of the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B has the potential to change the relationship between short-term use of the aquatic environment and the maintenance and enhancement of long-term productivity of this resource. As disclosed above, the East Boulder River provides high quality habitat to aquatic resources. The East Boulder Mine closure activities, including disposal of up to 737 gpm of treated adit water and 40 MG of tailings waters at the mine, may cause a short-term increase in the nitrogen and salts concentrations within the East Boulder River.

In the long-term, nitrogen and salts additions to the ground and surface water would not jeopardize the river's productivity since nitrogen and salts would be anticipated to flush within two years.

4.2.2.4.6 Irreversible and Irretrievable Losses

Implementation of the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B would not result in the irretrievable or irreversible commitment of aquatic resources. Although changes to the ground and surface water quality may occur during closure and post-closure, nitrogen and salts loads would flush over time. Ground and surface water quality, and ultimately, aquatic community diversity, composition, and productivity would begin to return to pre-mine levels within two years based on the operational East Boulder Mine ground and surface water quality monitoring experience.

4.2.2.5 Boe Ranch LAD System, Proposed Action Alternative 2C

4.2.2.5.1 Direct and Indirect Effects

Effects to Aquatic Resources in the East Boulder River

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the Boe Ranch LAD system could be constructed and used preferentially during operations and closure, if needed. The East Boulder Mine MPDES nitrogen limit of 30 lbs/day would not apply to activities at the Boe Ranch. SMC would have to comply with the DEQ-7 nitrogen ground water standard of 10 mg/L TIN at the Boe Ranch. In these analyses, the agencies used the East Boulder Mine MPDES permit surface water limit of 1 mg/L TIN as a limit for nitrogen in the East Boulder River below the Boe Ranch. SMC would have to comply with the Class II ground water beneficial use criterion for electrical conductivity of 2,500 µmhos/cm at the Boe Ranch.

The East Boulder River is located approximately one mile from the Boe Ranch LAD area, so ground water from the Boe Ranch LAD area must travel approximately one mile before being incorporated into surface water. The health of the East Boulder River aquatic resources is affected by surface water quality, which is influenced by ground water quality.

Operational Effects to Aquatic Resources from Ground and Surface Water Quality. During operations, treated adit water and tailings waters, if needed, would be routed to the Boe Ranch LAD system for disposal. SMC predicts minimal potential nitrogen loading to the East Boulder River resulting from operation of the Boe Ranch LAD system (Knight Piésold 2000c). SMC's study assumed that Boe Ranch soils have a naturally low permeability and that seepage through the LAD area soils would mix with ground water and flow towards the East Boulder River. During the growing season, land-applied mine waste waters would mix with and be diluted by the East Boulder River irrigation waters leaking from the Mason Ditch. SMC did not conduct salts effects analyses.

The agencies' analyses used several options to evaluate potential effects to ground and surface water from disposal of mine waste waters at the Boe Ranch. The agencies conclude that the Boe Ranch LAD system cannot handle the full 737-gpm adit flow rate at the Boe Ranch and empty the LAD storage pond by the end of the LAD season. SMC would have to discharge some adit water during operations at the East Boulder Mine (Appendix C, Boe Ranch LAD System Alternative 2C Operation and Closure Nitrogen and Salts Spreadsheets, DEQ 2010).

The agencies' analyses show that SMC could comply with ground water nitrogen and salts criteria (Appendix C, Boe Ranch LAD System Alternative 2C Operation and Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). SMC could also comply with the surface water nitrogen limit of 1 mg/L TIN used by the agencies for the East Boulder River below the Boe Ranch.

The East Boulder River below the Boe Ranch has a 340 mg/L ambient TDS concentration. SMC can not discharge treated adit water at the Boe Ranch during operations and comply with the agencies' 250 mg/L TDS recommendation. Operational salts concentrations for all options analyzed under the Boe Ranch LAD System Proposed Action 2C and Agency-Mitigated Alternative 3C would increase from 8 to 35 percent over ambient levels, potentially increasing effects to trout eggs (Appendix C, Boe Ranch LAD System Alternative 2C and Alternative 3C Operation and Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

During operations and the 12-month closure period, the most likely source of adverse effects to aquatic resources within the East Boulder River could occur from a rupture of the tailings pipeline accessing the Boe Ranch. The water quality effects to the East Boulder River were analyzed in *Water Quality and Quantity* Section 4.1.3.2. Assuming a direct discharge of the entire pipeline volume to the East Boulder River, the surface water nitrogen concentration would increase from 0.1 mg/L to 3.3 mg/L TIN. This would exceed the DEQ-7 narrative nitrogen standard for the East Boulder River. A short-term increase in algal blooms may result. The surface water salts concentration would increase from 49 mg/L to 196 mg/L TDS between the East Boulder Mine and the upgradient Boe Ranch surface water monitoring station EBR-007. The surface water TDS concentration is currently 270 mg/L TDS concentration at EBR-007. Based on the volume and velocity of the East Boulder River, any water quality effects would last less than one month (Freeze and Cherry, 1979, Table 1.1).

Tailings flows due to a pipeline rupture could cause localized erosion and increase sediment delivery to the East Boulder River. Depending on flow volumes of the East Boulder River during a pipeline rupture, sediment additions may result in short-term effects to aquatic resources. In the long-term, sediment would be diluted and would eventually flush from the surface water system. Implementation of SMC's Spill Contingency Plan and regular pipeline integrity inspections would be performed (Knight Piésold 2000c). This would serve to reduce potential effects from pipeline rupture.

Closure and Post-Closure Effects to Aquatic Resources from Ground and Surface Water Quality. During closure, a maximum of 737 gpm adit water from the East Boulder Mine and 40 MG of tailings waters would be treated for up to 12 months through the BTS/Anox system. Disposal options include the Boe Ranch LAD system and mine site disposal facilities. Under the Boe Ranch Closure and Post-Closure WMP Proposed Action Alternative 2C, the Boe Ranch is the preferred mine waste waters disposal option (Figure 2-29). As disclosed above under operations, depending on the adit flow at closure, SMC may have to discharge some adit water during closure at the East Boulder Mine.

Based on the agencies' water quality analyses, compliance with applicable ground and surface water nitrogen criteria at closure is achievable at the Boe Ranch and the East Boulder Mine. Application of treated tailings and adit waters at the Boe Ranch would result in a temporary increase in nitrogen and a decrease in salts concentrations in ground water during closure (Appendix C, Boe Ranch

LAD System Alternative 2C Operation and Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

As during operations, SMC can not discharge treated adit water at the Boe Ranch during closure and comply with the agencies' 250 mg/L TDS recommendation. For all closure options analyzed for the Proposed Action Alternative 2C, salts concentrations during closure would temporarily increase from 8 to 56 percent over ambient levels, potentially causing short-term adverse effects to wild trout egg fertilization and maturation (Appendix C, Boe Ranch LAD System Alternative 2C and Alternative 3C Operation and Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

Other mine waste waters would be discharged into the East Boulder Mine ground water during closure and post-closure. These include storm water, underdrain seepage, and liner leakage. Nitrogen ground water additions from these other sources were considered in the agencies' water quality analyses in the *Water Quality and Quantity* sections 4.1.3.3 and 4.1.3.4. Minor effects to water quality are predicted.

Minor increases in sediment loading to the East Boulder River may occur during construction, operations, and limited reclamation of the Boe Ranch LAD system. Implementation of erosion control measures and successful revegetation of disturbed areas would minimize potential sediment loading to the East Boulder River. No substantial effects to aquatic species from increased sedimentation would be expected during closure or post-closure.

At post-closure, untreated adit water would be routed around the mine percolation pond to the East Boulder River. SMC believes untreated adit water quality would meet the MPDES permit nitrogen limit of 30 lbs/day within 12 months at post-closure. The agencies' analyses predict it may take up to 24 months to meet that limit (Appendix C, Stillwater Mine East Side Nitrogen Decline Curve, DEQ, 2010). During post-closure, nitrogen increases in ground or surface water are anticipated to become diluted and to flush from the system over time due to the continual addition of fresh ground water. Based on the agencies' analyses, compliance with ground and surface water criteria is projected. No effects to aquatic resources are anticipated.

Effects to Threatened, Endangered, Sensitive, and Management Indicator Species in the East Boulder River

As discussed above, there are no threatened or endangered aquatic species found within the East Boulder River adjacent to or downstream of the East Boulder Mine.

Wild trout are listed as management indicator species for the Gallatin National Forest. Occasionally, Yellowstone cutthroat trout may be located adjacent to or downstream of the East Boulder Mine. Based on the projected concentrations of nitrogen and salts derived from the agencies' analyses, short-term minor adverse effects to the Yellowstone cutthroat trout, a State of Montana sensitive species and a Gallatin National Forest management indicator species, could occur. For all closure options analyzed in the Proposed Action Alternative 2C, TDS

concentrations would increase 8 to 56 percent over the ambient salts concentration (340 mg/L TDS) at surface water monitoring station EBR-008 in the East Boulder River below the Boe Ranch. This increase could incrementally affect wild trout eggs during operations and closure.

Under the Boe Ranch LAD System Proposed Action Alternative 2C, nitrogen levels in the East Boulder River are not expected to exceed the MPDES permit water quality standard (1 mg/L TIN). The agencies' analyses indicate that the nitrogen ground water standard (10 mg/L) would not be exceeded during operations, closure, and post-closure. During post-closure, surface and ground water quality would be expected to improve over time since no mine-related activities would take place at either the East Boulder Mine or the proposed Boe Ranch. Potential effects to wild trout under the Proposed Action Alternative 2C would be less than if the Boe Ranch LAD System is not utilized by SMC.

The Boe Ranch LAD System Proposed Action Alternatives 2C would accelerate tailings impoundment closure by actively dewatering the East Boulder tailings impoundment at closure. SMC believes it can dewater and reclaim the tailings impoundment in 12 months under this alternative and the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B. The water quality criteria used in the agencies' analyses may be met in most options analyzed under this alternative and the East Boulder Mine Closure and Post-Closure WMP Proposed Action Alternative 2B; however, the 12-month timeframe leaves little room for unforeseen problems at closure (Appendix C, East Boulder Mine Alternative 2B Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

4.2.2.5.2 Cumulative Effects

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C may reduce cumulative effects to aquatic resources within the East Boulder River near the East Boulder Mine. Potentially, the Boe Ranch LAD System could decrease mine-related nitrogen concentrations in the ground and surface water. However, use of the Boe Ranch LAD system also could increase salts concentrations below the Boe Ranch in the East Boulder River during operations and closure, which may increase cumulative effects to aquatic resources within the East Boulder River.

A list of projects or activities that could contribute additional cumulative effects to aquatic resources within the East Boulder River was considered (Table 4-1). Some of these activities, such as the spread of noxious weeds or aquatic nuisance species (*Didymosphenia geminata)*, increased recreational fishing pressure, and continued development of residential subdivisions, would cumulatively affect aquatic resources within the East Boulder drainage. Septic systems and agricultural application of fertilizers downstream of the Boe Ranch would cumulatively increase the nutrient loading to the East Boulder and Boulder rivers (DEQ and USFS 1998a).

4.2.2.5.3 Unavoidable Adverse Effects

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would not result in unavoidable adverse effects to aquatic resources within the East Boulder River. The Boe Ranch LAD site represents the best option for disposal of mine waste waters containing nitrogen. As previously discussed, nitrogen levels in ground water at the East Boulder Mine would increase due to LAD at Boe Ranch. However, the agencies' analyses indicate that nitrogen concentrations in the East Boulder River would remain well below surface water quality standards. Aquatic resources within the East Boulder River would not be adversely affected.

4.2.2.5.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would change the short-term use of Boe Ranch. However, changes to ground and surface water chemistry due to nitrogen additions would revert to baseline conditions once mining-related activities at the Boe Ranch and the East Boulder Mine ceases. The long-term productivity of the East Boulder River aquatic resources would be maintained.

4.2.2.5.5 Irreversible and Irretrievable Losses

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would not result in irretrievable or irreversible commitments of aquatic resources. Although changes to ground and surface water quality may occur during operations and closure, disposal of mine waste waters at the Boe Ranch would cease at post-closure. Over time, nitrogen and salts loads, which had been incorporated into ground or surface water, would flush. Ground and surface water quality, and ultimately aquatic community diversity, composition, and productivity, would be anticipated to return to pre-mine levels.

4.2.2.6 Stillwater Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3A and East Boulder Mine Closure and Post-Closure Water Management Plan Agency-Mitigated Alternative 3B

The Agency-Mitigated Alternatives for the Stillwater and East Boulder mines, 3A and 3B, respectively, differ from the Proposed Action Alternatives 2A and 2B concerning the timeframe to dewater the tailings impoundments and to treat and dispose of mine waste waters. Under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B, closure activities could last up to 18 months and provide up to two LAD seasons to dispose of mine waste waters.

These agency-mitigated alternatives would require SMC to conduct additional water monitoring during operations and to implement measures that would reduce nitrogen and salts concentrations and loads, thereby reducing potential closure effects from mine waste water disposal.

4.2.2.6.1 Direct and Indirect Effects

Effects to Aquatic Resources in the Stillwater and East Boulder Rivers

Potential effects to aquatic resources in the Stillwater and the East Boulder rivers would be less under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B than those disclosed for the Proposed Action alternatives 2A and 2B. Under the Agency-Mitigated alternatives 3A and 3B, the timeframe for closure dewatering of the tailings impoundments and disposal of treated mine waters and reclamation cap placement could be increased up to 18 months. This would provide two growing seasons for land application of mine waste water, if necessary. As a result, concentrations of nitrogen or salts could be less at any point in time within the first year of closure than resultant concentrations under the Proposed Action Alternatives 2A and 2B for the Stillwater and East Boulder mines, respectively.

During closure, Stillwater Mine adit water, at a rate of 650 to 2,020 gpm, and 80 MG of tailings waters would be treated for up to 18 months through the BTS and then land applied or percolated. Disposal options include the Hertzler Ranch LAD area and the Stillwater Mine percolation ponds.

During closure, East Boulder Mine adit water, at a rate of 150 gpm to 737 gpm, and 40 MG of tailings waters would be treated for up to 18 months through the BTS/Anox system and percolated or land applied. Disposal options include the East Boulder Mine percolation pond and the East Boulder Mine LAD areas.

Ground Water Nitrogen and Salts Effects. As disclosed in *Water Quality and Quantity* sections 4.1.1 and 4.1.2, percolation or land application of waste waters from the Stillwater and East Boulder mines would result in a temporary increase

in nitrogen and salts concentrations in ground water (Appendix C, Stillwater Mine Alternative 3A Closure Nitrogen and Salts Spreadsheets, East Boulder Mine Alternative 3B Closure Nitrogen and Salts Spreadsheets, and Summary of Water Quality by Alternative Table, DEQ 2010). The agencies' analyses indicate that nitrogen would increase, regardless of adit flow rates, but would be below the DEQ-7 ground water standard of 10 mg/L at the Stillwater Mine, the Hertzler Ranch, and the East Boulder Mine. Salts would also increase, regardless of adit flow rates, but would be below the Class I ground water beneficial use criterion of 1,000 µmhos/cm at the Stillwater and the East Boulder mines.

Surface Water Nitrogen and Salts Effects. As discussed in *Water Quality and Quantity* sections 4.1.1 and 4.1.2, percolation or land application of mine waste water would result in temporary increases in nitrogen and salts concentrations in surface waters at the Stillwater and East Boulder mines (Appendix C, Stillwater Mine Alternative 3A Closure TN and Salts Spreadsheets, East Boulder Mine Alternative 3B Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010). The agencies' analyses indicate that nitrogen would increase, regardless of adit flow rates, but would be below the MPDES permit nitrogen surface water standard of 1 mg/L. Salts would also increase, regardless of adit flow rates, but would be below the surface water TDS recommendation (250 mg/L) used by the agencies for the Stillwater and East Boulder rivers to be protective of wild trout egg fertilization and development. The resultant water quality in both ground and surface water is not expected to adversely affect aquatic communities.

Due to SMC's underground grouting practices, ground water inflows as high as 2,020 gpm at the Stillwater Mine or 737 gpm at the East Boulder Mine do not seem likely. Ground and surface water analyses based on 2008 Stillwater and East Boulder Mine ground water inflows, indicate that exceedances of the MPDES permit nitrogen limit of 100 lbs/day for the Stillwater Mine or 30 lbs/day for the East Boulder Mine would not be likely. Similarly, exceedances of the surface water standard of 1 mg/L TIN also would not be likely. A possible gain of less than 1 mg/L TN in the Stillwater River or 1 mg/L TIN within the East Boulder River would not result in adverse effects to aquatic resources as determined through previous MPDES permit analyses, which specifically considered water quality effects to aquatic communities.

Other mine waste water streams would be incorporated into ground and surface water at the Stillwater and East Boulder mines during closure and post-closure. These include storm water, seepage through the reclamation cover, and liner leakage. Underdrain seepage would also be incorporated into the ground water system at the Hertzler Ranch and East Boulder tailings impoundments during closure. These waste water streams were considered during water quality effects analyses in *Water Quality and Quantity* sections 4.1.1 and 4.1.2, for the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A and the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B.

Sediment loading and effects to the Stillwater and East Boulder rivers during reclamation of mine facilities would be the same as those disclosed for the

Stillwater Mine Closure and Post-Closure Proposed Action Alternative 2A and the East Boulder Mine Closure and Post-Closure Proposed Action Alternative 2B.

At post-closure, untreated adit water would be routed to the Stillwater and East Boulder rivers. Any gains in nitrogen or salts concentrations within the rivers are anticipated to be short-term and to flush over time. The Stillwater and East Boulder rivers' nitrogen and salts concentrations would be anticipated to return to near baseline levels within a couple of years at post-closure. No adverse effects to aquatic resources within the Stillwater and East Boulder rivers would be expected in the long term from implementation of the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B.

Based on water quality analyses conducted by the agencies, compliance with applicable ground and surface water criteria is much more achievable at the Stillwater Mine, the Hertzler Ranch, and the East Boulder Mine for both nitrogen and salts under the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A and the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B (Appendix C, Summary of Water Quality by Alternative Table, DEQ 2010). The second LAD season would help overcome any unforeseen closure problems.

Effects to Threatened, Endangered, Sensitive, and Management Indicator Species in the Stillwater and East Boulder Rivers

As previously disclosed, there are no threatened or endangered aquatic species found within the Stillwater or East Boulder rivers adjacent to or downstream of the mines.

Wild trout are listed as a management indicator species for the Gallatin National Forest, and the Yellowstone cutthroat trout is listed as a management indicator species for the Custer National Forest. Occasionally Yellowstone cutthroat trout may be located adjacent to or downstream of both the Stillwater and East Boulder mines.

Both the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A and the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would lengthen the closure timeframe to 18 months, which would allow an additional LAD season at each location and provide more time in case of unforeseen problems during the closure period. The agencies' analyses show that the longer closure timeframe minimizes the potential to exceed nitrogen and salts ground and surface water quality criteria (Appendix C, Stillwater Mine Alternative 3A Closure Nitrogen and Salts Spreadsheets, East Boulder Mine Alternative 3B Closure Nitrogen and Salts Spreadsheets and Summary of Water Quality by Alternative Table, DEQ 2010).

4.2.2.6.2 Cumulative Effects

The cumulative effects associated with the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine

Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would be the same as disclosed under Proposed Action alternatives 2A and 2B, respectively.

4.2.2.6.3 Unavoidable Adverse Effects

Implementation of the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would not result in unavoidable adverse effects to the Stillwater and East Boulder rivers' aquatic resources. Unavoidable adverse effects to aquatic species in excess of those previously considered and approved are not anticipated.

4.2.2.6.4 Relationship between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

Implementation of the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would not result in new area disturbances at the respective mines. Site disturbances associated with operations, closure, and post-closure activities have been considered previously and approved. Selection and implementation of these alternatives would not change the existing relationship between short-term use of the mine areas and the long-term maintenance and enhancement of the areas' productivity.

4.2.2.6.5 Irreversible and Irretrievable Losses

Implementation of the Stillwater Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3A or the East Boulder Mine Closure and Post-Closure WMP Agency-Mitigated Alternative 3B would not result in the irretrievable or irreversible commitments of aquatic resources. No new disturbances within or adjacent to the mine sites would take place. Over time, any operational and closure changes to ground and surface water quality would return to pre-mine conditions. No additional irreversible and irretrievable losses, in excess of those previously considered and approved in past environmental analyses, would be anticipated to take place near the mines.

4.2.2.7 Boe Ranch LAD System Agency-Mitigated Alternative 3C

Potential effects to aquatic resources in the East Boulder River would be similar to those disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C (Section 4.2.2.5). Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, operational and closure monitoring of irrigation practices would increase, as compared to the Proposed Action Alternative 2C. The timeframe for closure dewatering of the East Boulder tailings impoundment and disposal of treated adit waters could be increased to 18 months. This would provide up to two growing seasons for application of mine waste water, if necessary. Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, elimination of center pivot P10 and increased monitoring of center pivots P4 and P9 would be implemented at the Boe Ranch.

4.2.2.7.1 Direct and Indirect Effects

Effects to Aquatic Resources in the East Boulder River

Implementation of the Boe Ranch LAD System Agency-Mitigated Alternative 3C may reduce the potential for adverse effects to aquatic resources within the East Boulder River below the Boe Ranch. Land application of treated adit and tailings waters over two LAD seasons at closure could reduce potential nitrogen effects to ground or surface water, as compared to the Boe Ranch Proposed Action Alternative 2C. This extended timeline would reduce potential effects to aquatic resources as well. The addition of the Boe Ranch LAD area monitoring under this alternative would ensure that mine waste waters are managed in a way that minimizes effects to ground water within and adjacent to the Boe Ranch. This monitoring would reduce the potential for effects to aquatic resources.

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, nitrogen and salts concentrations in ground water and the East Boulder River near the East Boulder Mine would not exceed the nitrogen and salts surface and ground water quality criteria used by the agencies in their analyses (Appendix C, Summary of Water Quality by Alternative Table, DEQ 2010).

Also under this alternative, nitrogen concentrations in the ground water and East Boulder River below the Boe Ranch would not exceed the surface and ground water quality criteria used by the agencies in their analyses (Appendix C, Summary of Water Quality by Alternative Table, DEQ 2010). Salts concentrations in the Boe Ranch ground water would not exceed the ground water quality criteria. For all operational and closure options analyzed under the Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C, salts concentrations in the East Boulder River would increase 8 to 56 percent over the ambient 340 mg/L TDS concentration at surface water monitoring station EBR-008. This increase could incrementally affect wild trout eggs during operations and closure.

During post-closure, surface and ground water quality would be expected to improve over time since no mine-related activities would take place at either the East Boulder Mine or the Boe Ranch. Under the Agency-Mitigated Alternative

3C, potential effects to wild trout in the East Boulder River near the East Boulder Mine and below the Boe Ranch would be less than the potential effects disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C.

Effects to Threatened, Endangered, Sensitive, and Management Indicator Species in the East Boulder Rivers

The Boe Ranch LAD System Agency-Mitigated Alternative 3C would lengthen the closure timeframe to 18 months, which would allow for an additional LAD season and provide more time in case of unforeseen problems during the closure period. The agencies' analyses show that the longer closure timeframe minimizes the potential to exceed the nitrogen and salts ground and surface water quality criteria used. Effects to threatened, endangered, sensitive, and management indicator species in the East Boulder River would be less than those disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C (Appendix C, Summary of Water Quality by Alternative Table, DEQ 2010).

Additional monitoring of irrigation practices and ground water in the Boe Ranch LAD area would ensure the LAD system would be operated efficiently and that ground water quality criteria at the Boe Ranch are not exceeded. Surface water nitrogen and salts effects would also be reduced. These system design changes may potentially prove beneficial to wild trout, including Yellowstone cutthroat trout, in the East Boulder River.

4.2.2.7.2 Cumulative Effects

Anticipated cumulative effects to aquatic resources would be similar to those disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C.

4.2.2.7.3 Unavoidable Adverse Effects

Anticipated unavoidable adverse effects to aquatic resources would be similar to those disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C.

4.2.2.7.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Changes to the existing relationship between short-term uses of environment and the maintenance and enhancement of long-term productivity related to aquatic resources would be similar to those disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C.

4.2.2.7.5 Irreversible and Irretrievable Losses

Anticipated irreversible and irretrievable losses related to aquatic resources would be similar to those disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C.

