Final Environmental Impact Statement

Appendices

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

May 2012

Montana Department of Environmental Quality

Beartooth Ranger District
Custer National Forest

Yellowstone Ranger District
Gallatin National Forest

Appendix A — Synopses of Related Environmental Documents

This appendix includes synopses of related environmental documents for the Stillwater and East Boulder mines.

A.1 Stillwater Mine

A.1.1 Final Environmental Impact Statement, Stillwater Project

Final Environmental Impact Statement, Stillwater Project, Stillwater County, Montana. Prepared by Montana Department of State Lands and USDA Forest Service, Custer National Forest. December 1985.

A.1.1.1 Proposed Action

Stillwater Mining Company proposed to open a platinum-palladium mine within the Stillwater mineral complex. The project would have a 30-year mine life at a daily production rate of 1,000 tons of ore. Underground mining by means of cut-and-fill stoping primarily would be used. Tailings from the milling process would be separated into the sand fraction and the fines fraction. The sand fraction would be backfilled into mining stopes. The fine tailings would be placed in a tailings pond next to the mill. Concentrate from the mill would be trucked to Columbus and shipped by rail to various markets. The project permit area would cover 550 acres.

A.1.1.2 Alternatives Analyzed

In addition to the No Action alternative, several action alternatives were evaluated in detail in the analysis. Production System Alternatives consisted of three alternative tailings disposal locations (including the Hertzler Ranch Site). Mine Portal Arrangement Alternatives were chosen from three arrangements. Electrical Power Supply Alternatives were selected from three options. A public access route to the West Fork Stillwater River was chosen from two possibilities.

A.1.1.3 Environmental Impacts of the Proposed Action

The main areas where issues of concern were identified included: water quality and quantity, reclamation, wildlife, aesthetic values, transportation, surface subsidence, socioeconomic effects, and scenic quality. Water quantity and quality would be affected similarly to the effects from exploration. The mine would probably discharge about the same amount and quality of water as during exploration. Detectable increases in nitrate and total nitrogen concentrations in alluvial ground water would continue downstream of the mine. Water quality of the Stillwater River would be unaffected. Very high flood flows (greater than the 1000-year flood) would encroach on the tailings impoundment, contributing sediment to the Stillwater River. During such a flood, however, the sediment load would be so high from natural sources that the added mine-related sediment would be undetectable.

Reclamation would be affected by soil disturbance and storage. Soils would lose organic matter and this loss would yield a low post-mining water- and nutrient-holding capacity. The decreased capacity would probably result in lower vegetative densities during the initial reclamation years and perhaps some initial revegetation failures. A loss of, or reduction in, soil microorganism populations caused by prolonged storage could result in lower plant species diversity and vigor for several years following initial revegetation. Forage production would increase, primarily from revegetation of 59 acres of previously disturbed lands. Plant diversity would decline from pre-mining levels.

Critical wildlife habitat would not be disturbed. Mule deer and bighorn sheep would lose a small amount of wintering range. These two species could also react to mining activities and noise by withdrawing from nearby areas. The MTFWP believed a herd reduction was imminent and that herd elimination was possible if mining were permitted. Road kills of deer would increase. Population increases in Stillwater County, of which only a portion would be mine-related, would increase housing construction, hunting and other recreation, and poaching by an unknown amount. No threatened or endangered species would be adversely affected by the proposed project.

Aesthetic impacts would be visual (scenic quality) and auditory. The mine and mill would alter the landscape, significantly affecting the visual resources at the mine site. The visual quality objectives would not be met, if at all, until sometime after the completion of reclamation. Noise levels near the mine site would increase considerably. However, because noise decreases rapidly with distance, travelers on County Road 419 would be exposed to only a small increase in noise levels. Residents within 0.5 miles could hear noises associated with the facility.

Transportation effects would include increased traffic volumes on CR 419, CR 420, and CR 78 because of increases in mine-related and household trips. CR 419 and 420 would be most affected by work traffic, and CR 78 by household trips. Increased traffic would result in increased traffic accidents and road maintenance costs. Ranchers, recreationists, and wildlife could be adversely affected by the increased traffic.

Surface subsidence from possible collapse of portions of the mine workings would present minimal long-term risk to the public.

Socioeconomic effects: Area employment and income would both increase. The first year of project construction would add 100 to 150 new jobs to total county employment. If the company proceeded with project development, mill construction would add an additional 150 jobs. During operations the project would employ 200 to 220 people. About 89 jobs would be filled by local residents. The project could increase the population of Stillwater County by 8.1 percent, Absarokee by 24.7 percent, and Columbus by 10.3 percent above the 1995 level without the mine.

A.1.1.4 Decision

The Commissioner of the Department of State Lands and the Supervisor of the Custer National Forest identified a preferred alternative, approved the project, and issued a Record of Decision in 1985.

A.1.2 Preliminary Environmental Review/Environmental Assessment (PER/EA), Stillwater Project East Side Adit Development

Preliminary Environmental Review/Environmental Assessment (PER/EA), Stillwater Project East Side Adit Development. Montana Department of State Lands and Custer National Forest. February 1989.

A.1.2.1 Proposed Action

Stillwater Mining Company proposed to develop the ore reserves on the east side of the Stillwater River in order to reach 1000 tons per day (TPD) of ore production. SMC proposed the development of six adits and one shaft. Ore from the east side development would be trucked to the west side for processing in the existing mill/concentrator. Waste rock not used for construction or other uses would also be trucked to the west side for use in constructing the tailings impoundment dam. Tailings impoundment capacity and design would not change from that approved in 1986.

A.1.2.2 Alternatives Analyzed

Three alternatives were considered in detail. They included the Proposed Action (Alternative 1), the Proposed Action with several agency-identified mitigation measures (Alternative 2), and the No Action Alternative (Alternative 3).

A.1.2.3 Environmental Impacts of Proposed Action

Various impacts were considered capable of being fully mitigated with the implementation of the following measures: (1) two measures to provide traffic reduction; (2) two measures to reduce visual impact; (3) six specific actions to compensate for losses to bighorn sheep habitat; (4) two measures to protect raptors; (5) four measures to monitor ground water quantity and water rights; (6) three measures to protect water quality; and (7) a measure to protect cultural resources.

A.1.2.4 Decision

The decision was made by the Commissioner of the Department of State Lands and the Supervisor of the Custer National Forest to select Alternative 2 and approve the project (Amendment No. 5) with a Finding of No Significant Impacts on March 2, 1989.

A.1.3 Final Environmental Impact Statement, Stillwater Mine Expansion 2000 Tons Per Day, Application to Amend Plan of Operations and Permit No. 00118.

Final Environmental Impact Statement, Stillwater Mine Expansion 2000 Tons Per Day, Application to Amend Plan of Operations and Permit No. 00118. Prepared by Montana Department of State Lands, Montana Department of Health and Environmental Services, and Forest Service. 1992.

A.1.3.1 Proposed Action

SMC proposed to increase the mine production rate up to 730,000 tons per year (2,000 TPD). Included in the proposal was enlargement of the tailings impoundment, expanding waste rock storage, new buildings and berms, etc, on 35 acres, expanding processing facilities capabilities, relocating certain buildings, an incremental addition of 161 additional employees, and an application to change ambient water quality for total dissolved solids, ammonia, nitrates, and metals in both surface and ground water.

A.1.3.2 Alternatives Analyzed

Five alternatives were considered in detail. They were No Action, Proposed Action, Proposed Action with Modified Tailings Impoundment (Partial Approval), Proposed Action with Advanced Water Treatment, and Proposed Action with Modifications to Tailings Impoundment, Waste Rock Storage, and Water Resources.

A.1.3.3 Environmental Impacts of Proposed Action

About 35 acres of new disturbance would occur. Marginal reclamation would occur because of limited replacement soils. Facilities would eliminate vegetative production on 42 acres. Irrigation with nitrate-rich water would increase plant growth. The bighorn sheep herd would continue to be threatened; facilities would eliminate forage on the toe dike. Atmospheric emissions would increase, but permit levels would not be exceeded. Recreational use in area would increase some. Visually, the embankment would be raised 14 feet, the rock armor would be visually uniform, a longer period of time would be necessary to achieve retention of visual quality, and visual screening would be provided by berm on east side. A total employment impact of 232 jobs would occur. Stillwater County's population would increase by 150 people more than projected. Demands would increase for housing, community services, and community facilities. Traffic would double to about 262 vehicles per day.

A.1.3.4 Decision

The agency decision makers approved and permitted the amendment (Amendment No. 8) on September 23, 1992.

A.1.4 Final Environmental Impact Statement, Stillwater Mining Company Underground Valley Crossing and Mine Plan.

Final Environmental Impact Statement, Stillwater Mining Company Underground Valley Crossing and Mine Plan. Application to Amend the Plan of Operations, Permit No. 00118. Prepared by Montana Department of Environmental Quality. February 1996.

A.1.4.1 Proposed Action

In April, 1995, SMC proposed to amend its Operating Permit by proposing to connect the East and West mining areas by means of a haulage drift located at the 4400-foot level of the mine. The haulage drift would be developed beneath the Stillwater River and its floodplain. As part of the proposed amendment, SMC sought approval to mine the ore body at and below the 4400-foot level if and when mineralization was defined.

The project would be conducted in two phases. Phase 1 would include completion of the 4400-foot level haulage drift and the diamond drilling necessary to define the mineralization. Phase 2 would involve implementation of mining below the surface crown pillar. Approval of the proposed amendment would allow SMC to reduce ore and waste handling costs by reducing haul distances to the mill and to crush ore prior to reaching the mill, to access and further delineate additional ore reserves, and to reduce conflict with recreational traffic using County Road 419.

A.1.4.2 Alternatives Analyzed

Three alternatives were considered by DEQ. They were the Proposed Action, No Action alternative, and Proposed Plan with Modifications.

A.1.4.3 Environmental Impacts of Proposed Action

Impacts were analyzed to address the issues of geotechnical stability, increased inflow of ground water to the workings, and water quality of both surface and ground water. Stability analyses indicated the proposed crown pillar thickness (200 ft) was adequate. The long-term stability of the pillar was not considered to be an issue, particularly because SMC proposed to backfill the 4400-ft level haulage way at closure where it would be adjacent to the base of the crown pillar. In addition, all stopes would be backfilled upon completion of mining.

Inflows of ground water were expected to be similar to flows previously observed in the East Side Mine. The predicted rate of inflow to the haulage level

(200 gpm) was not expected to have any impact on flow in the Stillwater River or ground water levels in the valley.

Ground water and surface water quality were not expected to change following implementation of the proposed action. Mine production rates and associated nutrient loading from the mining activities would not be increased by the proposed action and would not exceed the levels analyzed in the SMC 2000 TPD EIS.

A.1.4.4 Decision

The Director of DEQ approved the permit amendment (Amendment No. 9) and the project was permitted in 1996.

A.1.5 Final Environmental Impact Statement Stillwater Mine Revised Waste Management Plan and Hertzler Tailings Impoundment.

Final Environmental Impact Statement Stillwater Mine Revised Waste Management Plan and Hertzler Tailings Impoundment. Prepared by Montana Department of Environmental Quality and USDA Forest Service. October 1998

A.1.5.1 Proposed Action

The proposed action amended operating permit #00118. Specific changes included: a new tailings impoundment on the Hertzler Ranch 7.8 miles northeast of the mine; a system of pipelines along Stillwater County roads 419 and 420 connecting the tailings impoundment to the mine and mill; expanding the waste rock storage areas on the east side of the Stillwater River; relocating the Land Application Disposal (LAD) system from the east side of the Stillwater River to both the Stratton Ranch and the Hertzler Ranch; and removing the 2000 tons per day restriction on processing ore.

A.1.5.2 Alternatives Analyzed

Four alternatives were analyzed: Alternative A — No Action, Alternative B — Proposed Action, Alternative C — Modified Centerline Expansion of the Nye Impoundment and a smaller Hertzler impoundment, Alternative D — Modified Centerline Expansion of the Nye impoundment plus a new impoundment and waste rock storage facility on the east side of the Stillwater River.

A.1.5.3 Environmental Impacts of Proposed Action

Key issue areas included water quality and quantity, wildlife, fisheries, air quality, socioeconomics, tailings impoundment stability, aesthetics, transportation and reclamation. Ground water quality would be affected by localized increases in nitrates. Surface water quantities would experience short-term increases in runoff. Surface water quality would experience minor degradation but no standards would be violated. Nitrate levels in the Stillwater River would increase, but would not violate any standard. Approximately 1.5 acres of wetlands (Waters of the U.S.) would be affected by the pipeline route, but these effects would be mitigated through in-kind reclamation. Air quality would experience slight increases in particulate matter, especially during construction. Vegetation and wildlife habitat communities on 678 acres would be changed from the current agricultural mixture of species to a different mixture after reclamation. Fish reproduction in the Stillwater River could be affected from increases in sedimentation over the short-term.

Socioeconomic effects would include approximately 424 new residents, including 34 new school students, 45 new jobs created, and a continuation of tax payments by SMC for an additional 30 years. Visual intrusion by new facilities would not violate visual quality objectives on Forest lands. Construction noise would be created at all new facilities. Transportation effects would increase the AADT on Stillwater County roads 419 and 420 from 803 to 906. Construction of the pipeline corridors would disrupt traffic on the roads in the short-term. No direct effects would occur to cultural resources.

A.1.5.4 Decision

The Director of DEQ and Supervisor of the CNF approved the permit amendment and Operating Plan revision, respectively, and the Proposed Action with mitigation measures was permitted in 1998.

A.2 East Boulder Mine

A.2.1 Final Environmental Impact Statement, East Boulder Mine Project.

Final Environmental Impact Statement, East Boulder Mine Project. Prepared by Montana Department of State Lands, USDA Forest Service, and Montana Department of Health and Environmental Services. 1992.

A.2.1.1 Proposed Action

The East Boulder Mine Project consists of an underground mine, a surface mill and support complex, a tailings impoundment and ancillary facilities located in Sweet Grass County about 30 miles south of Big Timber, MT. The majority of surface facilities would be in the East Boulder River valley.

A.2.1.2 Alternatives Analyzed

Seven alternatives were analyzed including: 1 – No Action, 2 – Proposed Action, 3 – Modified tailing impoundment configuration, 4 – Alternative access road and power line, 5 – Alternative power supply corridor systems, 6 – Water treatment options, 7 – Proposed Action with modifications, and 8 – Twin production adits instead of one adit.

A.2.1.3 Environmental Impacts of Proposed Action

Issue areas were identified as socioeconomics, transportation, surface and ground water, air quality and noise, wildlife, fisheries and vegetation, recreation and visuals, land use, geology, reclamation, health and safety, and the permitting procedure. Population growth was expected to occur in Big Timber as a result of increased employment at the mine. About 170 persons in the first year and up to 600 workers maximum would be employed. Indirect employment was expected to increase, as is the student population. Demands for housing and community services were expected to increase. Estimated tax revenues resulting from the project increase, but would lag behind the increase in need for services. Transportation effects would include increases in traffic, road maintenance, and a reduction in traffic safety for residents. Potential impacts to surface waters include sediment runoff to streams and water quality degradation from turbidity and nutrients or chemical loading. Impacts to ground water quality could occur from improper disposal of process waters, impoundment leakage, and chemical spills. Air quality would be decreased due to increased particulate and gaseous emissions. Noise would be generated at all facilities. Vegetation and wildlife habitat would be disturbed on 233 acres (most of which is timbered), and disturbance to wildlife would increase from increased traffic and area access. Fisheries could be affected by sediment loading, changes in water quality, changes in fish passages, and in fishing pressure.

Impacts to fishing and hunting quality and dispersed recreation would result. Visual effects on line and color in foreground views would result from construction of facilities, especially the tailings impoundment. Effects on land use would result from increased noise and traffic, and to the timber management by the USFS. Geological impacts would include changing landforms, creating a tailings impoundment, and the depletion of the mineral resources.

A.2.1.4 Decision

The decision-makers of DEQ, DHES and the Supervisor of the GNF approved the mine operating permit application (Plan of Operations), and the Proposed Action with mitigation measures was permitted in 1992.

Appendix B — Monitoring Plan for Boe Ranch LAD System Agency-Mitigated Alternative 3C

If the Boe Ranch LAD System Agency-Mitigated Alternative 3C is selected and approved by the agencies, the additional components listed in this appendix would be included in the Stillwater Mining Company's (SMC's) monitoring plan. Although the monitoring program under the Boe Ranch LAD System Proposed Action Alternative 2C would indicate effects on ground water from land application disposal (LAD), it would not provide data to evaluate the health of the soil resource beneath the LAD area. Selection of the Agency-Mitigated Alternative 3C would minimize the potential for direct adverse short-term and long-term effects from the accumulation of nitrogen and salts in Boe Ranch soils. The agencies' additional monitoring requirements and action plans would ensure that nitrogen and salts problems do not develop over the life of the Boe Ranch LAD system.

Under the Agency-Mitigated Alternative 3C, SMC would monitor the weather, soil quality, soils saturation, LAD application rate, vegetation, and water quality at the Boe Ranch LAD area. The monitoring plan would include threshold conditions and levels that, if exceeded, would trigger changes in LAD operation. SMC would propose to the agencies six to 12 months prior to the construction of the Boe Ranch LAD system a monitoring plan that includes these additional components. The agencies would review and approve the plan prior to implementation. Additional baseline soil, vegetation, water, and climate data would have to be collected before LAD is implemented at the Boe Ranch.

B.1. Monitoring

B.1.1 Weather

SMC would establish a complete weather station at the Boe Ranch site to collect baseline climate information at least one year before LAD is initiated and during operations. The agencies and SMC would jointly locate this station. Data from the station would be used to develop water budgets and to plan irrigation schedules for the Boe Ranch LAD System. Precipitation, wind speed, and weather predictions would be used with soil moisture data to determine the appropriate amount and rate of water to be applied through the LAD system. These data would be used to prevent surface runoff, over-irrigation (*i.e.,* saturation) of soils, salinization of soils, and to maximize plant uptake of nitrogen. The agencies suggest that SMC use a real-time system capable of electronically relaying this information immediately to SMC.

B.1.2 Soils

The following sections provide conceptual details of the proposed monitoring plan for soils.

B.1.2.1 Soils Mapping and Physical Characteristics

To facilitate the proper location of lysimeters, moisture probes, and soils sampling sites, the variability of soils within each proposed center pivot and adjacent control site(s) would be assessed through an Order II soil survey. The Order II soil survey would describe the gradation and range of soil properties and clearly depict each soil unit on an appropriately-scaled map. The survey would also include the following soil parameters:

- Thickness of horizons
- Porosity
- Texture
- Coarse fragment content
- Moisture content
- Bulk density
- Estimate of field capacity
- Depth to water table
- Existing surficial cracks and fill slope bulges

All future soils information would be consistently presented and coupled with the Order II soil survey and map. The location and dimensions of any changes in existing or new major surficial cracks and fill slope bulges would be identified and mapped.

B.1.2.2 Baseline Soils Quality Data

Baseline soils samples would be collected according to soil types and horizons, down to a depth of at least five feet or to the lithic contact. Samples would be collected using standard sample collection and handling quality assurance/quality control procedures. Each sample would be analyzed for:

- Nitrite plus Nitrate nitrogen ($NO_2^- + NO_3^-$)
- Ammonium (NH^+_4)
- Total Kjeldahl Nitrogen (TKN)
- Total Organic Carbon (TOC)
- Sodium Adsorption Ratio (SAR)
- Saturated Paste Extract Electrical Conductivity (EC) and pH

These data would be used to assess the health and condition of LAD area soils, identify major and critical soil types, and assist in developing irrigation schedules.

B.1.2.3 Operational Soils Monitoring

SMC would submit, six to 12 months prior to the construction of the Boe Ranch LAD system, a detailed plan for the location, installation, and monitoring schedule of lysimeters and moisture probes. The plan would include SMC's proposed schedule and criteria for application of LAD. Soils data would be collected within and downgradient of the proposed LAD areas and established in similar reference areas not influenced by the LAD. These locations would represent the major soil units within each area covered by the center pivots and, if present, critical units that have the most limitations or would most likely be affected by operation of the LAD system (*e.g.*, high-permeability, large coarse rock fragment content, potential for mass wasting). These locations would accurately reflect the variability in landscape and soils, position relative to prevailing winds, probable drift from the pivots, and potential for surface runoff and shallow subsurface interflow. At least one soil moisture probe (or array) would be located beneath each center pivot.

The soil profiles would be sampled by soil horizon. All lysimeters, moisture probes, and soil sampling sites would be permanently staked for identification on the ground, and delineated on a map for regular monitoring during and after the life of the LAD.

The weather station, array of lysimeters, soil moisture probes, and soil sampling sites are intended to provide data for the accurate estimation of evapotranspiration (ET), uptake of nitrogen by native and introduced plant species, attenuation and export of nitrogen and salts, and the annual loading of nitrogen and salts to the ground water. Considerable variation in ET rates would occur over the 30-year period of LAD operation. Daily soil water monitoring would be conducted, so irrigation would be optimized to control percolation of LAD water below the root zone. Soil moisture probes would be calibrated to the soil's moisture characteristics and have the capability of defining moisture content throughout the soil profile. The agencies suggest that SMC use a real-time system capable of electronically relaying this information immediately to SMC.

B.1.2.4 LAD Application Rate and Soil Water

Denitrification (net loss of nitrogen from the system) is negligible at moisture levels below about two-thirds of the water-holding capacity but is appreciable in flooded soils (Stevenson 1982). To facilitate the gaseous loss of nitrogen from soil, the LAD irrigation rate would be adjusted to maintain 65 to 80 percent of saturation in the top 12 to 18 inches of the soil profile. Optimal soil moisture content would facilitate denitrification through maximization of soil moisture residence time in the root zone.

To maximize plant nitrogen uptake and minimize the potential for runoff and nitrogen leaching below the root zone, SMC would adjust daily the LAD water application rate based on addition to soil water from precipitation and depletion of soil water by ET.

A daily water budget would be constructed to track water moving into and out of the effective root zone. The water budget would be solved in terms of daily soil moisture depletion. The amount of irrigation applied per day would be less than or equal to the amount of soil moisture depleted the previous day. Daily water budgets would be based on:

- Soil moisture readings
- Predicted or actual rainfall
- Depth of root zone (*i.e.,* soil reservoir water storage capacity)
- Soil field capacity
- Status of SMC's water balance
- Amount of LAD evaporated
- Amount of LAD delivered to soil
- Soil salts monitoring
- Ground water monitoring

LAD water application rates would be reduced with precipitation and when actual ET is low. LAD water application rates would increase when there is no precipitation and actual ET is high.

The volume of water collected in all lysimeters would be measured and noted weekly. Samples would be regularly collected according to standard sample collection and handling procedures for the following analyses:

- $NO_2^- + NO_3^-$
- NH^+_4
- TKN
- Chloride
- Sulfate
- EC
- pH

The results of these analyses would be compared with ground water quality data to evaluate nitrogen utilization by plants and the effect of deep percolate on ground water. SMC could apply at greater than these rates if a problem with the water balance or soil salinity develops as long as water quality levels are below the threshold action levels established for the site.

B.1.3 Ground Water, Seeps, and Springs

SMC would propose a monitoring network that encompasses the full extent of the Boe Ranch LAD system to the East Boulder River. This network would be placed to ensure identification of water quality changes due to application of LAD and any leaks from the LAD storage pond.

Pairs of monitoring wells consisting of a shallow, glacial-layer well and a bedrock well would be located upgradient, within, and downgradient of the LAD area.

The monitoring wells would be used to indicate whether an increasing trend of nitrogen or salts was occurring as a result of LAD.

Prior to the construction of the Boe Ranch LAD system, SMC would document the location and flow rate of seeps and springs downgradient of the Boe Ranch LAD area. SMC would propose for agency review and approval a list of seeps and springs to monitor. During the irrigation season, SMC would periodically perform visual inspections for new seeps and surface runoff caused by LAD and make appropriate adjustments to LAD application rates. SMC would document new seep location(s) using GPS coordinates, estimate the flow rate of the seep(s), and report the formation of new seeps to the agencies.

Monitoring wells and selected seeps and springs would be sampled at least three times annually (spring: March to April, summer: July to September, and fall/winter: November to January), according to standard sample collection and handling quality assurance/quality control procedures, and analyzed for the following parameters.

- $NO_2^- + NO_3^-$
- NH^+_4
- TKN
- Common ions (Ca, Mg, K, Na, Cl, SO_4, carbonate, bicarbonate, and hardness)
- EC
- pH

If newly identified seeps have sufficient volume to sample, they would also be sampled for these parameters.

B.1.4 LAD Storage Pond, Mason Ditch, and East Boulder River

The volume of water in the LAD storage pond would be measured and used in SMC's overall water balance calculations. SMC would include in its LAD operation plans contingencies for those times when a positive (excess) water budget exists due to precipitation or high water inflows at the East Boulder Mine.

The Mason Ditch and the East Boulder River would be sampled at least three times annually (spring: March to April, summer: July to September, and fall/winter: from November to January), according to standard sample collection and handling quality assurance/quality control procedures, and analyzed for the following parameters.

- Flow rate
- $NO_2^- + NO_3^-$
- NH^+_4
- TKN
- Common ions (Ca, Mg, K, Na, Cl, SO_4, carbonate, and bicarbonate)
- EC
- pH

The results of the Mason Ditch monitoring would allow the agencies to determine its effect on the quality of ground water flowing from the land application area to the East Boulder River. Flow information for both the Mason Ditch and the East Boulder River would be necessary to interpret the effect of land application on ground and surface water.

B.1.5 Vegetation

Vegetation would be sampled periodically to document plant community compositional changes and health over time. SMC would include vegetation management in its plan submitted to the agencies for review and approval.

B.1.6 Mass Wasting

SMC would not use center pivot 10 (P10) because of mass wasting concerns. CES (2008) recommends undertaking additional investigation to assess the soils' ability to absorb the design flow LAD capacity near center pivot P9. The agencies would recommend the same level of sampling near P4.

SMC would submit a plan that would identify conditions that favor slumping or mass wasting around center pivots P4, P9, and P10. In this plan, SMC would consider the effect of deep percolate (soil water) on slope stability within the Boe Ranch LAD area. SMC would perform regular slope stability inspections during operation of the LAD system and provide in its plan operational adjustments that could be made if conditions were identified that favor slumping or mass wasting around the center pivots or storage pond. A geotechnical specialist would look for visible signs of slope movement, soil failures, and other indications of deep-set slope instability annually for a period of three years. The need for further annual geotechnical inspections would be reviewed at that time.

The location and dimensions of major surficial cracks and fill slope bulges identified in the baseline survey would be monitored and any changes would be reported to the agencies. This information would be used to determine if surface cracks and fill slope bulges were the result of LAD activities. Surficial fractures that progressively widen and elongate, or surface cracks located above a prominent, recently-observed surface bulge would be considered an indication of slope failure. If the potential for instability raises concerns for public safety or the environment, SMC would develop corrective plans.

B.2. LAD Storage Pond High-Hazard Action Plan

SMC would prepare an Operations and Maintenance Plan and an Emergency Preparedness Plan for the high-hazard Boe Ranch LAD storage pond for review and approval by the Montana Department of Environmental Quality (DEQ). DEQ would consult with the Montana Department of Natural Resources and Conservation (DNRC) to ensure that the plans met the requirements of the Montana Dam Safety Act. SMC would also prepare a conceptual plan for reducing the volume of water in the LAD storage pond to less than 50 acre-feet at closure to eliminate the high-hazard classification. These plans would have to be submitted six to 12 months before the LAD storage pond is constructed.

B.3. LAD Pipeline Monitoring and Spill Contingency Plan

SMC would prepare for agency review and approval a Pipeline Monitoring and Spill Contingency Plan (PMSCP) for operation of the LAD supply pipeline from the East Boulder Mine. The plan would be submitted for approval by DEQ and the Gallatin National Forest (GNF) six to 12 months before the pipeline and LAD system are constructed.

B.4. Threshold Conditions, Action Levels, and Reporting

The primary concerns associated with the land application of mine water are the accumulation of nitrates and salts in soil and subsequent transport through ground water to the East Boulder River. The following threshold action or trigger levels would address these concerns.

The threshold action level for nitrogen in ground water would be 2 mg/L total inorganic nitrogen (nitrogen) above the ambient nitrogen concentration. This action level would identify over-application of LAD in wells upgradient of the LAD storage pond. The agencies may choose to select a seep as an alternate monitoring site to evaluate the application of LAD. The threshold action level for EC in ground water would be an increase of 20 percent above the baseline conditions. This action level would identify over-application of LAD in wells upgradient of the LAD storage pond. The agencies may choose to select a seep as an alternate monitoring site to evaluate the application of LAD.

If either of these threshold action levels were exceeded, SMC would immediately notify the agencies and take the appropriate measures to address the exceedance(s). SMC would identify in its plan several potential measures that would reduce nitrogen and salts loading from LAD. Potential action/contingency measures may include but are not limited to the following:

- Interseed with vegetation that is compatible with the surrounding ecosystem, adapted to local climatic conditions, and able to sequester larger amounts of nitrogen or tolerate the salts load.
- Mechanically remove aboveground plant biomass and standing litter in accessible areas.
- Manage livestock to facilitate the net removal of nitrogen.
- Periodically burn vegetation if it can be implemented safely under controlled conditions.
- Reduce the hydraulic load delivered to the LAD area to prevent seeps, erosion, and mass wasting.
- Reduce the nitrogen and salts load delivered to the LAD area. The adit and tailings waters should be monitored annually for EC and total dissolved solids (TDS) to provide advance warning of any salinity increase. Such monitoring would allow SMC to implement adaptive management actions to avoid concentrating salts in LAD area soils and vegetation when the tailings waters are disposed of at closure. SMC would supplement the frequency of its monitoring of salts in adit and tailings waters and make efforts to reduce the salts load and concentrations annually. SMC would include in each annual report the measures imple-

mented and the resulting reductions in salts concentrations achieved during the past year.

- Improve nitrogen removal efficiency of the BTS.
- Implement a salts removal treatment system at the East Boulder Mine.
- Redesign portions of the LAD system to allow regular mechanical removal of plant biomass.

Some of these action/contingency plans may not be feasible at the Boe Ranch or would have other effects that may negate the benefits. Regardless of the action/contingency plans implemented, SMC would be required to perform monitoring and assessment of the LAD system to see if operational changes could be made that could influence monitoring results. Some additional actions include:

- If either of the following triggers occur that may be reasonably attributed to the Boe Ranch LAD area, SMC would evaluate the extent of mining-related impacts on periphyton and macroinvertebrates for two additional, consecutive, late summer sampling events to establish whether a trend exists: annual chlorophyll A measurements indicate impairment (greater than 150 mg/m^3) based on the MDEQ narrative standard (Suplee et al 2009), or in-stream total inorganic nitrogen exceeds 1 mg/L downstream of the Boe Ranch LAD.SMC would submit to the agencies the results of monitoring at the end of the first two LAD seasons. If monitoring shows little effect, reporting may be changed to annual. Also, if monitoring suggests some constituents are not appearing in ground water after the first five years of operation of the Boe Ranch LAD facility, SMC may provide written documentation and request that those parameters be dropped from monitoring.

SMC would monitor the flow rate of the East Boulder River during operations. If the flow in the East Boulder River downstream of the Mason Ditch irrigation diversion drops below 3 cubic feet per second (cfs), SMC would have to dispose of some of the nitrogen load at the East Boulder Mine.

SMC would have to implement additional monitoring and mitigating measures if soil SAR concentrations in the Boe Ranch LAD area downgradient monitoring well increase two units above the Boe Ranch LAD storage pond water SAR concentrations.

If the LAD supply pipeline leaks or ruptures, SMC would sample the discharge and report to the agencies as directed in the PMSCP. A cleanup plan would have to be submitted in the PMSCP.

If the LAD storage pond develops a leak as indicated by downgradient ground water monitoring wells, a leak response plan would have to be submitted for agency review and approval.

Appendix C — Agency Water Quality & Quantity Analyses

The analyses and technical memoranda published as draft in this appendix have been revised in response to public comment. The final revised spreadsheets and memoranda are found in Appendix E.

Appendix D — Boe Ranch Supporting Data

This appendix contains maps and tables used in the agencies' effects analysis for the Boe Ranch LAD System Proposed Action Alternative 2C and the Boe Ranch LAD System Agency-Mitigated Alternative 3C.

Table 15. Average Hydraulic Flow Capacity and Management Summary- Operations or Closure

Alternative	Site	Average Flow Capacity[1,2] Growing Season gpm	Winter gpm	Total LAD Capacity gpm	Percolation Pond gpm	Total Flow gpm	Max N-Load[2] lb N/d	Maximum Volume in Boe Ranch Storage Pond MG	Comments
No Action - 1C	**East Boulder Mine**								
	LAD 6	**14**	**45**	**24**	**21**	**45**	**2.7**	**N/A**	**Phase Ia, No LAD April, May or October**
	LAD 6, 3 Upper	25	81	44	37	81	4.9	N/A	Winter Snowmaking, Summer LAD
	LAD 6, 3 Upper, 4	36	117	64	53	117	7.0	N/A	Winter Snowmaking, Summer LAD
	LAD 6, 3 Upper/Lower, 4	57	117	72	45	117	7.0	N/A	Add Summer Only Area 3 Lower
	LAD 6, 2, 3 Upper/Lower, 4	68	117	77	43	117	7.0	N/A	All East Boulder LAD Sites
	LAD 6, 2, 3 Upper/Lower, 4	68	117	77	660	737	73.5	N/A	Full Permitted Flow, Additional N Treatment Needed for East Boulder Discharge
Proposed Action - 2C	**Boe Ranch**								
	Upper Boe Ranch	**166**	**166**	**166**	**0**	**166**	**N/A**	**46**	**Phase Ib, No East Boulder LAD**
	Upper Boe Ranch + East Boulder Mine	243	243	243	0	243	1.8	50	If Boe Ranch and all East Boulder LAD Areas are constructed
Agency-Mitigated Action - 3C	**Boe Ranch**								
	Upper Boe Ranch	**162**	**162**	**162**	**0**	**162**	**N/A**	**45**	**Phase Ib, No East Boulder LAD**
	Upper Boe Ranch + East Boulder Mine	239	239	239	0	239	1.8	49	If Boe Ranch and all East Boulder LAD Areas are constructed

NOTES:

Capacities developed from monthly water balances created to illustrate possible water management practices. Winter LAD capacity based on East Boulder Mine Snowmaking Test (SMC, 2004) and 68 inches snow accumulation at 40% snow water equivalent. Growing season flow based on vegetation ET according to Montana Guidelines. Storage Pond capacity is 108 million gallons. Storage pond allows steady flows year round without percolation pond use.

Abbreviations: gpm = gallons per minute, MG = million gallons, lb N/d = pounds nitrogen per day, ET = evapotranspiration, LAD = land application disposal, Max = maximum.

1 Flows computed as gallons per minute for the season or year for comparison with SMC Water Management Plan (SMC, 1998b) = total gallons per year ÷ 1440 minutes per day ÷ days per season or year. Adit flow assumed stable. Growing Season = Jun - Oct (153 days) and is conservative using the high range precipitation. Winter = Nov - Mar (151 days).

2 LAD and Percolate Pond discharge vary on a daily basis. Max. N-Load is the maximum average daily nitrogen load at the East Boulder Mine site assuming the first 250 gpm are treated 5 mg N/L with any flow additional at 10 mg/L. Actual treatment performance shown to provide less than 5 mg/L.

3 Phases represent the Phased development of LAD in the Boe Ranch Alternative (Knight-Piésold. 2002.Stillwater Mining Company East Boulder Project, Water Management Plan Appendix K, Boe Ranch LAD Alternative, Revision 3 (Ref # 31333/18-1). Knight Piesold, Inc. Vancouver, B.C. Canada, updated April 2002.)

Table 17. Summary of Projected LAD Deep Percolation Losses- Soil Water Volume - All Alternatives (1C, 2C, 3B, and 3C)

Location	Site Type	Predicted LAD Percolate Loss								Soil AWC[2]
		Winter	Summer	Total	Leaching Reqm't[1]	Winter	Summer	Total	Leaching Reqm't[1]	
		inches per acre				inches per acre				
Operations		**Low Precipitation**				**High Precipitation**				
East Boulder Mine	Summer Only	2.6	0.3	**2.9**	**1.6**	7.0	1.1	**8.1**	**1.1**	5.7
	Winter & Summer	29.7	0.4	**30.1**	**5.5**	34.1	1.1	**35.2**	**4.9**	5.7
Boe Ranch	Boe Ranch LAD	2.6	0.3	**2.9**	**1.6**	7.0	1.1	**8.1**	**1.1**	7.8
	Boe Ranch Evaporators[3]	0.0	0.0	**0.0**	**0.0**	0.0	0.0	**0.0**	**0.0**	N/A
	Boe Ranch Snow[4]	15.1	0.0	**15.1**	**3.8**	21.8	0.0	**21.8**	**3.7**	7.8
Closure - Proposed Action Alternative 2B[5]		**Low Precipitation**				**High Precipitation**				
East Boulder Mine	Summer Only	2.6	0.3	**2.9**	**1.8**	7.0	1.1	**8.1**	**1.1**	5.7
	Winter & Summer (LAD 6)	29.7	0.4	**30.1**	**6.9**	34.1	1.1	**35.2**	**6.3**	5.7
Closure - Agency Mitigated Action Alternative 3B[5]		**Low Precipitation**				**High Precipitation**				
East Boulder Mine	Summer Only	2.6	0.3	**2.9**	**1.7**	7.0	1.1	**8.1**	**1.1**	5.7
	Winter & Summer (LAD 6)	29.7	0.4	**30.1**	**6.4**	34.1	1.1	**35.2**	**5.8**	5.7
Closure - Proposed Action 2C		**Low Precipitation**				**High Precipitation**				
Boe Ranch	Boe Ranch LAD	2.6	0.3	**2.9**	**1.9**	7.0	1.1	**8.1**	**1.4**	7.8
	Boe Ranch Evaporators[3]	0.0	0.0	**0.0**	**N/A**	0.0	0.0	**0.0**	**0.0**	N/A
	Boe Ranch Snow[4]	15.1	0.0	**15.1**	**4.5**	21.8	0.0	**21.8**	**4.4**	7.8
Closure - Agency Mitigated Action 3C		**Low Precipitation**				**High Precipitation**				
Boe Ranch	Boe Ranch LAD	2.6	0.3	**2.9**	**1.8**	7.0	1.1	**8.1**	**1.3**	7.8
	Boe Ranch Evaporators[3]	0.0	0.0	**0.0**	**N/A**	0.0	0.0	**0.0**	**N/A**	N/A
	Boe Ranch Snow[4]	15.1	0.0	**15.1**	**4.3**	21.8	0.0	**21.8**	**4.2**	4.3

NOTES:

Estimated deep percolation volumes for LAD at East Boulder Mine and Boe Ranch. Based on MT LAD Guidelines operations in summer, approximately 68 inches depth for snowmaking in winter. Summer Flow is May or June - October. Snow melt is assumed April and May. Winter snowmaking is November through March. Predictions are for average Low and average High precipitation years (Knight-Piesold, 2000).

Abbreviations: LAD = land application disposal; Reqm't = requirement; gpm = gallons per minute.