4.3 Irrigation Practices

The Boe Ranch LAD System Proposed Action Alternative 2C prompted concerns during scoping about potential effects to soils, vegetation, and mass wasting if mine waste water disposal rates exceed the capacity of the Boe Ranch LAD area soils to store the applied LAD water. These issues regarding the health and diversity of the vegetation community and the condition of irrigated soils are also applicable to the Boe Ranch LAD System Agency-Mitigated Alternative 3C. Specific concerns are detailed in the description of Issue 3 (Section 2.2.1) and include the following:

- Effects to soils from nitrates, salts, and heavy metal accumulations (heavy metal accumulations have been dismissed as disclosed in Section 2.2.2);
- Alterations that would occur in plant community composition due to increased water and nitrogen availability under the Boe Ranch LAD system during operation and closure;
- Alterations that would occur in plant community composition due to reduced availability of water and nitrogen when LAD is eliminated during post-closure;
- Spread of noxious weeds during operations, closure, and post-closure; and
- Instability and increased potential for mass wasting beneath and downgradient of the irrigation center pivots during operations, closure, and post-closure.

4.3.1 LAD Disposal Analyses

The following analyses are performance-based and not prescriptive. These analyses do not stipulate what SMC must do to comply with water quality and quantity. SMC has many options available to manage water and the resultant nitrogen and salts loads as needed. A potential list of options is described in the spreadsheets in Appendix C (DEQ 2010). These analyses recognize SMC's need for flexibility in managing water to limit nitrogen and salts loads and the resultant effects to soils and plant communities.

These analyses were conducted by comparing more than ten years of existing data from similar irrigation systems used at the Stillwater Mine, the Stillwater Hertzler Ranch LAD area, and the East Boulder Mine with baseline conditions at the Boe Ranch LAD area. The Boe Ranch analyses draw heavily from the soils technical analysis completed by Cascade Earth Sciences (CES 2008) and water quality and loading calculations in Appendix C (DEQ 2010). Concentrations of nitrate+nitrite-nitrogen and ammonia-nitrogen in mine waste waters are disclosed in Appendix C, Untreated Adit and Tailings Waters Quality (DEQ 2010). Effects to water quality and quantity from the disposal of adit and tailings waters are

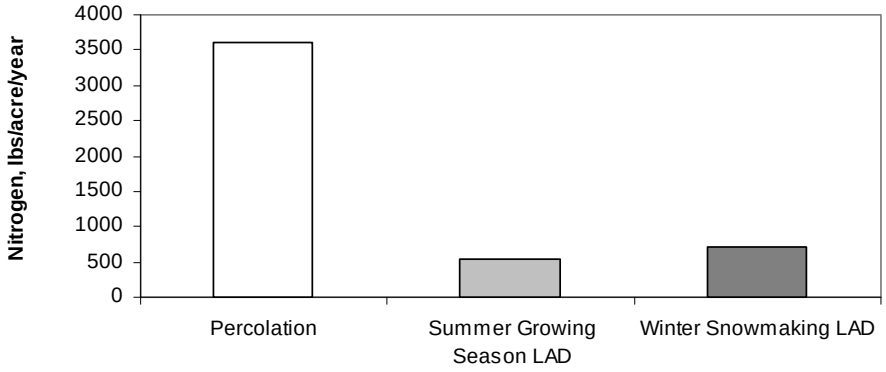
based on the calculations in Appendix C (DEQ 2010) and disclosed in Chapter 4 Section 4.1 under each Proposed Action and Agency-Mitigated Alternative.

4.3.1.1 Land Applied Nitrogen

LAD is an additional treatment process for nitrogen compounds (nitrate-nitrogen and ammonia-nitrogen) because it utilizes several natural processes that attenuate nitrogen. Plants require nutrients for growth and absorb both nitrate-nitrogen and ammonia-nitrogen compounds from land-applied water. Ammonia-nitrogen is rapidly converted to nitrate-nitrogen in the root zone at soil temperatures in excess of 50°F during the growing season (EPA 1993, Alexander 1977). Bacteria living in soil or on plant roots break down ammonia-nitrogen and convert it to make their own organic compounds. Bacteria convert ammonia-nitrogen to nitrate-nitrogen for uptake by plants and conversion to nitrogen gas, which escapes from the soil to the atmosphere. It can be assumed that all nitrogen from treated adit and tailings waters, in the form of organic ammonia-nitrogen, would be mineralized and nitrified to more mobile nitrate-nitrogen in the root zone (CES 2008). During recent summer LAD operations at the Hertzler Ranch (SMC 2006) and at the Stillwater Mine LAD (SMC 1996, 1997, 1998, and 1999), nitrogen removal has averaged approximately 85 percent of applied nitrogen.

Because nitrate-nitrogen is a negatively charged molecule and the soil is negatively-charged, the remaining 15 percent of nitrate-nitrogen that is not attenuated would be repelled by the soil particles and would move readily with deep percolate (*i.e.,* water that exceeds the soil water holding capacity and infiltrates below the root zone toward ground water). All nitrogen not treated by summer LAD, snowmaking, or soil and vegetation interactions could be leached (mobilized) to ground water by deep percolate as nitrate-nitrogen (CES 2008). To illustrate the nitrogen treatment processes that occur during LAD, the nitrogen load to ground water resulting from LAD of 20 lbs/day nitrogen at the East Boulder Mine during a maximum 180-day LAD season would be reduced by plant uptake and root zone soil processes from 3,600 lbs to 540 lbs nitrogen (Figure 4-21).

Figure 4-21. A Comparison of Nitrogen Loading to Ground Water by Disposal Method



In contrast, nitrogen discharged to the percolation pond is not attenuated by plants or other processes in the root zone and could result in a buildup of nitrogen in the deeper glacial subsoils above the ground water table. These nitrogen compounds in the deeper glacial subsoils could affect ground water quality but would not affect surface soil quality or health. Percolation of 20 lbs/day nitrogen at the East Boulder Mine during a maximum 180-day LAD season would result in a load of 3,600 lbs of nitrogen being routed directly to ground water without any reduction due to plant uptake, surface soil storage, or other processes in the root zone (Figure 4-21).

During winter snowmaking, natural nitrogen treatment processes occur in the crystallization, consolidation, and thawing processes of snow. Snowmaking reduces water volume and nitrogen concentration through volatilization, sublimation, non-biological denitrification, and nitrification (SMC et al. 2004). As water freezes, ammonia-nitrogen is volatilized and some nitrate-nitrogen is converted to nitrogen gas that dissipates in the atmosphere. Nitrogen compounds remaining in the snow pack dissipate when the snow sublimes (evaporates) (CES 2008). In a 2002 snowmaking study, nitrogen removal averaged approximately 80 percent of the applied nitrogen (SMC 2004). To illustrate the nitrogen treatment processes that occur during snowmaking LAD, the nitrogen load to ground water resulting from LAD of 20 lbs/day nitrogen at the East Boulder Mine during a maximum 180-day snowmaking season would be reduced from 3,600 lbs to 720 lbs nitrogen (Figure 4-21).

Snowmaking is an important LAD option, but it is highly dependent on weather conditions. Optimum snowmaking conditions do not always exist, so storage or an alternate disposal method is necessary in winter. The volume of snowmelt that infiltrates the soil is dependent on whether an ice layer forms beneath the snow as a result of thawing and refreezing during the winter (Redding and Devito 2005, Bayard et al. 2005). Infiltrating snowmelt dilutes the concentration of deep percolate in subsoils. Research by Bayard et al (2005) showed that 25 to 35 percent of snowmelt in an alpine area of Switzerland ran off (*i.e.,* did not infiltrate) when a frozen layer formed at the soil surface.

4.3.1.2 Land Applied Salts

Salts are minerals dissolved in mine waste waters. Total dissolved solids (TDS) is a measure of mineral salts dissolved in water. Electrical conductivity (EC) is a measure of water salinity and is directly related to the TDS content of the water. As TDS increases, EC increases. TDS can be used to compute a total salts load applied to a site, while soil testing for EC can be used to monitor salts buildup and compute the need to apply excess irrigation to prevent salts from accumulating in the root zone. The terms TDS and salts are used interchangeably in this document. Salinity concentrations differ between adit and tailings waters. BTS treatment, LAD (including snowmaking), and percolation do not reduce the salts load in adit and tailings waste water streams.

The potential increase in soil salinity during operations is an important long-term consideration for soil quality. In large concentrations, salts, particularly sodium salts, can cause dispersion of soil clay minerals that may restrict soil water movement and reduce soil health. The sodium adsorption ratio (SAR) measures the potential sodium hazard to soil. A SAR of zero to three is considered no hazard, three to six a slight hazard, and six to nine a moderate hazard. The SAR can be calculated for mine waste waters and the potential sodium hazard evaluated for LAD.

Salts applied to soil in LAD waters are not used by plants and will accumulate in the root zone and inhibit plant growth unless the salts are leached from the root zone. The soil leaching requirement is a measure of the potential to mobilize salts (and nitrate-nitrogen) accumulated in the root zone as a result of applying LAD at agronomic rates. The soil leaching requirement is dependent on the soil type and the concentration of salts in land applied waters. It is computed from irrigation water salinity tables to determine the amount of water that should be applied to keep the root zone soils at a healthy salinity level that would not inhibit plant growth (CES 2008). The soil leaching requirement may necessitate the application of land applied waters at greater than agronomic rates.

Deep percolate forms when the soil water holding capacity is exceeded and excess water drains through the root zone toward ground water. This excess water dissolves plant nutrients such as nitrate-nitrogen and salts that have accumulated in the root zone and mobilizes them as deep percolate in a process called leaching. Deep percolate occurs naturally in the spring each year from snowmelt and from rainfall events. Nitrate-nitrogen and salts should not accumulate in the root zone due to this annual leaching but may dissolve in deep percolate infiltrating through subsoils until ground water is reached.

In contrast to LAD, which is applied to the soil surface, percolated waters are discharged below the root zone and do not affect the health of soils in the root zone. When effects to soil are a primary concern, percolation has an advantage over LAD for the disposal of waste waters containing salts. Once salts and nitrate-nitrogen reach the water table, they are not attenuated and will flow with ground water.

4.3.1.3 Experience from Other LAD Systems

4.3.1.3.1 Land application disposal at the Stillwater Mine: nitrogen loading.

Until 2003, the Stillwater Mine percolation ponds were used as the main waste water disposal method during the non-irrigation season. When the LAD system operated, water may have been applied at greater than agronomic rates. The nitrogen concentrations in ground water monitoring wells fluctuated about 1 mg/L seasonally, with higher concentrations corresponding to the flushing of nitrogen from the subsoil beneath the root zone to the ground water system. These fluctuations indicate that during operations some nitrogen from LAD seasonally accumulated in the root zone and subsoil. Nitrogen also likely accumulated in the subsoil during operations from use of the percolation ponds. At one point, the increased nitrogen and salts content in ground water monitoring wells downgradient of the percolation pond was up to 4 mg/L nitrate-nitrogen and 150 µmhos/cm conductivity. Since the Hertzler Ranch LAD system was commissioned in 2003, LAD at the Stillwater Mine has ceased and use of the percolation ponds has decreased. Recent ground water monitoring data indicate that nitrogen concentrations have returned to near baseline levels at the mine (Appendix C, Stillwater Mine Figures MW-11A, MW-14A, MW-18A, and MW-20A, DEQ 2010). The agencies have concluded that the return of water quality to near baseline levels demonstrates that any accumulated nitrogen from percolation and LAD has flushed through the subsoils and ground water. The agencies believe that a similar response between soils and ground water would occur at the Boe Ranch if the Boe Ranch LAD system is implemented and used as the primary water disposal system for the East Boulder Mine during operations and closure.

4.3.1.3.2 Percolation disposal at the East Boulder Mine: nitrogen and salts loading.

At the East Boulder Mine, the percolation pond is the primary disposal method for treated adit water. Water quality data indicate that use of the percolation pond has increased the nitrogen and salts content of ground water (Appendix C, Figures EBMW-2, EBMW-3, EBMW-6, and EBMW-7, DEQ 2010). The nitrogen and salts content in wells downgradient of the percolation pond (prior to the 2007 spill) increased up to 4 mg/L nitrate-nitrogen and 350 µmhos/cm conductivity. The agencies believe that a response of improved ground water quality similar to that at the Stillwater Mine would occur at the East Boulder Mine if percolation and LAD use at the mine were decreased and if the Boe Ranch LAD system is implemented and used as the primary water disposal system during operations and closure.

During operations at the East Boulder Mine, the annual soil leaching requirement ranges from 1.1 to 1.6 inches on a growing season LAD area to 4.9 to 5.5 inches on winter and summer LAD areas (Appendix D, Table 17 from CES 2008). The annual soil leaching requirement is applied incrementally (LAD and precipitation) throughout the year. If the leaching requirement is met or exceeded during operations, nitrogen and salts should not accumulate in the root zone to levels harmful to vegetation (CES 2008). At the East Boulder Mine, the

percolated adit water volume during operations has exceeded the LAD soil leaching requirement. Nitrogen and salts may accumulate in the deeper glacial subsoils beneath the percolation pond but would not affect surface soil.

4.3.1.3.3 Land application disposal at the Hertzler Ranch: hydraulic and nitrogen loading

Since 2003, all Stillwater Mine west-side treated adit water has been disposed of at the 264-acre Hertzler Ranch LAD area. There is no requirement at the Hertzler Ranch to apply at agronomic rates, and water may have been applied at greater than agronomic rates. During the growing season, SMC avoids water balance problems by disposing of all water stored in the Hertzler Ranch LAD storage pond along with the excess operational adit water that is not recycled.

The Hertzler Ranch LAD system is operated to maximize evaporation. Thirty percent of the water that enters the central pivot irrigation system is evaporated. About 70 percent of the land applied water reaches the soil. When the application rate of water reaching the soil exceeds the agronomic rate, some nitrogen may not be utilized in the root zone. The unused nitrogen would flush from the root zone in deep percolate and infiltrate into deeper glacial subsoils. Some deep percolate occurs naturally in the spring each year from snowmelt and rainfall. The flushing of some nitrogen from the root zone and movement of deep percolate to ground water has been verified by the fluctuation of nitrogen concentrations within ground water. Periodic high concentrations of nitrogen represent deep percolate entering ground water after snowmelt and other precipitation events, and the periodic low concentrations represent the removal of nitrogen by ground water.

Operational ground water monitoring data at the Hertzler Ranch show annual fluctuations of 1 to 1.5 mg/L in nitrogen concentrations (Appendix C, Figure HMW-10, DEQ, 2009). These drops in nitrogen concentration suggest that nitrogen does not accumulate in the root zone; rather, ground water removes residual nitrogen that is flushed from the root zone at the Hertzler Ranch LAD area.

Since the Hertzler Ranch LAD system has been commissioned, the only noteworthy observed increases in nitrogen concentrations in ground water resulted from leaks from the Hertzler Ranch tailings impoundment underdrain system, the Hertzler Ranch LAD storage pond, and an application of fertilizer in the alfalfa field downgradient of the LAD area. Subsequently, the elevated nitrogen concentrations resulting from these events have declined (Appendix C, Figure HMW-10, DEQ, 2009).

SMC has land applied since 2003 at the Hertzler Ranch, sometimes at greater than agronomic rates, with minimal ground water nitrogen effects. Based on ground water quality monitoring, the agencies have concluded that land application at greater than agronomic rates has flushed residual nitrogen from the root zone. This flushing of unused nitrogen minimizes the effects of nitrogen accumulation in soils at the Hertzler Ranch. The continual application and subsequent removal of nitrates from the Hertzler Ranch root zone that is occurring during operations would produce limited effects to soils over mine life.

In most agricultural operations, fertilization occurs in one application. Over-irrigation or a precipitation event occurring shortly after application could flush the fertilizer below the root zone before the plants could use it. Conversely, the native (*i.e.*, western wheatgrass) and introduced grasses (*i.e.,* smooth bromegrass, intermediate wheatgrass, and Kentucky bluegrass) at the Hertzler Ranch benefit from nitrogen supplied in small, weekly doses throughout the growing season. Small, weekly doses are more likely to temporarily accumulate in the root zone where plants can use the nitrogen. Through 2008, the largest volume of water SMC has disposed of at the Hertzler Ranch in one LAD season has been 141 MG of treated adit water with a concentration of 6.4 mg/L TIN. When compared with typical agricultural fertilization rates, this load equals 28.5 lbs/acre/year on this 264-acre LAD Area. The amount of nitrogen would represent a light fertilization load. At the Hertzler Ranch LAD area, the plant cover and productivity has been enhanced, and the vegetation has been grazed by cattle and deer. The agencies believe that a similar response in plant cover and productivity would occur at the Boe Ranch LAD area if the Boe Ranch LAD system is implemented and used as the primary water disposal system during operations and closure.

4.3.1.3.4 Land application disposal at the Hertzler Ranch: salts loading.

The baseline soil sodium absorption ratio (SAR) value is 0.5 at the Hertzler Ranch LAD area. Stillwater Mine treated adit water has an average SAR value of 4.3. It is intuitive that while adit water with a 4.3 SAR is being land applied, soil SAR values would increase to at least 4.3. If salts are not flushed annually from the root zone, the soil SAR value should increase well above 4.3 over time. Operational soils monitoring data indicate that soil SAR values under the Hertzler Ranch center pivot P3 have increased to 4.4 after ten years of LAD. A SAR between 3 and 6 indicates a slight sodium soil hazard. The soils under center pivot P3 are fine-grained and hold salts more readily than a coarse-grained soil. SAR values under center pivot P3 at the Hertzler Ranch represent the worst-case (highest SAR values) since the other soils are coarser-grained and less likely to accumulate salts. The SAR values in Hertzler Ranch LAD soils are similar to the SAR values in land applied mine waste waters. Hertzler Ranch LAD soil SAR values are not anticipated to increase as long as SMC land applies at rates that ensure seasonal flushing of salts from the root zone. The operational salts load to date has not adversely affected soil quality. The agencies believe that a similar response in soil SAR values would occur at the Boe Ranch LAD if the Boe Ranch LAD system is implemented and used as the primary water disposal system during operations and closure.

4.3.2 Boe Ranch Land Application Disposal System No Action Alternative 1C

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be constructed. Mine waste waters would be managed during operations as described in the *Final Environmental Impact Statement, East Boulder Mining Project, Sweet Grass County, Montana* (DSL et al. 1992b) and the *Final Environmental Assessment, Stillwater Mining Company East Boulder Project Water Management Plan* (DEQ 1999). Under this alternative, waste waters would be managed during closure and post-closure as described in the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B. The *Final Environmental Impact Statement, East Boulder Mining Project* did not consider, analyze, or disclose consequences of the disposal of the East Boulder Mine tailings impoundment waters during closure. The *Final Environmental Assessment, Stillwater Mining Company East Boulder Project Water Management Plan* did not consider effects to soils and vegetation from mine waste waters disposal during closure. After closure, LAD would not be needed.

4.3.2.1 Assumptions and Parameters of Agency Analyses

To evaluate the effects that could potentially occur under the Boe Ranch LAD System No Action Alternative 1C, the agencies used the following assumptions and parameters in their analyses (Appendix C, DEQ 2010):

- The nitrogen load from treated adit water at the East Boulder Mine would be 20 lbs/day during operations and closure. The concentrations of nitrogen and salts in adit water would remain relatively constant over time;

- Both the 2008 average adit flow rate of 150 gpm and the maximum MPDES permitted adit flow rate of 737 gpm were analyzed;

- The growing season would be reduced from 180 days to 120 days to account for potential problems with wet growing seasons or potential down-time for equipment;

- The East Boulder Mine MPDES permit requires an agronomic LAD rate (DEQ 2000);

- The LAD system would be operated to evaporate 30 percent of the water from the center pivots, so that only about 5.4 gpm/acre/12-hour day would actually be delivered to soil at the East Boulder Mine LAD Area 6;

- A maximum treatment efficiency of 80 percent would be achieved for both summer LAD and winter snowmaking;

- East Boulder Mine LAD areas 2, 3-Upper, and 4 have been approved but not constructed. SMC would ramp up the treatment and disposal options as necessary to manage the adit flow rate;

- SMC would manage the East Boulder Mine LAD Area 6 to comply with the MPDES permit nondegradation standard of 7.5 mg/L nitrogen at the end of the permitted mixing zone; and

- SMC would manage the East Boulder Mine LAD Area 6 to comply with the DEQ-7 ground water nitrogen standard of 10 mg/L TIN and the Class I ground water EC beneficial use criterion of 1,000 µmhos/cm beyond the mixing zone.

4.3.2.2 Operational Effects at the Boe Ranch LAD Area

Under the No Action Alternative 1C, the Boe Ranch LAD system would not be constructed or operated. All irrigation effects under this alternative would occur at the East Boulder Mine at constructed LAD areas. Over mine life, noxious weeds may invade from agricultural practices and vehicle use of the area.

4.3.2.3 Operational Nitrogen Effects to Soils at the East Boulder Mine

SMC's preferred water management options during operations are reuse within the mine, disposal in the percolation pond, and land application in LAD Area 6 at the East Boulder Mine using evaporation and snowmaking systems (Figure 2-18).

SMC has used the percolation pond at the East Boulder Mine almost exclusively during the last few years. Water discharged to the percolation pond enters below the root zone and has resulted in deep percolation beyond the root zone. The 2000-2007 water quality data indicate a gradual increase in nitrogen concentrations in ground water during operations at the East Boulder Mine. The agencies believe that one reason for this upward trend is use of the percolation pond as a primary disposal option. It is possible that nitrogen compounds have accumulated beneath and downgradient of the percolation pond in the deeper glacial subsoils (Appendix C, Figures EBMW-2, EBMW-3, EBMW-6, and EBMW-7, DEQ 2010).

Exclusive continued use of the percolation pond for disposal of mine waste waters would not affect the quality or health of surface soil. The discharged nitrogen would mobilize in deep percolate through the deeper glacial subsoils to ground water and continue to affect ground water quality as disclosed in Section 4.1.3.

If SMC uses land application for disposal of excess treated adit water, LAD at agronomic rates at the East Boulder Mine would not exceed the soil water-holding capacity and should not flush accumulated nitrogen from the soil root zone during the LAD season (CES 2008). Nitrogen could accumulate in the root zone and affect soil health unless it is flushed periodically to deeper glacial subsoils.

LAD area irrigation onto native plant communities would reduce nitrogen loading to ground water as compared with percolation disposal. An operational adit water discharge nitrogen load of 20 lbs/day on the 10.2 acre LAD Area 6 for up to 180 days would result in 353 lbs/acre/year of nitrogen applied to the soil (2 lbs/ac/day). This LAD nitrogen load at the East Boulder Mine would exceed the native rangeland fertilization rate of 150 lbs/acre/yr.

Native and introduced grasses, native shrubs, and young conifers at the East Boulder Mine would benefit from LAD of 2 lbs/ac/day nitrogen applied in small doses over the growing season. This gradual application of nitrogen would result in enhanced vegetation growth and would provide browse for deer and elk that would graze on the grass and shrubs. In comparison, a rancher may, in one large application, apply 50-150 lbs/acre/year of nitrogen on pasture grasses similar to the East Boulder Mine and the Boe Ranch sites (Jacobsen *et. al*. 2005 as cited in CES 2008).

4.3.2.4 Operational Salts Effects to Soils at the East Boulder Mine

Unlike nitrogen, which is largely consumed in the soil root zone, salts are not utilized by plants or other soil processes. The East Boulder Mine MPDES permit requires SMC to land apply at agronomic rates to limit mobilization of nitrogen to ground water. Land application at agronomic rates could accumulate salts in the root zone.

The potential increase in soil salinity during operations is an important long-term consideration for soil quality. Baseline SAR values in soils at the East Boulder Mine site are less than 1 and considered no hazard. The median treated adit water SAR is 4.3 indicating a slight hazard (CES 2008). It is intuitive that soil SAR values would increase to at least 4.3 during operations as long as treated adit water with a SAR of 4.3 is land applied. The SAR is most critical in fine-grained soils. SMC has collected limited data on salts levels in the soils at LAD Area 6 and in the percolation pond at the East Boulder Mine.

The adit and tailings waters have moderate salts content that make them suitable for irrigation use on a large, long-term scale (Ayers and Wescott 1985 as cited in CES 2008). Waters with similar salts concentrations are considered satisfactory to excellent for agricultural irrigation (CSU 2008 as cited in CES 2008). For comparison purposes, if SMC were to land apply drinking water containing salts approximating the public drinking water supply standard limit of 500 mg/L, the total salts load would be 90 percent of East Boulder Mine adit water. If SMC were to land apply East Boulder River water, the annual salts load would be

about one-sixth (17 percent) of the salts load of East Boulder Mine adit water (CES 2008).

If SMC land applies at agronomic rates, some deep percolate would occur naturally in the spring each year from snowmelt and rainfall. With annual flushing, salts should not accumulate in the soil to levels harmful to vegetation from year to year during operations (CES 2008). Salts may accumulate in the deeper glacial subsoils or mobilize to ground water. At the East Boulder Mine during operations, the annual soil flushing requirement would range from 1.1 to 1.6 inches on a growing-season LAD area, to 4.9 to 5.5 inches on winter and summer LAD areas (Appendix D, Table 17 from CES 2008).

If water is land applied at greater than agronomic rates, the soil flushing requirement would be met and more water would be available for plant use. As discussed in the previous section, nitrogen contained in the applied water would enhance vegetation production and vigor. The simultaneous addition of salts in land applied water is not anticipated to affect vegetation to the same extent as would the application of salts without nitrogen. At the East Boulder Mine, the vegetation consists of native and introduced grasses, native shrubs, and young conifers that should not be harmed from the salts load supplied in small doses over the growing season.

From August 2000 through May 2008, approximately 159 MG of treated adit water containing 599,645 lbs of salts were discharged primarily through the percolation pond, although some treated adit water was land applied at the East Boulder Mine LAD Area 6 (CES 2008). At the East Boulder Mine, ground water quality data from 1989 to 2007 indicate a gradual increase of about 100 µmhos/cm EC during operations at the East Boulder Mine (Appendix C, Figures EBMW-2, EBMW-3, EBMW-6, and EBMW-7, DEQ 2010). The agencies believe the reason for this upward trend is use of the percolation pond as the primary adit water disposal option. No noticeable change in plant productivity and community structure attributable to the salts load has been noted to date at LAD Area 6.

Based on data from the Hertzler Ranch LAD area, LAD of treated adit water at the East Boulder Mine LAD Area 6 has likely resulted in the seasonal accumulation of salts in the root zone with subsequent flushing to deeper glacial subsoils and eventually to ground water.

4.3.2.5 Operational Effects to Vegetation at the East Boulder Mine

Irrigation with treated adit water containing nitrogen has altered and will continue to alter over mine life the cover, production, standing litter, and species composition of plant communities at the East Boulder Mine LAD area. Increased use of LAD would increase the amount of water and nitrogen available to plants, as well as the salts applied in treated waters during LAD operations. Plant communities affected would include lodgepole pine clear cuts now dominated by native and introduced grasses, some shrubs, and young conifers.

Continued use of the percolation pond at the mine would have minimal effects to plant communities because the water is applied below the land surface.

Water and nitrogen additions would increase production of plant communities within the developed East Boulder Mine LAD areas. Based on experience at the Stillwater Mine and the Hertzler Ranch LAD sites, grass and forb production at the East Boulder Mine LAD area should at least double as a result of LAD during mine life.

An increase in litter over mine life would reduce plant community diversity and favor shade- tolerant species. SMC has not proposed grazing at the East Boulder Mine LAD site to control litter accumulation. Grazing on the East Boulder Mine LAD areas could reduce litter and enhance the use of nitrogen by the plant communities. Grazing would also limit the establishment of plant species that favor or tolerate litter accumulations. Fire could be used to reduce litter but the risk of spread to adjacent forested areas would be too great. Fire does release nitrogen that flushes from soils to ground water after the fire.

Plant species composition would change in response to application of nitrogen-containing irrigation waters. In general, native species adapted to drier conditions would decrease in abundance with increased irrigation as they are out-competed by more aggressive, mesic (water-loving) introduced and native species.

In summary, despite the general increase in vegetation production that would occur with use of LAD at the East Boulder Mine, the increase of mesic species would lead to a decline in overall species diversity. Many of the species would be introduced non-native plants and noxious weeds. Conifers should respond favorably to the addition of water and nitrogen if new seedlings can become established while competing with existing, aggressive non-native grasses and forbs that occupy the LAD areas. Conifers would be the species most sensitive to the salts load applied during operations.

Construction-related disturbance and increased traffic during mine life would increase noxious weeds at the East Boulder Mine. Noxious weeds are present within or adjacent to the East Boulder Mine. Noxious weeds and the methods used to control them would reduce native plant community diversity. SMC has an approved weed control plan for the mine, but regardless of weed control efforts, noxious weeds would increase in the area. This is an unavoidable result of construction disturbance, irrigation practices, competitiveness of noxious weeds, weed control, and loss of native species.

4.3.2.6 Operational Mass Wasting Effects at the East Boulder Mine

The agencies evaluated the potential for mass wasting at the East Boulder Mine under the Boe Ranch LAD System No Action Alternative 1C (CES 2008). Use of the East Boulder Mine LAD system use could exceed the soil water-holding capacity or saturate soils at some point during the growing season. Although the LAD system hydraulic loading at the East Boulder Mine LAD site could

contribute 50 or more inches of water per acre to the LAD areas and percolation pond each year, there is little potential for mass wasting in the glaciated soils with less than 10 percent slopes. Mass wasting potential at the East Boulder Mine site will not be considered further in these analyses.

4.3.2.7 Closure Effects at the Boe Ranch LAD Area

Under the Boe Ranch LAD System No Action Alternative 1C, adit and tailings waters would be managed at closure as described in the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B (Figure 2-19).

Under the No Action Alternative 1C, the Boe Ranch LAD system would not be constructed or operated. All closure irrigation effects under this alternative would occur at the East Boulder Mine at constructed LAD areas.

4.3.2.8 Closure Nitrogen Effects to Soils at the East Boulder Mine

4.3.2.8.1 Adit Water

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD System would not be built. Adit water management at closure would essentially be the same as during operations. Nitrogen effects to the East Boulder Mine soils would be the same as during operations except nitrogen loads in adit water would decline as blasting ceases (Appendix C, Stillwater Mine Projected Nitrogen Concentration Decline Curve, DEQ 2010). Less nitrogen would be available to load the East Boulder Mine soils. Soil nitrogen levels from adit water would be less than observed during operations.

4.3.2.8.2 Tailings Waters

Tailings waters management during closure would be handled as described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B in *Water Quality and Quality* Section 4.1.2.2.2. (Figure 2-19). There would be minor additional effects to the East Boulder Mine soils from tailings waters. Tailings waters would be evaporated over the tailings impoundment surface, and most nitrogen would remain in the tailings impoundment. During closure, some nitrogen would continue to exit the tailings impoundment in liner leakage. Underdrain seepage would be recycled back into the impoundment for evaporation with supernatant and tailings mass waters. Nitrogen effects to soils would be localized and limited.

4.3.2.9 Closure Salts Effects to Soils at the East Boulder Mine

4.3.2.9.1 Adit Water

Under the Boe Ranch LAD System No Action Alternative 1C, treatment, routing, and disposal of adit water would be the same at closure as during operations. Salts effects to the East Boulder Mine soils would be the same as during operations, except salts loads in mine adit water would start to decline (Appendix

C, Stillwater Mine East-Side Adit Water Electrical Conductivity Figure, DEQ 2010). Fewer salts would be available to load the East Boulder Mine soils. Soil salts levels would be reduced from those observed during operations.

4.3.2.9.2 Tailings Waters

Under the Boe Ranch LAD System No Action Alternative 1C, treatment, routing, and disposal of tailings waters would be the same as described for the East Boulder Mine Closure and Post-Closure WMP No Action Alternative 1B in *Water Quality and Quantity* Section 4.1.2.2.2. There would be minor additional effects to mine soils from tailings waters. Tailings waters would be evaporated on the tailings impoundment surface, and most salts would remain in the tailings impoundment. During closure, some salts would continue to exit the tailings impoundment in liner leakage. Underdrain seepage would be recycled back into the tailings impoundment to be managed with tailings supernatant and tailings mass waters. Salts effects to soils would be localized and limited during closure.

4.3.2.10 Closure Effects to Vegetation at the East Boulder Mine

Effects to vegetation from adit water irrigation practices at the East Boulder Mine from LAD during closure would continue for up to 12 months as described for operations. There would be no irrigation effects from tailings waters disposal since tailings waters would be evaporated in the tailings impoundments. Nitrogen and salts would exit the impoundment in liner leakage and underdrain seepage.

4.3.2.11 Post-Closure Effects at the Boe Ranch LAD Area

No effects would occur during post-closure from irrigation practices at the Boe Ranch since under the Boe Ranch LAD System No Action Alternative 1C, the LAD facilities would not be constructed or operated.

4.3.2.12 Post-Closure Nitrogen and Salts Effects to Soils at the East Boulder Mine

Nitrogen and salts loads from the tailings impoundment to the East Boulder Mine area soils would continue to decline and would eventually return to levels in equilibrium with local area soils, precipitation, and the vegetation community existing on the site at closure. No post-closure LAD would occur.

4.3.2.13 Post-Closure Effects to Vegetation at the East Boulder Mine

As the amount of land-applied water and nitrogen is reduced during post-closure, effects to vegetation at the East Boulder Mine would include reduced plant productivity. Accumulations of applied nitrogen and salts in soils would return to levels in equilibrium with surrounding local area soils, precipitation, and the vegetation community existing on the site at closure. After reclamation, lodgepole pine and other conifers would eventually dominate the mine area.

Understory species would be permanently altered compared to the native communities that existed before mine construction. More introduced species and mesic native species would persist at the mine. SMC would be required to control noxious weeds on all LAD sites until reclamation bonds were released. Noxious weeds would never be completely eliminated from the mine site.

4.3.2.14 Cumulative Effects

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD area would not be constructed or operated. Mine-related activities would not contribute to cumulative effects to soils, plant communities, or mass wasting potential at the Boe Ranch.

Cumulative effects to vegetation from non-mine-related activities in the East Boulder River valley would occur due to subdivisions, agricultural practices, and other land use changes, resulting in a reduction and fragmentation of native plant communities. The diversity of native species within these plant communities is being reduced by invasion of noxious weeds and other aggressive plant species. Surface disturbance and traffic corridors have facilitated the expansion of noxious weeds and other aggressive species. These effects would be anticipated to continue whether or not this alternative is selected.

4.3.2.15 Unavoidable Adverse Effects

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be constructed or operated. There would be no adverse environmental effects at the Boe Ranch that could not be avoided by selection of this alternative.

4.3.2.16 Relationship between Short-term Use and Long-term Productivity

Under the Boe Ranch LAD System No Action Alternative 1C, no short-term mine-related use of the Boe Ranch lands would occur. The long-term productivity of the land would be maintained. The productivity of the Boe Ranch resource would be available for future use and would not be changed from present conditions.

4.3.2.17 Irreversible or Irretrievable Commitments of Resources

There would be no irreversible or irretrievable commitments of existing natural resources at the Boe Ranch related to irrigation practices if the Boe Ranch LAD System No Action Alternative 1C is selected.

4.3.3 Boe Ranch Land Application Disposal System Proposed Action Alternative 2C

If the East Boulder Mine requires additional storage or disposal capacity for adit and tailings waters during operations and closure, the Boe Ranch LAD system would be a water management option under this Proposed Action Alternative 2C. SMC would construct and operate the Boe Ranch LAD system only if needed. If constructed, the Boe Ranch LAD system would be SMC's preferred location for disposal of treated adit water during operations and treated adit and tailings waters during the first year of closure (Figure 2-28). SMC would maintain the option to dispose of mine waste waters at the East Boulder Mine as permitted.

SMC must dispose of all treated adit water that is not recycled underground during operations. Under the Boe Ranch LAD System Proposed Action Alternative 2C, LAD at the Boe Ranch would be operated using the template that SMC has successfully implemented at SMC's Hertzler Ranch LAD area. The agencies believe that there are sufficient similarities between treated adit and tailings waters at the East Boulder and Stillwater mines and the LAD areas at the Boe and Hertzler ranches to make direct comparison between the sites. The Boe Ranch LAD system as described in Section 2.4.8.1.1, would rely on center pivot irrigation.

During operations and closure, existing and new pipelines to the Boe Ranch would route water from the mine to the Boe Ranch LAD facilities. No changes are proposed to the existing 33,000 feet of pipeline currently installed in the East Boulder Mine access road right-of-way. During operations, this alternative would pipe treated adit water and, if needed, treated adit and tailings waters from the East Boulder Mine to SMC's Boe Ranch. Mine waste waters could be stored at the 108 MG-capacity Boe Ranch LAD storage pond over fall, winter, and early spring seasons when the weather is cold or when LAD at the Boe Ranch is not possible. During the growing season, which is generally April through October, stored waste waters would be routed from the storage pond to center pivots for land application at the Boe Ranch, as is done at the Stillwater Mine and the Hertzler Ranch. SMC has committed to manage the Boe Ranch LAD system similarly to the Stillwater Mine Hertzler Ranch LAD system, except that SMC has proposed to apply water at agronomic rates at the Boe Ranch. The Boe Ranch LAD system would include growing season evaporation over the LAD storage pond and winter snowmaking capabilities.

Under Proposed Action Alternative 2C, the Boe Ranch LAD irrigation system would consist of 10 center pivots with a maximum LAD discharge rate of almost 1,500 gpm during a 12-hour application day. The 10 center pivots would be sited on 194 acres and operated at a 7.7 gpm/acre agronomic rate to minimize the potential for mobilization of nitrogen to ground water. Excessive application rates at the Boe Ranch LAD area could result in increased runoff, ponding, and potential for mass wasting on some identified steep and susceptible sites in the LAD area.

As with the Hertzler Ranch LAD system design, the Boe Ranch LAD center pivot system would operate at high pressure with overhead spray nozzles that produce a fine mist to enhance wind drift and maximize evaporation. SMC's Hertzler Ranch LAD system is operated to evaporate 30 percent of the water that enters the central pivot irrigation system. Water that does not evaporate would infiltrate into the soil and be consumed by rangeland vegetation, stored in the soils, utilized by microbial action, or would infiltrate as deep percolate to ground water as discussed above. Plant cover and production would increase due to irrigation and additional nitrogen. As at the Hertzler Ranch, the Boe Ranch LAD area may be grazed by livestock as a means of harvest and nitrogen removal.

The following sections evaluate operation and closure irrigation practices in terms of flow capacity, formation of deep percolate, potential to accumulate nitrogen and salts in soils, effects to the existing plant community, and the potential that LAD would increase the risk of mass wasting at the Boe Ranch. The goals of LAD at the Boe Ranch during operations and closure are to increase SMC's capacity for disposal of mine waste waters, to reduce effects to ground and surface waters and other resources at the East Boulder Mine, and to minimize the effects to natural resources at the Boe Ranch. Mine waste waters would be managed to maximize evaporation and plant uptake of nitrogen. The advantage of the Boe Ranch LAD System is the ability to dispose of mine waste waters in an agricultural setting that is farther from the East Boulder River than the East Boulder Mine LAD areas.

4.3.3.1 Assumptions and Parameters of Agency Analyses

The goal of the Boe Ranch center pivot LAD system would be to dispose of treated adit water during operations in a manner that maximizes evaporation while providing uniform distribution of waste waters across a large acreage. SMC's method of center-pivot application would limit the occurrence of deep percolate to protect ground water and other natural resources at the Boe Ranch.

The agencies performed independent operational and closure analyses of both the existing and proposed systems at the East Boulder Mine and the Boe Ranch to deduce the potential effects from LAD irrigation at the Boe Ranch. These analyses assume that SMC would build and operate the Boe Ranch LAD system in conjunction with the approved East Boulder Mine water management systems.

To evaluate the effects that could potentially occur under the Boe Ranch LAD System Proposed Action Alternative 2C, the agencies used the following assumptions and parameters in their analyses:

- The nitrogen load produced by treated adit water at the East Boulder Mine would be 20 lbs/day during operations;

- The water and resulting nitrogen load that had been disposed of at the East Boulder Mine would preferentially be stored in the Boe Ranch LAD storage pond over winter and land applied on the 194-acre Boe Ranch LAD area;

- Both the 2008 average adit flow rate of 150 gpm and the maximum MPDES permitted adit flow rate of 737 gpm were analyzed;

- The growing season would be reduced from 180 days to 120 days to account for potential problems caused by wet growing seasons and equipment down-time;

- The agronomic application rate to prevent deep percolation at the Boe Ranch would be 7.7 gpm/acre/12-hour LAD day, or 743 gpm at all 10 center pivots (KP Appendix K 2000c);

- The LAD system would be operated to evaporate 30 percent of the water from the center pivots, so that only 5.4 gpm/acre/12-hour day would actually be delivered to soil;

- SMC would manage the Boe Ranch LAD system to comply with the DEQ-7 ground water nitrogen standard of 10 mg/L TIN and the Class II ground water EC beneficial use criterion of 2,500 µmhos/cm;

- SMC would manage the East Boulder Mine LAD areas to comply with the DEQ-7 ground water nitrogen standard of 10 mg/L TIN and the Class I ground water EC beneficial use criterion of 1,000 µmhos/cm;

- The hydraulic capability of each disposal system was calculated using the average adit flow rate of 150 gpm and maximum permitted adit flow rate of 737 gpm.

There is no MPDES permit or nitrogen load limit for the Boe Ranch LAD area. SMC would manage the LAD area to comply with the DEQ-7 ground water nitrogen standard of 10 mg/L total inorganic nitrogen (TIN). The Boe Ranch LAD area receives less precipitation and has better-developed soils as compared to the East Boulder Mine. The better-developed soils at the Boe Ranch LAD have a finer texture with less percentage of rock fragments than the East Boulder Mine soils. The finer texture of these soils would result in increased contact time between land-applied water and soils, which would decrease the amount of nitrate-nitrogen flushed from soil as deep percolate. The Boe Ranch LAD area has a higher evaporation potential and a slightly longer growing season. These site-specific attributes would increase plant evapotranspiration potential, soil microbial metabolism and denitrification, and ammonia volatilization as compared to the East Boulder Mine LAD areas. The Boe Ranch soils would increase the sequestration of inorganic nitrogen by plant and microbial communities (CES 2008).

One major difference between the two LAD areas is that the slopes range from zero to 20 percent beneath the proposed Boe Ranch LAD center pivot locations. If SMC land applied water at rates exceeding the infiltration rate of the Boe Ranch soils or if these soils were saturated from LAD or precipitation, runoff would occur. SMC would have to exercise greater care to prevent runoff during these conditions, such as reducing or stopping LAD. SMC may have to store

water in the Boe Ranch LAD storage pond or use other water management options at the East Boulder Mine to dispose of excess water.

4.3.3.2 Operational Analyses

For all operational options analyzed at the Boe Ranch under the Proposed Action Alternative 2C, the hydraulic load generated could be handled at the Boe Ranch LAD area or by partitioning water between the Boe Ranch LAD area and the East Boulder Mine percolation pond or LAD areas. All operational options analyzed would dispose of less water at the East Boulder Mine compared to the Proposed Action Alternative 2B and the Agency-Mitigated Alternative 3B (Appendix C, Boe Ranch LAD System Operations and Alternative 2C Closure Nitrogen and Salts Spreadsheets, DEQ 2010).

In the Proposed Action Alternative 2C, tailings waters would remain in the East Boulder tailings impoundment during operations unless excess tailings waters would need disposal at the East Boulder Mine or at the Boe Ranch. Operational tailings waters disposal effects to soils at the East Boulder Mine were never disclosed in previous environmental documents. Effects from a portion of operational tailings waters disposal under the Boe Ranch LAD System Proposed Action Alternative 2C or Agency-Mitigated Alternative 3C would be less than those disclosed below in the closure section when disposal of all tailings waters would occur.

4.3.3.3 Operational Nitrogen Effects to Soils at the Boe Ranch

Under the operational scenarios analyzed by the agencies, the total nitrogen load applied to the soil at the Boe Ranch LAD would vary from 8 to 23 lbs/acre/yr, which is a light agricultural fertilization rate. Over a 120-day LAD season, the projected nitrogen load would range from 2,460 to 7,209 lbs per year (Boe Ranch LAD System Proposed Action 2C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). The nitrogen in treated adit water would be applied incrementally over a 120-day LAD season, rather than in one application as in most non-center pivot rangeland agricultural operations. The native rangeland vegetation at the Boe Ranch consists of native and introduced grasses and native shrubs that would benefit from nitrogen supplied in small doses throughout the growing season. Small doses would be more likely to accumulate in the root zone where plants can use the nitrogen. Growth of the native rangeland vegetation would be enhanced, and the grass may be grazed by cattle and deer.

Nitrogen LAD rates at the Boe Ranch would be less than agricultural fertilizer application rates. Although nutrient requirements for crops have been developed, few studies have been devoted to the specific nutrient requirements of native rangeland like the Boe Ranch LAD area. Based upon aboveground plant production at the Boe Ranch for two existing plant communities, 10 to 32 lbs of nitrogen/acre/year would be required (CES 2008). An annual Boe Ranch LAD nitrogen application rate of 8 to 23 lbs/acre/year would not exceed the existing Boe Ranch plant community nitrogen use requirement.

Irrigation at the Boe Ranch LAD area would increase available water and nitrogen. The increased water and nitrogen would increase plant production and nitrogen use requirements. This increased plant production and nitrogen use effect has been observed at the Hertzler Ranch LAD area and was described in the introduction to the *Irrigation Practices* Section. The Boe Ranch LAD agronomic application rate would not exceed the soil water-holding capacity and would not flush residual nitrogen from soil. If SMC applies at agronomic rates and the plant communities use the majority of the nitrogen load applied during a 120-day LAD season, then the amount of nitrogen stored in soil would be limited over the life of the Boe Ranch LAD system.

4.3.3.4 Operational Nitrogen Effects to Soils at the East Boulder Mine

The nitrogen load disposed of at the East Boulder Mine would be reduced by the amount land applied at the Boe Ranch LAD. If all treated adit water is disposed of at the Boe Ranch, then the operational nitrogen load at the East Boulder Mine would be limited to leakage from the tailings impoundment. SMC could continue to land apply at the Boe Ranch provided the DEQ-7 nitrogen ground water standard of 10 mg/L is met. SMC's preferred disposal options after the Boe Ranch LAD area would be the East Boulder Mine LAD areas and then the percolation pond (Figure 2-28). Use of the East Boulder Mine percolation pond would result in continued nitrogen loading to the ground water, but this load would be less than the current operational load disposed of under the East Boulder Mine WMP No Action Alternative 1B.

If the Boe Ranch LAD system cannot be used or if adit flows increase beyond the Boe Ranch LAD capacity, the East Boulder mine LAD Area 6 and percolation pond would be used to dispose of treated adit water during operations. Under this scenario, there would be the potential to accumulate nitrogen in the East Boulder Mine soils and glacial subsoils over the life of the mine.

If excess water is percolated, then the total nitrogen load discharged to the East Boulder Mine percolation pond would vary from 12.5 to 15.8 lbs/day nitrogen, which is less than the MPDES permit limit of 30 lbs/day. Over a 120-day LAD season, the projected nitrate-nitrogen load would range from 1,898 lbs to 4,970 lbs per year depending upon the option analyzed (Boe Ranch LAD System Proposed Action 2C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010).

4.3.3.5 Operational Salts Effects to Soils at the Boe Ranch

There is no MPDES permit for the Boe Ranch LAD Area. SMC would not have a permit-based salt load limit for soil at the Boe Ranch. SMC would have to manage the LAD at the Boe Ranch LAD area to comply with the Class II ground water EC beneficial use criterion of 1,000 to 2,500 µmhos/cm.

When compared to the East Boulder Mine, the Boe Ranch LAD area has higher evaporation potential, a longer growing season, and increased plant

evapotranspiration potential. The lower precipitation rate and better developed soils would tend to accumulate land-applied salt in soil at the Boe Ranch. Salts would accumulate in soil or would be flushed to ground water in deep percolate.

Under the operational scenarios analyzed by the agencies, the total salts load applied to the soil at the Boe Ranch LAD would vary from 1,840 to 4,904 lbs/acre/yr (Boe Ranch LAD System Proposed Action 2C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). To put this in perspective, this load is analogous to sprinkling from one to two and two-thirds tablespoons of salt over one square foot of soil over the 120-day LAD season.

If sufficient flushing does not occur, applying these salts loads at the Boe Ranch over an assumed 30-year operational life for the East Boulder Mine could result in an accumulation of salts in the soil. At the Boe Ranch LAD area, SMC proposes to land apply at an agronomic application rate that would not exceed the soil water-holding capacity. Water land applied at this rate would not be adequate to flush residual salts from soil, potentially resulting in 100 percent of the salt load being stored in the soil root zone.

The potential increase in soil salinity at the Boe Ranch LAD during operations is an important long-term consideration for soil quality and plant community productivity and composition. Baseline SAR values in soils at the Boe Ranch LAD are less than 1 and considered to have no sodium salinity hazard. The East Boulder Mine treated adit water median SAR is 4.3, indicating a slight sodium salinity hazard for soil (CES 2008). It is intuitive that soil SAR values would increase to the level of the land applied water during operations while treated adit water is land applied. The finer-grained soils at the Boe Ranch LAD area would be more susceptible to SAR effects than the coarser-grained soils at the East Boulder Mine.