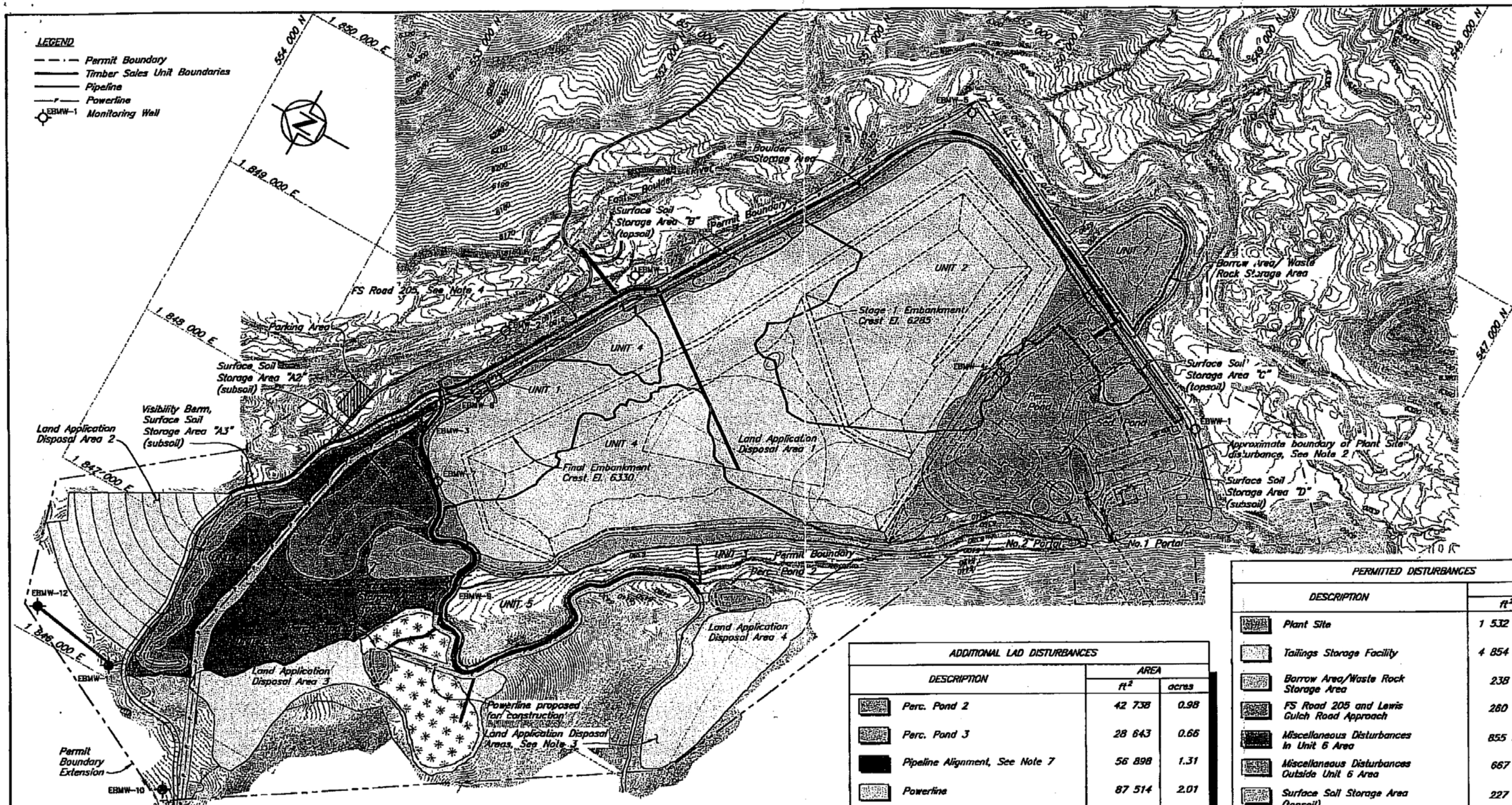
1 Leaching requirement computed from average electrical conductivity of applied mine water. Represents amount of deep percolation needed to prevent salts accumulation and maintain soil salinity less than 2 mmhos/cm (Ayers and Westcot, 1985).

2 Soil available water holding capacity shown for perspective compared to leaching requirement and deep percolation.

3 Evaporators operate over the pond so there is no percolate loss or load to be calculated.

4 Deep percolation from snowmelt includes natural and artificial snow and assumes 30% of artifical snow will runoff into storage pond.

5 Alternative 3B is in place because there were no plans under no action for East Boulder Mine Closure. Includes up to 18 months to empty Tailings Impoundment (51 gpm) + adit flow to LAD and percolation pond up to 250 gpm.



ADDITIONAL LAD DISTURBANCES		
DESCRIPTION	AREA	
	ft²	acres
Perc. Pond 2	42 738	0.98
Perc. Pond 3	28 643	0.66
Pipeline Alignment, See Note 7	56 898	1.31
Powerline	87 514	2.01
LAD 2 Pivot Disturbance	22 824	0.52
LAD Monitoring Wells and Road	11 230	0.26
	TOTAL	5.74

PERMITTED DISTURBANCES		
DESCRIPTION	AREA	
	ft²	acres
Plant Site	1 532 166	35.17
Tailings Storage Facility	4 854 273	111.44
Borrow Area/Waste Rock Storage Area	238 346	5.47
FS Road 205 and Lewis Gulch Road Approach	260 059	5.97
Miscellaneous Disturbances In Unit 6 Area	855 560	19.64
Miscellaneous Disturbances Outside Unit 6 Area	667 594	15.33
Surface Soil Storage Area (topsoil)	227 436	5.22
Surface Soil Storage Area (subsoil)	595 386	13.67
Powerline	455 179	10.45
	TOTAL	222.36

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. Additional topography for proposed permit boundary extension was surveyed in 1998.
2. Layout of Plant Site provided by Kilborn, February 1999.
3. Land Application Disposal (LAD) areas, Perc. Ponds and pipeline alignments provided by MSE/HKM. LAD areas are not additional disturbances. Pipeline alignments only account for additional disturbances outside of areas disturbed by FS Road 205 and Lewis Gulch Road approach.
4. FS Road 205 and Lewis Gulch road locations and reconstruction details provided by Morrison Maierle.
5. The Plant Site disturbance area includes 3.21 acres that extends onto the Tailings Storage Facility. This is not included in the disturbance area for the Tailings Storage Facility.
6. Monitoring Wells EBMW-10, 11, and 12 to be installed.
7. Disturbances for pipeline alignment are based on a width of 12 feet.

Scale 300 0 300 600 900 1200 1500 Feet

NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D
F	4MAY99	TIMBER SALES UNIT BOUNDARIES ADDED	KDE	DSR	DAH	KDE
E	8APR99	RE-ISSUED FOR INFORMATION	KDE	DSR		
D	18APR99	RE-ISSUED FOR INFORMATION	KDE	DSR		
C	17MAR99	RE-ISSUED FOR INFORMATION	KDE	DSR		
B	16MAR99	RE-ISSUED FOR INFORMATION	KDE	DSR		
A	12MAR99	ISSUED FOR INFORMATION	KDE	DSR		

REVISIONS

DWG. NO.	DESCRIPTION
—	—

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D

REVISIONS

STILLWATER MINING COMPANY

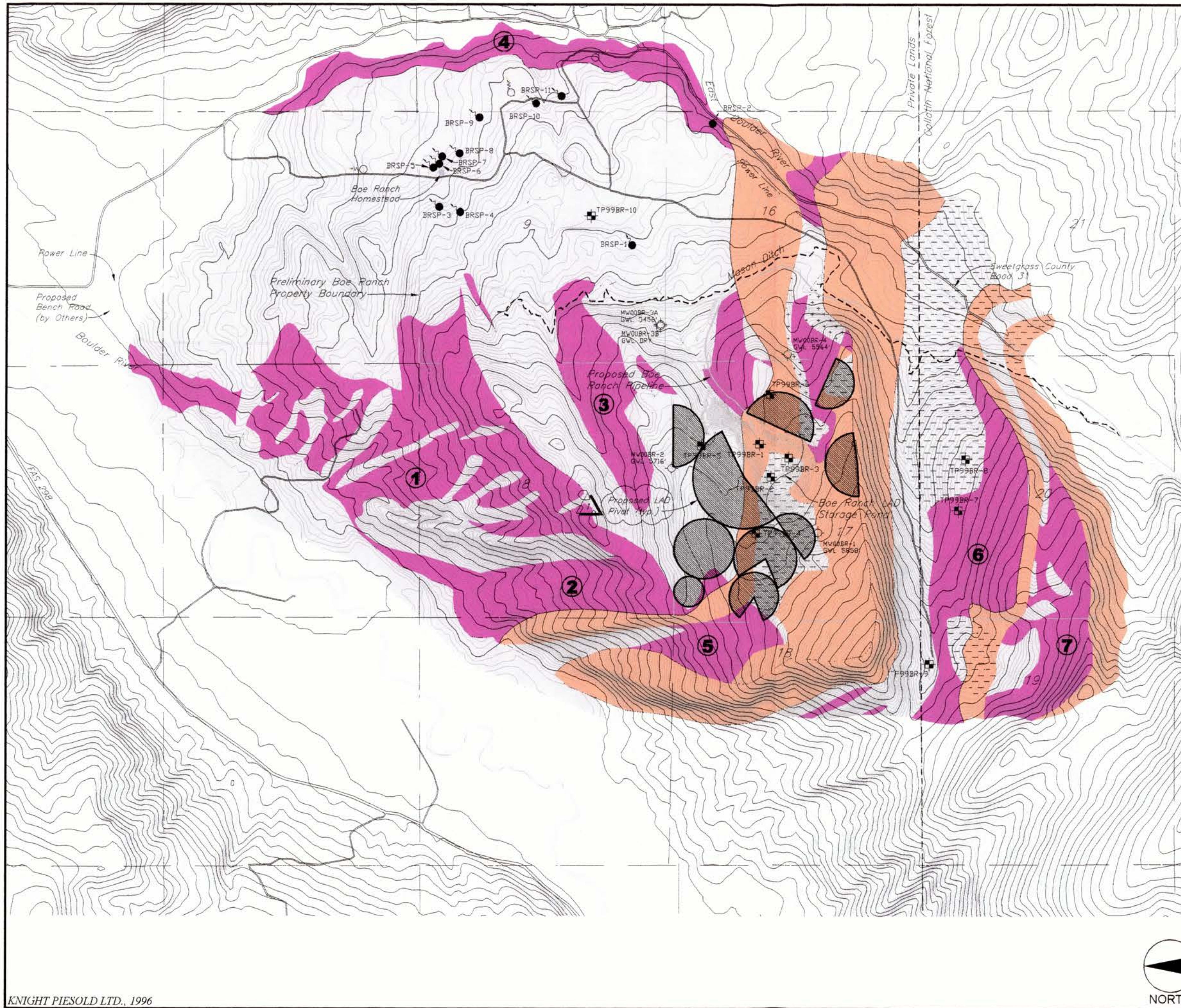
EAST BOULDER PROJECT

PERMITTED SITE DISTURBANCES

DESIGNED KDE | CHECKED | DRAWN DSR | APPROVED

Knight Piésold CONSULTING

SCALE AS SHOWN | REVISION F | DRAWING NO. 31333-8-010



STILLWATER MINING COMPANY
DRAFT EIS
Sweet Grass County, Montana

OVERALL LAYOUT OF BOE RANCH AND EAST BOULDER MINE SITE BEDROCK GEOLOGY MASS MOVEMENT POTENTIAL

FIGURE 3-5

DWG:1200 01 015.DWG | LAYOUT: 3-5
DRAWN BY: ETC | PREPARED BY: HS | DATE: 02/27/07

Appendix E — *Revised* Agency Water Quality & Quantity Analyses

This appendix contains the spreadsheets that have been revised in response to comment and four agency technical memorandums. These revised spreadsheets form the basis for the agencies' water quality and quantity analyses and effects disclosure.

Two technical memoranda have been revised and two new memoranda were written to respond to comments received on the DEIS.

- Revised projected nitrogen concentration decline in adit water when operations cease;
- Revised projected nitrogen loading estimates to the Stillwater River from the shaft at post-closure;
- New potentials for acid generation and metals mobility from ore, tailings, and waste rock;
- New in-stream nutrient criteria.

TECHNICAL MEMORANDUM

February 16, 2012

To: Kristi Ponozzo, MEPA Specialist, MDEQ
Pat Pierson, NEPA Coordinator, Custer and Gallatin National Forests, USFS

From: Lisa M. Boettcher C.P.G., Reclamation Specialist, MDEQ LB

Re: ***Revised*** Projection of Nitrogen Concentration Decline in Adit Water at the Stillwater Mining Company Mines at Nye (Stillwater Mine) and Big Timber (East Boulder Mine), Montana

What has been revised since the DEIS:

- Comments received during the comment period on nitrogen speciation are addressed in detail.
- Data from the decline of nitrogen concentration during the interim shutdown at the Troy Mine, Troy, Montana have been added.
- Further clarification of how the nitrogen decline curve would be used to determine the length of time that water treatment would be needed at closure.
- Tables that contained raw data (Table 1), annually-averaged nitrate data (Table 2), and extrapolated nitrogen concentrations in untreated adit water at closure (Table 3), are displayed graphically in figures 2, 3, and 4, respectively. These tables have been deleted from this technical memorandum.

This memo describes the analysis performed to project the decline of nitrogen concentrations in adit water from workings that do not flood during closure and post-closure at the Stillwater and East Boulder mines. Other calculations have been made with respect to flooded workings and are included in the Appendix E, March 2012 revised technical memorandum discussing Projection of Post-closure Water Quality and Nitrogen Loading from the Stillwater Mine Shaft, Stillwater Mining Company, Nye, Montana. However, it should be clarified that these memos do not address the need for treatment prior to disposal of undiluted tailings waters by percolation or land application.

Adit water would discharge from both mines following closure (*i.e.,* post-closure). If the concentrations of nitrogen in discharged waters during closure could be projected accurately, the agencies could then identify the length of time that treatment of adit water would be needed. The agencies could also identify whether there is potential for, and the duration of, post-closure untreated water quality effects.

The Stillwater Mine changed its mining plan and suspended blasting in the east-side workings in 2002. As a result of the suspension of blasting, the nitrogen concentration has declined in east-side adit water from 10.3 mg/L to less than 0.2 mg/L. The agencies believe that this 10-year decline in nitrogen concentrations measured in the east-side adit water would be representative of the rate of decline in concentrations that would occur during closure and continue into the post-closure period.

The agencies have used these nitrogen concentration data to construct a mathematical model of the post-2002 decline and used the model to project the concentrations of nitrogen in adit water that could be expected at closure and post-closure. The agencies have used standard regression analysis to develop a nitrogen decline curve. This type of analysis describes the nature of the relationship between the two variables of interest: nitrogen concentration in adit water and time. It is used to predict the value of the concentration of nitrogen in mg/L with time.

The assumptions underlying this analysis are:

- There is adequate similarity of characteristics (*e.g.* geology, hydrogeology, chemical composition of ore and waste rock, operations methodology, housekeeping practices, adit water background quality, tailings water quality, etc.) between the Stillwater and East Boulder mines that a direct comparison between the mines can be made;

- The nitrogen concentration decline observed by the ramping down and suspension of activity on the East Side of the Stillwater Mine is directly comparable to what can be expected at the Stillwater and East Boulder mines during closure; and

- The decline in nitrogen concentrations would continue at similar rates throughout closure and post-closure.

Background

Nitrogen (N) compounds in mine waters originate from blasting agents used during mine development and production of ore. Blasting residue from incomplete detonations or spilled explosives contains concentrations of nitrogen that can dissolve into adit water. Nitrogen is measured in tailings supernatant waters at about the same concentration as untreated adit water. Tailings supernatant water that migrates through the tailings mass to the underdrain undergoes a reduction in concentration from an average of about 56 mg/L to 1.7 mg/L. Species are reduced in underdrain water from nitrate to ammonia (2009 through 2011 data, SMC Annual Reports). Nitrogen concentrations are reduced in mine waste waters when treated in SMC's biological treatment systems (BTS) and during land application disposal. After treatment at the Stillwater Mine BTS, the ammonia-nitrogen and total Kjeldahl nitrogen (TKN)-nitrogen concentrations in adit water are nearly non-detectable concentrations (usually less than 0.1 mg/L). The nitrate+nitrite-N concentrations in treated adit water are consistently less than 3 mg/L. Nitrite is a short-lived nitrogen species, is at very low to non-detectable concentrations in SMC's mine waters, and will not be discussed further. Nitrogen concentrations in mine waters could become a water quality concern at post-closure when treatment would not be occurring.

Nitrogen Speciation

The agencies used nitrate data measured in adit water collected during operations and after blasting ceased on Stillwater Mine's east side to calculate the rate that nitrogen concentration would decline in adit water during closure and post-closure. The agencies believe that this rate of decline would be applicable to both mines and could be used to determine the length of time necessary to treat water at closure, and project the concentration of nitrogen in adit water at the beginning of the post-closure period.

Commenters noted that East Boulder adit water contains about 10 percent more ammonia than Stillwater's adit water, and questioned the applicability of the nitrogen decline curve constructed by the agencies to East Boulder adit water. Concerns included the potential effect that a higher percentage of ammonia would have on the rate of nitrogen decline and length of water treatment at closure. To project the time needed for water treatment, the agencies intended that the total inorganic nitrogen concentration would be used as the initial concentration on the curve, rather than only the nitrate species in adit water.

The agencies agree that ammonia is a different species of nitrogen with different geochemical characteristics from nitrate. The characteristic most worthy of note is that ammonia is more volatile than nitrate, which means that ammonia dissolved in water tends to move into the air instead of remaining in the water. Nitrate tends to remain in water. During biological treatment, ammonia is oxidized by microbes to nitrite then nitrate before being converted to nitrogen gas. There are few, if any, published data that address microbial oxidation of ammonia in underground mine waters. Most of the published literature refers to ammonia from fertilizer that oxidizes to nitrite and nitrate in soil and wetlands, or in biological treatment systems, and is not directly applicable to the quality of waters resulting from underground mining. Data have become available from the Troy Mine shutdown that are useful to project how different species of nitrogen compounds would decline after blasting ceases.

Data Evaluation: Troy Mine

Data were collected during the Troy Mine shutdown, which began in late 1992 and continued through 2004. The operational data at the mine, collected from 1982 through 1992, indicate that the nitrogen species in Troy Mine adit water were half ammonia, half nitrate ($1NH_3$:$1NO_3$). In comparison, the East Boulder adit water has a lower ratio of about one-third ammonia, two-thirds nitrate ($1NH_3$:$2NO_3$). When blasting ceased at the Troy Mine in October 1992, the average nitrate concentration during operations of about 22 mg/L declined to less than 5 mg/L by July 1993 (Figure 1). Over that nine-month time frame, the average ammonia concentration declined from 11 mg/L to less than 1 mg/L (Clum 2011). It should be noted that the change in nitrogen concentration was slightly greater for ammonia than for nitrate. These data indicate that both nitrogen species in mine adit water reduce quickly to very low concentrations once blasting ceases.

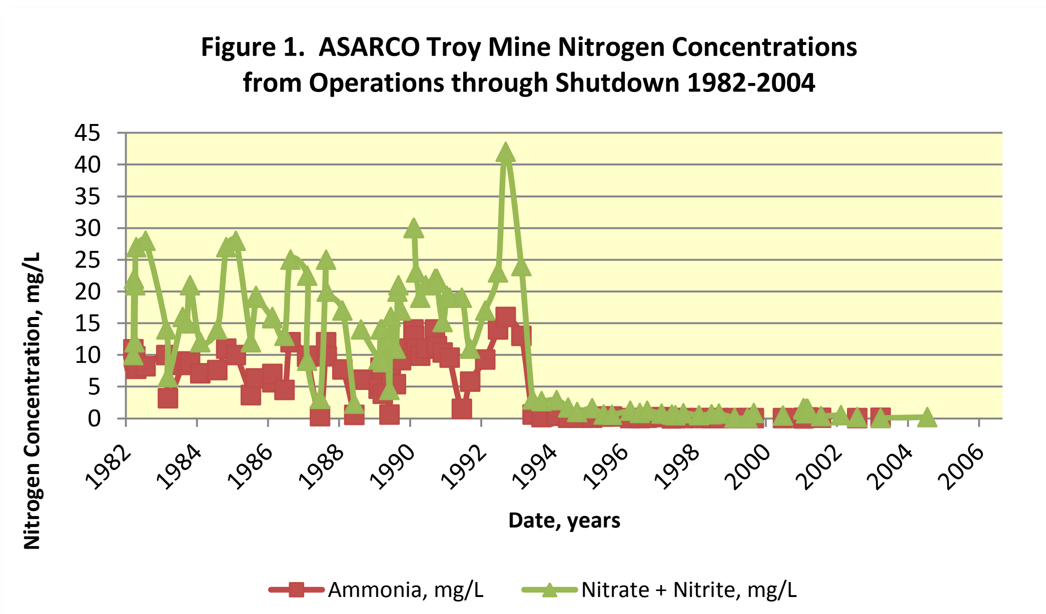


Figure 1 is a plot of the nitrate+nitrite and ammonia concentrations measured in adit water from the Troy Mine 1992 through 2004 shutdown. The ammonia concentration in Troy Mine adit water was about half that of nitrate+nitrite during operations, and both species reduced to <5 mg/L within nine months of shutdown.

The agencies recognize that there are significant differences between the Troy and SMC mines: mining method, workings magnitude and configuration, hydrology, climate, ore geology, ratio of nitrogen species in adit water, and mode of backfill. Differences aside, these data confirm that once blasting ceases, nitrogen concentrations in adit water, regardless of nitrogen species, quickly decline.

<u>*Data Evaluation:* East Boulder Mine</u>

SMC has noted reductions in nitrogen concentrations in adit waters when blasting ceased at the East Boulder Mine. Samples of untreated adit water and riser (tunnel) water were collected during two shutdown periods. The first occurred during a brief holiday shutdown December 23 through 25, Christmas 2001. During this time, no blasting occurred. The nitrogen (nitrate+nitrite as N) concentration in untreated adit water decreased from 17 mg/L to 3 mg/L over three days (Stillwater Mining Company 2002).

The second decrease in nitrogen levels occurred during the 2008 layoff shutdown, November 18 through December 1, 2008. During this time, no blasting occurred. Grab samples of riser water were taken and the nitrogen (nitrate+nitrite as N) concentrations in untreated adit water decreased from 5.7 mg/L to as low as 0.23 mg/L over this period (SMC 2008 data obtained from M. Wolfe) (Figure 2). These data indicate an overall 66-percent decline in the concentration of nitrogen over a two-week period.

These two occurrences, although not statistically significant, provide support that when operational blasting ceases and closure begins, a substantial decline in the nitrogen concentration of untreated adit water would occur over a short time frame.

Figure 2. East Boulder Mine 2008 Layoff Shutdown Nitrogen Concentration in Untreated Riser Water

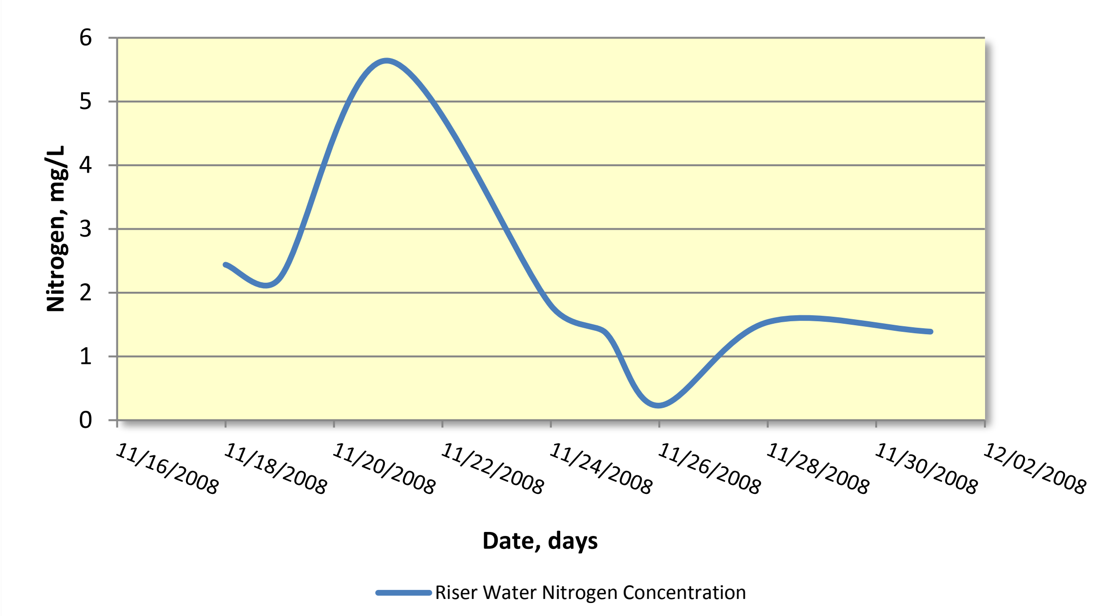


Figure 2 is a plot of the data from the two week 2008 Layoff Shutdown that occurred at the East Boulder Mine. The highest concentration was 5.7 mg/L on November 21, and the lowest concentration was 0.23 mg/L on November 26, 2008. These data represent a 66-percent decline in the concentration of nitrogen over a two-week period.

Data Evaluation: Stillwater Mine

SMC has collected nitrogen (nitrate+nitrite-nitrogen, total ammonia-nitrogen, and TKN-nitrogen) data from untreated adit water flowing from the east-side workings of the Stillwater Mine since 1989. These data were collected during operations and collection continued after the suspension of blasting in 2002 through the present. SMC collected samples from the east side at frequencies that varied from twice-annually to near-daily.

The nitrogen concentration in untreated east-side adit water reached a maximum of 10.3 mg/L in 2000 and declined to less than 0.2 mg/L since September 2007 (Figure 3). Figure 3 shows that

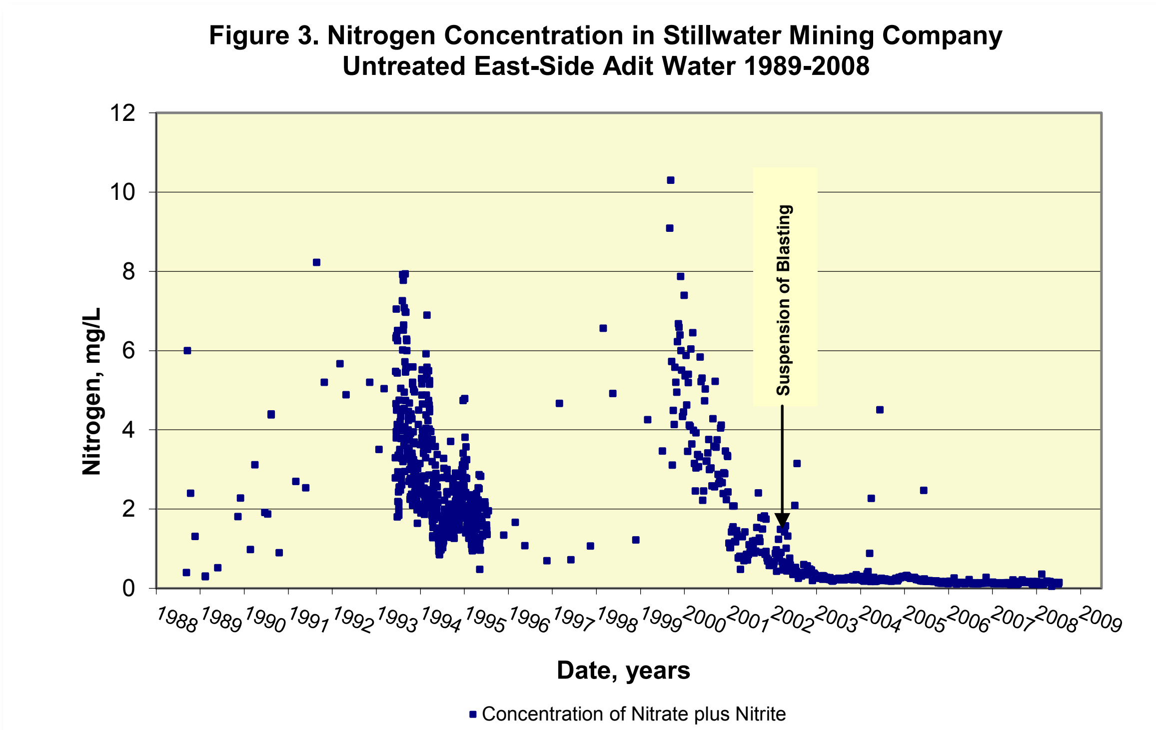


Figure 3 is a scatter plot of the concentrations of nitrogen in untreated adit water from the east-side workings from 1989 through 2008. The highest concentration was 10.3 mg/L in April 2000. The approximate date that blasting was suspended on Stillwater Mine's east side is indicated on the figure.

the concentration of nitrogen in untreated adit water increased from less than 2 mg/L in 1989 to about 8 mg/L in 1993, then decreased to generally less than 2 mg/L through 1997. There are several factors that may be responsible for this decline in nitrogen concentration: 1) a change in the mine plan that altered the amount of production and development from the east side to the west side; 2) the completion of the tunnel beneath the Stillwater River connecting the east-side to the west-side workings that may have rerouted adit water; and 3) the continual progress SMC has made to upgrade its housekeeping and blast hole loading procedures to reduce waste.

Beginning in 1998, the nitrogen concentration increased again, reaching the highest concentration of 10.3 mg/L in April 2000. The nitrogen concentration then decreased, likely a result of the ramping down of east-side production until mid-2002 when blasting on the east side was suspended. The nitrogen concentrations continued to decline after the suspension of blasting and have been less than 0.2 mg/L from fall 2007 through 2010. The agencies are satisfied that the dataset is sufficient to draw conclusions regarding the trend of nitrogen in adit water.

Method: Projecting the Decline of Nitrogen Concentration

To make predictions of the nitrogen concentrations at closure, the agencies fit an exponential decay curve to SMC's raw east-side water quality data. An exponential decay curve is a mathematical model that shows how the amount of a quantity, which in this instance is nitrogen, decreases with time. The agencies chose an exponential decay curve to model the decrease because the quantity of nitrogen in SMC's adit water was seen to decay by a fixed percent at regular intervals of time.

The agencies then determined how accurately the decay curve could predict subsequent nitrogen concentrations. A high degree of accuracy would be required to project the nitrogen concentrations at closure. Statistical methods were used to measure the accuracy of the decay curve. The coefficient of determination, R^2, is the statistical metric the agencies used to measure the accuracy of the decay curve model.

A model curve that can exactly predict subsequent data has an R^2 coefficient equal to one. For example, if the first value of a data set is 438, the second value is 279, and the third value is 105, a model curve that has an R^2 coefficient equal to one will predict 279 as the second value and 105 as the third. Such a model curve would be very accurate at predicting subsequent values. If, however, a model curve cannot predict subsequent data accurately, the R^2 coefficient will be close to zero. In other words, this means that a model curve with an R^2 of 0.10 could not accurately predict the correct second and third data values. Most R^2 values reflect varying levels of success in predicting subsequent values and have values between one and zero (Box *et al* 1978,).

When the agencies fit an exponential decay curve to the raw water quality data collected by SMC since 1999, many of the data points did not fall on the curve. If the data are sufficiently variable that many points do not fall on the curve, the R^2 coefficient will have a value closer to zero than one. The best fit exponential decay curve for all of the raw data from 2000 to present had an R^2 coefficient of 0.48. This R^2 coefficient value indicated that the initial decay curve did not successfully predict all of the subsequent data points. This initial decay curve did not have the necessary degree of accuracy and is not adequate to project the concentration of nitrogen at closure.

If the variability in the data were smoothed, more of the points would fall on the exponential decay curve model and provide a better fit of the data. A better fit would increase the success for predicting subsequent nitrogen concentrations. A method was needed that would preserve the integrity of the data yet reduce its variability. Data smoothing is typically used on a dataset to extract real trends and identify patterns (National Institute of Standards and Technology 2012). The agencies assumed that there was no small scale "structure" within the data causing the variability in the data. That is, it was assumed that the variability in the data is random and not a result of a specific undefined process or phenomenon. To smooth the data, the agencies chose to calculate the annual average nitrogen concentration for each year.

This data smoothing approach solved two problems: it reduced the number of data points to be plotted, thus increasing the accuracy of the curve fit to these data, and it preserved the time-dependence of the data (x-intercepts), giving equal weight to each year, regardless of the number of samples collected per year (annually-averaged). Recall that SMC collected samples between 1989 and 2009 at frequencies that varied from twice-annually to near-daily. This technique has resulted in an over-emphasis of the data collected in some years compared to other years. Figure 4 is a plot of the annually averaged nitrogen concentrations in untreated adit water from the Stillwater Mine east-side workings from 1989 to 2008. It is visually apparent that this data-smoothing technique was effective in preserving the trend of the raw data set shown in Figure 3.

The agencies reviewed the annually-averaged data and identified an exponential decay trend that began in the year 2000 and extended through 2008. The agencies interpreted the break in the slope of the data at year 2000 to correspond with the ramping down of production prior to suspension of blasting at Stillwater Mine's east side in 2002. It is reasonable to expect that a ramping down of production would occur at both the Stillwater and East Boulder mines as closure is approached. Based on the shape of the plotted data, the agencies chose these data to model the reduction in nitrogen concentration during closure.

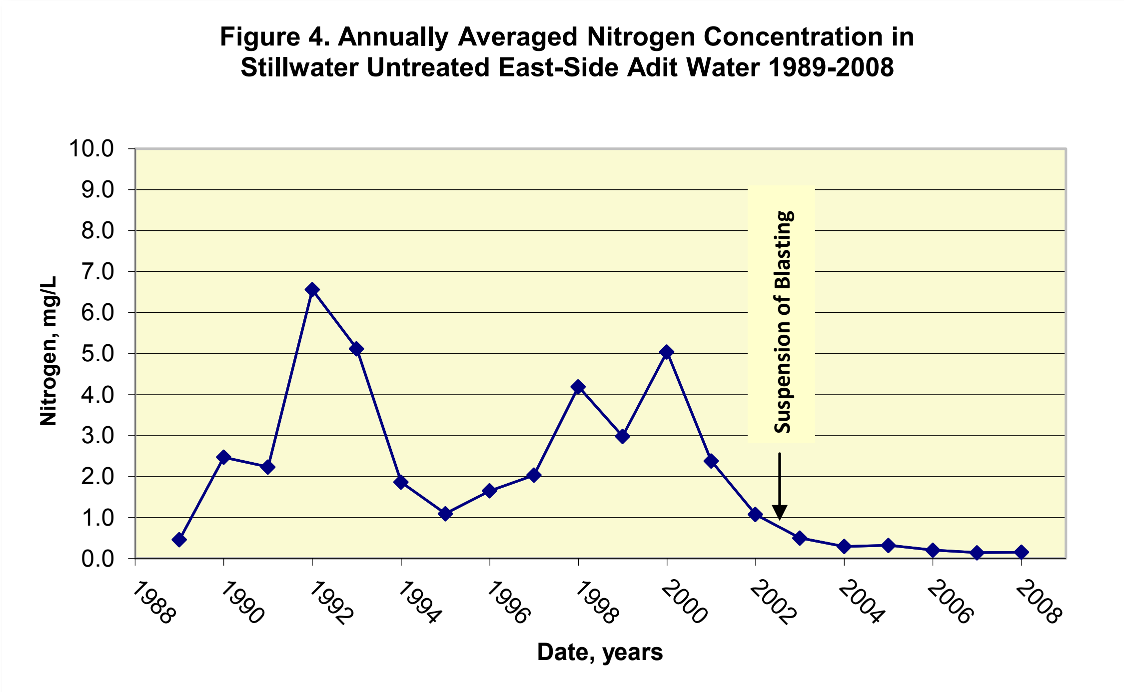


Figure 4 is a plot of the annually averaged concentrations of nitrogen in untreated adit water from the east-side workings from 1989 through 2008. The approximate date that blasting was suspended on Stillwater Mine's east side is indicated on the figure. The data used to generate the decline curve are from 2000 to 2008.

The agencies fit an exponential decay curve $y = 3.9801\ e^{-0.0348x}$ to the annually-averaged data from 2000 to 2008, where x is the time in months and y is the nitrogen concentration in mg/L. The coefficient of determination (R^2) calculated for the exponential decay curve model was 0.93, indicating excellent predictability of subsequent nitrogen concentrations within this annually-averaged data set. This exponential decay curve model derived from the east-side data could be used to calculate the future rate of nitrogen decay in untreated adit water from the west side.

Closure Nitrogen Decline Curve Calculation

The agencies reviewed SMC's current operational concentration of nitrogen in untreated adit water from the west-side workings and assumed that nitrogen concentrations would be similar at the end of mine life. The 2009 through 2011 untreated adit water concentrations average 40 to 45 mg/L nitrogen, whereas the highest concentration on the east-side workings from 1989 to 2009 was about 10 mg/L. The agencies extrapolated the exponential decay curve model to match the expected maximum concentration of untreated adit water prior to the ramping down of production, *i.e.,* about 40 to 45 mg/L nitrogen. The equation for the decay curve is then $y = 37.456\ e^{-0.0348x}$ where x is the time in months and y is the nitrogen concentration in mg/L (Figure 5). The modeled closure nitrogen decline curve has an R^2 value of 0.97, indicating that the fit of the values used to extrapolate this curve are similar to the fit of the annually-averaged data curve.

The agencies assume that a planned closure will follow a ramping down of production as closure approaches. In the case of unplanned closure, the mine would have been placed on care and maintenance as a result of an unanticipated event. In either case, explosive use at the mines would diminish or cease at some time prior to the onset of the closure period. Based upon the data obtained during the ramping down of production on the Stillwater Mine's east side, and using equivalent positions on the curves in figures 4 and 5, nitrogen decline curve, the concentration of

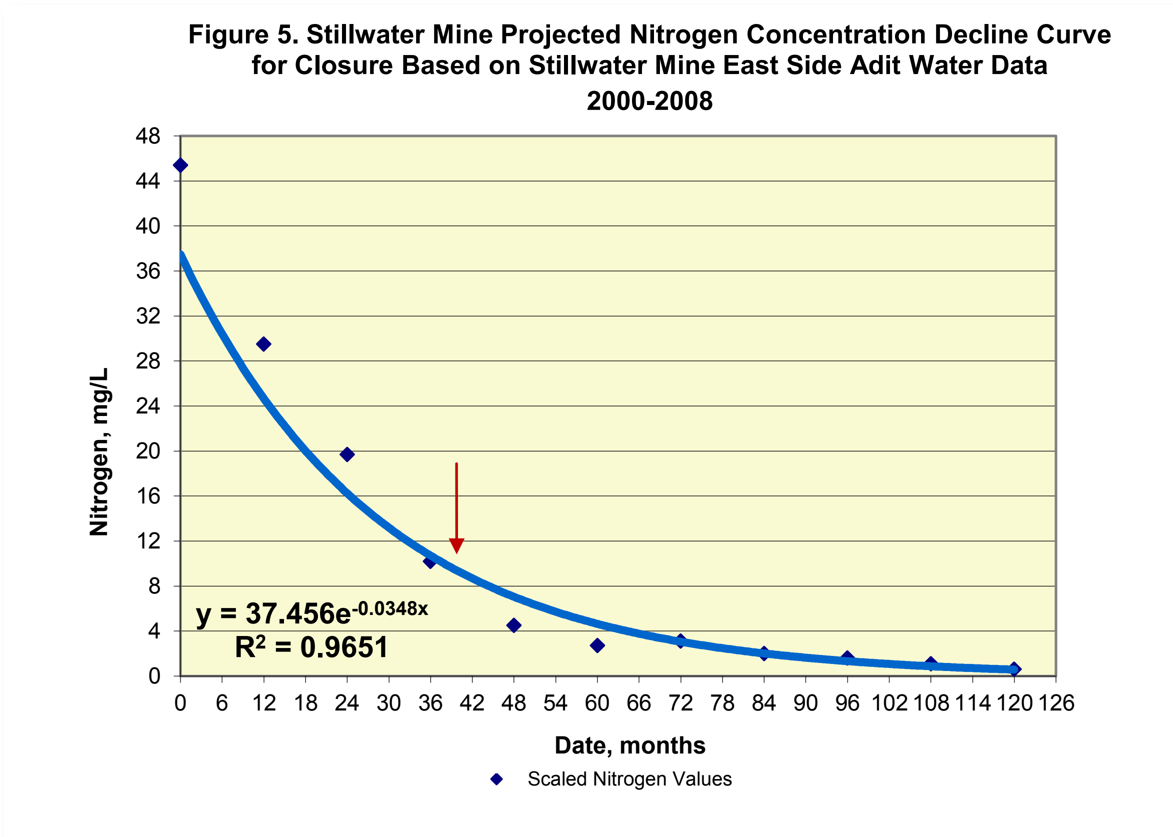


Figure 5 is the projected decline in the nitrogen concentration of untreated adit water at closure based upon data collected from the Stillwater Mine east-side workings from 2000 through 2008. The diamonds are the nitrogen values extrapolated from 2000 to 2008 east-side adit water data to compare with untreated 2009 through 2011 operational nitrogen concentrations. These extrapolated values are inclusive of the period of time in which Stillwater began to ramp down production before blasting was suspended. The curve is the exponential nitrogen decay model based on these data. The equivalence point for the suspension of blasting is indicated with a red arrow.

of adit water is anticipated to reduce about 80 percent from the operational concentration. That is, adit water containing about 45 mg/L nitrogen would reduce to about 9 mg/L when the closure period commences.