Precipitation and snowmelt at the Boe Ranch LAD area could provide some flushing of salts from the soils. If treated adit waters are applied at agronomic rates that do not flush salt from soil, and the volume of precipitation and snowmelt are not adequate to sufficiently flush salt, then the agencies believe that there would be effects to plant productivity and changes in plant species composition. The plant species composition would change from native rangeland vegetation, consisting of native and introduced grasses and native shrubs, to salt-loving species.

Soils monitoring would be needed to assess the salts build-up during operations. SMC has not proposed soil salts monitoring as part of the Boe Ranch LAD system operations. Monitoring the soil salinity would be necessary so that adjustments can be made to the land application rate to properly manage soil health at the Boe Ranch LAD area.

4.3.3.6 Operational Salts Effects to Soils at the East Boulder Mine

The description of operational adit water management under this alternative is the same as discussed under the Boe Ranch LAD System No Action Alternative 1C.

The disposal of any volume of treated mine waste waters at the Boe Ranch would reduce the salts load disposed of at the East Boulder Mine. Salts effects at the East Boulder Mine from disposal of the excess water that could not be managed at the Boe Ranch LAD area would be less than effects under the East Boulder Mine WMP Proposed Action Alternative 2B, which disposes of all treated adit water at the mine.

If the adit flow rate is 150 gpm, all treated adit water could be managed at the Boe Ranch, and there would be no salts effects at the East Boulder Mine, unless the Boe Ranch has operational problems. If the adit flow rate increases to 737 gpm, it would exceed the hydraulic capacity of the Boe Ranch. If SMC percolates the excess treated adit water at the East Boulder Mine, the agencies project the total salts load applied below the root zone to subsoils at the East Boulder Mine would be 1,187,934 lbs/yr (Boe Ranch LAD System Proposed Action 2C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). As previously disclosed in *Water Quality and Quantity* Section 4.1.3.2, this load of salts to ground water would not exceed the Class I beneficial use ground water standard of 1,000 µmhos/cm conductivity at the East Boulder Mine.

If SMC chooses to land apply to the capacity of LAD Area 6 and percolate the remainder, the salts loads at LAD Area 6 over an assumed 30-year operational life could result in an accumulation of salts in the soil if soil flushing does not occur. SMC is required by its MPDES permit to land apply at an agronomic application rate that does not exceed soil water-holding capacity. Treated adit water land applied at this rate would not be adequate to flush residual salts from soil, potentially resulting in 100 percent of the salt load being stored in the soil root zone. It is intuitive that during operations while treated adit water with a SAR of 4.3 is land applied, the LAD Area 6 soil SAR values would increase to 4.3.

During operations, regardless of adit flow rate, the same amount of salts would continue to exit the East Boulder tailings impoundment in liner leakage to the East Boulder Mine soils. Underdrain seepage from the tailings impoundment would be captured and routed back into the impoundment during operations.

In summary, disposal of treated adit water using LAD at the Boe Ranch during operations under the Boe Ranch LAD System Proposed Action Alternative 2C would result in reduced salts effects to the East Boulder Mine soils compared to the East Boulder Mine WMP Proposed Action Alternative 2B. Depending on adit flow rate, the disposal of treated adit water at the Boe Ranch could result in a 64 to 100 percent reduction in the salts load disposed of at the East Boulder Mine.

4.3.3.7 Operational Effects to Vegetation at the Boe Ranch

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would increase plant cover, plant production, and standing litter, as well as alter the species composition of existing plant communities at the Boe Ranch. The affected plant communities at the Boe Ranch are dominated by these native grass communities: Idaho fescue/bluebunch wheatgrass and Idaho fescue/western wheatgrass.

The native rangeland, which consists of native and introduced grasses and native shrubs, would benefit from the nitrogen component carried with the salts in the LAD water. Vegetation production and cover would increase. Plant species composition would change from the addition of nitrogen, salts, and water. Overall species diversity would decline, and irrigation would favor the mesic species. Many of these species at the Boe Ranch LAD area are non-native plants and some are noxious weeds. Interseeding of nitrogen-accumulating introduced forage grass species, as proposed by the SMC to enhance nitrogen utilization, would change the community species composition and would result in a loss of species diversity. In general, when irrigation commences, the native species that are adapted to drier conditions would decrease in abundance as they are out-competed by more mesic introduced and native species.

An increase in litter would reduce plant community diversity and favor shade tolerant species. SMC has proposed grazing to remove aboveground plant biomass, including litter, to maintain plant community productivity. Grazing could remove 45 to 70 percent of the biomass, depending on cattle management (Volesky et al. 1994 as cited in CES 2008). On ryegrass pastures, 80 to 90 percent of nitrogen in forage consumed is returned to the land in feces and urine (Ryden et al. 1984 as cited in Hatfield and Stewart 1998). Estimates of soil nitrogen additions from the manure of beef cattle weighing 750 lbs and 1,000 lbs are 0.26 lbs/day and 0.34 lbs/day, respectively. This equals 47 lbs and 62 lbs of nitrogen per cow that would be returned to the 194-acre LAD area over a six-month grazing season. Removal of plant nitrogen from the Boe Ranch LAD by livestock and wildlife may not reduce nitrogen flushing potential since nitrogen-bearing animal wastes would not leave the LAD area. Grazing would limit the establishment of plant species that favor or tolerate litter accumulations. Grazing on the LAD area by cattle and deer would reduce standing plant litter, incorporate fallen litter and seeds into the top layer of soil, and enhance the use of nitrogen by the plant communities.

Salts may accumulate in soils if not flushed from the soil profile over the operational life of the Boe Ranch. The accumulation of salts in soil would eventually affect the vegetation community composition on the site by favoring more salt-tolerant species.

4.3.3.8 Other Operational Effects on Soils and Vegetation at the Boe Ranch

In addition to the effects of the Boe Ranch LAD system operation on nitrogen and salts in soils, the vegetation and soils at the Boe Ranch would be disturbed due to construction, regular operations and maintenance, and monitoring activities. These effects would be primarily related to trampling, soil compaction, and potential increases in soil loss due to accelerated erosion. Compaction and increased erosion potential during construction and maintenance of the LAD facilities would be mitigated in areas of temporary disturbance as these areas are reclaimed. The Boe Ranch LAD storage pond is a permanent disturbance that would result in a loss of soil and plant productivity on 36 acres.

Construction of the new Boe Ranch LAD system pipeline would begin where the existing pipeline ends at the USFS boundary on USFS Road 205. New pipeline construction would follow Sweetgrass County Road 31 north to the turnoff to the Boe Ranch called Bench Road (Figure 2-31). There would be no additional disturbance to vegetation and soils in this section of pipeline since all this area has been previously disturbed by road construction.

Vegetation and soils would be disturbed over the assumed 50-foot construction right-of-way and on 16 acres, due to new pipeline and road construction on the Boe Ranch (Knight Piésold 2000c). Concurrent reclamation of the 16 acres would be conducted to the extent possible to limit the potential for erosion, sedimentation, and noxious weed establishment. Stockpiling of soil for the Boe Ranch LAD storage pond construction would affect another 3.2 acres. Vegetation cover and production would recover in reclaimed areas three to five years after seeding. Plant species diversity and soil productivity would not return to pre-disturbance levels.

Construction-related disturbance and increased traffic during mine life would increase noxious weeds at the Boe Ranch. Noxious weeds reduce the diversity of native plant communities. Noxious weeds are present within or adjacent to the Boe Ranch (Section 3.3.1.2). SMC has an approved weed control plan that includes all of the Boe Ranch. The weed control plan would be implemented at the Boe Ranch. Weed control solutions would kill some native forbs and shrub species adjacent to the plants being sprayed. Weed control increases the establishment of other introduced non-noxious weeds such as cheatgrass. Loss of native species from weed control is an unavoidable impact of aggressive weed control programs. Regardless of weed control efforts, noxious weeds would increase in the area. This is an unavoidable result of construction disturbance, irrigation practices, the competitiveness of noxious weeds, and loss of native species.

4.3.3.9 Operational Effects to Vegetation at the East Boulder Mine

The operational effects to vegetation at the East Boulder Mine under the Agency-Mitigated Alternative 2C would be less than those described above under the Boe Ranch LAD System No Action Alternative 1C. The vegetation effects during

operations at the East Boulder Mine would be reduced because the majority of the treated adit and tailings waters would be land applied at the Boe Ranch LAD area.

4.3.3.10 Operational Mass Wasting Effects at Boe Ranch

The Boe Ranch LAD area has been strongly affected by glaciation: glaciers scoured and deposited substantial amounts of geologic material at the Boe Ranch as they retreated north from the Boulder River drainage. Surficial materials left behind include glacial till, colluvium, and weathered bedrock. Mass wasting has been observed on or near the proposed Boe Ranch LAD area (Knight-Piésold, 2002). Site investigations identified numerous types of mass movement features, including thin-skin slides, slumps along the riverbank, and earth-slump flows (Knight Piésold 2000c).

Areas of potentially unstable slopes have been identified by SMC as slopes with gradients greater than 15 percent, underlain by shale, and slopes with similar surface and underlying slope orientation (Knight Piésold 2000c). Seven areas with mass movement potential were identified in the vicinity of the Boe Ranch, and the LAD system has been designed to avoid these areas (Appendix D Figure 3-5 CES 2008). It is possible that the Boe Ranch LAD system operations, if not properly managed, could mobilize small, ancient slumps. These ancient slumps are underlain by shale and could mobilize if soils under the center pivots are allowed to become saturated for long periods of time (Appendix C Figure 2-32 DEQ 2010 and Appendix D Figure 3-5 CES 2008).

SMC has not indicated that LAD would be limited in any of the proposed center pivot areas. Mass wasting in these areas could occur if LAD rates exceed soil water-holding capacity and deep percolate infiltrates into the underlying shale bedrock. The potential for movement would be greater in high precipitation years. It is expected that if mobilized, the minor slumps that could occur would have minimal direct adverse effects. SMC has not proposed any measures to monitor for mass movement during operations and closure or to repair areas that could fail.

The Boe Ranch LAD area receives 15 inches of precipitation per year. The LAD system would be operated to maximize evaporation, to minimize the formation of deep percolate, and to limit mass wasting potential in areas of concern. The Boe Ranch LAD system agronomic application rate could contribute approximately 23 inches of additional water per acre to the 194-acre LAD area over one 120-day LAD season. This additional water could destabilize areas susceptible to mass wasting. Center pivots P4, P9, and P10 are located in areas potentially susceptible to mass wasting (Appendix D, Figure 3.5 from CES 2008).

Slope failure at the locations of center pivots P4, P9, and P10 would result in the permanent loss of all or a portion of those three pivots. This loss would reduce the acreage available for LAD at the Boe Ranch and would have to be recovered elsewhere. Disposal capacity could be recovered by increasing the volume of

water disposed of at the East Boulder Mine or by constructing additional LAD pivots on other portions of the Boe Ranch not considered in these analyses.

Mass wasting would generate sediment along the failed slopes and cause downslope erosion. Soil and vegetation productivity would be reduced where sediment is deposited. In the event that sediment from slope failure would reach the Boe Ranch LAD storage pond, the pond capacity and function could be compromised.

4.3.3.11 Closure Analyses

During closure, in addition to adit water, 40 MG of treated East Boulder Mine tailings impoundment waters would require disposal. Under Proposed Action Alternative 2C, if the Boe Ranch is constructed, mixed treated adit and tailings waters would be preferentially routed for up to 12 months to the Boe Ranch LAD area for disposal (Figure 2-29). In the event that the Boe Ranch LAD area could not be used, SMC would route water to the East Boulder Mine LAD Area 6 and/or the percolation pond and, if needed, would construct and operate contingency LAD areas 2 and 3-Upper. SMC has many options for water management and disposal during closure.

In their analyses, the agencies chose reasonable, non-prescriptive options to determine the effects of mine waste water disposal. SMC may use other routing options to manage the disposal of mine waste water.

4.3.3.12 Closure Nitrogen Effects to Soils at the Boe Ranch

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the treatment, routing, and disposal of adit water to the Boe Ranch would be the same during closure as operations. At closure, the nitrogen load in adit water would decline rapidly as discussed under the East Boulder Mine WMP No Action Alternative 1B (Appendix C, Stillwater Mine Projected Nitrogen Concentration Decline Curve, DEQ 2010).

An additional 40 MG of tailings waters from the East Boulder tailings impoundment would be mixed and treated with adit water during closure. These waters would be preferentially land applied in an agency-assumed 120-day LAD season at the 194-acre Boe Ranch LAD area. The nitrogen load applied at closure would be greater than the operational load because of the addition of treated tailings waters. In these analyses, the agencies evaluated both the 150 and 737 gpm adit flow rates with the addition of tailings waters.

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the full capacity of the 194-acre Boe Ranch LAD area would be used at closure. Only 743 gpm can be land applied at the Boe Ranch at agronomic rates during the 120-day LAD season. At the higher adit flow rate, the remaining mixed treated water would be partitioned to the East Boulder Mine LAD Area 6 and the percolation pond for disposal (Appendix C, Boe Ranch LAD System Alternative 2C Nitrogen and Salts Spreadsheets, DEQ 2010). After the 120-day LAD season, the Boe Ranch and the East Boulder Mine LAD Area 6 would be reclaimed.

Treated adit water would be disposed of in the East Boulder Mine percolation pond for the rest of the 12-month closure period.

During the 12-month closure period, the disposal of mixed treated adit and tailings waters would result in a nitrogen load projected to range from 38.3 to 94.6 lbs/day on the 194-acre LAD area. The total nitrogen load applied to the soils is projected to range from about 24 to 59 lbs/acre/year, which would be about 0.2 to 0.5 lbs/acre/day. These nitrogen loads are light to moderate agricultural fertilization rates for the Boe Ranch LAD area soils. Due to the addition of tailings waters, the closure nitrogen load would nearly double the operational nitrogen load applied at the Boe Ranch. Irrigation at the Boe Ranch LAD area would increase water and nitrogen available to plants.

The agencies believe that the majority of the excess water and nitrogen from tailings waters would be utilized by the plant communities. Plant production would be expected to increase as a result. This same increased plant production and nitrogen use effects have been observed at the Hertzler Ranch LAD area. The Boe Ranch LAD agronomic application rate would not exceed the soil water-holding capacity and would not flush residual nitrogen from soil. As during operations, the agencies assume the Boe Ranch irrigation practices at closure would result in additional nitrogen storage in the soil root zone. This additional stored nitrogen could be flushed through the soil profile to ground water with sufficient precipitation.

4.3.3.13 Closure Nitrogen Effects to Soils at the East Boulder Mine

In contrast to the East Boulder Mine WMP Proposed Action Alternative 2B, where disposal of treated adit and tailings waters would concentrate effects at the percolation pond and LAD Area 6, effects to the mine soils from nitrogen would be limited under the Boe Ranch LAD System Proposed Action Alternative 2C.

SMC would land apply mine waste waters at the Boe Ranch as long as the ground water nitrogen concentration meets the DEQ-7 TIN water quality standard of 10 mg/L. During closure, SMC's preferred disposal option after the Boe Ranch LAD area would be the East Boulder Mine percolation pond (Figure 2-29).

At lower adit flow rates, all mixed treated adit and tailings waters could be disposed of at the Boe Ranch LAD area during the LAD season. After the 120-day LAD season, the Boe Ranch LAD area would be closed and treated adit water would be managed at the East Boulder Mine percolation pond. At higher adit flow rates, LAD Area 6 and the East Boulder Mine percolation pond would also have to be used to dispose of the remaining treated adit and tailings waters during the 120-day LAD season. After the 120-day LAD season, LAD Area 6 would be closed, and treated adit water would be managed at the East Boulder Mine percolation pond.

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the treated mixed adit and tailings waters that would be applied at closure on the 10.2-acre

East Boulder Mine LAD Area 6 could be up to 178 lbs nitrogen/acre. This would be a heavy fertilization rate for the East Boulder Mine LAD Area 6 soils. Depending on adit flow rate, the nitrogen load from treated adit water disposed of at the East Boulder Mine percolation pond during the remainder of the 12-month closure period is projected to range from 4 to 28 lbs/day and would meet the MPDES permit nitrogen limit.

The total closure nitrogen load disposed of at the East Boulder Mine during the 12-month closure period would be more than double the operational load. If the Boe Ranch LAD system cannot be used or is unavailable during closure, the percolation pond and LAD Area 6 would be used to dispose of all treated adit and tailings waters. The potential exists under the Boe Ranch LAD System Proposed Action Alternative 2C to accumulate nitrogen in the East Boulder Mine soils and glacial subsoils during the 12-month closure period.

Some nitrogen would continue to exit the East Boulder tailings impoundment in liner leakage. Underdrain seepage from the tailings impoundment would be captured and routed back into the impoundment during closure. Even if some of the treated adit and tailings waters would need disposal at the East Boulder Mine during closure, the effects to the East Boulder Mine soils from nitrogen would be less than soil effects from all treated adit and tailings waters disposed of under the East Boulder Mine WMP Proposed Action Alternative 2B.

4.3.3.14 Closure Salts Effects to Soils at the Boe Ranch

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the treatment, routing, and disposal of adit water to the Boe Ranch would be the same during closure as operations. At closure, the salts load in adit water would decline rapidly, as discussed under the East Boulder Mine WMP No Action Alternative 1B (Appendix C, Stillwater Mine East-Side Adit Water Electrical Conductivity Figure, DEQ 2010).

At closure, an additional 40 MG of tailings waters from the East Boulder tailings impoundment would be mixed and treated with the adit water. The closure salts load would be greater than during operations because of the increased salts content of tailings waters (Adit and Tailings Waters Quality, Appendix C, DEQ 2010). These waters would be preferentially land applied in an agency-assumed 120-day LAD season at the 194-acre Boe Ranch LAD area. The salts load applied at closure would be greater than the operational load because of the addition of treated tailings waters.

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the full capacity of the 194-acre Boe Ranch LAD area would be used at closure. Only 743 gpm can be land applied at the Boe Ranch at agronomic rates during the 120-day LAD season. At the higher adit flow rate, the remaining mixed treated water would be partitioned to the East Boulder Mine LAD Area 6 and the percolation pond for disposal (Appendix C, Boe Ranch LAD System Alternative 2C Nitrogen and Salts Spreadsheets, DEQ 2010). After the 120-day LAD season, the Boe Ranch and the East Boulder Mine LAD Area 6 would be reclaimed.

Treated adit water would be disposed of in the East Boulder Mine percolation pond for the rest of the 12-month closure period.

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the total salts load land applied in treated adit and tailings waters at the mine is projected to range from 3,530 to 4,256 lbs/acre/year. This load is 0.08 to 0.1 lbs salts/ft^2/year (Boe Ranch LAD System Proposed Action 2C Operations and closure Nitrogen and Salts Spreadsheets, DEQ 2010). For comparison purposes, 0.1 lb/ft^2 salt is equivalent to about two and a half tablespoons of salt sprinkled on one square foot of soil. The salts load applied during the closure period is about one teaspoon more salt per square foot than was applied at Boe Ranch during operations.

The total closure salts load applied at the Boe Ranch during the final LAD season depends on the adit flow rate and is projected to range from 684,749 to 825,600 lbs. The closure salts load would be greater than the operational load of 588,480 lbs salt. The additional increment of salt applied during closure would increase the volume of water and the amount of time needed to flush salts from Boe Ranch soils. There would be no long-term effects to soil, and the additional effects to soil would be minimal.

The mixture of adit and tailings waters that would be land applied at closure is projected to have a SAR ranging from 4.2 to 4.5, which would classify these waters as having a slight SAR hazard (Appendix C East Boulder Mine and Boe Ranch LAD SAR Calculations Spreadsheet DEQ 2010, U.S. Salinity Lab Staff, 1954). A slight hazard could cause minor, adverse short-term effect to the Boe Ranch LAD soils if salts are not flushed from the root zone. Water land applied at an agronomic rate would not be adequate to flush residual salts from soil, potentially resulting in 100 percent of the salt load being stored in the soil root zone. Precipitation and snowmelt at the Boe Ranch LAD area would provide flushing of salts from the soils after closure.

4.3.3.15 Closure Salts Effects to Soils at the East Boulder Mine

In contrast to the East Boulder Mine WMP Proposed Action Alternative 2B, where disposal of all treated adit and tailings waters would concentrate the effects on soils at the percolation pond and LAD Area 6, effects to the mine soils from salts would be limited under the Boe Ranch LAD System Proposed Action Alternative 2C.

SMC would land apply mine waste waters at the Boe Ranch as long as the ground water salts concentration meets the EC Class II beneficial use ground water quality standard of 1,000 to 2,500 µmhos/cm. During closure, SMC's preferred disposal option after the Boe Ranch LAD area would be the East Boulder Mine percolation pond (Figure 2-29).

At lower adit flow rates, all mixed treated adit and tailings waters could be disposed of at the Boe Ranch LAD area during the LAD season. After the 120-day LAD season, the Boe Ranch LAD area would be closed and reclaimed.

Treated adit water would be managed then at the East Boulder Mine percolation pond. At higher adit flow rates, the excess treated adit and tailings waters would be partitioned between the East Boulder Mine LAD Area 6 and the percolation pond during the LAD season. After the 120-day LAD season, both LAD areas would be closed and reclaimed. Treated adit water would be managed for the remainder of the 12-month closure period at the East Boulder Mine percolation pond.

The effects to soil from salt at the East Boulder Mine from disposal of the excess water that could not be managed at the Boe Ranch LAD would be less than effects disclosed under the East Boulder Mine WMP Proposed Action Alternative 2B.

If SMC land applies the excess waters during closure at the capacity of LAD Area 6, salts would accumulate in the root zone. SMC is required by the East Boulder Mine MPDES permit to use an agronomic application rate that would not exceed the soil water-holding capacity. Treated adit and tailings waters land applied at this rate would not be adequate to flush residual salts from soil. An agricultural application of these waters would potentially result in 100 percent of the salt load being stored in the soil root zone. It is intuitive that, during closure, treated adit and tailings waters with a SAR up to 4.3 could increase the SAR values of LAD Area 6 soils up to 4.3. A soil SAR value of 4.3 is classified as having a slight sodium hazard (U.S. Salinity Lab Staff, 1954).

If the adit flow rate is high enough that SMC has to manage some treated adit and tailings waters at the East Boulder Mine, the total salts load partitioned for land application during the 120-day LAD season is projected to be 26,473 lbs/acre/year. This closure salts load applied to the 10.2 acre LAD Area 6 would equal 0.6 lbs salts/ft^2/year. For comparison purposes, 0.6 lb/ft^2 salt is analogous to nearly one cup of salt sprinkled on one square foot of soil. The additional salt increment applied to LAD Area 6 would require additional time and water to flush as deep percolate but would have minimal additional soil salt effects. The total salts load applied to LAD Area 6 during the closure LAD season would be about 270,000 lbs. After the 120-day LAD season, all treated adit water would be routed to the mine percolation pond.

Under this option, the salts load from treated adit and tailings waters that would be partitioned to the East Boulder Mine percolation pond during closure would range from 242,550 to 1,689,393 lbs. Depending on adit flow rate, the closure salts load could exceed the operational salts load by up to 500,000 lbs. Salts may accumulate in the glacial subsoils below the percolation pond during the 12-month closure period. The additional salt applied to the percolation pond during the 12-month closure period would not affect soil because it would be discharged below the root zone. Effects to ground water have been previously disclosed in the *Water Quality and Quantity* Section 4.1.3.3.

During closure, regardless of adit flow rate, salts would continue to exit the East Boulder tailings impoundment in liner leakage to the East Boulder Mine soils. Underdrain seepage from the tailings impoundment would be captured and routed back into the impoundment during closure.

In summary, disposal of treated adit and tailings waters using LAD at the Boe Ranch during closure would result in less soil effects to the East Boulder Mine soils than under the East Boulder Mine WMP Proposed Action Alternative 2B.

4.3.3.16 Closure Effects to Vegetation at Boe Ranch

At mine closure, the Boe Ranch LAD system would not be completely dismantled by SMC, and the irrigation system could be relinquished to a future landowner. Portions of the Bench Road and the Boe Ranch access road would be reclaimed as part of mine closure. Plant cover and productivity of these roads would recover after reclamation.

The effects to plant community cover, productivity, structure, species diversity, and noxious weeds would be the same as described in the introduction to this section for the East Boulder Mine, the Stillwater Mine, and the Hertzler Ranch LAD area. If the Boe Ranch LAD system is built and operated under this alternative, more area would be disturbed and there would be more effects than under the No Action Alternative 1C.

Nitrogen and salts would leach in deep percolate formed by snowmelt or precipitation. Since nitrogen and salt additions applied during closure would eventually be leached to ground water, there would be minimal long-term effects to the Boe Ranch plant communities. Any effects to the plant community from land applied salts at closure would be short-term. Operationally, SMC may need to apply sufficient LAD to annually leach accumulated salts to minimize long-term vegetation effects at closure. Implementation of this alternative would cause an irreversible loss of native species and would encourage establishment of a community dominated by introduced species and mesic native species.

4.3.3.17 Closure Effects to Vegetation at the East Boulder Mine

If the adit flow rate is high enough to require routing of water to the East Boulder Mine LAD Area 6, effects to vegetation would continue for one additional 120-day LAD season. Disposal of treated adit and tailings waters at the Boe Ranch during closure would reduce the volume of mine waste waters disposed of at the East Boulder Mine. This would reduce the effects to vegetation when compared to the East Boulder Mine WMP Proposed Action Alternative 2B, which disposes of all waters at the mine. Adit and tailings waters disposed of in the East Boulder Mine percolation pond would not affect soil because discharge would occur below the root zone. Effects to ground water have been previously disclosed in *Water Quality and Quantity* Section 4.1.3.3.

Any plant community effects from the land application of nitrogen and salts during closure at LAD Area 6 would be short-term. At closure, it may be necessary to apply a sufficient volume of LAD to leach the salts that may have accumulated annually during operations. Leaching the accumulated salts from soil would increase soil health and minimize long-term vegetation effects at closure. Under this alternative, there would be minimal effects to the East Boulder Mine plant communities since less water containing nitrogen and salts would be applied at the mine LAD areas during closure.

As during operations, nitrogen and salts would continue to exit the impoundment in liner leakage and underdrain seepage during closure.

4.3.3.18 Closure Mass Wasting Effects at Boe Ranch

At closure, the mass wasting potential and resulting effects to the Boe Ranch soils would be increased over those disclosed under operations. If the Boe Ranch LAD is constructed, some portion of the 40 MG of East Boulder tailings waters would be land applied at the Boe Ranch during closure. Application of an additional 40 MG would increase the total volume of water and salts load applied on the 194-acre Boe Ranch LAD area. The addition of too much water would reduce the cohesion of soil and cause it to fail.

Disposal of 40 MG of East Boulder tailings waters with adit water would increase the SAR of the land applied waters. Accumulation of sodium salts in soil would negatively affect soil structure and cohesion, increasing its susceptibility to mass wasting. If the salts load in tailings waters adversely affects soil structure and increases soil SAR values, portions of the Boe Ranch LAD area would become increasingly susceptible to mass wasting. This is especially critical in areas where ancient mass movement has already taken place or where problematic geology is located at or near surface, such as under the proposed center pivots P4, P9, and P10.

If periodic leaching occurs from precipitation, salts may not accumulate under normal LAD system management during operations and closure. The application of a volume of water sufficient to prevent salts accumulation in the soils each year while limiting mass wasting potential would be difficult to manage. This is a concern beneath the proposed center pivot areas P4, P9, and P10 because inadequate soil monitoring has been proposed under Proposed Action Alternative 2C.

4.3.3.19 Post-Closure Nitrogen and Salt Effects to Soils at the Boe Ranch

After the 12-month closure period, no additional mine-related waste waters would require disposal at the Boe Ranch. A future landowner would control the area.

By post-closure, all adit and tailings waters would have been treated and disposed of. No additional mine waste waters would be routed to the Boe Ranch LAD system. Residual nitrogen and salts loads that would accumulate during operations and closure in the Boe Ranch soils would continue to leach from the root zone due to precipitation and snowmelt. During post-closure, the future landowner would likely use East Boulder River water in the LAD system. East Boulder River water supplied from the Mason Ditch is lower in salt and nitrogen content than adit and tailings waters and would leach any residual nitrates and salts from the soils over time.

4.3.3.20 Post-Closure Nitrogen and Salt Effects to Soils at the East Boulder Mine

By post-closure, all adit and tailings waters would have been treated and disposed of. No additional mine waste waters would be routed to the East Boulder Mine LAD Area 6. Snowmelt and precipitation events would leach residual nitrogen and salts concentrations from soils during post-closure. SMC proposes that after one year adit water treatment would no longer be needed, and adit water would be routed directly to the East Boulder River. The agencies conclude that it could take up to two years for nitrogen concentrations in untreated adit water to reduce sufficiently to meet the 30 lb/day MPDES permit nitrogen load limit (Appendix C, Projected Nitrogen Concentration Decline Curve, DEQ 2010).

At post-closure, East Boulder mine tailings impoundment liner leakage would discharge directly to ground water beneath the tailings impoundment. Seepage through the reclamation cover and storm water runoff would exit through the seepage outlet structure and be routed to the East Boulder Mine site percolation pond. These sources would contribute a minor, localized amount of nitrogen and salts to soils but would not affect the health and quality of surface soils.

4.3.3.21 Post-Closure Vegetation Effects at the Boe Ranch

During post-closure, SMC would no longer land apply water at the Boe Ranch. Termination of LAD would reduce plant production as the nitrogen and water supply diminishes and eventually ceases. Accumulated residual concentrations of nitrogen in soils would be used by plants or would flush with residual salts in soils during snowmelt and precipitation events. As the root zone nitrogen and salts concentrations diminish, soils would begin to return to equilibrium with local area soils and the vegetation community existing on the Boe Ranch LAD area. Any changes that would occur during mine life to plant community and species diversity would largely remain at post-closure. Aggressive introduced species and mesic native species that would be favored during mine life at the Boe Ranch would maintain their hold on the site, although their productivity would decline without irrigation. This is an unavoidable effect of construction and operation of the LAD system. If the future landowner continues irrigation at the Boe Ranch, productivity would remain elevated.

SMC would be required to control noxious weeds on all LAD sites until reclamation bonds are released. Noxious weeds would never be completely eliminated at all sites. This is an unavoidable effect of construction and operation of the Boe Ranch LAD system.

4.3.3.22 Post-Closure Vegetation Effects at the East Boulder Mine

At post-closure, SMC would no longer dispose of adit water at the East Boulder Mine LAD areas or in the percolation pond. Termination of LAD would reduce plant production as nitrogen and water supply diminishes. Accumulated residual

concentrations of nitrogen in soils would be used by plants or would leach with residual salts during snowmelt and precipitation events. As the root zone nitrogen and salts concentrations diminish, soils would begin to return to equilibrium with local area soils and the vegetation community existing on the East Boulder Mine LAD areas. Any changes that would occur during mine life to plant community and species diversity would largely remain. Aggressive introduced species and mesic native species favored during mine life at the East Boulder Mine would maintain their hold on the site, although their productivity would decline without irrigation. This is an unavoidable effect of construction and operation of the LAD system.

SMC would be required to control noxious weeds on all LAD sites until reclamation bonds are released. Noxious weeds would never be completely eliminated at all sites. This is an unavoidable effect of construction and operation of the East Boulder Mine LAD system.

4.3.3.23 Post-Closure Mass Wasting Effects at Boe Ranch

SMC would dispose of all mine waste waters that would be routed to the Boe Ranch before the post-closure period. The soils at the Boe Ranch LAD areas would dry out during post-closure. Drier soils are less susceptible to mass wasting. Residual sodium adsorption effects could remain in the finer-grained soils unless sodium salts are leached from the root zone. Sodium salts can negatively affect soil structure and increase the potential for mass wasting. Improper irrigation practices by the future landowner could contribute to mass wasting during post-closure.

4.3.3.24 Cumulative Effects

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C would contribute effects when combined with the likely effects of other developments in the East Boulder River drainage. Cumulative effects to vegetation from non-mine-related activities in the East Boulder River valley would occur due to subdivisions, agricultural practices, and other land use changes, resulting in fragmentation and a reduction of native plant communities. The diversity of native species within these communities is being reduced by invasion of noxious weeds and other aggressive non-native species. Surface disturbance and traffic corridors have facilitated the expansion of noxious weeds, aggressive species, and the loss of soils. The Boe Ranch LAD System Proposed Action Alternative 2C would add to these effects.

4.3.3.25 Unavoidable Adverse Effects

If the Boe Ranch LAD System Proposed Action Alternative 2C is selected, constructed, and operated, then adverse environmental effects could not be avoided. The adverse effects in the LAD area would include changes to plant communities, increased erosion and sedimentation in disturbance areas, and loss of soil and native vegetation productivity on acres not reclaimed at closure.

4.3.3.26 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Under the Boe Ranch LAD System Proposed Action Alternative 2C, short-term mine-related use of the Boe Ranch lands would result in vegetation and soil productivity increases. The long-term soil and vegetation productivity of the land would change. Thirty-six acres of vegetation and soil productivity would be lost due to construction of the Boe Ranch LAD system. Vegetation productivity would increase during operations and closure. At post-closure, when irrigation would cease, vegetation productivity would begin to return to pre-LAD levels, although changes to the plant community and species diversity would persist. Boe Ranch resources would be available for future use but would be altered from present conditions.

4.3.3.27 Irreversible or Irretrievable Commitments of Resources

There would be irreversible or irretrievable commitments of existing natural resources related to irrigation practices if this Boe Ranch LAD System Proposed Action Alternative 2C is selected. Alterations to plant communities would persist on site. Soil and vegetation productivity would be lost on the 36 acres beneath the Boe Ranch LAD system.

4.3.4 Boe Ranch LAD System Agency-Mitigated Alternative 3C

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the Boe Ranch LAD system would be a water management alternative during operations and closure if the East Boulder Mine requires additional storage or disposal capacity for adit and tailings waters. The Boe Ranch LAD system would only be constructed and operated if needed. SMC would maintain the option to dispose of mine waste waters at the East Boulder Mine as permitted.

If constructed, use of the Boe Ranch LAD system in the Agency-Mitigated Alternative 3C would be similar to the Proposed Action Alternative 2C with the following changes:

- The closure period would be extended from 12 to 18 months;
- Additional soil and soil-water monitoring would be instituted at the East Boulder Mine and, if constructed, the Boe Ranch to monitor potential nitrogen and salts accumulation in soils;
- Additional vegetation monitoring would be instituted at the East Boulder Mine and the Boe Ranch to monitor potential plant community changes;
- SMC would have the option to land apply water at greater than agronomic rates to ensure flushing of residual accumulated nitrogen and salts from soils during operations and closure;
- Ground water and soil monitoring locations (shallow wells, lysimeters, etc.) would be established in the Boe Ranch LAD area for early detection of soil and ground water changes that could induce mass wasting;
- The area beneath proposed center pivots P4 and P9 would be sampled and additional monitoring would be implemented to best manage LAD to prevent mass wasting;
- The proposed center pivot P10 would be eliminated due to mass wasting concerns; and
- The total area of the Boe Ranch LAD area would be 188 acres.

Appendix B contains the mitigations the agencies consider necessary to reduce potential effects to soils and vegetation at the Boe Ranch LAD from disposal of treated mine waste waters during operations and closure. If this alternative is approved and before SMC could construct the Boe Ranch LAD System, SMC would submit a monitoring plan for agency review and approval. The monitoring plan would include the agencies' mitigations and describe how SMC would limit effects to the Boe Ranch natural resources.

SMC must dispose of all treated adit water that is not recycled underground during operations. Water management options during operations under the Boe Ranch Agency-Mitigated Alternative 3C would be similar to the Boe Ranch LAD System Proposed Action Alternative 2C described above. After SMC

maximizes the use of the Boe Ranch LAD system, SMC would preferentially use the East Boulder Mine LAD system when possible before using the mine percolation pond (Figure 2-33).

In Agency-Mitigated Alternative 3C, SMC would have the option to apply water at greater than agronomic rates. This modification would ensure annual flushing of salts from the root zone of LAD area soils. SMC would be required to balance the use of LAD and percolation to limit salts effects to soils, vegetation, and water quality.

The agencies have proposed trigger levels in the Agency-Mitigated Alternative 3C to identify and prevent potential operational soil nitrogen and salts problems from developing at the Boe Ranch (Appendix B). SMC would have to implement additional monitoring and mitigating measures if ground water nitrogen and EC concentrations in the Boe Ranch LAD area increased above the trigger levels. SMC would also implement additional monitoring and mitigation measures if soil SAR values increased above trigger levels based on the Boe Ranch LAD storage pond water SAR concentrations. Other elements that would be included in the monitoring program are listed in Appendix B.

4.3.4.1 Assumptions and Parameters of Agency Analyses

To evaluate the effects that could potentially occur under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the agencies have made several assumptions in these analyses:

- The nitrogen load produced by treated adit water at the East Boulder Mine would be 20 lbs/day during operations;
- The water and resulting nitrogen load that had been disposed of at the East Boulder Mine would be stored preferentially in the Boe Ranch LAD storage pond over the winter and land applied on an agency-assumed 166-acre Boe Ranch LAD area. The 166-acre acreage was used for analysis only as the actual acreage in the alternative is 188 acres);
- The agencies assumed a 120-day LAD season during operations and at closure to account for potential problems with wet growing seasons and potential down-time for equipment;
- The 2008 average adit flow rate of 150 gpm and the maximum MPDES permitted adit flow rate of 737 gpm were analyzed to provide a range of flows;
- The agencies assumed an application rate at the Boe Ranch of 10.4 gpm/acre/12-hour LAD day, or 863 gpm using 9 center pivots based on operational rates applied at the Hertzler Ranch LAD area;

- The LAD system would be operated to evaporate 30 percent of the water from the center pivots, so that only 7.3 gpm/acre/12-hour day would actually be delivered to soil;

- SMC would manage the Boe Ranch LAD system to comply with the DEQ-7 ground water nitrogen standard of 10 mg/L TIN and the Class II ground water EC beneficial use criterion of 2,500 µmhos/cm;

- SMC would manage the East Boulder Mine LAD areas to comply with the DEQ-7 ground water nitrogen standard of 10 mg/L TIN and the Class I ground water EC beneficial use criterion of 1,000 µmhos/cm;

- The disposal of treated adit water at the Boe Ranch would result in a 64 to 100 percent reduction (depending on the adit flow rate) in the nitrogen and salts load disposed at the East Boulder Mine.

As proposed by the agencies, the 166-acre Boe Ranch LAD area would have the capacity to manage the maximum permitted adit water hydraulic load during the LAD season (Appendix C, Boe Ranch LAD System Agency-Mitigated Alternative 3C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). At the maximum adit flow rate, the Boe Ranch LAD storage pond would fill with adit water 115 days after the LAD season ceases. At the maximum adit flow rate, there would be no storage for adit water generated during the following 130 days. The excess treated adit water would have to be disposed of at the East Boulder Mine percolation pond. At a 150 gpm adit flow rate, all adit water can be managed using the Boe Ranch LAD system.

4.3.4.2 Operational Nitrogen Loading to Soils at the Boe Ranch

For the operational scenarios analyzed by the agencies, the projected total nitrogen load applied to the soil at the 166-acre Boe Ranch LAD would vary from about 17.2 to 43.4 lbs/acre/yr, which is a light agricultural fertilization rate. Over a 120-day LAD season, the projected nitrogen load would range from 2,856 to 7,212 lbs per year (Boe Ranch LAD System Agency-Mitigated Alternative 3C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010).

This operational nitrogen load would be the same as the Boe Ranch LAD System Proposed Action Alternative 2C operational nitrogen load. The effects would be similar to those disclosed above under Alternative 2C. However, the nitrogen load per unit area would be slightly more than that applied under Alternative 2C because the LAD area is reduced under the Agency-Mitigated Alternative 3C. The nitrogen load per unit area would be less than that applied at the East Boulder Mine under the East Boulder Mine WMP Alternatives 1B, 2B, and 3B and the Boe Ranch No Action Alternative 1C.

Nitrogen LAD rates at the Boe Ranch would be less than agricultural fertilizer application rates. The projected Boe Ranch LAD nitrogen application rate of up to 43.4 lbs/acre/year could slightly exceed the existing Boe Ranch plant community nitrogen use requirement.

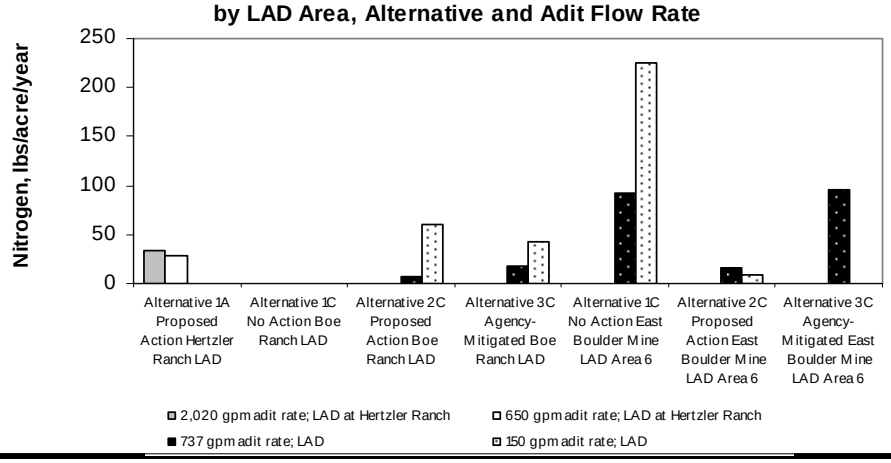
Irrigation would increase plant production and use of nitrogen by plants, as described above. The agency-proposed Boe Ranch LAD application rate for this alternative could exceed the soil water-holding capacity and leach residual nitrogen from soil. If SMC applies at greater than agronomic rates, the plant communities would likely use the majority of the nitrogen load applied during the 120-day LAD season, and the amount of nitrogen stored in soil would be limited over the life of the Boe Ranch LAD system.

4.3.4.3 Operational Nitrogen Loading to Soils at the East Boulder Mine

Under the Agency-Mitigated Alternative 3C, the preferred disposal option after the Boe Ranch LAD area would be the East Boulder Mine LAD areas before the percolation pond (Figure 2-33). For analysis purposes, water that exceeds the LAD capacity of Area 6 would be routed to the mine percolation pond. If the Boe Ranch LAD system cannot be used, waste waters would be routed first to the East Boulder Mine LAD Area 6 and then to the percolation pond.

The agencies analyzed several adit flow rate options for Agency-Mitigated Alternative 3C (Figure 4-22). At the highest adit flow rate, the total nitrogen load applied to the soil using both summer and winter LAD seasons at LAD Area 6 is projected to vary from 67 to 95 lbs/acre/yr, which is a moderate agricultural fertilization rate. The total operational nitrogen load applied to the East Boulder Mine soils from summer LAD, winter snowmaking, and percolation is projected to be 4,563 lbs, slightly less than the 4,959 lbs applied under the Proposed Action Alternative 2C (Boe Ranch LAD System Agency-Mitigated Alternative 3C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). The excess treated adit water disposed of in the East Boulder Mine percolation pond would produce a nitrogen load projected to vary from 4.4 to 12.5 lbs per day.

Figure 4-22. A Comparison of Projected Nitrogen Loading to Soil from LAD during Operations by LAD Area, Alternative and Adit Flow Rate



The agencies assumed that at a 150 gpm adit flow rate, no water would be applied at the East Boulder Mine (Figure 4-22). All adit water would be managed at the Boe Ranch unless precluded by operational problems (Appendix

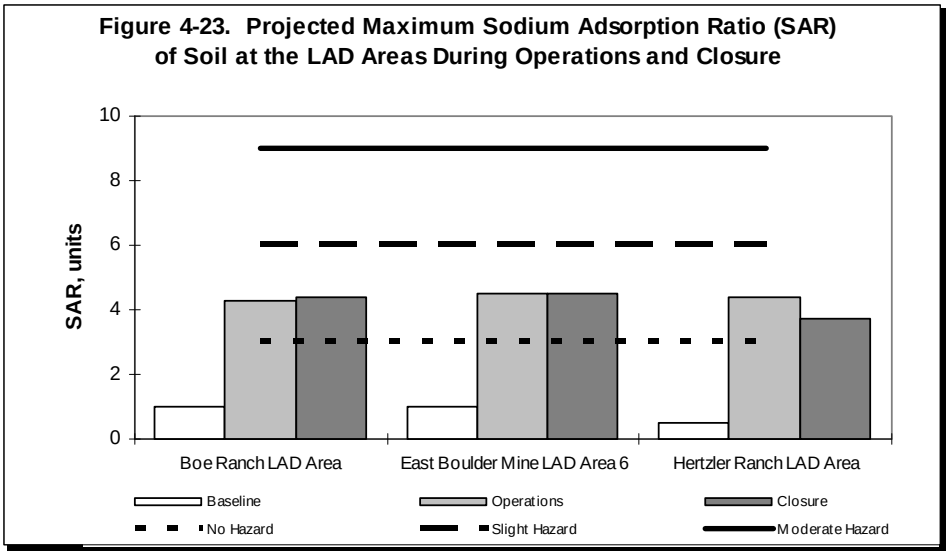
C, Boe Ranch LAD System Alternative 3C Operations and Closure Salts Spreadsheet, DEQ 2010). The nitrogen load would be the same load applied at the mine under the Proposed Action Alternative 2C and less than that applied at the East Boulder Mine under the East Boulder Mine WMP Alternatives (1B, 2B, 3B) and the Boe Ranch No Action Alternative 1C. No nitrogen effects would occur to the soil at the percolation pond.

4.3.4.4 Operational Salts Loading to Soils at the Boe Ranch

For the operational scenarios analyzed by the agencies, the total salts load applied to the soil at the Boe Ranch LAD is projected to vary from 2,152 to 4,117 lbs/acre/yr (Boe Ranch LAD System Proposed Action 2C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). To put this in perspective, this amount of salt is analogous to sprinkling from one and one-quarter to two and one-half tablespoons of table salt over one square foot of soil over the 120-day LAD season. The total salts load would be the same as the load applied under the Proposed Action Alternative 2C. The salts load would be less than that applied at the East Boulder Mine under the East Boulder Mine WMP Alternatives (1B, 2B, and 3B) and the Boe Ranch No Action Alternative 1C (Appendix C, Boe Ranch LAD System Alternative 3C Operations and Closure TIN Spreadsheet, DEQ 2010).

Baseline SAR values in soils at the Boe Ranch LAD are less than 1 and indicate that no sodium salinity hazard exists (Figure 4-23). The median treated adit water SAR is 4.3 at the East Boulder Mine, indicating a slight sodium salinity hazard for soil (CES 2008). While treated adit water is land applied, it is intuitive that soil SAR values at the Boe Ranch would increase to the level of that water during operations.

Figure 4-23. Projected Maximum Sodium Adsorption Ratio (SAR) of Soil at the LAD Areas During Operations and Closure



Applying this salts load at the Boe Ranch over an assumed 30-year operational life for the East Boulder Mine could result in an accumulation of salts in the soil if soil flushing does not occur. Under the Boe Ranch LAD System Agency-

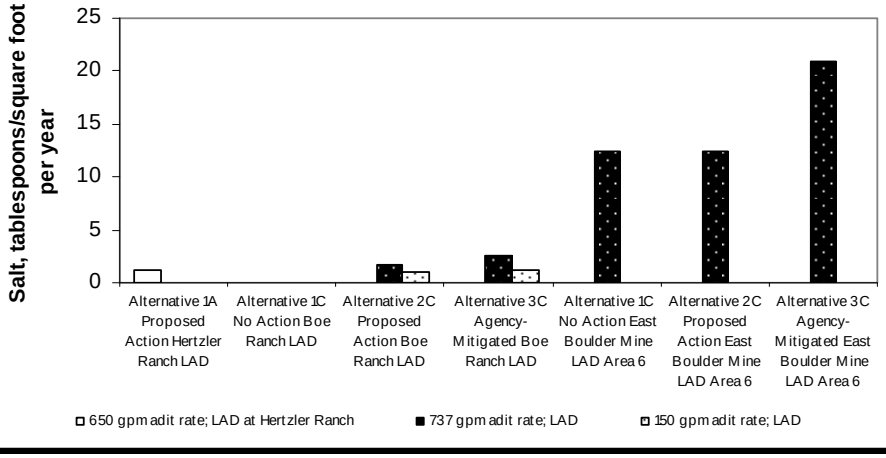
Mitigated Alternative 3C, SMC could land apply at an application rate that would exceed the soil water-holding capacity. Water land applied at this rate would flush residual salts from soil, preventing the storage of salt in the soil root zone. Salts should not accumulate in the soil at levels harmful to vegetation during operations (Appendix D Table 17 CES 2008). Under Agency-Mitigated Alternative 3C, soil salts monitoring would be part of the Boe Ranch LAD System operations (Appendix B). Monitoring the soil salinity to assess the salts build-up during operations would permit adjustments to the land application rate to properly manage salinity at the Boe Ranch LAD area.