In the situation that an unanticipated event for the company would result in unplanned closure, it is the agencies' experience that the explosive use would have ceased, resulting in an extended care and maintenance scenario, the concentration of adit water is anticipated to decrease from the operational 48 mg/L nitrogen to about 4 mg/L going into the closure period.

The closure period for either scenario would continue for 12 to 18 months, depending on the alternative selected and implemented. At the end of closure/beginning of post-closure, the concentration of nitrogen would be less than 7 mg/L for a planned closure and less than 3 mg/L after an extended care and maintenance scenario. Post-closure occurs after reclamation covers are placed on the tailings impoundments and is defined as the time when no further adit or tailings water treatment is needed. Both of these scenarios support the maintenance of the BTS and BTS/Anox systems for up to an 18-month closure period.

How to Use the Nitrogen Decline Curve

Projections for the length of time that adit water treatment at closure would be necessary are based on the nitrogen load (*i.e.,* concentration of nitrogen and adit flow rate). For example, if the untreated concentration of adit water when closure commences at the Stillwater Mine was 9 mg/L at a flow rate of 2,020 gpm, then the resulting nitrogen load would be 218 pounds of nitrogen per day (lbs-N/day), and treatment would be needed until the nitrogen load is less than water quality standards protective of aquatic resources (that is, prevention of nuisance algal growth). At the end of an 18-month closure period, the nitrogen concentration is projected to be about 4 mg/L. At a flow rate of 2,020 gpm, the resulting nitrogen load would be less than the Stillwater Mine MPDES permitted nitrogen load limit of 100 lbs-N/day. In this second example, adit water would not need treatment at closure.

Conclusion

The agencies believe that the decline in nitrogen concentration observed at the east-side workings from 2000 to 2008 is representative of the decline in concentration that would occur at closure for adit water flowing through workings that do not flood at both the Stillwater and East Boulder mines. The agencies used these nitrogen concentration data to construct a mathematical model of the nitrogen decline and to project the concentrations of nitrogen in adit water that could be expected at closure and during post-closure.

The reduction in nitrogen concentration can be represented by the equation $y = 37.456\, e^{-0.0348x}$ where x is the time in months and y is the nitrogen concentration in mg/L (Figure 5). It should be noted for prediction purposes that this model is based on data inclusive of the period when east-side blasting was still occurring but east-side production was ramping down. The time frame projected by this model for the decline of nitrogen concentrations will, therefore, be conservative. These nitrogen concentration projections indicate the maximum time needed from the cessation of blasting at closure for adit water nitrogen levels to decline to a specific concentration. This model also provides nitrogen concentration projections that can be used in concert with adit flow rate to estimate the maximum amount of time adit water treatment would be needed at closure. This technical memorandum assumes that tailings waters would require treatment or dilution prior to disposal by percolation or land application. The biological treatment systems would be needed to treat undiluted tailings waters removed from the impoundments while the reclamation covers are placed, which is 12 to 18 months.

References

Box, G.E.P., W. G. Hunter, and J. S. Hunter. 1978. Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building. John Wiley & Sons, Inc. New York. 653 pages.

Clum, Juliann. 2011. Personal Communication e-mail re: information needed for response to EPA comments on the Troy Mine water quality during interim shutdown and operations. 5 pages.

Gilbert, R. O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold. New York. 320 pages.

National Institute of Standards and Technology. US Department of Commerce. 2012. February. http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc42.htm

Stillwater Mining Company. 2002. Memorandum from M. Wolfe to B. Gilbert. Nitrogen Decline in Riser Water over Christmas Holiday Shutdown. January. 1 page.

TECHNICAL MEMORANDUM

March 24, 2012

To: Kristi Ponozzo, MEPA Specialist, Montana DEQ
Pat Pierson, NEPA Coordinator, Custer and Gallatin National Forests, USFS

From: Lisa M. Boettcher, C.P.G. Reclamation Specialist, Montana DEQ LB
Catherine Dreesbach, P.E. Mining Engineer

Re: ***Revised*** Projection of Post-closure Water Quality and Nitrogen Loading from the Stillwater Mine Shaft, Stillwater Mining Company, Nye, Montana

This memo describes the agencies' analysis to estimate post-closure nitrogen loading to the Stillwater River from the discharge of waters flooding the underground workings below the 5,000-foot elevation at the Stillwater Mine, Nye, Montana. This analysis parallels and reviews SMC's analysis (Hydrometrics, Inc. 2004). These calculations are conservative, that is, predict the highest concentrations of nitrogen that may discharge from the shaft based on the assumptions that no denitrification would occur in the underground workings prior to discharge, and that the slimes would fully mix with the ground water flowing into the workings rather than stratify at the bottom of the workings. SMC has documented in-situ denitrification of waters in the LAD storage pond and Hertzler Ranch tailings impoundment underdrain system (Weimer 2012). Based on these data, the agencies expect that denitrification would also occur within the underground workings. Included in this memo are updated end-of-mining volume and backfill projections based on the long-range mine plan provided to the agencies by SMC (SMC 2009).

What has been revised in this memo:

- The calculations have been revised to include the nitrogen concentration of the slimes fraction of the tailings that would be disposed of underground when decommissioning is complete under Alternative 3A.
- Tables 1 and 2 have been combined into one table and reformatted.
- Additional descriptive information has been added to provide clarity.

<u>Calculations for Mined-Out Void</u>

The agencies used the former mine plan provided by SMC to calculate the volumes of backfill and voids in production and development workings at the Stillwater Mine through December 2009 (Table 1). These calculations update the volumes used in the 2004 Hydrometrics, Inc. technical memorandum, and would represent the extent of underground workings and backfill for the short term. These calculations are sufficient to provide documentation to calculate the agencies' 5-year financial assurance requirements. SMC has updated its long-term mine plan and provided data to the agencies so that calculations could be made to extrapolate the underground volume at the projected end of mining (Table 1). The end of mining void and backfill volumes are used to project post-closure nitrogen loading from water filling the workings below the 5,000-foot level for some point in the future.

Ground Water Hydraulics

The rate of ground water inflow to the Stillwater Mine workings in 2011 averaged about 930 gallons per minute (gpm). The upper workings are above 5,000 feet and would not flood post-mining because the regional water table is below this elevation. The shaft is a vertical shaft that extends 1,900 feet beneath the Stillwater River Valley floor through the lower workings. It is used to dewater the lower workings (those below 5,000 feet) (Figure 1, from Hydrometrics, Inc. 2004).

After the underground is decommissioned at closure, the east-side and west-side portals would be plugged with permeable waste rock plugs, and pumping of ground water from the lower workings would cease. Snowmelt and precipitation that infiltrates above the upper workings would flow vertically through open and backfilled areas and fractures to fill the lower workings of the mine. The rate of inflow from the upper workings is estimated to average about 280 gpm at closure (Hydrometrics, Inc. 2004). This inflow rate is expected to continue post-closure. Surrounding ground water would flow laterally into the deeper workings of the mine. Eventually the level of water in the flooding workings would rise to the 4,972-foot elevation of the shaft collar then discharge. Because its elevation is lowest, water would discharge from the shaft collar before discharging from the 4,974-foot east portal or the 5,000-foot west portal (Figure 2, Hydrometrics, Inc. 2004, attached).

While blasting the shaft, SMC grouted any interval having sustained inflow. The grout prevents the flow of water between the alluvial gravels of the Stillwater River and the shaft. Although the alluvial gravels (4,900-foot elevation) are at a lower elevation than the collar of the shaft (4,972-foot elevation), while the grout remains competent, shaft water would not discharge to the Stillwater River alluvium. In the event, however, that water would directly discharge to the alluvium, the loading calculations in this memo remain valid.

The hydrostatic pressure of ground water is dynamic and primarily dependent upon its elevation. The rate of water inflow to the workings and shaft would not be dependent on the total volume of workings, but would depend on the elevation of rising water. As the workings flood, the hydrostatic pressure increases. Initially the rate of flooding is rapid, and as the workings fill, the flooding rate slows. Using the updated end-of-mining backfill and void volumes, SMC estimated that it would take between four and 48 years to fill the maximum projected extent of the workings, depending on ground water inflow rate (SMC 2009).

The agencies assume that there would be no discharge of water to the Stillwater River from the lower workings until the flooded elevation reaches the collar of the shaft. The agencies have confirmed SMC's ground water flow calculations (Hydrometrics, Inc., Inc. 2004), and concur that when the workings are nearly flooded the rate of inflow to the shaft is expected to be 20 to 40 gpm. The water entering the shaft from the lower workings would mix with the projected 280 gpm of inflow from the upper workings and approximately 300 to 320 gpm would discharge from the shaft post-closure. The agencies used the higher 40 gpm inflow rate from the workings and 320 gpm shaft discharge rate for this analysis.

Nitrogen Loading

In the 2004 technical memorandum, Hydrometrics estimated the potential contribution of nitrogen from tailings, waste rock, and paste backfill materials based on column leach tests performed by SMC in 1988 and 2003 (Hydrometrics, Inc. 2004). Hydrometrics constructed a mass balance mixing model to estimate the potential nitrogen concentration and load in mine waters that would discharge from the shaft. Hydrometrics projected flows, and performed surface water mixing calculations and sensitivity analyses to evaluate the influence of individual parameters on the modeling results. This enabled Hydrometrics to assess a maximum nitrogen loading scenario. The agencies have reviewed Hydrometrics' calculations for verification purposes. No measurements of leached salts were taken from the three types of backfill materials. Salts will not be addressed further in this memo.

In this analysis, the agencies assume that the nitrogen concentration in mine water flowing from the upper workings would decrease over time as indicated by the *Revised* Projected Nitrogen Concentration Decline Curve (Appendix E). The agencies agree that water moving through the flooded lower workings would flush nitrogen compounds from the mine. The highest concentration of nitrogen would occur in the first pore volume of mine water through the workings. The nitrogen concentration would decrease in subsequent pore volumes of water flowing through the flooded workings. It is not known how long it would take for one complete pore volume of ground water to flow through the workings and discharge, but is likely to be on the order of decades.

The agencies independently calculated the nitrogen concentration of water discharging from the shaft using the pore volume concentrations estimated by SMC (Hydrometrics, Inc. 2004). The agencies calculated the nitrogen loads for the first and second pore volumes of water flowing through the workings. The first pore volume of mine water would contain the maximum nitrogen concentration, and provides a conservative (worst-case) loading scenario.

Calculations for Nitrogen Loading at Closure

The nitrogen loading calculations that follow are based on the volume of void, volume of backfill, and type of backfill. The ground water inflow rate affects the time to flood the mine.

Concentration of the First Pore Volume

The projected nitrogen concentrations of the first pore volume of water that flood the workings are as follows (Hydrometrics, Inc. 2004):

30 mg/L N_{T1} from tailings backfilled areas
30 mg/L N_{CP1} from cemented paste backfilled areas
112 mg/L N_{WR1} from waste rock backfilled areas
53 mg/L N_S from slimes; concentration from SMC data 2009 to 2011
0.2 mg/L N_V from void (empty) areas, east- and west-side workings, post-closure

where V_P is the pore volume of backfilled areas (tailings, cemented paste, waste rock), V_{Slimes} is the volume of the 18 million gallons of slimes remaining in the tailings impoundment when decommissioning is completed, and V_{Void} is the volume of the void (empty) areas, calculated by the agencies from data provided by SMC (Table 1).

Calculation for Nitrogen Concentration in Water from Flooded Workings (volume of workings up through December 2009):

These calculations project the nitrogen concentration and load that would be expected from the flooded workings if closure at the Stillwater Mine was imminent.

$$= \frac{[V_{P\ Tailings} \times N_{T1} + V_{P\ Cemented\ Paste} \times N_{P1} + V_{P\ Waste\ Rock} \times N_{WR1} + V_{Slimes} \times N_S + (V_{Void\ Workings} - V_{Slimes}) \times N_V]}{(V_{P\ Tailings} + V_{P\ Cemented\ Paste} + V_{P\ Waste\ Rock} + V_{Void\ Workings})}$$

= 35.6 mg/L nitrogen (first pore volume, mining void through December 2009)

Calculation for Nitrogen Concentration in Water Discharged from the Shaft (volume of workings up through 2009):
where V is volumetric flow rate and C is concentration:

$$= \frac{(V_{\text{east-side workings}} \times C_{\text{east-side}} + V_{\text{west-side workings}} \times C_{\text{west-side}} + V_{\text{flooded workings}} \times C_{\text{flooded workings}})}{(V_{\text{east-side workings}} + V_{\text{west-side workings}} + V_{\text{flooded workings}})}$$

$$= \frac{(160 \text{ gpm} \times 0.2 \text{ mg/L} + 120 \text{ gpm} \times 0.2 \text{ mg/L} + 40 \text{ gpm} \times 35.6 \text{ mg/L})}{(160 \text{ gpm} + 120 \text{ gpm} + 40 \text{ gpm})}$$

= 4.6 mg/L nitrogen (first pore volume, mining void through December 2009)

Nitrogen Load$_{1stPV\ 2009}$ = (320 gpm x 4.6 mg/L x 0.012 lbs min L mg^{-1}gal^{-1}day^{-1}) = 17.8 lbs/day

The total nitrogen load of 17.8 lbs/day exiting from the shaft is less than the 100 lbs/day MPDES permit load for the Stillwater Mine. A nitrogen load of 17.8 lbs/day would result in a nitrogen concentration of about 0.2 mg/L in the Stillwater River when streamflow is at seven-day, ten-year low flow value ($7Q_{10}$) of 31 cfs.

- To check the sensitivity of this calculation, the agencies recalculated using a nitrogen concentration of 10 mg/L for the 280 gpm from the upper workings and flooded mine voids. The weighted average nitrogen concentration in the flooded workings water would then be 41.4 mg/L. The weighted average concentration of nitrogen in water discharged from the shaft is 13.9 mg/L, and the nitrogen load is 53.5 lbs/day. This load is less than the 100 lbs/day MPDES permit load for the Stillwater Mine and would result in a nitrogen concentration less than 1 mg/L in the Stillwater River.

Calculation for Nitrogen Concentration in Water from Flooded Workings at End-of Mining:
The calculation for the first pore volume nitrogen concentration of flooded workings was repeated using the updated end-of-mining void and backfill volumes. These calculations project the nitrogen concentration and load that would be expected from the flooded workings at full build-out at the end of mining. These volumes were calculated by the agencies from data provided by SMC (Table 1).

$$= \frac{[V_{P\ \text{Tailings}} \times N_{T1} + V_{P\ \text{Cemented Paste}} \times N_{P1} + V_{P\ \text{Waste Rock}} \times N_{WR1} + V_{\text{Slimes}} \times N_S + (V_{\text{Void Workings}} - V_{\text{Slimes}}) \times N_V]}{(V_{P\ \text{Tailings}} + V_{P\ \text{Cemented Paste}} + V_{P\ \text{Waste Rock}} + V_{\text{Void Workings}})}$$

= 25.8 mg/L nitrogen (first pore volume, full projected extent of mine void at end-of-mining)

Calculation for Nitrogen Concentration in Water Discharged from Shaft at End-of Mining:

$$= \frac{(V_{\text{east-side workings}} \times C_{\text{east-side}} + V_{\text{west-side workings}} \times C_{\text{west-side}} + V_{\text{flooded workings}} \times C_{\text{flooded workings}})}{(V_{\text{east-side workings}} + V_{\text{west-side workings}} + V_{\text{flooded workings}})}$$

$$= \frac{(160 \text{ gpm} \times 0.2 \text{ mg/L} + 120 \text{ gpm} \times 0.2 \text{ mg/L} + 40 \text{ gpm} \times 25.8 \text{ mg/L})}{(160 \text{ gpm} + 120 \text{ gpm} + 40 \text{ gpm})}$$

= 4.1 mg/L (first pore volume, full projected extent of mine void at end-of-mining)

Nitrogen Load$_{1stPV\ E\text{-}o\text{-}M}$ = (320 gpm x 4.1 mg/L x 0.012 lbs min L $mg^{-1} gal^{-1} day^{-1}$) = 15.8 lbs/day

The total nitrogen load of 15.8 lbs/day is less than the 100 lbs/day MPDES permit load for the Stillwater Mine. A nitrogen load of 15.8 lbs/day would result in a nitrogen concentration of about 0.2 mg/L in the Stillwater River at the $7Q_{10}$ low streamflow.

- To check the sensitivity of this calculation, the agencies recalculated using a nitrogen concentration of 10 mg/L for the 280 gpm from the upper workings and flooded mine voids. The weighted average nitrogen concentration in the flooded workings water would then be 32.6 mg/L. The weighted average concentration of nitrogen in water discharged from the shaft is 12.8 mg/L, and the nitrogen load is 49.3 lbs/day. This load is less than the 100 lbs/day MPDES permit load for the Stillwater Mine. A nitrogen load less than 100 lbs/day would result in a nitrogen concentration less than 1 mg/L in the Stillwater River.

Concentration of the Second Pore Volume

The projected nitrogen concentrations of the second pore volume of water that floods the Life-of-Mine workings are as follows (Hydrometrics, Inc. 2004):

0.4 mg/L N_{T2} from tailings backfilled areas
0.4 mg/L N_{CP2} from cemented paste backfilled areas
29 mg/L N_{WR2} from waste rock backfilled areas
0.2 mg/L N_V from void (empty) areas

where V_P is the pore volume of backfilled areas (Tailings, Cemented Paste, Waste Rock), and V_{Void} is the volume of the void (empty) areas, calculated by the agencies from data provided by SMC (Table 1).

Calculation for Nitrogen Concentration in Water from Flooded Workings at End-of-mining:

$$= \frac{(V_{P\ \text{Tailings}} \times N_{T2} + V_{P\ \text{Cemented Paste}} \times N_{P2} + V_{P\ \text{Waste Rock}} \times N_{WR2} + V_{\text{Void Workings}} \times N_V)}{(V_{P\ \text{Tailings}} + V_{P\ \text{Cemented Paste}} + V_{P\ \text{Waste Rock}} + V_{\text{Void Workings}})}$$

= 5.9 mg/L nitrogen concentration (second pore volume, full projected extent of mine void at end of mining)

Calculation for Nitrogen Concentration in Water Discharged from Shaft at End-of-mining:
where V is volumetric flow rate and C is concentration:

$$= \frac{(V_{\text{east-side workings}} \times C_{\text{east-side}} + V_{\text{west-side workings}} \times C_{\text{west-side}} + V_{\text{flooded workings}} \times C_{\text{flooded workings}})}{(V_{\text{east-side workings}} + V_{\text{west-side workings}} + V_{\text{flooded workings}})}$$

$$= \frac{(160 \text{ gpm} \times 0.2 \text{ mg/L} + 120 \text{ gpm} \times 0.2 \text{ mg/L} + 40 \text{ gpm} \times 5.9 \text{ mg/L})}{(160 \text{ gpm} + 120 \text{ gpm} + 40 \text{ gpm})}$$

= 1.6 mg/L nitrogen (second pore volume, full projected extent of mine void at end of mining)

$Nitrogen\ Load_{2ndPV\ 2008}$ = (320 gpm x 1.6 mg/L x 0.012 lbs min L $mg^{-1}gal^{-1}day^{-1}$) = 6.2 lbs/day

The total nitrogen load is 6.2 lbs/day, which is less than the 100 lbs/day MPDES permit load for the Stillwater Mine. A nitrogen load of 6.2 lbs/day would result in a nitrogen concentration less of about 0.1 mg/L in the Stillwater River at the $7Q_{10}$ low streamflow.

Conclusions

This memo provides the basis of the agencies' estimate of post-closure nitrogen loading to the Stillwater River from the flooding of Stillwater Mine workings. This analysis parallels and reviews SMC's analysis (Hydrometrics, Inc. 2004) and includes updated end-of-mining backfill and void projections based on the long-range mine plan provided to the agencies by SMC (SMC 2009).

The highest concentration of nitrogen would occur in the first pore volume of mine water entering the shaft, and is a conservative (worst-case) loading scenario. The nitrogen concentration would decrease in subsequent pore volumes of water flowing through the flooded workings. No estimates have been made of the time it would take for one pore volume of ground water to flow through the workings, but is likely to be on the order of decades.

The nitrogen load in the first pore volume of water that would discharge post-closure from the shaft would be about 18 lbs/day, which is less than the MPDES permit limit of 100 lbs/day. Based upon these calculations, the MPDES permit limit for nitrogen would be met and no treatment of shaft water would be necessary post-closure.

References

DEQ. 2012. Stillwater Mining Company Projected Nitrogen Concentration Decline Curve. Technical Memorandum. Montana Department of Environmental Quality, Helena, Montana. March 2012. 14 pages.

Freeze R.A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 1979. 604 pages.

Hydrometrics. Inc. 2004. Projected Off-Shaft Discharge Projection and Nitrogen Loading Estimates after Closure. Technical Memorandum. September 2004. Helena, Montana. 8 pages + attachment. 6 pages.

SMC. 2009. Off-Shaft Filling Projection – Update. Technical Memorandum. Nye, Montana. February 2009. 1 page.

Weimer, R. 2012. Personal communication [*February 27* e-mail to P. Pierson, Custer National Forest, Billings, MT. *RE:* Mine ownership acres]. Environmental Manager, Stillwater Mine, Nye, Montana. 2 pages.

Table 1. *Revised* Underground Workings Void and Backfill Calculations

ASSUMPTIONS: The average development area is not rectangular; tailings mass per foot of development is 16 tons of combined tailings/paste per foot; cemented mass per foot of development is 16 tons of combined mass per foot; waste rock backfill ratio was 24 tons up through December 31, 2009 and 18 to 20 tons thereafter; volume per ton of backfill does not consider any caving; pore volume of the tailings is based on Hydrometrics, Inc. 2004: tailings porosity = 0.4, cemented paste porosity = 0.08, waste rock porosity = 0.4.

all mass is in tons, volume in cubic feet	**Prior to Dec 31, 2009**	**From Jan 1, 2010 to end of mine life**	**Life of Mine**
Mass of tailings placed as backfill	828,235	3,202,941	4,031,176
Mass of cemented paste placed as backfill	828,235	3,202,941	4,031,176
Mass of waste rock placed as backfill	2,484,706	7,606,985	10,091,691
Volume of tailings placed as backfill	16,564,700	64,058,820	80,623,520
Volume of cemented paste placed as backfill	16,564,700	64,058,820	80,623,520
Volume of waste rock placed as backfill	49,694,120	152,139,700	201,833,820
Void volume of tailings placed as backfill	6,625,880	25,623,528	32,249,408
Void volume of cemented paste placed as backfill	1,325,176	5,124,706	6,449,882
Void volume of waste rock placed as backfill	19,877,648	60,855,880	80,733,528
Mined-out development void	14,112,459	54,575,524	68,687,982
Mined-out production void	113,887,541	440,424,476	554,312,018
Volume of development void available for water storage (without backfill; empty mined-out void)	14,112,459	54,575,524	68,687,982
Volume of production void available for water storage (mined-out void with backfill placed)	31,064,021	160,167,136	191,231,158
Total volume available for water storage (development + production + backfill voids)	58,892,725	251,771,250	310,663,975

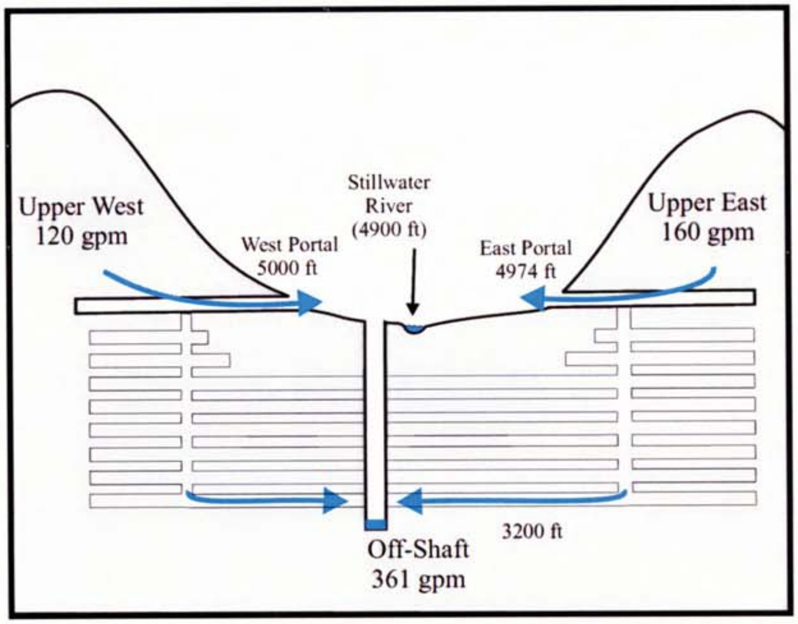


Figure 1.
Flow Schematic
Present Operational Scenario

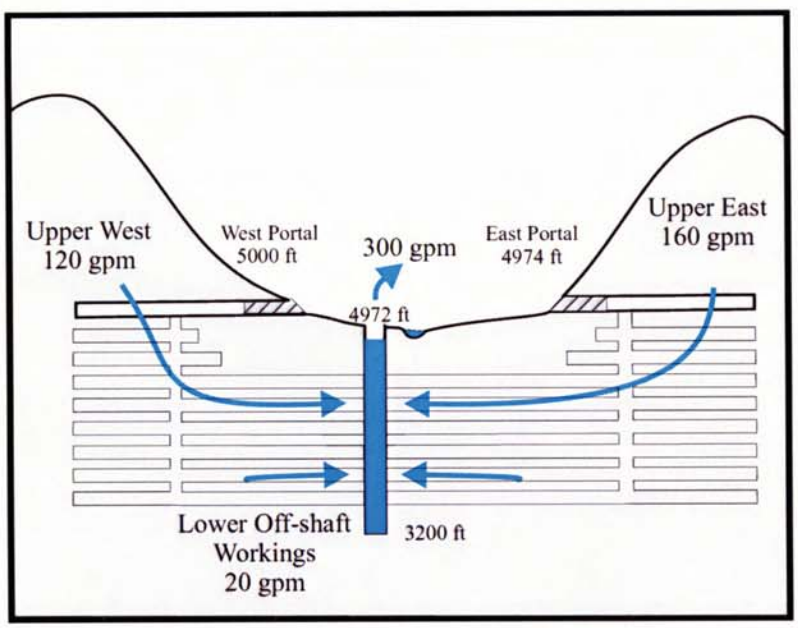


Figure 2.
Flow Schematic
Closure Scenario

K:\project\Nload Schematic2.cdr

TECHNICAL MEMORANDUM

Date: January 3, 2012

To: Kristi Ponozzo, Stillwater Mining Company EIS Project Coordinator, Montana DEQ
Patrick Pierson, Stillwater Mining Company EIS Project Coordinator, Custer National Forest, USFS

From: Lisa M. Boettcher, C.P.G., Reclamation Specialist, Montana DEQ LB

Subject: Potentials for long-term acid rock drainage or metals mobility at the Stillwater Mine near Nye and the East Boulder Mine near Big Timber, Montana

Brief overview

The Environmental Protection Agency (EPA) provided comments regarding the need for the 2010 Stillwater Mining Company's Revised Water Management Plans and Boe Ranch LAD Draft Environmental Impact Statement (DEIS) to address the post-closure potential for acid rock drainage and near-neutral metals mobility from waste rock, tailings, and the adits at the Stillwater Mining Company (SMC) Stillwater and East Boulder mines. This memo compiles the statutory and scientific basis upon which the agencies decided to determine the potential for water quality impacts from metals as nonsignificant, and therefore, only reference their coverage in the DEIS. This memo then addresses the EPA comments using data collected at both mines over a 13- to 25-year period of record and summarizes papers, reports, data and the appropriate water quality criteria so that these data may be evaluated in context.

The potentials for long-term acid rock drainage or metals mobility have been addressed to differing degrees in previous environmental documents to which the 2010 Draft Environmental Impact Statement (DEIS) was tiered and were not raised as significant issues during the agencies' scoping process. Federal guidance related to implementation of the National Environmental Policy Act (NEPA) found at 40 Code of Federal Regulations (CFR) 1500 – 1508 directs federal agencies to identify at an early stage "the significant environmental issues deserving of study and [deemphasize] insignificant issues, narrowing the scope of the environmental impact statement accordingly" [40 CFR 1501.1(d)]. Agencies are directed in this section to "Identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Section 1506.3), narrowing the discussion of these issues in the statement to a brief presentation of why they will not have a significant effect on the human environment or providing a reference to their coverage elsewhere" [40 CFR 1501.7(a)(3)].

The Administrative Rules of Montana(ARM) related to determining the scope of an Environmental Impact Statement are similar, directing the agency to identify issues that "are likely to involve significant impacts and that will be analyzed in depth in the EIS" [ARM § 17.4.615 (b)]. Further, the ARM directs agencies to "identify the issues that are not likely to involve significant impacts, thereby indicating that unless the unanticipated effects are discovered during the preparation of the EIS, the discussion of these issues in the EIS will be limited to a brief presentation of the reasons they will not significantly affect the quality of the human environment (c)", and to "identify those issues that have been adequately addressed by prior environmental review, thereby indicating that the discussion of these issues in the EIS will be limited to a summary and reference to their coverage elsewhere (d)" A.R.M § 17.4.615.

The 2010 Draft Environmental Impact Statement (DEIS) lists on page 1-16 the previous environmental analyses that have been prepared for the Stillwater and East Boulder mines. Appendix A of the DEIS contains a synopsis of each of these documents. Chapter 2 of the DEIS identifies the issues and concerns identified based on public and agency input and describes the agencies' scoping process on pages 2-1 and 2-2. The significant issues were identified in Chapter 2.2.1 (pages 2-2 through 2-6), and the issues considered but dismissed were identified in Chapter 2.2.2 (pages 2-7 through 2-14).

EPA Comments
The comments specifically requested that the DEIS provide the following:

1) disclosure of the geochemical characterization of the Stillwater Complex, specifically the sulfide content;
2) summary of the long-term monitoring plan for potential acid generation and leaching of metals post-closure;
3) analysis of the effects of metals on surface and ground water at both mines, operationally and post-closure;
4) disclosure of the operational concentrations of metals in adit and tailings waters at both the Stillwater and East Boulder mines with a comparison of the operational concentrations to applicable water quality standards;
5) documentation of the potential for acid generation and metals mobility based on a large-scale field column (humidity cell) test performed over a period of several years;
6) expansion of the list of metals for long-term monitoring (aluminum, arsenic, cadmium, copper, iron, manganese, mercury, selenium, silver, zinc, platinum, palladium) and inclusion of total hardness, calcium, magnesium, and sulfate for mine drainage and runoff; and
7) evaluation of the effects of the mine during operations on downgradient surface (Nye Creek) and ground water with respect to metals loading.

Agency Responses
Comment 1: *Disclosure of the geochemical characterization of the Stillwater Complex, specifically the sulfide content.*

<u>Geology</u>*:* Platinum and palladium are produced from the Stillwater Complex, an ultramafic-to-mafic cumulate (layered crystalline accumulation) intrusive deposit, mined at two surface locations, the Stillwater Mine at Nye and the East Boulder Mine near Big Timber. The sulfide minerals occur almost exclusively within the ore zone and not within waste rock. The Stillwater Complex is an estimated 5,500 m thick, preserved between the intrusive lower contact and the pre-Middle Cambrian unconformity that bound the complex. The complex has been grouped into three main stratigraphic series—the Basal series, the Ultramafic series, and the Banded series. The Basal series, lowermost in the complex is in contact with basement rock and is approximately 150 m thick. The 1,000 m thick ultramafic series is next in sequence and overlain by the Banded series. The Banded series hosts the platinum-palladium deposit. The Banded series makes up more than three-fourths of the exposed thickness of the complex and is subdivided into the Lower, Middle, and Upper series, which is further broken down into lithologic zones.

The Lower Banded Series is subdivided into the *Norite I*, *Gabbro I*, and *Troctolite-Anorthosite I*. *Norite I* consists of plagioclase-bronzite cumulates and can be identified at the base of the section along the entire length of the complex; *Gabbro I* is composed of cumulates containing plagioclase, bronzite, and augite; *Troctolite-Anorthosite I* is a complex succession of olivine-, plagioclase-, bronzite-, and augite-bearing cumulates and pegmatoidal (very coarsely crystalline) rocks. The *Troctolite-Anorthosite I* zone hosts the J-M Reef, which is 1 to 3 m thick and contains the platinum-palladium ore mined by SMC (Kirk et al 2006).

<u>Sulfide occurrence and content</u>: The ore minerals are present as braggite $(Pt_{0.60}Pd_{0.34}Ni_{0.06})_{\Sigma=1.00}S_1$, cooperite $(Pt_{0.98}Pd_{0.01}Ni_{0.03})_{\Sigma=1.02}S_{0.98}$, and are associated with chalcopyrite ($CuFeS_2$), pyrrhotite ($Fe_{1-x}S$), pentlandite $(Fe, Ni)_9S_8$, and minor pyrite (FeS_2). The sulfide minerals are present in small concentrations (0.05 to 1 weight percent) in the ore. The sulfide-bearing rock is, for the most part, mined as ore. The sulfide minerals that pose a risk of acid generation occur almost exclusively in the ore zone so that little risk of acid generation is anticipated from waste rock and the underground workings (Kirk et al 2006). This conclusion is supported by the water monitoring data provided in comments 3 and 4.

Supplemental samples of low grade ore, high grade ore, mineralized dike, and paste backfill (tailings amended with cement and used to backfill stopes), were collected by Kuipers and Associates in 2001 and analyzed for sulfur content, the potential to generate acid, and the potential to mobilize metals. The sulfur content in Stillwater ore ranged from 0.13 to 0.49 weight percent, and in East Boulder ore ranged from 0.13 to 0.24 weight percent. The sulfur content in mineralized dike material at the Stillwater Mine was 0.05 percent and at the East Boulder Mine was 0.08 weight percent. The sulfur content was 0.09 weight percent in Stillwater Mine paste backfill. Samples of tailings and waste rock from both mines were also collected from 2001 to 2004, analyzed, and reported by Kuipers. The sulfur content of Stillwater tailings ranged from 0.05 to 0.08 weight percent, and 0.06 weight percent from a composite of East Boulder tailings. The Stillwater Mine waste rock total sulfur ranged from 0.01 to 0.04 weight percent. The East Boulder Mine waste rock total sulfur ranged from less than detection to 0.16 weight percent (Kuipers and Associates 2006). The total sulfur content of all of these samples, with the exception of the high grade Stillwater ore, was well below the generally accepted threshold of 0.3 weight percent sulfide sulfur for acid generation (Jambor et al 2000).

Further evidence was provided by static tests performed by SMC on gabbronorite (n=15 samples), norite (n=17 samples), troctolite (n=6 samples), and anorthosite (n=9 samples). The neutralization potential varied from 20 to 70 T/kT as calcium carbonate. The acid generation potential for all rock types was equal to or less than 1 and falls within the "not acid-generating" region of the plot (**Figure 1)**. These results confirm that there is very low risk of ARD formation in waste rock mined from the Stillwater complex (Kirk et al 2006).

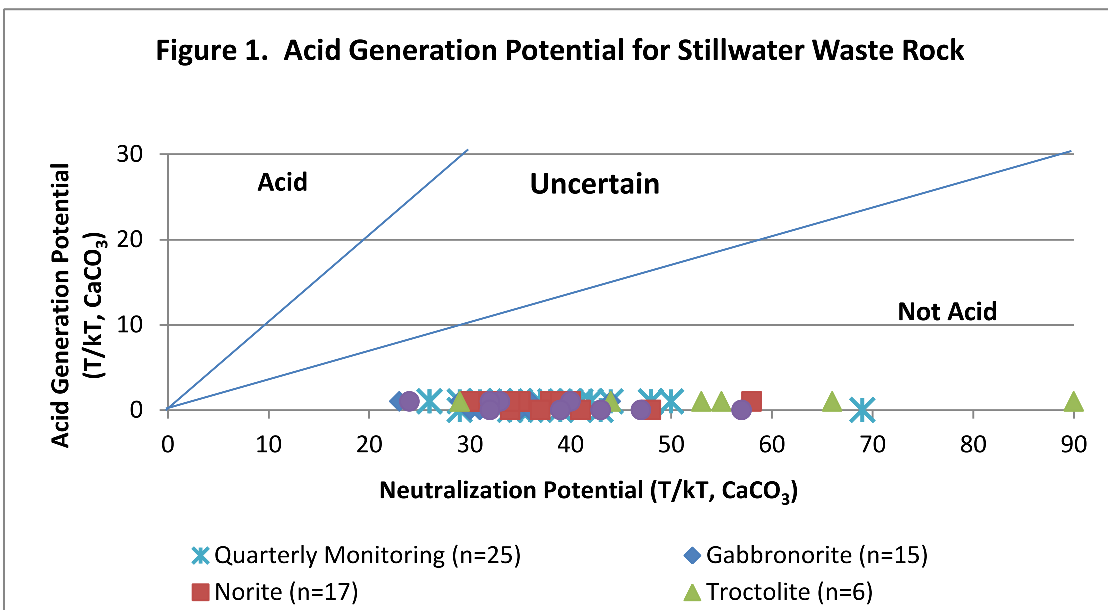


Figure 1. Comparison of neutralization and acid generation potential by waste rock type (after Kirk et al 2006).

<u>Determination of ore and waste rock</u>: Geologists at the mine determine whether a material will be shipped as ore or waste rock based on visual estimates of sulfide content. These estimates are based on experience from mapping the reef production stopes as well as sampling results that are taken regularly to calibrate the geologists' estimates. Geologists do not map development headings on a regular basis because much historical data has been collected to indicate that these rocks do not contain significant sulfides. The probe drill holes are logged and any material that may contain sulfides is sampled (Kirk et al 2006). SMC conducts operational quarterly testing of active waste rock headings to evaluate whether there is any change in rock type or characterization. As an additional management practice, SMC processes an average of 200 tons per day of "reef waste" material. Reef waste is material from the J-M Reef remaining on the edges of the stope or on the hanging wall that could contain sulfides. Processing the reef waste ensures that any rock that may contain sulfides is not disposed of in the east side waste rock storage site (ESWRS) and adds sand inventory for use underground as fill (R. Weimer, personal communication).

<u>Disposal of tailings and waste rock</u>: At the Stillwater Mine, rock that is determined to be waste in production stopes may be shipped to the ESWRS (from the lower west and east sides of the mine), or used underground to gob-fill sublevel extractions (upper west) (Kirk et al 2006). Tailings are components of paste backfill used in production stopes for the underhand cut-and-fill method of mining (with cement additive) or sandfill for overhand mining (without cement additive). Tailings may be stored in the impoundments at the mine or at Hertzler Ranch. Waste rock may also be used at both mines for road and construction materials (Kuipers and Associates 2006). At the East Boulder Mine, waste rock is used exclusively for concurrent construction of the tailings storage facility embankments, with only a fraction of a percent used as gob-fill. The majority of tailings at the East Boulder Mine are used underground as sandfill. The coarser sand fraction remains underground and the fine fraction reports to the surface impoundment (M. Wolfe, personal communication).

<u>Potential for acid generation</u>: SMC has historically collected data on a quarterly basis as part of the waste rock characterization plan to evaluate the potential for acid formation and trace element release. Recently, an operational study was done on 46 samples collected in 2004 and 2005 to correlate recently-mined waste rock with historical waste, based on geological characterization and mining practices (Kirk et al 2006). Based on the geology of the mined rock, mineralogical and whole rock geochemical analyses were used to fingerprint volumetrically significant (>1% by weight) waste lithologies. Five-kilogram samples were collected throughout the mine at multiple locations over a two-year period as part of routine operations, to produce a representative suite of samples for geochemical analysis. Thirty-one samples of waste rock were taken from primary development headings (permanent openings to approach the J-M reef), nine samples were taken from stope accesses (secondary development headings to access the stope), and seven samples were taken from reef waste rock in the stope (ore production) headings.