4.3.4.5 Operational Salts Loading to Soils at the East Boulder Mine

The agencies assume that at a 150 gpm adit flow rate, no water would be applied at the East Boulder Mine under the Boe Ranch LAD System Agency-Mitigated Alterative 3C. All adit water would be managed at the Boe Ranch unless precluded by operational problems (Appendix C, Boe Ranch LAD System Alternative 3C Operations and Closure Salts Spreadsheet, DEQ 2010). The salts load would be the same load applied at the mine under the Proposed Action Alternative 2C. No salts effects would occur to the soil at the percolation pond.

At the highest flow rate, the agencies assume that treated adit water would be discharged at the East Boulder Mine year round. SMC would preferentially land apply treated adit water during summer and winter at LAD Area 6. In the analysis, water that exceeds the capacity of LAD Area 6 would be routed to the mine percolation pond (Appendix C, Boe Ranch LAD System Alternative 3C Operations and Closure TIN Spreadsheet, DEQ 2010).

Figure 4-24. A Comparison of Projected Salts Loading to Soil from LAD during Operations by LAD Area, Alternative and Adit Flow Rate



Percolation and LAD do not treat or reduce the salts load. Application of the highest adit flow rate on LAD Area 6 would produce a salts load of 0.9 lbs/ft^2/yr. To put this in perspective, this amount of salt is analogous to sprinkling more than two cups of table salt over one square foot of soil over the 120-day LAD

season (Figure 4-24). This salts load is concentrated because of the comparatively small size of LAD Area 6 (10.2 acres). During each operational year, the total salts load applied to the East Boulder Mine soils would be 394,416 lbs, including summer LAD and winter snowmaking. This salts load is less than the load that would be land applied under the Proposed Action Alternative 2C (Boe Ranch LAD System Agency-Mitigated Alternative 3C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010). The total salts load disposed of in the mine percolation pond under this alternative is projected to be 696,861 lbs, which is less than the salts load under the East Boulder Mine WMP Alternatives (1B, 2B, and 3B) and the Boe Ranch No Action Alternative 1C (Appendix C, Boe Ranch LAD System Alternative 3C Operations and Closure TIN Spreadsheet, DEQ 2010).

4.3.4.6 Operational Vegetation Effects at the Boe Ranch

Vegetation effects at the Boe Ranch under the Agency-Mitigated Alternative 3C would be similar to those disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C. The Boe Ranch LAD nitrogen application rates during the growing season would be similar to those applied at the Hertzler Ranch. The vegetation should remain healthy if LAD is properly operated during the effective portion of the growing season. Under this alternative, SMC would have the option to apply at higher than agronomic rates to dispose of all stored mine water during the growing season. If the LAD rate exceeds plant uptake, it would result in the formation of deep percolate and would prevent accumulation of salts in soil. Precipitation and snowmelt would eventually leach accumulated salts, as discussed above under operational salts effects to soils. Minimal effects would be expected to the Boe Ranch plant communities if soil salinity is maintained at healthy levels.

4.3.4.7 Operational Effects to Vegetation at the East Boulder Mine

The operational effects to vegetation at the East Boulder Mine under the Agency-Mitigated Alternative 3C would be less than those described above under the Boe Ranch LAD System No Action Alternative 1C and similar to those described for the Boe Ranch LAD System Proposed Action Alternative 2C. The vegetation effects at the East Boulder Mine would be reduced because the majority of the treated adit and tailings waters would be land applied at the Boe Ranch LAD area.

4.3.4.8 Other Operational Effects of LAD on Soils and Vegetation

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the soil and unsuitable materials stockpiles below the Boe Ranch LAD storage pond would be relocated out of the draw with ephemeral drainage. This relocation of the stockpiles would mitigate potential effects in the event of a Boe Ranch LAD storage pond failure during operations (See *Stability of the Boe Ranch LAD Storage Pond* Section 4.5.2). Other operational effects of LAD on soils and

vegetation would be similar to those disclosed under the Boe Ranch LAD System Proposed Action Alternative 2C.

4.3.4.9 Operational Mass Wasting Effects at Boe Ranch

One difference between the Boe Ranch LAD System Proposed Action Alternative 2C and the Agency-Mitigated Alternative 3C is that there would be a reduction in LAD area due to mass wasting concerns. Under the Agency-Mitigated Alternative 3C, center pivot P10 would not be constructed, a monitoring plan would be required for use of center pivots P4 and P9, and an operation plan would be required prior to commencing the use of LAD at the Boe Ranch (Appendix B). These additional measures would minimize mass wasting risks.

The agencies propose that monitoring is needed to reduce potential effects to soil health, water quality, and stability in the Boe Ranch LAD area (CES 2008) (Appendix B). Monitoring would include the installation of additional lysimeters and soil moisture probes under each center pivot, shallow and bedrock monitoring wells, and monitoring of and for downgradient seeps and springs. The stability of susceptible soils would be monitored around the center pivots during operations and closure. SMC would submit the monitoring plan for approval prior to the construction and operation of the Boe Ranch LAD system. CES (2008) recommended undertaking additional detailed investigation to assess the soils' ability to absorb the design flow capacity near center pivot P9. This investigation would occur prior to final design, construction, and operation of the LAD system in this area. Land application rates would be adjusted based on monitoring data to limit soil saturation and to decrease the risk for mass wasting.

Ground water flows down the ephemeral drainage beneath the snowmaking area, the LAD storage pond, and most of the center pivots. An area of susceptible soil is located down the ephemeral drainage from the center pivots (Figure 2-32 and Appendix D Figure 3-5 CES 2008). These pivots and the snowmaking area above the pond should be operated to minimize the potential effect on stability.

The potential for mass wasting under Agency-Mitigated Alternative 3C would be less than that described for the Proposed Action Alternative 2C because of elimination of center pivot P10, reduced application under pivots P4 and P9, and increased monitoring proposed in other areas. The agencies recommend applying mine waste waters at greater rates to minimize nitrogen and salts accumulation in the soil. The increased application rate could increase the potential for mass wasting. If the Boe Ranch LAD system were constructed, SMC would be required to prepare a plan that would describe how the formation of deep percolate and slope stability would be monitored during operations.

4.3.4.10 Closure

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, SMC would treat and preferentially dispose of up to 40 MG of East Boulder tailings waters mixed with adit water at the 166-acre Boe Ranch LAD area during closure (Figure 2-33). The 18-month closure period prescribed under this alternative is

long enough to land apply for two 120-day growing seasons, if needed. The closure treatment, routing, and disposal of treated adit water would be the same as during operations. If the hydraulic capacity of the Boe Ranch LAD system is exceeded, SMC would route excess water to the East Boulder Mine LAD Area 6 or the mine percolation pond. The disposal capacity at the mine could be needed in a wet year to prevent runoff from the sloped Boe Ranch LAD area or if the Boe Ranch system has operational problems. SMC could choose to build the approved contingency LAD areas 2, 3-Upper, and 4 at the East Boulder Mine, if needed (Figure 2-33).

During the first summer LAD season of closure, the following waters would need to be disposed of: 40 MG of East Boulder tailings impoundment waters (mixed and treated with adit water) and 100 MG of treated operational adit water stored in the Boe Ranch LAD storage pond from the previous winter. In the agency-assumed analysis, much of this hydraulic load could be preferentially managed using seven center pivots on the 166-acre Boe Ranch LAD area during the 120-day LAD season (Appendix C, Boe Ranch LAD System Alternative 3C Nitrogen and Salts Spreadsheets, DEQ 2010). The remainder of the hydraulic load would be stored in the Boe Ranch LAD storage pond, and any excess water would be routed for disposal at the East Boulder Mine LAD Area 6 and the percolation pond. For the rest of the year until the next LAD season, excess water would be routed to the percolation pond.

During the second LAD season, treated adit water would be routed to the Boe Ranch and land applied with water stored over the winter from the Boe Ranch LAD storage pond. After the second LAD season, use of the Boe Ranch LAD system would cease for disposal of mine waste waters and all treated adit water would be disposed of at the East Boulder Mine percolation pond through the end of the closure period (Appendix C, Boe Ranch LAD System Alternative 3C Nitrogen and Salts Spreadsheets, DEQ 2010).

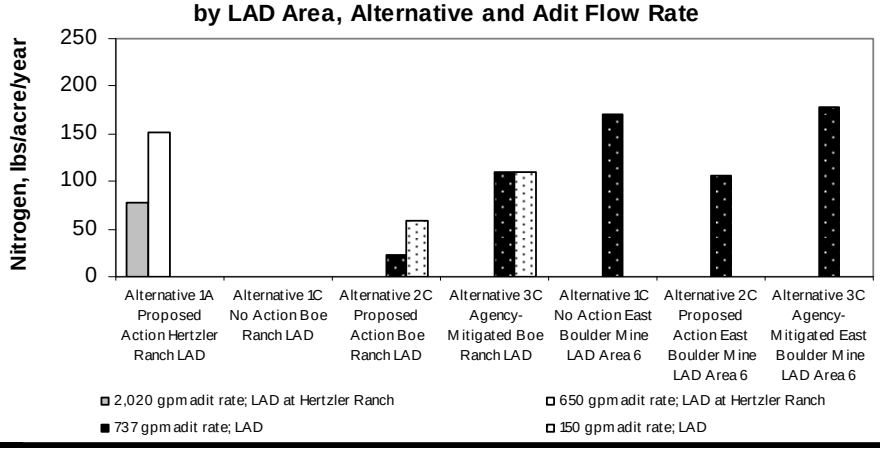
4.3.4.11 Closure Nitrogen Effects to Soils at Boe Ranch

The nitrogen load applied at the Boe Ranch LAD area during closure would be greater than operational loads because of the addition of tailings waters. At closure, the nitrogen concentration in adit water would decline as discussed under the East Boulder Mine WMP No Action Alternative 1B (Appendix C, Stillwater Mine Projected Nitrogen Concentration Decline Curve, DEQ 2010).

The increased load of nitrogen at closure would provide additional nitrogen to plants during the growing season. The increased volume of water applied at the Boe Ranch during closure also would increase the leaching of nitrogen and salts from the Boe Ranch soils to ground water. The soil leaching requirement of 6.9 inches per acre could be exceeded at some point during the year and could cause deep percolate to form (CES 2008). Flushing would prevent accumulation of nitrogen and salts in the root zone and would maintain the health of the soil. If flushing occurs, nitrogen and salts accumulation in the soils should not reach levels harmful to vegetation during the 18-month closure period at the Boe Ranch LAD area.

During the 18-month closure period, the disposal of mixed treated adit and tailings waters would result in a load projected to be up to 107 lbs/acre on the 166-acre LAD area (Figure 4-25). This nitrogen load is a moderate agricultural fertilization rate for the Boe Ranch LAD area soils. The total nitrogen load applied over the 18-month closure period would range from 6,458 to 17,770 lbs, which would be higher than the total nitrogen load (4,596 lb) applied under the Proposed Action Alternative 2C. The substantial increase in nitrogen load applied at the Boe Ranch LAD under the Agency-Mitigated Alternative 3C is due to an additional year of treated adit water disposal. Irrigation at the Boe Ranch LAD area would increase water and nitrogen available to plants. The increased water and nitrogen would increase plant production and nitrogen use requirements.

Figure 4-25. A Comparison of Projected Nitrogen Loading to Soil from LAD during Closure by LAD Area, Alternative and Adit Flow Rate



The average annual nitrogen application rate of up to 54 lbs/acre/year over an 18-month closure period would exceed the Boe Ranch anticipated nitrogen use requirement. No additional effects to soils from the closure nitrogen load disposed of at the Boe Ranch would be expected if stored nitrogen is flushed from the soil. As long as periodic soil leaching occurs, the agencies' analyses indicate no adverse effects to soil quality would be anticipated.

4.3.4.12 Closure Nitrogen Effects to Soils at East Boulder Mine

Under the Agency-Mitigated Alternative 3C, the Boe Ranch LAD area would be used as the primary disposal location for treated adit and tailings waters. Treated mine waste waters in excess of the capacity of the Boe Ranch LAD system would be disposed of at the East Boulder Mine. The Boe Ranch LAD system would be used until the end of the second growing season when it would be closed and the roads and disturbance areas reclaimed. The East Boulder Mine percolation pond would be used for disposal of treated adit water after closure of the Boe Ranch LAD system.

For the options analyzed by the agencies under this alternative, the total nitrogen load applied to the soil during closure at the East Boulder Mine LAD Area 6 would vary from 95 to 178 lbs/acre/yr, which would be a heavy agricultural fertilization rate. The total nitrogen load applied to the East Boulder Mine soils during the 18-month closure period would be 8,991 lbs, which would be less than the 10,142 lbs applied under the Proposed Action Alternative 2C (Boe Ranch LAD System Agency-Mitigated Alternative 3C Operations and Closure Nitrogen and Salts Spreadsheets, DEQ 2010).

The nitrogen load in the excess waste waters that would be disposed of in the East Boulder Mine percolation pond is projected to vary from 20 to 25 lbs/day. The total load of nitrogen percolated to ground water during 18 months of closure would be 4,245 lbs and would exceed the 1,014 lbs/year nitrogen load applied during closure under the Proposed Action Alternative 2C. However, the total nitrogen load disposed of at the mine LAD area and percolation pond under the Agency-Mitigated Alternative 3C would be less than that applied at the East Boulder Mine under the East Boulder Mine WMP Alternatives (1B, 2B, and 3B) and the Boe Ranch No Action Alternative 1C. No nitrogen effects would occur to the soil at the percolation pond.

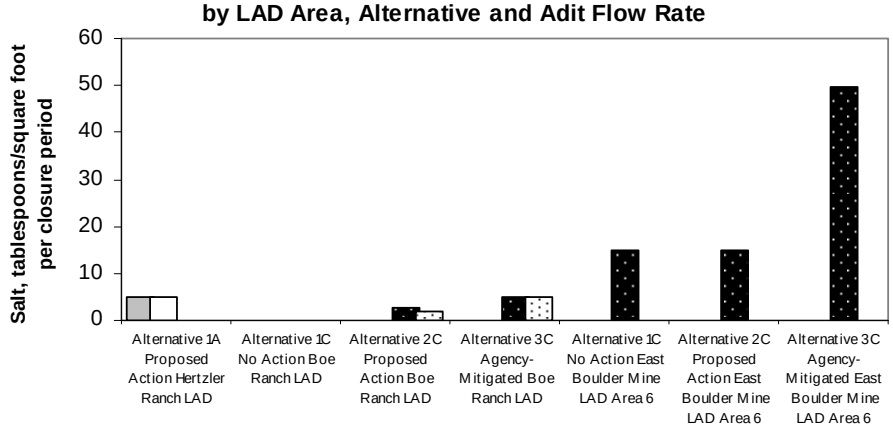
Some nitrogen would continue to exit the East Boulder tailings impoundment in liner leakage to East Boulder Mine soils. Underdrain seepage from the tailings impoundment would be captured and routed back into the impoundment during closure.

4.3.4.13 Closure Salts Effects to Soils at Boe Ranch

The salts load applied at the Boe Ranch LAD area during closure would be greater than operational loads because of the addition of tailings waters. At closure, the salts concentration in adit water would decline as discussed under the East Boulder Mine WMP No Action Alternative 1B (Appendix C, Stillwater Mine East-Side Adit Water Electrical Conductivity Figure, DEQ 2010).

Percolation and LAD do not treat or reduce the salts load. The total salts load/acre that would be applied to the Boe Ranch soils during the 18-month closure season is projected to be 5,759 lbs/acre or about 0.2 lbs/ ft^2. This would equate to about five tablespoons of salt sprinkled over a square foot of soil. The total salts load/acre applied to the Boe Ranch soils during the 18-month closure season could be up to 1,497,480 lbs. Because of the additional LAD season, this salts load would be more than the highest projected salts load (832,440 lb) that would be disposed of during the 12-month closure period under the Proposed Action Alternative 2C (Figure 4-26).

Figure 4-26. A Comparison of Projected Salts Loading to Soil from LAD during Closure by LAD Area, Alternative and Adit Flow Rate



Regardless of the adit flow rate, use of the Boe Ranch LAD system for the 18-month closure period would add to the operational salts load. At closure, no effects greater than operational effects would be expected if the salts are flushed from Boe Ranch soils. If the soils are flushed periodically, the analyses indicate no adverse effects would occur to soil quality or health from the disposal of mine waste waters. In the event that soil salinity levels increase, minor adverse effects to soil would be possible.

4.3.4.14 Closure Salts Effects at the East Boulder Mine

Under the Agency-Mitigated Alterative 3C, the capacity of the Boe Ranch LAD system would be exceeded at the highest adit flow rate. Excess treated mine waste waters would be discharged at the East Boulder Mine LAD Area 6 and the percolation pond. SMC would preferentially land apply excess treated adit water at the East Boulder Mine LAD Area 6. Water that exceeds the capacity of LAD Area 6 would be routed to the mine percolation pond (Appendix C, Boe Ranch LAD System Alternative 3C Operations and Closure TIN Spreadsheet, DEQ 2010).

During an 18-month closure period, the salt load disposed of in the East Boulder Mine percolation pond is projected to vary from 61,380 to 1,783,337 lbs, depending on adit flow rate. At the 150 gpm adit flow rate, the closure salts load is less than the projected salts load (242,550 lb) under the Proposed Action Alternative 2C. At the 737 gpm adit flow rate, the Agency-Mitigated Alternative 3C projected salts load is greater than the Proposed Action Alternative 2C salts load (Figure 4-26). There would be no effect to soil or vegetation from percolated waste waters because the discharge would be below the root zone. The effect to ground water was discussed previously under *Water Quality and Quantity* Section 4.1.3.3.1.

The total salts load applied at the East Boulder Mine LAD Area 6 during the 18-month closure season is projected to be up to 572,060 lbs. This salts load would be 1.3 lbs/ft^2/yr on the 10.2-acre LAD Area 6. For comparison purposes, 1.3 lbs/ft^2 is analogous to about three and one-half cups of salt sprinkled on one square foot of soil.

Some salts would continue to exit the East Boulder tailings impoundment in liner leakage to East Boulder Mine soils. Underdrain seepage from the tailings impoundment would be captured and routed back into the impoundment during closure. Even if some of the treated adit and tailings waters would need disposal at the East Boulder Mine during closure, salts effects to the East Boulder Mine soils would be less than soil effects from all treated adit and tailings waters disposed under the East Boulder Mine WMP alternatives.

4.3.4.15 Closure Effects to Vegetation at the Boe Ranch

At mine closure, the Boe Ranch LAD system would not be completely dismantled by SMC, and the irrigation system could be relinquished to the future landowner. Portions of the Bench Road and the Boe Ranch access road would be reclaimed as part of mine closure. Plant cover and productivity of these roads would recover after reclamation.

The effects to plant community cover productivity, structure, species diversity, and noxious weeds would be the same as described in the introduction to this section for the East Boulder Mine, the Stillwater Mine, the Hertzler Ranch LAD area and those described for the Boe Ranch LAD Proposed Action Alternative 2C. If the Boe Ranch LAD system is built and operated under this alternative, more area would be disturbed and more effects would occur than under the No Action Alternative 1C.

Any vegetation effects at closure from land applied salts load would be short-term. The flushing of salts annually by land applying at greater than agronomic rates during operations would reduce the risk of any long-term vegetation effects at closure. Monitoring of vegetation effects during operations would help identify any measures that may need to be implemented at closure to minimize vegetation effects.

As with the Boe Ranch LAD System Proposed Action Alternative 2C, changes to plant communities would occur. These effects would occur over the life of the mine, after the mine closes, and when LAD operations cease. Implementation of this alternative would cause an irreversible loss of native species and would encourage establishment of a community dominated by introduced species, as well as more mesic native species.

4.3.4.16 Closure Effects to Vegetation at the East Boulder Mine

Effects to vegetation from LAD of adit and tailings waters at closure at the East Boulder Mine could continue for an additional 18 months past operations.

Disposal of treated adit and tailings waters at the Boe Ranch during closure would reduce the volume of mine waste waters needing disposal at the East Boulder Mine. Disposal of waters at the Boe Ranch under the Agency-Mitigated Alternative 3C would reduce the effects to vegetation when compared to the East Boulder Mine WMP alternatives, which call for all waste waters to be disposed of at the mine.

At closure, it may be necessary to apply a sufficient volume of mine waste waters to flush the salts that may have accumulated annually during operations. Flushing the accumulated salts from soil would increase soil health and minimize long-term vegetation effects at closure.

Under this alternative, there would be minimal effects to the East Boulder Mine plant communities since less water containing nitrogen and salts would be applied at the mine LAD areas during closure. Any plant community effects from the land application of nitrogen and salts during closure would be short-term. Implementation of this alternative would cause an irreversible loss of native species and would encourage establishment of a community dominated by introduced species as well as more mesic native species.

4.3.4.17 Closure Mass Wasting Effects at Boe Ranch

The potential for mass wasting of the Boe Ranch soils at closure would be greater than those disclosed above for the Boe Ranch LAD System Proposed Action Alternative 2C and the operational effects disclosed for the Agency-Mitigated Alternative 3C. Some portion of the 40 MG of tailings waters would be land applied at the Boe Ranch during the 18-month closure period. Tailings waters would increase the total volume of water and salts load applied on the 166-acre agency-assumed Boe Ranch LAD area. Applying this additional volume of treated mine waste waters at greater than agronomic rates could increase the mass wasting potential under center pivots P4 and P9. Agency-proposed monitoring of soils during operations would help identify how SMC would adjust LAD rates at the Boe Ranch at closure to prevent mass wasting.

If the salts load in tailings waters adversely affects soil structure and increases soil SAR values, portions of the Boe Ranch LAD area could become increasingly susceptible to mass wasting. Agency-proposed monitoring of soils during operations would help identify how SMC could minimize the SAR increase and its impact on soils.

Based on the ability of SMC to apply water at greater than agronomic rates, salts should not accumulate during operations under routine LAD system management. SMC could also manage the salts load applied at closure so that it would be flushed from the root zone by the increased volume of land-applied water. A healthy soils salinity level would limit the adverse effect of salts on soil structure and reduce the potential for mass wasting.

4.3.4.18 Post-Closure Nitrogen and Salts Effects to Soils at the Boe Ranch

Under the Agency-Mitigated Alternative 3C, adit and tailings waters would be treated and disposed of during the 18-month closure period. No further disposal of mine-related waste waters would be required at the Boe Ranch at post-closure. A future landowner would control the LAD area. At post-closure, residual nitrogen and salts loads, which may accumulate during closure in the Boe Ranch soils, would be flushed by precipitation and the application of irrigation water by the future landowner. It is likely that the irrigation water source would be East Boulder River water in the Mason Ditch. This water would have lower nitrogen and salts content than East Boulder Mine adit and tailings waters. No additional mine-related nitrogen or salts effects would occur at the Boe Ranch at post-closure.

4.3.4.19 Post-Closure Nitrogen and Salts Effects to Soils at the East Boulder Mine

Under the Agency-Mitigated Alternative 3C, adit and tailings waters would be treated and disposed of during the 18 months of closure. During post-closure, residual nitrogen and salts loads that may accumulate during closure in the East Boulder Mine LAD Area 6 soils would be leached by precipitation.

After the 18-month closure period, the East Boulder Mine adit water would require disposal. Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the untreated adit water would be routed directly to the East Boulder River. The effects of the discharge of this water were discussed previously under *Water Quality and Quantity* Section 4.1.3.4.1.

Liner leakage from the East Boulder Mine tailings impoundment would be routed to ground water and would contribute a minor amount of nitrogen and salts to soils. Seepage through the reclamation cover and storm water runoff would be routed to ground water in the East Boulder Mine site percolation pond. This water also would contribute a minor amount of nitrogen and salts to soils. These effects would continue throughout post-closure.

4.3.4.20 Post-Closure Effects to Vegetation at Boe Ranch and the East Boulder Mine

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the effects to plant community cover and productivity, structure, species diversity, and noxious weeds would be similar to those disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C. These effects would continue throughout post-closure.

4.3.4.21 Post-Closure Mass Wasting Effects at Boe Ranch

No mine water would need disposal at the Boe Ranch during post-closure. The residual post-closure mass wasting effects from operational and closure LAD of

mine waste waters at the Boe Ranch would be similar to those disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C.

4.3.4.22 Cumulative Effects of Boe Ranch LAD System Agency-Mitigated Alternative 3C

Implementation of the Boe Ranch LAD System Agency-Mitigated Alternative 3C would likely result in cumulative effects similar to those disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C. Land development in the East Boulder River drainage would likely have effects that would add to mine-related effects under this alternative. The monitoring and mitigation programs proposed under the Agency-Mitigated Alternative 3C would improve the management of soils, as well as vegetative cover and production, but the effects would be similar to those under Proposed Action Alternative 2C.