During the operational study, four rock types were identified as significant waste rock units. All of these rock types may be placed on the ESWRS. These are the rock types, the percentage of rock produced, and the number of samples collected per type: Norite is 54 percent of the waste rock (15 recent operational samples, 30 historical samples); gabbro is 31 percent of the waste rock (16 recent operational samples, 33 historical samples); anorthosite is 13 percent of the waste rock (9 recent samples, 33 historical samples); and troctolite is 2 percent of the waste rock (6 recent samples, 22 historical samples).

Several results were indicated by the analyses of the waste rock in the operational study:

- Total sulfur in all samples is less than 0.05 weight percent, well below the generally accepted threshold of 0.3 weight percent sulfide sulfur for acid generation (Jambor et al 2000).
- Neutralization potential of waste rock ranged from an equivalent of 20 to 70 tons of calcium carbonate per thousand tons of rock. In general, the neutralization potential of troctolite > norite > anorthosite > gabbronorite, and the acid generation potential for all rock types was less than or equal to 1 (**Figure 1)**.
- Historical data show that more than 97 percent of waste rock samples have total sulfur contents of less than 0.3 weight percent, further supporting the conclusion that waste rock mined throughout the history of production at the Stillwater Mine has negligible potential to generate acid.

These results confirm the original conclusion made during the hardrock permitting process that there is very low risk of ARD formation in waste rock mined from the Stillwater complex and suggest that kinetic testing for the oxidation of metal sulfides is unwarranted (Kirk et al 2006).

To fulfill the Hardrock operating permit requirements, both the Stillwater and East Boulder mines have an ongoing monitoring program to characterize waste rock and tailings for the potential to generate acid and leach metals. The Stillwater Mine also characterizes ore for the potential to generate acid and leach metals. Quarterly composite samples are analyzed at an accredited laboratory for neutralization potential, acid potential, and acid/base accounting using the modified Sobeck method; extractable metals have been analyzed historically using the toxicity characteristic leaching procedure (TCLP)(EPA Method 1311) and are currently analyzed by the synthetic precipitation leaching procedure (SPLP)(EPA Method 1312); and total metals are analyzed by EPA Method 6010/6020.

Kuipers and Associates independently evaluated the potential for ore, tailings, and waste rock from both the Stillwater and East Boulder mines to produce acid based on data collected from 2001 to 2004. Supplemental samples were collected in 2005 for separate geochemical analysis. They concluded that ore, tailings, and waste rock from both the Stillwater and East Boulder mines have a very low potential to generate acid (Kuipers and Associates 2006).

<u>Operational data for Stillwater Mine</u>: The parameters pH and sulfate have long been recognized as indicators of acid generation. When oxidation of sulfide occurs, the pH decreases and sulfate concentration increases. The agencies evaluated the long-term trends of pH and sulfate concentration in ground water at the Stillwater Mine and Hertzler Ranch land application disposal facility (LAD), Stillwater adit water, and tailings water from the Stillwater and Hertzler Ranch impoundments. The results are presented below. Please refer to the 2010 DEIS for figures that show the location of facilities and monitoring wells at the Stillwater Mine (Figures 2-3 and 3-1), Hertzler Ranch LAD (Figures 2-3 and 3-1), and the East Boulder Mine (Figure 2-27).

Ground water at the Stillwater Mine: **Figure 2** shows that the trend of pH for the 13-year period of record in downgradient wells is strongly controlled by the fluctuations of pH in upgradient ground water, as represented by MW-10A (west side of the Stillwater River) and MW-T1A (east side of the Stillwater River). The upgradient monitoring well data are displayed with dashed lines. The fluctuations noted in pH appear to be related to seasonality; that is, the slight changes in water quality would be attributed to variation in the level of the water table (higher level in spring and lower level in fall-winter). The overall trend of pH is constant in the upgradient ground water wells MW-10A and MW-

T1A. The monitoring wells located downgradient of the ESWRS (MW-15A and MW-18A) and the Stillwater tailings impoundment on the west side (MW-7A and MW-9A) follow the trend of the upgradient monitoring wells. The pH of ground water at the mine is representative of ambient water quality and is not indicative of acid formation in the ESWRS or tailings impoundment with subsequent infiltration to ground water.

Figure 3 shows the trend of sulfate in ground water at the Stillwater Mine. The concentration of sulfate in upgradient wells MW-10A and MW-T1A (displayed with dashed lines) is nearly constant. The concentrations of sulfate in wells MW-5A, MW-7A, and MW-18A downgradient of the tailings impoundment and the ESWRS fluctuate, but have an overall decreasing trend over the 13-year period of record. These fluctuations in sulfate appear to be related to seasonality and do not appear to reflect the influence of mine water. Monitoring well MW-15A is downgradient of the Stillwater Valley Ranch percolation ponds and the former East Side center pivot north LAD area. The short-term increases in sulfate between 2000 and 2003 are likely a result of seasonal disposal of mine water at the LAD. The increase in 2004 is associated with increased use of the Stillwater Valley Ranch percolation ponds while the Hertzler Ranch LAD storage pond was being constructed. The concentration of sulfate in ground water at MW-15A has since returned to near background concentrations. The sulfate concentration of ground water at the mine is representative of ambient water quality and is not indicative of acid formation in the ESWRS or tailings impoundment with subsequent infiltration to ground water.

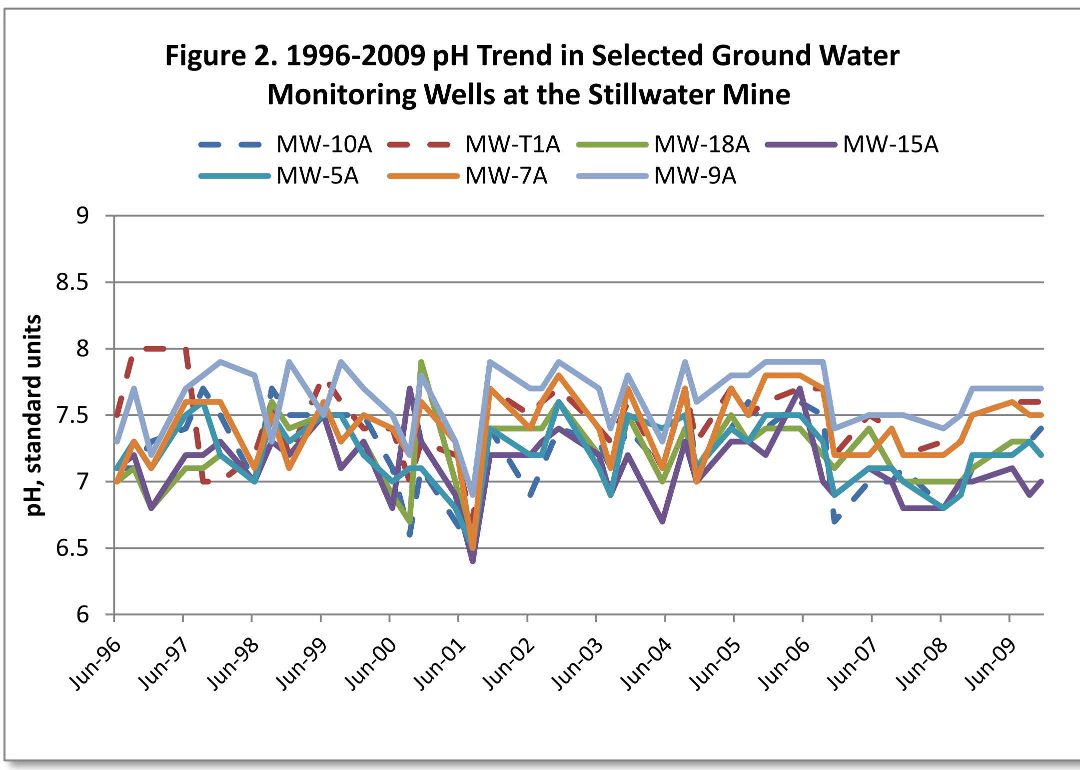


Figure 2. The trend of pH in ground water in selected monitoring wells at the Stillwater Mine. Upgradient wells are displayed with dashed lines. See the text of this memo and 2010 DEIS Figure 3-1 for monitoring well locations.

Ground water at the Hertzler Ranch LAD: The trend of pH in ground water at the Hertzler Ranch LAD is similar to that of Stillwater Mine (SMC database). The pH in upgradient ground water well HMW-5 fluctuates around a constant pH value of about 7.9, and the fluctuation appears to be related to seasonality. The pH of ground water in downgradient monitoring wells HMW-6 and HMW-10 (LAD system compliance well) is strongly controlled by upgradient ground water, and also fluctuates around a constant value of 7.9. Monitoring well HMW-9 has shown the short-term influence of mine water as a result of a 2003 leak from piping, and has a slightly lower pH averaging 7.4 standard units. Ground water in HMW-14 has a slightly higher average pH (8.7) that has been generally constant over time. The higher pH of HMW-14 is likely due to the geologic unit in which the well is screened and does not appear to reflect the influence of mine water.

The sulfate concentrations of upgradient well HMW-5 and downgradient wells HMW-6, HMW-10, and HMW-14, have fluctuated around a constant value of 23 mg/L that appear to be related to seasonality. The average sulfate concentration of monitoring well HMW-9 is 87 mg/L as a result of the 2003 piping leak. The sulfate concentration and pH of ground water at the Hertzler Ranch is strongly controlled by ambient ground water and is not indicative of acid generation from the Hertzler Ranch tailings impoundment with subsequent infiltration to ground water.

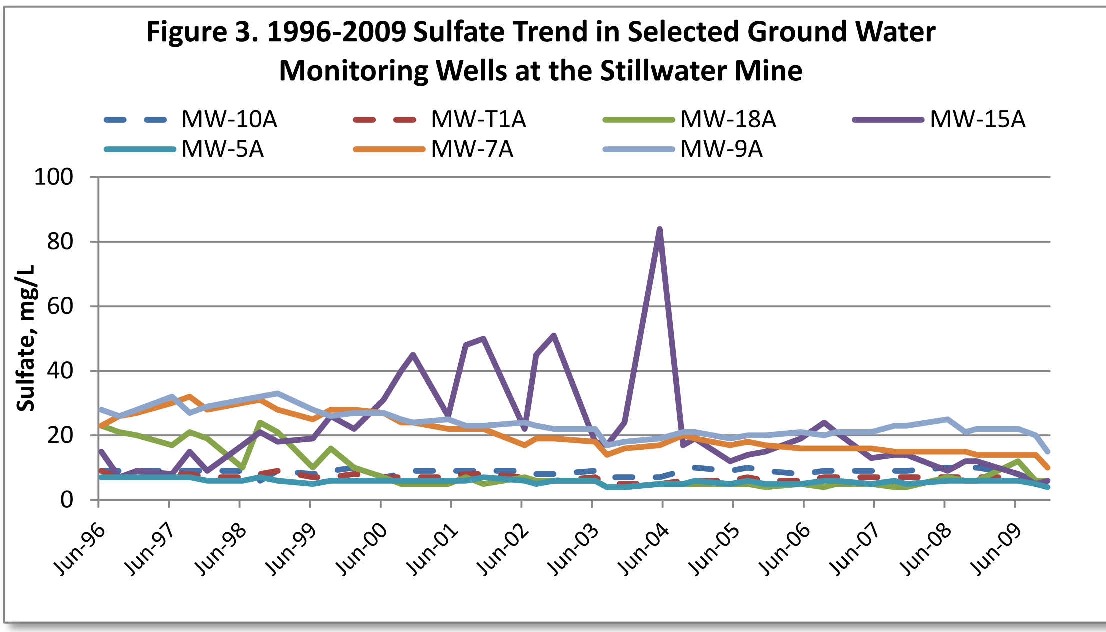


Figure 3. The trend of sulfate concentration in ground water monitoring wells at the Stillwater Mine. Upgradient wells are displayed with dashed lines. See the text of this memo and the 2010 DEIS Figure 3-1 for monitoring well locations.

Stillwater Mine adit water: Stillwater Mine currently produces an average of 650 to 800 gpm (gallons per minute) of adit water. This water is collected underground, used underground to wash down muck piles and cool drilling equipment, or used in the mill. Excess adit water is treated in the biological treatment system (BTS) to remove nitrogen before disposal in the percolation pond or at Hertzler Ranch LAD. **Figure 4** indicates that the concentration of sulfate in adit water at the Stillwater Mine has been constant around a mean of 170 mg/L over the 13-year period of record. The pH of adit water from 1987 to 2004 has been constant around a mean of 7.5. The pH has increased since 2004 about half a standard unit.

The pH spikes noted in figure 4 are likely due to the fact that Stillwater recycles about 55 percent of its tailings in cemented paste backfill or in sandfill of stopes. Paste backfill consists of the coarse tailings fraction mixed with cement and emplaced as slurry. Water that drains from cemented backfill is higher in pH and sulfate concentration than adit water and drains to sumps that collect adit water. The spikes in data may be due to times when sampling events occurred simultaneously with large underground paste pours (R. Weimer personal communication). These pH and sulfate data are not indicative of acid formation underground at the Stillwater Mine.

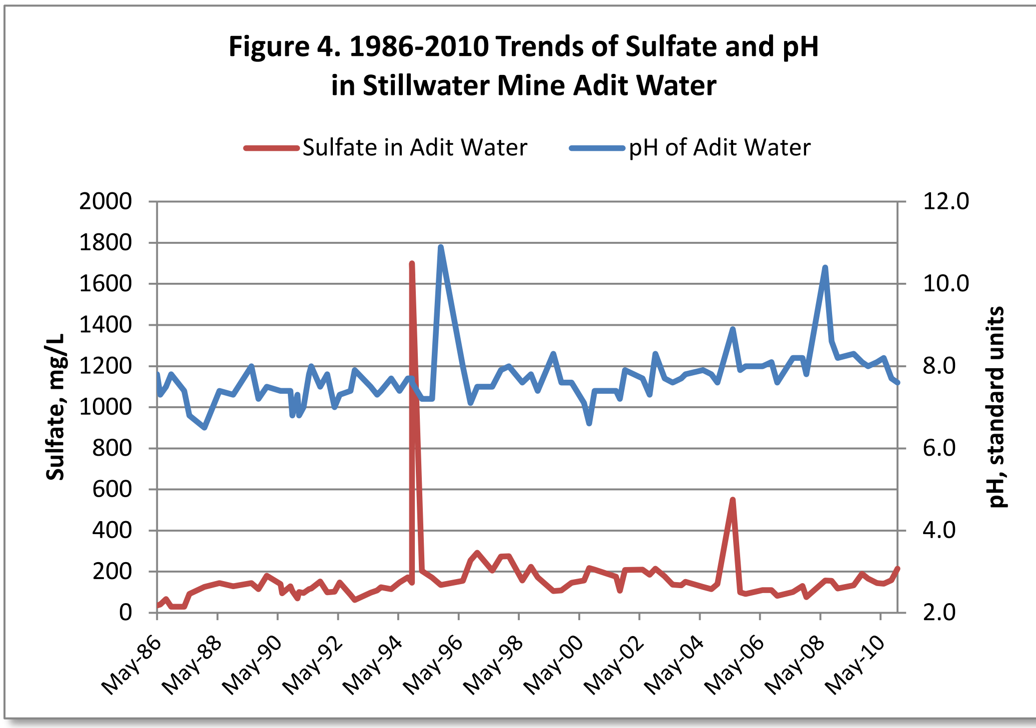


Figure 4. The trends of sulfate and pH in untreated adit water at the Stillwater Mine. The mine currently produces about 650 to 800 gpm of adit water.

Stillwater Mine tailings water: During operations, adit water contributes to the tailings water that is continuously recycled between impoundments, used in the milling process, and used for dust control on the impoundment beaches. Water is routed between the Stillwater and Hertzler Ranch impoundments so that it is combined and homogenized for a consistent quality signature. **Figure 5** displays the concentrations of sulfate and pH in tailings waters. The pH of tailings waters from 1986 to 2004 has fluctuated around a mean of 7.5. Since 2004, the pH of tailings water has increased about half a standard unit, most likely from the use of cemented paste backfill. These pH values are consistent with that of adit water, as would be expected from the routing of water within the mine. The concentration of sulfate in tailings waters gradually increased from 1986 to 2003 as a result of recycling water underground and between impoundments (for water balance). Between 2003 and 2005, the overall sulfate concentration of tailings water declined, likely a result of routing water to Hertzler Ranch to ballast the Stage II tailings impoundment liner, rather than recycling it. The mean sulfate concentration since 2005 (520 mg/L) is consistent with recycled tailings waters prior to ballasting the Stage II impoundment liner. These pH and sulfate concentration data are not indicative of acid formation within the Stillwater or Hertzler Ranch tailings impoundments.

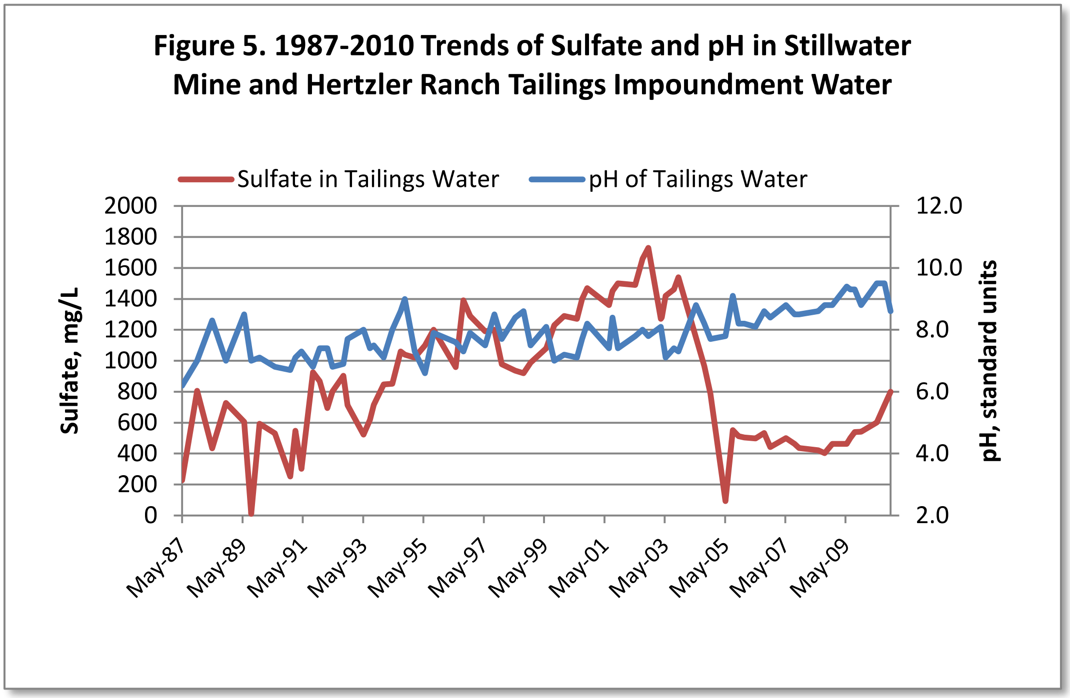


Figure 5. The trends of pH and sulfate in untreated tailings impoundment waters at the Stillwater Mine and Hertzler Ranch. The water from the Hertzler Ranch tailings impoundment is recycled back to the Stillwater impoundment during operations, so the water in both impoundments has the same quality signature.

Operational data for East Boulder Mine: The agencies evaluated the long-term trends of pH and sulfate concentration in ground water, adit water, and tailings water at the East Boulder Mine. The results are presented below.