4.3.4.23 Unavoidable Adverse Effects

Adverse environmental effects, which cannot be avoided, would be similar to those disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C.

4.3.4.24 Relationship between Short-term Use and Long-term Productivity

The relationship between short-term use and long-term productivity under the Boe Ranch Agency-Mitigated Alternative 3C would be similar to the relationship disclosed for the Proposed Action Alternative 2C. Boe Ranch resources would be altered from its present condition, but would be available for future use.

4.3.4.25 Irreversible or Irretrievable Commitments of Resources

There would be irreversible or irretrievable commitments of existing natural resources related to irrigation practices if the Boe Ranch LAD System Agency-Mitigated Alternative 3C is selected. Effects would be similar to those disclosed for the Proposed Action Alternative 2C.

4.4 Cultural Resources

Proposed implementation of the Boe Ranch LAD System Proposed Action Alternative 2C raised some concern during scoping about potential adverse effects to cultural resources on the Boe Ranch property resulting from construction and operation of the LAD system (Issue 4, Section 2.2.1). Effects to cultural resources were evaluated by comparing the locations, types, and extent of disturbances associated with construction and operation of the Boe Ranch LAD system with the distribution and type of cultural resources located on the Boe Ranch.

The following section presents the findings of this analysis for the Boe Ranch LAD System alternatives (1C, 2C, and 3C). All other alternatives evaluated in this EIS would be implemented, if approved, on lands that are currently disturbed or have been evaluated previously for effects to cultural resources.

4.4.1 Boe Ranch LAD System No Action Alternative 1C

4.4.1.1 Direct and Indirect Effects

Under the Boe Ranch LAD System No Action Alternative 1C, the Boe Ranch LAD system would not be built and all mine waste waters would be managed at the approved East Boulder Mine site water treatment and disposal facilities. There would be no effects to cultural resources on the Boe Ranch during the East Boulder Mine closure or post-closure activities.

4.4.1.2 Cumulative Effects

Selection of the Boe Ranch LAD System No Action Alternative 1C would not produce any cumulative effects to cultural resources on the Boe Ranch. Under this alternative, the Boe Ranch LAD facilities would not be constructed or operated.

4.4.1.3 Adverse Environmental Effects, Which Cannot Be Avoided

There would be no adverse cultural resource effects that could not be avoided if the Boe Ranch LAD System No Action Alternative 1C were selected.

4.4.1.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Under the Boe Ranch LAD System No Action Alternative 1C, short-term use of the Boe Ranch would not occur. The long-term productivity of the land would be available for future use, and the cultural resources would not be changed from present conditions.

4.4.1.5 Irreversible or Irretrievable Commitments of Resources

There would be no irreversible or irretrievable commitments of cultural resources if the Boe Ranch LAD System No Action Alternative 1C is selected.

4.4.2 Boe Ranch LAD System Proposed Action Alternative 2C

The Boe Ranch LAD system as described in Section 2.4.8 would be similar to the existing Stillwater Mine Hertzler Ranch LAD System. Under Proposed Action Alternative 2C, the Boe Ranch LAD system could be constructed, if needed. Treated adit and tailings waters would be piped, if needed, during operations and the 12-month closure period from the East Boulder Mine facilities to the Boe Ranch where they could be stored and land applied.

4.4.2.1 Direct and Indirect Effects

4.4.2.1.1 Operations

Under the Boe Ranch LAD System Proposed Action Alternative 2C, the Boe Ranch LAD system would be SMC's preferred location for the disposal of treated adit (and tailing waters, if necessary) during operations, if needed. The Boe Ranch LAD system would consist of a lined storage pond with 108 MG of storage capacity and 10 center pivot land application areas. Snowmakers and evaporators would be located on the upper portions of the proposed LAD storage pond (Figure 2-32).

Twelve cultural resource sites have been recorded near the proposed Boe Ranch LAD area. One of these identified sites, the Boe Ranch Drive Line Site (24SW716), would be affected by the construction and operation of the access road and pipeline to the Boe Ranch LAD system. Three other cultural resource sites are close enough to the proposed facilities for inadvertent disturbance to be a concern during construction. The Boe Ranch LAD system is designed to minimize affects to these three sites by ensuring that all are outside of the construction disturbance footprint.

Effects to the Boe Ranch Drive Line site cannot be avoided since the line extends for more than 1 mile across the area, and the road and pipeline must cross it to access the LAD site. Construction of the proposed access road and pipeline would have a disturbance width of up to 50 feet and could affect as many as four of the more than 250 known individual features associated with the drive line cultural site.

In accordance with standard construction monitoring practices, SMC would identify the drive line complex in order to pick a crossing location that would minimize the effects of the access road and pipeline on the Boe Ranch Drive Line. Individual features that would be disturbed would be mapped and photographed. The road and pipeline corridor and associated work and equipment staging areas would be staked with re-bar and flagged in order to keep

activities in these limited areas and away from cultural sites. The cultural sites would not be identified in any construction documents.

Proposed mitigations included in this alternative include provisions for an archaeologist, approved by DEQ and the Montana State Historic Preservation Office (SHPO), to monitor construction activities and to ensure disturbance is minimized. All 12 cultural resource sites would be monitored by the approved archaeologist during construction to ensure they are not inadvertently disturbed. In the event that any previously unidentified cultural resources are discovered during construction, the project would be halted in that location, and the project archeologist would evaluate the situation. Consultation with the Montana SHPO may be initiated.

Operation of the Boe Ranch LAD System would increase forage production (see *Irrigation Practices* Section 4.3.3.7.) in areas where treated mine waste waters are land applied. SMC may graze the LAD areas with a short-duration, high-intensity grazing system that utilizes portable fences to manage grazing intensity. Development of an increased forage base could serve to concentrate cattle use in the LAD area. A high-intensity grazing system could contribute to the deterioration of cultural features by trampling and rubbing by cattle. The use of portable electric fences would minimize impacts to cultural resources since no appreciable ground disturbance from placement of the fences would occur.

In summary, construction and operation of the Boe Ranch LAD system would affect the Boe Ranch Drive Line Site (24SW716). Four individual features within this larger site could be disrupted due to installation of the road and pipeline corridor. Additional affects may include trampling and rubbing by cattle and potential vandalism. Increased access to the Boe Ranch by mine employees and trespassers, if the access gate is not locked, would increase the potential for vandalism of the sites.

4.4.2.1.2 Closure

During the first year of closure, the Boe Ranch LAD system, if constructed, would be used as described for operations, except adit water would be mixed and treated with up to 40 MG of tailings waters for disposal. After the 12-month closure period, adit and tailing waters would no longer be routed to the Boe Ranch. Effects during closure would be similar to those during operations.

Partial reclamation of the LAD facilities at the Boe Ranch would not result in any additional affects to cultural resources other than those incurred during construction. Reclamation activities would be limited to areas that were disturbed previously to construct the LAD facilities. Most of the LAD facilities would be retained for future agricultural use. Any cultural resources present in the LAD areas would have been previously located, evaluated, tested, photographed, and managed in accordance with SHPO consultation before the original disturbance occurred.

4.4.2.1.3 Post-Closure

Use of the Boe Ranch LAD facilities would likely be controlled by a private agricultural interest at post-closure. No additional affects to cultural resources related to mine waste water disposal would be anticipated during post-closure.

4.4.2.2 Cumulative Effects

Selection of the Boe Ranch LAD System Proposed Action Alternative 2C would contribute cumulative effects to cultural resources within the Boe Ranch, if the system is constructed and used. Over the life of the mine, no other land uses would be anticipated to take place at the Boe Ranch as a result of operations of the LAD system. In the long term, the area is expected to revert back to agricultural use during post-closure.

A list of projects that have potential to contribute cumulative effects to the Boe Ranch LAD system construction and operation were reviewed (Table 4-1). This project list consists of past, present, and reasonably foreseeable activities within the general project area. The only land use practices that have potential to contribute cumulative effects to Boe Ranch cultural resources include the continuation of livestock grazing, other agricultural practices, and recreational activities like hunting. The Boe Ranch has primarily been used for agricultural purposes in the past. Continuation of grazing, other agricultural practices, and hunting would not substantially change the character and setting of the Boe Ranch and its cultural resources. Increased access to the site during construction, operation, and one year of closure would increase the potential for vandalism of the sites.

4.4.2.3 Adverse Environmental Effects, Which Cannot Be Avoided

Potential disturbance of four individual cultural resource features within the Boe Ranch Drive Line Site (24SW716) would take place due to construction and operation of the Boe Ranch LAD road and pipeline corridor. Implementation of this alternative could not avoid all identified disturbance and adverse effects to cultural resources on the Boe Ranch.

4.4.2.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

The long-term integrity of the Boe Ranch Drive Line Site (24SW716) could be affected due to implementation of the Boe Ranch LAD System Proposed Action Alternative 2C. The short-term use of the Boe Ranch for the construction and operation of a mine waste water LAD system would enable beneficial use of most mine waste waters in an agricultural setting with minimal effects to cultural sites.

4.4.2.5 Irreversible or Irretrievable Commitments of Resources

The construction and operation of the Boe Ranch LAD system would result in an irreversible and irretrievable commitment of some of the cultural resources associated with Boe Ranch Drive Line Site (24SW716).

4.4.3 Boe Ranch LAD System Agency-Mitigated Alternative 3C

4.4.3.1 Direct and Indirect Effects

4.4.3.1.1 Operations

The Boe Ranch LAD System Agency-Mitigated Alternative 3C (Section 2.4.9) would be similar to Proposed Action Alternative 2C with the addition of several mitigation measures to minimize potential for mass wasting and to enhance the stability of the Boe Ranch LAD storage pond during operations and closure. The Boe Ranch LAD facilities would be the same as those proposed for Proposed Action Alternative 2C except that center pivot P10 would not be used and center pivots P4 and P9 would require additional monitoring because of mass wasting concerns.

The effects on cultural resources due to alternative implementation would be the same as those for Proposed Action Alternative 2C. The same cultural resource mitigation measures would be applied to this alternative as under Proposed Action Alternative 2C. Other than center pivot P10 not being constructed and the material stockpiles being relocated, the same facilities (roads, LAD storage pond, and center pivots) would be constructed on the Boe Ranch and would affect known cultural resources similarly. Increased monitoring of slope stability under the Agency-Mitigated Alternative 3C would contribute to the preservation of archaeological sites that could be affected if mass wasting were to occur. No appreciable difference in effects is expected between the implementation of Proposed Action Alternative 2C and this alternative.

4.4.3.1.2 Closure

No appreciable difference in effects is expected between the implementation of Proposed Action Alternative 2C and this alternative at closure.

4.4.3.1.3 Post-Closure

No appreciable difference in effects is expected between the implementation of Proposed Action Alternative 2C and this alternative at post-closure.

4.4.3.2 Cumulative Effects

No appreciable difference in cumulative effects is expected between the implementation of Proposed Action Alternative 2C and this alternative.

4.4.3.3 Adverse Environmental Effects, Which Cannot Be Avoided

No appreciable difference in adverse environmental effects which cannot be avoided is expected between the implementation of Proposed Action Alternative 2C and this alternative.

4.4.3.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

No appreciable difference in the relationship between short-term use of the Boe Ranch area and its long-term productivity between implementation of the Proposed Action Alternative 2C and this alternative is expected.

4.4.3.5 Irreversible or Irretrievable Commitments of Resources

The construction and operation of the Boe Ranch LAD system would result in an irreversible and irretrievable commitment of some of the cultural resources associated with Boe Ranch Drive Line Site (24SW716).

4.5 Stability of Boe Ranch LAD Storage Pond

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C or the Agency-Mitigated Alternative 3C would result in construction and long-term use of a 32-acre LAD storage pond at the Boe Ranch to store up to 108 MG of treated adit and tailings waters prior to routing to the center pivots for disposal during operations and closure. The pond would be built in a natural depression (Figure 3-16), using native materials excavated from the site. It would be lined with an 80 millimeter (mil) HDPE liner. For comparison, the HDPE liner for the Stillwater Mine Hertzler Ranch LAD storage pond is 60 mil. SMC proposes to leave the pond in place during post-closure to support local ranching operations.

During public scoping, some commenters expressed concerns associated with the construction and long-term use of the 32-acre LAD storage pond as proposed under the Boe Ranch LAD System Proposed Action Alternative 2C. Most of the comments questioned the structural stability of the pond. Specific concerns are detailed in Chapter 2, Issue 5 (Section 2.2.1) and include the following:

- The pond embankment stability based on site geologic and seismic conditions;
- The pond embankment stability should the geo-membrane lining fail;
- The ability of the pond to contain or pass a 100-year storm event and the effect of such an event on the drainage below the pond; and
- Damage to property and effects on water quality and quantity in the East Boulder River if the pond fails during operations, closure, or post-closure.

The agencies' analyses of potential effects focused on the proposed design of the LAD storage pond. Existing knowledge of the site and construction materials was used to support the evaluation. The following items or actions were included in the agencies' analyses:

- Evaluation of the Boe Ranch LAD storage pond design criteria.
- Site-specific engineering studies and field data were used to evaluate the suitability of the Boe Ranch LAD storage pond site and the material proposed for constructing the embankment.
- The risk of failure was evaluated based on known geologic conditions, anticipated seismic activity, and potential for flooding.
- Damage to property and effects on water quality were also analyzed.

4.5.1 Boe Ranch LAD System No Action Alternative 1C

4.5.1.1 Effects to downstream property and water quality

The Boe Ranch LAD System No Action Alternative 1C would make use of the water treatment and disposal systems currently in place at the East Boulder Mine. The existing pipeline in the Forest Service road would not be used, and the Boe Ranch LAD system would not be developed. There would be no embankment stability concerns at the Boe Ranch from the No Action Alternative 1C since the LAD storage pond would not be constructed.

4.5.1.2 Cumulative Effects

The Boe Ranch LAD System No Action Alternative 1C would not contribute cumulative effects to the ephemeral drainage and river systems below the Boe Ranch LAD storage pond area. Cumulative effects from non-mine related activities would continue to occur within the area surrounding the Boe Ranch. Erosion from other disturbances in the East Boulder River valley would continue whether or not this alternative is selected.

4.5.1.3 Unavoidable Adverse Effects

There would be no unavoidable adverse effects resulting from selection of the Boe Ranch LAD System No Action Alternative 1C.

4.5.1.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Under the Boe Ranch LAD System No Action Alternative 1C, the short-term mine-related use of the Boe Ranch lands would not take place. The long-term productivity of the land would be similar to that experienced under current conditions. The existing Boe Ranch resource conditions would be available for future uses and would not be changed from present conditions.

4.5.1.5 Irreversible or Irretrievable Commitments of Resources

There would be no irreversible or irretrievable commitments of existing natural resources related to construction and operation of the LAD storage pond if the Boe Ranch LAD System No Action Alternative 1C is selected.

4.5.2 Boe Ranch LAD System Proposed Action Alternative 2C

4.5.2.1 Boe Ranch LAD Pond Stability Analyses

4.5.2.1.1 Site Investigation and Laboratory Testing

The proposed Boe Ranch LAD area was investigated in order to evaluate geologic conditions and geotechnical parameters for the design of the center pivots and LAD storage pond (Knight Piésold 2000d). The investigation included test pits, *in situ* and laboratory testing, and detailed topographical surveying. Forty-eight test pits were excavated within the area of the proposed LAD center pivots and Boe Ranch LAD storage pond. These test pits were distributed among the areas proposed for the center pivot area, pond spillway, site access road, and the embankment areas of the LAD storage pond.

Laboratory tests confirm that most of the *in situ* materials at the Boe Ranch LAD storage pond site are suitable for embankment construction and underliner purposes (Knight Piésold 2000c). The test pits and laboratory results also indicate that sufficient quantities of suitable fill material for embankment construction should be available for grading the proposed pond site.

These test pits and subsequent laboratory analyses established parameters for a stable design of the proposed embankment. The following laboratory tests were completed: particle size distribution, Atterberg limits (liquid limit, plastic limit, and plasticity index), natural moisture content, specific gravity, compaction, and permeability. Triaxial shear testing was also performed on a sample from a silt layer collected from the foundation area of the embankment. The sample yielded an effective friction angle of 32.4 degrees and an effective cohesion of 0 pounds per square inch (psi). These strength values are typical for silty sand. Further testing was done to identify whether this layer needed to be removed if the Boe Ranch LAD storage pond was constructed.

4.5.2.1.2 Liquefaction Potential

SMC evaluated the soils for their susceptibility to liquefaction, a condition where soil loses strength when subjected to induced stresses, such as those generated by an earthquake. The silt sample discussed above was evaluated for its affinity to lose strength under such a seismic loading event. These soils, because of their overall fines content, are likely to be susceptible to liquefaction if they become saturated. This could occur due to an excessively high water table or from leaks in the LAD storage pond liner. Based on this preliminary assessment, the silt layer would be removed from the foundation during construction (Knight Piésold 2000c).

4.5.2.1.3 Embankment Stability

For an evaluation of the stability of the embankment itself, SMC completed an analysis using the limit equilibrium computer program SLOPE/W (GEO-SLOPE International 2008), which computes the minimum factor of safety for a number

of potential failure surfaces (Knight Piésold 2000c). The stability of the embankment was modeled under both static and pseudostatic conditions. Static conditions evaluate embankment stability from the effects of constant forces that act on the structure, such as gravity. Pseudostatic analysis simulates dynamic forces, such as those generated by an earthquake. Parameters used in the pseudostatic analysis were based on a maximum credible earthquake (MCE) of magnitude 7.0 occurring on the Emigrant Fault. This is the same fault and earthquake magnitude used in the analysis of the East Boulder Mine tailings impoundment. A seismic coefficient of 0.1 (55 percent of the maximum acceleration of 0.18 gravity for the MCE) was applied in the stability analysis to simulate seismic loading from a magnitude 7.0 earthquake occurring on the Emigrant Fault.

Two different site-specific conditions were evaluated for the static and dynamic analyses. For Case 1, the Boe Ranch LAD storage pond liner was assumed to be functioning properly (*i.e.*, no leaks), but the ground water table was assumed to be located at the base of the liner. In Case 2, a liner leak was assumed to be causing saturation of the LAD storage pond embankment. Since a saturated embankment can result in lower embankment strength, this condition is of particular interest in the analysis.

For Case 1, the minimum factor of safety (FS) was calculated at 1.9 for static conditions and 1.4 for pseudostatic conditions. The factor of safety is defined as the sum of stabilizing forces divided by the sum of destabilizing forces. Safety factors less than or equal to 1 represent unstable conditions while safety factors greater than 1 indicate stable conditions. For Case 2, the minimum factor of safety was calculated at 1.7 for static conditions and 1.3 for pseudostatic conditions. Standard acceptable factors of safety are 1.5 for static and 1.0 for pseudostatic conditions (U. S. Army Corps of Engineers, 2003). Based on field and laboratory data, the proposed design should result in a stable embankment (Knight Piésold 2000c). The design, input parameters, and method of analysis used in the assessment of the Boe Ranch LAD storage pond are consistent with industry standards for the design of earth filled embankments. A summary of the findings are presented below:

- Should the geo-membrane lining fail, the embankment could become saturated. The preliminary design safety factors of 1.7 for static conditions and 1.3 for pseudostatic conditions would still exceed standard minimum levels for the saturated condition.
- The embankment is designed to be stable during the MCE (magnitude 7.0) in both saturated and unsaturated conditions.
- Reasonable geologic field investigations and laboratory analyses were carried out to support the preliminary design (Knight Piésold, 2000c).

The agencies reviewed the data provided by SMC and agree that the embankment would be stable as designed.

4.5.2.1.4 High Hazard Dam Classification

Enforcement of the Montana Dam Safety Act is the responsibility of the Dam Safety Bureau of the Department of Natural Resources (DNRC). The DNRC regulates the operation of water-retaining dams in the state. The agencies asked DNRC to review the design of the Boe Ranch LAD storage pond. DNRC determined that the structure would meet the high-hazard classification under its rules (DNRC 2002). To qualify for high-hazard classification, a dam must impound 50 acre-feet or more of water and have the potential to cause a loss of life in the event of a dam failure. When full, the Boe Ranch LAD storage pond would impound over 330 acre-feet of water. An acre-foot is defined as a layer of water one foot deep on an acre. The DNRC modeled a dam breach and determined that the peak flow from the failure of the Boe Ranch LAD storage pond could cause shallow inundation of downstream residential properties along the East Boulder River.

A high-hazard classification does not indicate that a dam is inherently unstable or unsafe; rather, it triggers operation and management protocols to ensure safe operating conditions. Among the requirements accompanying a high-hazard classification are the following: an operating permit issued by the DNRC, an engineer's inspection report, and an operating plan which includes operating, maintenance, and emergency procedures. In its permit amendment application to the agencies, SMC has not proposed any specific operation and maintenance plan or emergency action plan that meets or exceeds DNRC specifications to deal with the failure of a high-hazard dam. SMC has not proposed to inspect the Boe Ranch LAD storage pond embankment on a regular basis during operations and closure. The Boe Ranch LAD storage pond would be operated and maintained in a similar fashion to the existing tailings impoundment at the East Boulder Mine. As under current practice, mine personnel would be on site daily: their ongoing work-related activities would bring them to the Boe Ranch LAD storage pond area where any discernable change in conditions could be assessed.

Although the size of the Boe Ranch LAD storage pond should bring it under the purview of DNRC's Dam Safety Bureau, since it is being permitted under the Montana Metal Mine Reclamation Act as part of an active mining operation, it would fall under DEQ's jurisdiction while the mine permit is in place. SMC has proposed that the Boe Ranch LAD storage pond and other LAD system components be left at post-closure for use by future landowners as a storage reservoir for irrigation water from the Mason Ditch. The pipeline from the East Boulder Mine area to the Boe Ranch LAD area would be reclaimed. At post-closure, the Boe Ranch LAD storage pond would be classified as a high-hazard dam according to DNRC criteria. The landowner of record would have to apply for and receive an operating permit from the DNRC under the Montana Dam Safety Act.

4.5.2.1.5 Holding Capacity

The Boe Ranch LAD storage pond is designed to hold 108 MG of treated mine waste water. There is additional capacity to allow for the containment of a 25-year storm event and another 3 feet of embankment height to prevent overtopping by wind-generated wave action. The total holding capacity of mine waste waters

and storm water would be 115 MG. A spillway with an elevation 3 feet below the main embankment crest would pass water when the volume of water exceeds 115 MG. The maximum embankment height would be 55 feet.

In the event of overtopping, the spillway would safely pass the overflow, but the soil and unsuitable foundation material stockpiles located in the drainage below the pond would potentially erode, releasing large amounts of sediment downstream towards the East Boulder River (Figure 2-35.).

4.5.2.2 Potential effects to downstream property and water quality from storage pond flooding

The DNRC's breach analysis concluded that failure of the Boe Ranch LAD storage pond could result in potential loss of life due to inundation of downstream residences (DNRC 2002). Proper LAD storage pond management and the implementation of emergency procedures would make the prospect of a pond breach unlikely.

The potential for unanticipated discharges through the spillway is more likely to occur than a failure of the pond embankment itself. SMC proposes to stockpile soil and unsuitable foundation materials downgradient from the Boe Ranch LAD storage pond. If for any reason the spillway passes water, a portion of the stockpiled materials in the ephemeral drainage below the LAD storage pond would be washed towards the East Boulder River. These events could have a direct adverse short-term effect to downstream properties and a potential long-term effect to the surface water quality of the East Boulder River. Effects would include deposition of large amounts of soil and geologic materials in the East Boulder River, as well as farther downstream in the Boulder River and Yellowstone River valleys. Any materials deposited along the East Boulder River flood plain would be unstable. At times of high water, such as during spring run-off, the materials deposited in the flood plain could be reactivated, and sediment and turbidity in the rivers would increase. This would continue until the materials were revegetated or flushed from the active flood plains.

4.5.2.3 Cumulative Effects

There are no other off-site activities in the East Boulder River valley that would add cumulative effects to the Boe Ranch LAD storage pond stability. Past, present, and reasonably foreseeable future actions on-site that may cumulatively result in a change in the stability of the Boe Ranch LAD storage pond include:

- Irrigation practices on or near the embankment and pond which could weaken the soil structure.
- Vandalism or wildlife incursions which could tear or puncture the pond liner.

The identified actions that could materially affect the Boe Ranch LAD storage pond, as described in the Proposed Action Alternative 2C, are actions that are directly under the control of SMC and in part controlled by the agencies. Any change in the currently proposed location of the LAD area would need prior approval from the agencies due to the potential for irrigation water to affect soils

near the LAD storage pond. The Boe Ranch LAD storage pond is located on private land and public access is restricted to the site. The Boe Ranch LAD area would be visited by mine personnel on a regular basis, so any acts of vandalism should be noticed. For less obvious damages, downgradient monitoring wells would pick up changes in water quality, alerting mine personnel to a possible tear or puncture in the liner. Corrective action could then be taken to prevent a compromise to the embankment stability. The pond area would also be fenced to prevent wildlife from entering and puncturing the pond liner.

4.5.2.4 Unavoidable Adverse Effects

Implementation of the Boe Ranch LAD System Proposed Action Alternative 2C, as proposed, would not initiate any unavoidable adverse environmental effects with respect to the stability of the Boe Ranch LAD pond.

4.5.2.5 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Failure of the Boe Ranch LAD storage pond embankment could influence the interplay between short-term use and long-term productivity. Embankment failure would result in the discharge of up to 115 MG of water over a very short period of time. Such an event would likely result in massive amounts of erosion and sediment loss immediately downstream of the Boe Ranch LAD storage pond, as well as discharge of sediment to the East Boulder River. Under such a scenario, the area impacted by the flood would be lost to livestock grazing. There may be loss of fish and other aquatic species and their habitats in the East Boulder River due to excessive sediment discharge. There would also be a short-term loss of the Mason Ditch as a conduit for irrigation water, impacting downstream water users. All of these conditions would be temporary, and long-term productivity of affected areas (*e.g.*, East Boulder River, grazing lands, Mason Ditch) would revert to productivity levels similar to those that existed prior to a pond failure.

4.5.2.6 Irreversible or Irretrievable Commitments of Resources

There would be no irreversible or irretrievable commitment of existing natural resources under the Proposed Action Alternative 2C relative to the stability of the Boe Ranch LAD storage pond, other than the elimination of potential grazing lands under the footprint of the pond itself. This is an insignificant effect given the small 32-acre grazing area that would be removed relative to the overall size of adjacent grazing areas available to livestock and wildlife.

4.5.3 Boe Ranch Land Application Disposal Agency-Mitigated Alternative 3C

Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, potential effects from a Boe Ranch LAD storage pond failure or from a water discharge over the pond spillway would be mitigated. Even though the pond would be part of an active mine operating permit regulated by DEQ, SMC would be required to submit an Operation, Maintenance, and Emergency Preparedness Plan to the agencies that meets the Montana Dam Safety Act requirements for high-hazard dams under this alternative. These plans would require monitoring and maintenance work needed to ensure stability during operations and closure.

Under the Proposed Action Alternative 2C, the high-hazard dam would pass to the future landowner at post-closure, and the landowner would have to obtain an operating permit from DNRC. Under the Agency-Mitigated Alternative 3C, the capacity of the pond would be decreased to less than 50 acre-feet at post-closure to reduce the high-hazard classification for the Boe Ranch LAD storage pond. The smaller Boe Ranch LAD storage pond would no longer qualify as a high-hazard dam as defined under DNRC regulations. Reducing the overall size and capacity of this dam would decrease the potential for long-term risks to ground and surface water quality, the potential loss of life, and personal property damage associated with failure of this structure as disclosed for the Boe Ranch LAD System Proposed Action Alternative 2C. Reducing the LAD storage pond volume would result in several acres of redisturbance. The effects from erosion of the disturbed pond embankment and haul roads would be mitigated by installation of BMPs until the disturbances are revegetated.

The agencies would require a facility monitoring plan to assess liner integrity. The plan would include such things as regular inspections of the liner, installation of piezometers in the embankment to measure changes in water levels, and regular water balance calculations to compare to the measured volume of actual impounded water. Shallow ground water wells or other measures to identify saturation of soil in the Boe Ranch LAD storage pond area would also be required.

SMC would be required to inspect the dam embankment, the LAD storage pond HPDE liner, and the spillway on a regular basis during operations and closure. The aim of regular inspections would be to assess changes in the embankment and appurtenances which could forewarn of potential unstable conditions. At least once a year, a third-party geotechnical engineer with dam safety experience would be required to inspect the facility.

The agencies would require SMC to relocate the soil and unsuitable foundation material stockpiles out of the ephemeral drainage downgradient of the embankment to avoid soil loss and erosion in case of an embankment failure or from water passing over the spillway (Figure 2-35).

4.5.3.1 Effects to downstream property and water quality

As a result of the mitigations listed above for the Agency-Mitigated Alternative 3C, the potential effects to downstream property and water quality from failure of the Boe Ranch LAD storage pond embankment or from water passing over the spillway during operations, closure, and post-closure would be less than under the Proposed Action Alternative 2C.

Erosion would still occur in the ephemeral drainage below the pond, but the volume of material moved would be substantially less than the materials that could erode under the Proposed Action Alternative 2C. Reducing the size of the pond at post-closure would also reduce the risk of long-term failure over time.

4.5.3.2 Cumulative Effects

The Boe Ranch LAD storage pond would be considered a high-hazard dam during operations and closure. Under the Boe Ranch LAD System Agency-Mitigated Alternative 3C, the Boe Ranch LAD storage pond would be reduced in size at post-closure to eliminate the high-hazard classification. This reduction would eliminate any probability for long-term stability problems. Past, present, and reasonably foreseeable future actions that may cumulatively result in a change in the stability of the Boe Ranch LAD storage pond are the same as described under the Boe Ranch LAD System Proposed Action Alternative 2C.

4.5.3.3 Unavoidable Adverse Effects

Implementation of the Agency-Mitigated Alternative 3C would not initiate any unavoidable adverse environmental effects with respect to the stability of the Boe Ranch LAD pond.

4.5.3.4 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Actions associated with the stability of the Boe Ranch LAD storage pond that could influence the interplay between short-term use and long-term productivity are the same as those described for the Proposed Action Alternative 2C.

4.5.3.5 Irreversible or Irretrievable Commitments of Resources

Other than the elimination of potential grazing lands under the footprint of the pond itself, there would be no irreversible or irretrievable commitments of existing natural resources under the Agency-Mitigated Alternative 3C relative to the stability of the Boe Ranch LAD storage pond. This is an insignificant impact given the 32-acre grazing area that would be removed relative to the overall size of adjacent grazing areas available to livestock and wildlife.

Chapter 5 — Consultation and Coordination

Agencies, companies, and organizations consulted include the following:

- ACZ Laboratories
- Knight Piésold Ltd. Consulting Engineers
- Montana Department of Fish, Wildlife, and Parks
- Montana Department of Natural Resources & Conservation
- Montana Natural Heritage Program
- Montana State Historic Preservation Office
- Stillwater Mining Company
- Sweet Grass County
- U.S. Fish and Wildlife Service
- U.S. Department of Agriculture - Agricultural Research Service

Chapter 6 — Preparers and Contributors

This Draft EIS was jointly prepared by DEQ, GNF, and CNF. Representatives from the cooperating agencies contributed to and participated in the MEPA/NEPA process. Technical input regarding the proposed project was provided by SMC and its consultants. Early versions of the Draft EIS were prepared by two third-party contractors, Greystone Environmental Consultants, Inc. and ARCADIS U.S., Inc. Over the life of this project, many preparers and contributors were involved. Only those Interdisciplinary Team members who were involved in production of the final Draft EIS are listed below. In the event that members of the public are interested in others who have been involved in the project, information can be provided by contacting the DEQ.

The following section presents individuals and their area or areas of responsibility. Brief biographical information also is provided.

Montana Department of Environmental Quality

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Warren McCullough	Bureau Chief, Environmental Management Bureau / Document Review	B.A., Anthropology M.S., Economic Geology 33 years experience
Patrick Plantenberg	Irrigation Practices and Boe Ranch LAD Pond Stability	B.S., Plant & Soil Science/ Recreation Area Management M.S., Range Science/Land Rehabilitation 35 years experience

Rebecca Ridenour	Water Quality and Quantity, Irrigation Practices, and MPDES permitting	B.S., Geological Engineering, Hydrogeology Emphasis M.S., Geoscience – Geochemistry 10 years experience
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Custer National Forest

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Department of Natural Resources and Conservation

Name	*Project Responsibility*	*Education*
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Chapter 7 — Distribution and Review of the Draft EIS

The following list identifies the agencies and organizations to whom the Draft EIS was sent.

Federal and State Officials

U.S. Senator Max Baucus
U.S. Senator John Tester
U.S. Representative Dennis Rehberg
Montana Representative Joel Boniek (District 61)
Montana Representative David Howard (District 60)
Montana Senator John Esp (District 31)
Montana Senator Robert Story (District 30)

Federal Agencies

U.S. Army Corps of Engineers
U.S. Bureau of Land Management, Montana State Office
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

State Agencies

Montana Board of Environmental Review
Montana Department of Commerce
Montana Department of Fish, Wildlife and Parks
Montana Department of Natural Resources and Conservation
Montana Department of Transportation
Montana Environmental Quality Council
Montana Governor's Office
Montana Natural Heritage Program
Montana State Historical Preservation Office

Local Agencies

Stillwater County Commissioners
Stillwater County Planner
Stillwater Conservation District
Sweet Grass County Commissioners
Sweet Grass County Planner
Sweet Grass Conservation District

Tribal Organizations

Crow Tribal Council
Crow Cultural Committee

Organizations

Alliance for the Wild Rockies
Fishtail Community Center
Greater Yellowstone Coalition
Mineral Policy Center
Montana Council Trout Unlimited
Montana Wildlife Federation
National Wildlife Federation
Northern Plains Resource Council
Northern Rockies Geological Data Center
Sierra Club
Stillwater Protective Association
The Ecology Center
Yellowstone Valley Audubon Society

Companies

Maxim Technologies
Stillwater Mining Company
Stillwater Printing

Educational Institutions

Absarokee High School Library
Billings Parmly Library
Carnegie Public Library
Montana State Library
Montana Technical Library
Stillwater County Library
University of Montana Mansfield Library

Media Outlets

Billings Gazette
Carbon County News
KSVI TV (Billings)
KTVQ TV (Billings)
KULR TV (Billings)
Stillwater County News
Yellowstone Public Radio

Chapter 8 — Glossary

acid rock drainage – drainage with a pH of 2.0 to 4.5 from mines and mine wastes that is the result of oxidation of sulfides exposed during mining.

acre-foot – the volume of liquid or solid required to cover 1 acre to a depth of 1 foot, 43,560 cubic feet (also, 325,900 gallons); measure for volumes of water, reservoir rock, etc.

adjudicated springs – spring for which water rights have been filed with the Montana Department of Natural Resources and Conservation and that have certain rights in a judicial court of law.

adit – access tunnel from the surface to the mine workings that is nearly horizontal.

adit water – ground water intercepted by the mine workings that is pumped to or reaches the surface.

adverse impact – in the context of most resources, an adverse impact refers to a change that moves the resource away from a desired condition or detracts from its appearance or condition.

affected environment – the natural, physical, and human-related environment that is sensitive to changes due to proposed actions; the environment under the administration of one line officer, such as District Ranger or Forest Supervisor.

Agency-Mitigated Alternative – an alternative that includes additional requirements imposed by the regulatory agencies (Montana Department of Environmental Quality, Custer National Forest and Gallatin National Forest) on Stillwater Mining Company.

agronomic rate– rate of water or nutrient application equal to the rate at which vegetation can transpire or consume it.

agronomic uptake – rate at which vegetation consumes water or nutrients.

alkalinity – a measure of the ability of water to neutralize acids.

ambient concentration – the mass of a pollutant in a given volume of water.

angle of repose – the maximum angle of slope at which loose, cohesionless material remains stable. It commonly ranges between 33 and 37 on natural slopes.

aquifer – a body of rock, alluvium, or colluvium that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs.

baseflow – the portion of streamflow that comes from groundwater and not run-off.

beneficial impact – a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

best management practice – a practice or combination of practices determined by the State to be the most effective and practicable (including technological, economic and institutional considerations) means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals.

biodiversity – the diversity of species, ecosystems, and natural processes in an area.

browse – shrubby forage utilized especially by big game.

BTS (biological treatment system) – a treatment system that uses microbial action to remove nitrate and ammonia from waters during operations and closure.

CFR (Code of Federal Regulations) – the compilation of federal regulations adopted by federal agencies through a rule-making process.

channel – a drainageway constructed to convey water from one point to another.

clarification – process of removing suspended particles from water by allowing them to settle as a sludge to the bottom of a container and drawing the sludge off.

clast – a rock fragment resulting from the breakdown of larger rocks.

CNF – Custer National Forest.

closure – the period after operations have ceased, during which tailings impoundments are being dewatered and reclaimed, mine facilities are being reclaimed, and active adit and impoundment water treatment is ongoing.

cultural resources – the archaeological and historical remains of human occupation or use. Includes any manufactured objects such as tools or buildings. May also include objects, sites, or geological/geographical locations significant to Native Americans.

cumulative effects – as defined by 40 CFR 1508.7, cumulative effects are the impacts on the environment which result 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 effects can result from individually minor but collectively significant

actions taking place over a period of time. Similar to cumulative impacts under MEPA.

DEQ – Montana Department of Environmental Quality.

direct effects – as defined by 40 CFR 1508.9, effects that are caused by the action and occur at the same time and place as the action. Synonymous with direct impacts under MEPA.

direct impacts – are those impacts that occur at the same time and place as the action that triggers the effect. Synonymous with direct effects under NEPA.

discharge – the volume of water flowing past a point per unit time, commonly expressed as cubic feet per second (cfs), gallons per minute (gpm), or million gallons per day (mgd).

DSL – Montana Department of State Lands.

earthquake – sudden movement of the earth's crust resulting from faulting, volcanism, or other mechanisms.

effects – environmental consequences as a result of a proposed or alternative action. Included are direct effects, which are caused by the action and occur at the same time and place, and indirect effects, which are caused by the action and are later in time or farther removed in distance but which are still reasonably foreseeable. Also referred to as impacts.

effluent – a discharge of liquids.

endangered species – any species in danger of extinction throughout all or a significant portion of its range. Plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act.

environmental impact statement – a detailed statement prepared by the responsible official in which a major Federal action which significantly affects the quality of the human environment is described, alternatives to the proposed action provided, and effects analyzed. Required by NEPA. A similar statement may be prepared for a State action under MEPA.

erosion – detachment or movement of soil or rock fragments by water, wind, ice, or gravity.

ESA – Federal Endangered Species Act.

evaporation – the conversion of water into vapor.

evapotranspiration (ET) – the combined measure of the loss of water from the soil by evaporation and by transpiration from the vegetation.

event pond – an HDPE-lined pond at the East Boulder Mine constructed to further minimize the potential for releases of untreated mine water and tailings. The event pond is located at the east end of the existing percolation pond and within the percolation pond disturbance footprint.

fill – a term used at the East Boulder Mine to indicate a combination of waste rock and borrow material.

floodplain – that portion of a river valley, adjacent to the channel, which is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stages.

forb – any herbaceous plant other than grasses, sedges, or rushes.

FWP – Montana Fish, Wildlife, and Parks.

game species – animals regulated by Montana Fish, Wildlife, and Parks.

GNF – Gallatin National Forest

gpm – gallons per minute.

ground water – all subsurface water in the zone of saturation, especially that as distinct from surface water.

ground water table – the surface between the zone of saturation and the zone of aeration; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

grout – a pumpable slurry of neat cement or a mixture of neat cement and fine sand, commonly forced into boreholes or crevices in a rock to prevent ground water from seeping or flowing into an excavation, to seal crevices in a dam foundation, or to consolidate and cement together rock fragments.

habitat fragmentation – the process by which habitats are increasingly subdivided into smaller units, resulting in their increased isolation as well as loss of total habitat area.

high-density polyethylene (HDPE) – a high-density, man-made geo-membrane used for reservoir liners and pipelines. This material deforms with a low probability of puncturing or splitting. Seams are heat welded instead of glued, thus preventing rupture.

heavy metals – a group of common transition metals, such as copper, lead, mercury, molybdenum, nickel, cobalt, chromium , iron, and silver, that are considered a cause of environmental pollution. Living organisms require varying amounts of certain "heavy metals" such as iron, cobalt, copper, manganese, molybdenum, and zinc but excessive levels can be toxic. Other heavy metals, such as mercury, plutonium, and lead, have no known vital or beneficial effect on organisms, and their accumulation over time in animals can cause serious illness.

hydraulic conductivity – the capacity of rock or soil to transmit water.

hydrology – a science that deals with the properties, distribution, and cycling of surface and subsurface water.

hydrophytic vegetation – plants that grow in and are adapted to an aquatic or very wet environment.

indirect effects – as defined by 40 CFR 1508.8, effects that are caused by the action but occur later in time or are removed in distance from the action, but are still reasonably foreseeable. Synonymous with secondary impacts under MEPA.

indirect impacts – those impacts that occur at a different location or later time than the action that triggers the effect. Synonymous with indirect effects under NEPA.

indurated – rock or soil that has been hardened by heat, pressure, or cementation.

infrastructure – the basic framework or underlying foundation of a community including road networks, electric and gas distribution, water and sanitation services, and facilities.

irreversible and irretrievable loss – those impacts that are not eliminated by mitigation.

jurisdictional wetland – a wetland area identified and delineated by specific technical criteria, field indicators, and other information for purposes of public agency jurisdiction. The public agencies that administer jurisdictional wetlands are the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and USDA-Natural Resources Conservation Service.

LAD (land application disposal) – the beneficial use of treated mine water applied to the land through center pivots or snowmakers. Application of water to the land is based on the objectives of maximizing vegetative uptake of nitrogen, maximizing evaporation, and minimizing deep percolation.

landslide – a perceptible downhill sliding or falling of a mass of soil and rock lubricated by moisture or snow; also known as mass wasting.

lifts – individual layers or stages in construction of waste rock dumps.

liner leakage – tailing water that has infiltrated through the tailings impoundment and manages to leak through a liner designed to prevent seepage. This volume is usually very low unless there is damage to the liner.

long-term – a change in a resource or its condition that does not return the resource to pre-disturbance condition or appearance and, for all practical purposes, is considered permanent.

lysimeter – a device for measuring the percolation of water through soils and measuring the soluble constituents in the water.

mass wasting – a perceptible downhill sliding or falling of a mass of soil and rock lubricated by moisture or snow; also known as landslide.

mill infrastructure – includes those constructed facilities used for processing ore and administering the mine.

milling – the general process of separating the economic constituents (metals) from the undesired or uneconomic constituents of ore material (tailings).

mineralization – process of introducing valuable minerals into bedrock.

minerals, locatable – those minerals on public domain lands that are regulated under the general mining laws. Included are minerals such as ores of gold, silver, lead, zinc, and copper, which are not classified as leasable or salable.

modified mercalli intensity scale – a qualitative measurement scale describing the intensity (degree of shaking) felt by people, structures, and the ground in an earthquake. Intensities range from I (felt by few, if any, people) to XII (damage total).

monitor – to systematically and repeatedly watch, observe, or measure environmental conditions in order to track changes.

National Register of Historic Places – a list maintained by the National Park Service of areas that have been designated as being of historical significance under the National Historic Preservation Act.

native species – plants that originated in the area in which they are found, *i.e.*, they naturally occur in that area.

The National Environmental Policy Act of 1969 (NEPA) – the national charter for protection of the environment. NEPA establishes policy, sets goals, and provides means for carrying out the policy. Regulations at 40 CFR 1500–1508 implement the act.

No Action Alternative – an alternative describing the currently approved operating, reclamation, and closure activites of the Stillwater Mining Company at the Stillwater and East Boulder Mines.

operations – the period during which active mining is taking place, tailings are being generated, and active adit water treatment is ongoing.

Organic Administration Act of 1897 – Act of Congress that provides the authority for the USFS to administer reserved and outstanding mineral operations in conjunction with the Secretary of Agriculture. The law specifically authorizes the USFS to manage the surface resources on National Forest System lands.

peak flow – the greatest flow attained during melting of winter snowpack, during a large precipitation event, or during discharge of adit water.

percolation ponds – ponds constructed to discharge treated process water into shallow ground water.

pH – the negative logarithm of the hydrogen ion activity in solution; a measure of the corrosivity of a solution.

plan of operations – as required by 36 CFR 228.4, the operator submits a Plan of Operations to the USFS that includes: the name and address of the operator, location of the proposed area of operations, information sufficient to describe the type of operations proposed, and measures to be taken to meet the requirements for environmental protection.

Porosity – the amount of connected pore spaces, i.e. the space available for fluid penetration.

potentiometric surface – a surface that represents the total head of ground water; defined by the level to which water will rise in a well. The water table is a particular potentiometric surface.

post-closure – the period after which reclamation has been completed and active water treatment is no longer required. Monitoring and maintenance would continue.

ppm – parts per million.

Proposed Action Alternative – an alternative that includes the activities proposed by Stillwater Mining Company at the Stillwater and East Boulder Mines during operations, closure, and post closure periods.

precious metal – a general term for gold, silver, or any of the minerals of the platinum group.

preservation – a visual quality objective that provides for ecological change only.

reclamation cover – the glacial borrow material and waste rock that will be utilized to cover tailings impoundments during closure activities.

ravel – the particle-by-particle transport of material downslope due to gravity.

riparian – situated on or pertaining to the bank of a river, stream, or other body of water. Riparian is normally used to refer to plants of all types that grow along streams, rivers, or at spring and seep sites.

run-on diversion channel – a constructed feature used to control storm water from either entering or discharging from the mine site.

runoff – that part of precipitation that appears in surface streams; precipitation that is not retained on the site where it falls and is not absorbed by the soil.

scatter (archeological) – random evidence of prior human activity or disturbance that is distributed around an area rather than concentrated in a single location.

sediment – material suspended in or settling to the bottom of a body of water. Sediment input comes from natural sources, such as soil erosion, and rock weathering from soil erosion as a result of agricultural practices or construction activities.

sediment retention basin – a mine site feature used to trap sediment from storm water prior to discharge or infiltration.

seepage through the cover – precipitation that infiltrates through the reclamation cover into the tailings impoundment.

sensitive species – those species of plants or animals that have been identified in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species under the Endangered Species Act. This also includes species that are on an official State list or are recognized by the Regional Forester as needing special management to prevent their being placed on Federal or State lists.

short-term effects – an impact that, within a short period, would no longer be detectable as the resource is returned to its pre-disturbance condition or appearance.

Site Vulnerability Index – a field approach to readily assess a site's potential susceptibility to the loss of nitrogen by leaching and phosphorus by surface runoff.

slickenside – a polished and striated (scratched) surface that results from friction along a fault plane.

slimes – the fine fraction of tailings that is smaller than 45 microns in size.

Slurry – a mixture of fine-grained solid material and water used to allow pumping as a way to transport the solid material over long distances.

SMC – Stillwater Mining Company.

storm water – rain and snow melt that runs off a slope into streams and ponds or infiltrates into the ground. Storm water from reclaimed areas must be handled separately from unreclaimed areas due to the potential for contamination in the unreclaimed areas.

storm water channel – a constructed conveyance to control storm water.

supernatant water – standing water on top of the tailings mass (solid materials) within the tailings impoundment.

tailings water – water that has been mixed with and carries the tailings through the milling process and is stored between particles in the tailings impoundment.

threatened species – any species of animal or plant that is likely to become endangered within the foreseeable future throughout all or significant portions of its range.

tiering – the coverage of general matters in broader Environmental Impact Statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional program statements or ultimately site-specific statements) incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared.

TDS – total dissolved solids – an expression of all inorganic and organix substances contained in a liquid which are present in a molecular, ionized or micro-granular suspended form.

TIN – total inorganic nitrogen – a measure of the total nitrates, nitrites, and ammonia concentrations in water. It is typically measured in milligrams per liter (mg/l).

TSS – total suspended solids – undissolved particles suspended in a liquid.

tpd – tons per day.

transmissivity – a measure of the ability of a material or medium to transmit electromagnetic energy, as light.

turbidity – a visual, qualitative measurement of the total suspended solids in water.

underdrain water – tailing water that has infiltrated through the tailings mass and has been captured by an engineering drainage layer at the base of a tailings impoundment.

underdrain sump – an engineered water collection tank that captures underdrain water and facilitates pumping of the water back to the tailings pond during operations.

Waters of the United States – a jurisdictional term from Section 404 of the Clean Water Act referring to water bodies, such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce.

water in the tailings mass – the tailings water held within the tailings mass that is stored between tailings particles, much of which is freed as the tailings consolidate.

watershed – the geographic area from which water drains into a particular stream, river, or body of water.

wetlands – areas that are inundated by surface or ground water with a frequency sufficient to support a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

whole tailings – refers to concentrator tailings that contain both the coarse fraction (sandfill) and the fine fraction (slimes), which are directed to the cyclones for separation into the coarse and fine fractions.

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