Ground water at the East Boulder Mine: The East Boulder Mine has a much smaller footprint than the Stillwater Mine, and fewer ground water monitoring wells. The upgradient well, WW-1 is the potable water source for the mine. Monitoring well EBMW-4 is immediately downgradient of the percolation pond, which is the primary method for disposal of treated adit water. Due to annual water table fluctuations beneath the screened interval, a second monitoring well, EBMW-4A was drilled near EBMW-4 at a deeper depth with a longer screen. EBMW-2 is between the tailings impoundment and the East Boulder River. There are seven monitoring wells at the downgradient end of the tailings impoundment used to indicate compliance with the MPDES-permitted percolation pond outfall. Of these seven wells, EBMW-6 and EBMW-7 best represent downgradient water quality and are included in this evaluation.

Figure 6 shows that the pH of upgradient ground water, represented by monitoring well WW-1 (shown by a dotted line), has fluctuated around a mean of 7.8. The pH of ground water in down-gradient monitoring wells EBMW-2, EBMW-4, EBMW-6, and EBMW-7 fluctuates around a mean of 7.8 over the 22-year period of record. The fluctuations noted in pH appear to be related to seasonality; and downgradient water quality appears to be strongly influenced by upgradient water quality.

Figure 7 shows the trend of sulfate in ground water at the East Boulder Mine. The concentration of sulfate in upgradient well WW-1 is generally less than 10 mg/L. The concentration of sulfate in EBMW-2, which is strongly influenced by the East Boulder River, is less than 25 mg/L, with a mean of 15 mg/L.

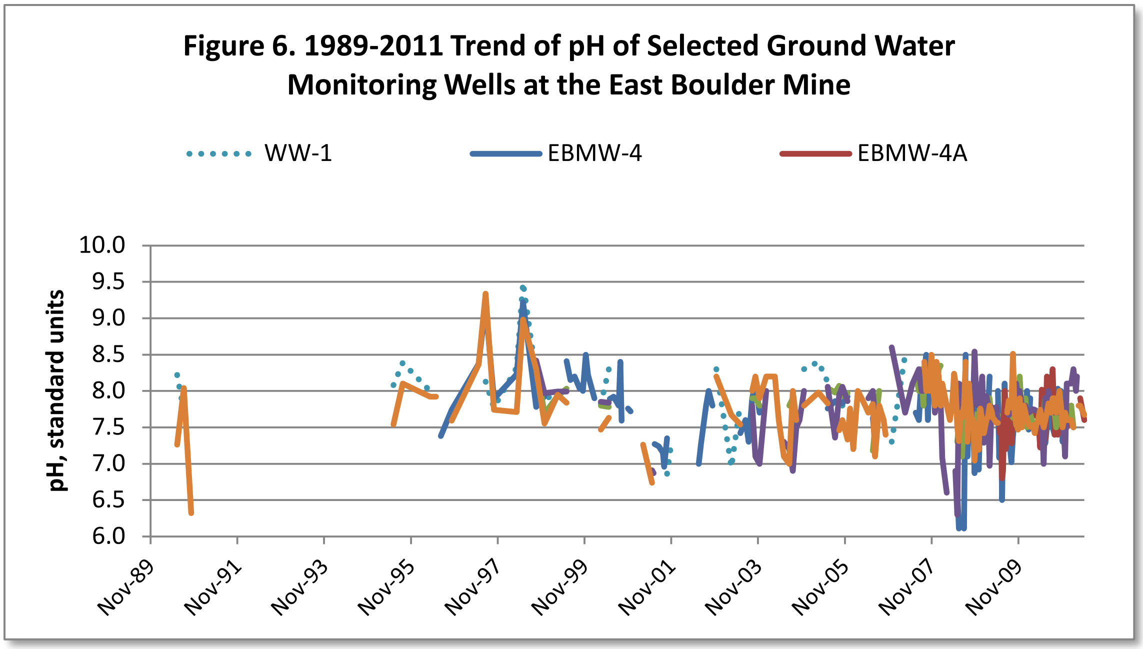


Figure 6. The trend of pH in ground water at the East Boulder Mine. Upgradient well WW-1 is displayed with a dotted line. See the text of this memo and the 2010 DEIS Figure 2-27 for the location of the monitoring wells.

The concentrations of sulfate in monitoring wells EBMW-4 and EBMW-4A downgradient of the percolation pond fluctuate around a mean of about 30 mg/L. The concentrations of sulfate in wells EBMW-6 and EBMW-7 downgradient of the tailings impoundment fluctuate around a mean of about 20 mg/L. The increase in sulfate concentration in MW-4 is due to percolation disposal of treated excess

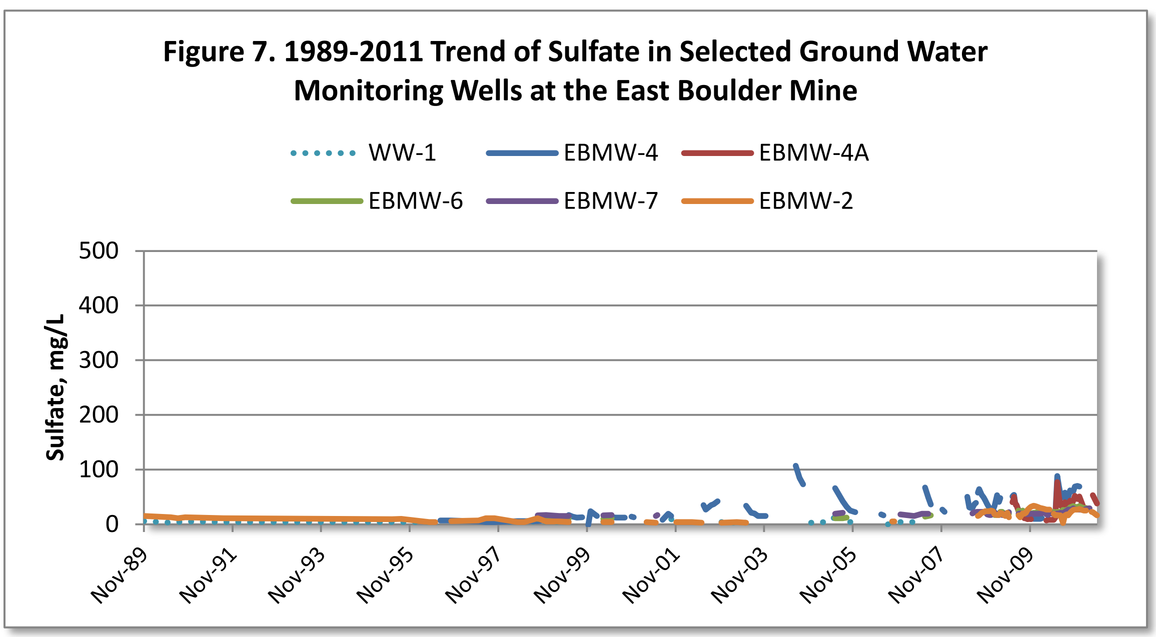


Figure 7. The trend of sulfate in ground water at the East Boulder Mine. Upgradient well WW-1 is displayed with a dotted line. See the text of this memo and the 2010 DEIS Figure 2-27 for the location of the monitoring wells.

mine waters. These pH and sulfate data, in general, reflect ambient water quality and do not indicate acid generation in the tailings impoundment or from waste rock used in construction of mine facilities.

East Boulder Mine adit water: East Boulder Mine currently produces, on average, 150 gpm of adit water. This water is collected underground, treated as needed to remove nitrogen, and routed for reuse underground to cool drilling equipment and wash down muck piles, used in the mill, or disposed of by percolation. During the period 1998 through 2002, the East Boulder Mine underwent a phase of underground construction. During this time, the three-mile adit was bored, shops were constructed, and these areas were coated with shotcrete. An acid neutralizing circuit was added to the East Boulder Mine biological treatment system (BTS) to adjust pH and protect the denitrifying bacteria. **Figure 8** portrays the pH and concentration of sulfate in untreated adit water. The sulfate concentration has fluctuated since 2003, but its nine-year trend is generally constant around a mean of 130 mg/L. The pH of adit water during the construction phase was about 9.5, but since 2002 has averaged about 7.8 standard units. The East Boulder Mine produces much less water than the Stillwater Mine, so the pH and sulfate content of adit water would strongly reflect the influence of shotcrete (pH) and sandfill (sulfate) in the underground workings. The East Boulder Mine does not use cemented paste backfill (M. Wolfe, personal communication). These data are not indicative of acid generation in the underground workings.

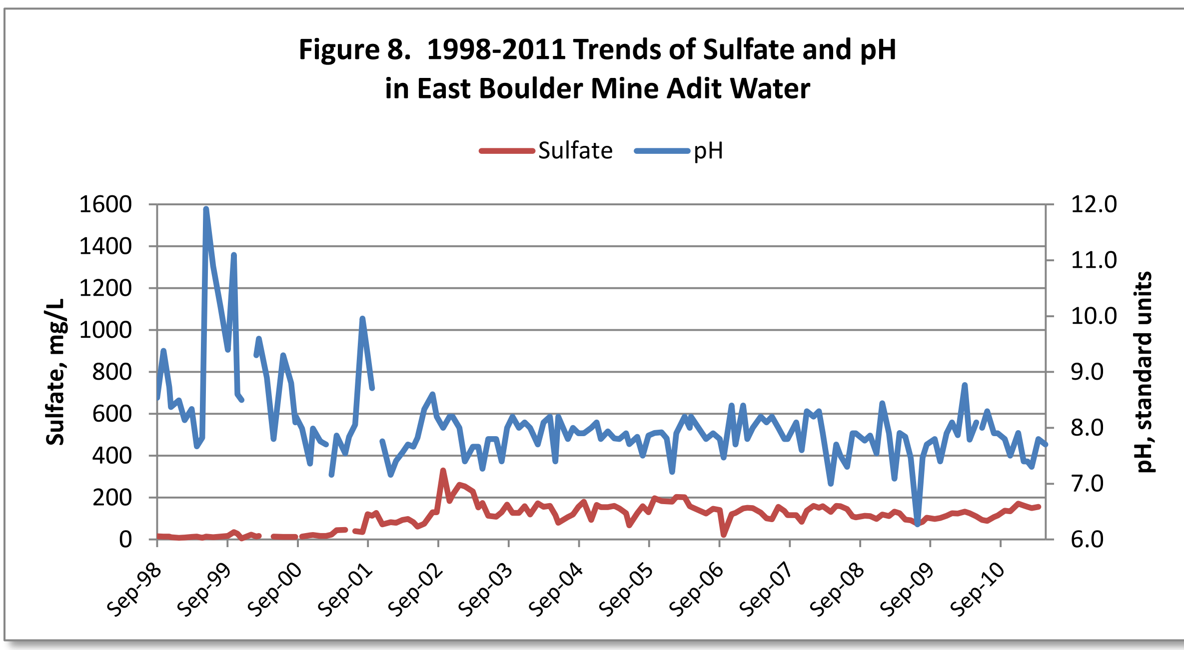


Figure 8. The trends of sulfate and pH in untreated adit water at the East Boulder Mine. The mine produces about 150 gpm of adit water.

East Boulder Mine Tailings water: Water is collected from the tailings impoundment as supernatant and underdrain (also called subdrain) water. The underdrain is a system of gravel and pipe finger drains installed above the liner to collect water that has migrated through the tailings mass. At the East Boulder Mine, approximately 80 gpm of tailings water is collected from the underdrain and recycled with supernatant water. The pH and sulfate concentrations of tailings water are presented in **Figure 9**.

The pH of the tailings waters has fluctuated around a mean of about 8.3. The sulfate concentration of the tailings waters since 2003 has averaged about 260 mg/L. These data are not indicative of acid formation in the East Boulder tailings impoundment.

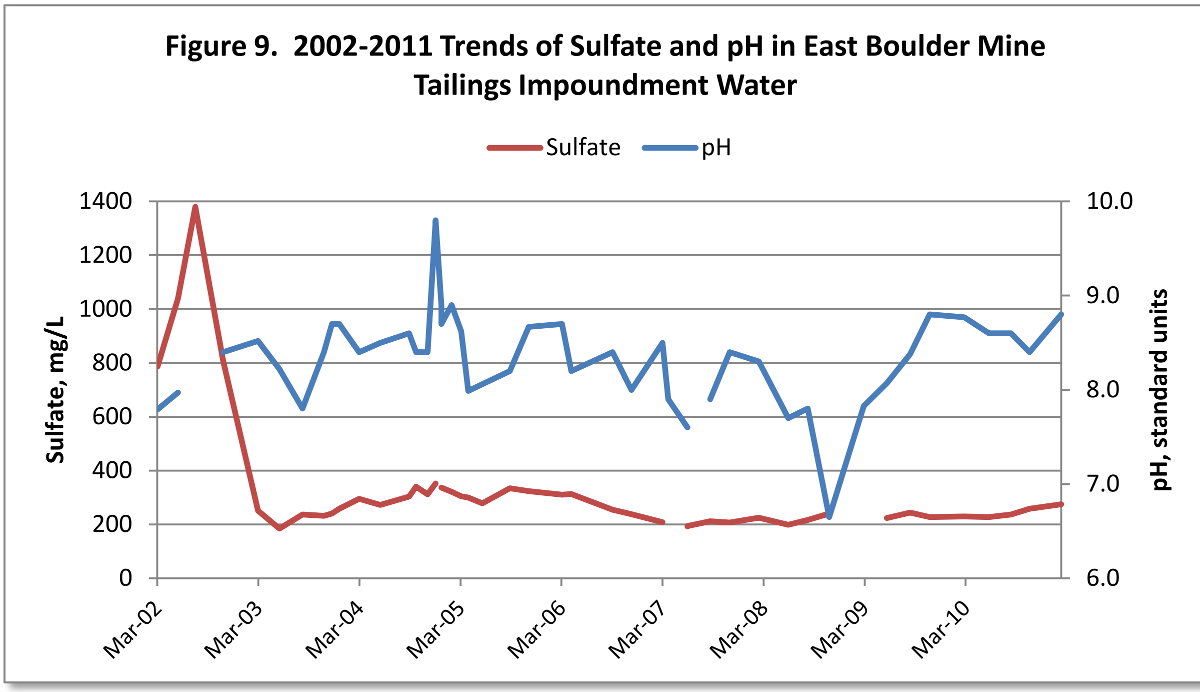


Figure 9. The trends of sulfate and pH in tailings impoundment water at the East Boulder Mine.

Conclusion: Current and historical geochemical data for waste rock, tailings, and ore at both mines indicate a very low potential to generate acid. SMC conducts operational quarterly testing of active waste rock headings to evaluate whether any changes are discernable in rock type or characterization (R. Weimer, personal communication). SMC has an ongoing quarterly operational monitoring program to characterize ore, waste rock, and tailings for the potential to generate acid (hardrock permit plans of operations). The ground water quality at both mines and the Hertzler Ranch LAD is strongly influenced by the ambient ground water signature and is not indicative of impacts resulting from acid generation in waste rock or from the tailings impoundments. The quality of adit and tailings waters, based on pH and sulfate concentrations, is not indicative of acid generation in the underground or in the tailings impoundments.

These data suggest that static and kinetic testing is unwarranted post-closure. Geologic interpretation of the Stillwater Complex J-M Reef, comparisons of geology and rock type/composition between the Stillwater and East Boulder Mines, probe holes drilled in advance of the heading/footwall underground, exploration drilling from the surface along the length of the deposit, and extensive surface mapping all attest to the remarkable consistency of this Pt-Pd deposit (R. Weimer, personal communication). Due to this consistency, no change in rock type or mineralogy is anticipated. If the rock types, geochemical data, and water quality data remain consistent with current and historical data, the potential for generation of acid is extremely low, and the agencies would not require additional static or kinetic testing.

Comment 2: *Summary of the long-term monitoring plan for potential acid generation and leaching of metals post-closure.*

Potential for acid generation: Based on the data provided in response to Comment 1, if the rock types, geochemical data, and water quality data remain consistent with operational and historic data, the potential for generation of acid is extremely low. These data suggest that monitoring for acid generation is unwarranted post-closure. The agencies will require water quality monitoring during closure.

Potential for metals leaching-- geochemical data: Leaching tests are used at hard rock mines to evaluate whether metals might be leached from waste rock or tailings that could infiltrate soil and potentially discharge to ground water. SMC has an ongoing quarterly operational monitoring program to characterize ore (Stillwater Mine only), waste rock, and tailings for the potential to generate acid and leach metals.

Under the Good Neighbors Agreement (GNA), Kuipers and Associates performed an independent review of quarterly geochemical data collected from 2001 to 2005 by both mines (whole rock and leachable metals by TCLP and SPLP). The TCLP had initially been used by SMC at Stillwater Mine to evaluate metals mobility and is a more aggressive leaching analysis performed on whole rock. The fixed pH 5 of the extraction solution used in the TCLP is lower than any pH measurement recorded for the site and the results obtained, therefore, are conservative in assessing metals mobility from the site.

EPA has suggested that a less aggressive leaching test such as SPLP could be applied to mineral processing wastes, and may be more appropriate than TCLP (EPA 1995). In their independent review of the leaching data from both mines, Kuipers and Associates recommended that “Stillwater Mine modify the Waste Rock Characterization Plan to analyze ore, tailings, and waste rock samples for SPLP extractable metals instead of TCLP extractable metals” (Kuipers and Associates 2006). The SPLP is less aggressive, designed to evaluate the mobility of organic and inorganic contaminants by simulating the effect of acid rain on land disposed wastes. SMC now uses the SPLP test at both Stillwater and the East Boulder mines on a quarterly basis to evaluate metals mobility.

A third test, the Meteoric Water Mobility Procedure (MWMP), was developed by the Nevada Department of Environmental Protection for mining wastes and is a laboratory analysis described by the American Society of Testing and Materials (ASTM E2242-07). The MWMP test is designed to evaluate the potential for dissolution and mobility of certain constituents from mine waste by leaching with meteoric water (precipitation). SMC performed MWMP leaching analyses on samples obtained from cores of waste rock collected from the ESWRS at the Stillwater Mine (SMC 2009).

In addition to their review of existing data, Kuipers and Associates collected supplemental samples from the Stillwater and East Boulder mines in 2001 to analyze for sulfur content, the potential to generate acid, total metals concentration, and the potential to mobilize metals using the SPLP analyses (reported in Kuipers and Associates 2006). The Stillwater Mine’s highest concentration laboratory metals leaching results for waste rock, tailings, and ore are listed in **Table 1** (Kuipers and Associates 2006 and SMC 2009). It should be noted that three leaching procedures were used to provide the results listed in Table 1. All of the laboratory SPLP and MWMP leachable metals results for waste rock and tailings are less than ground water quality criteria. Two TCLP leachable metals detections (from a tailings sample) exceeded MT DEQ Circular 7 ground water criteria.

Table 1. **Stillwater Mine Maximum Laboratory Leachate Concentrations from Mine Waste compared to Ground Water Criteria** (from Kuipers and Associates 2006 and SMC 2009).

Parameter (all values mg/L)	**Laboratory Metals Leaching Maximum Results from Stillwater Mine Waste Rock, Tailings, and Ore***						**MT DEQ Circular 7 Ground Water Criteria**
	Waste Rock		**Tailings**		**Ore**		
	MWMP 2009 n=37	SPLP 2006 n=11	SPLP 2006 n=1	TCLP 2006 n=15	SPLP 2006 n=1	SPLP 2006 n=6	
Cadmium	<0.0001	<0.0001	<0.0001	**0.5**	<0.0001	<0.1	0.005
Chromium	0.029	<0.01	<0.01	<1	<0.01	<0.5	0.100
Copper	0.0175	<0.01	<0.01	<0.5	<0.01	<0.5	1.3
Iron	<0.06	NA	NA	NA	NA	NA	0.300
Lead	<0.003	0.0007	0.0002	<0.5	0.0004	<0.5	0.015
Manganese	0.007	NA	NA	<5	NA	NA	0.050
Mercury	<0.0002	0.0003	<0.0002	<0.05	<0.0002	<0.02	0.002
Nickel	0.031	<0.01	<0.01	**0.9**	<0.01	<0.5	0.1
Zinc	0.011	0.01	0.01	<5[€]	0.01	<0.5	2.000

* The maximum, and therefore, most conservative, laboratory result is listed in the table. [€]For tailings, four TCLP samples were analyzed for zinc. Abbreviations: **n**= the number of samples analyzed; **MWMP**-Meteoric Water Mobility Procedure; **SPLP**-Synthetic Precipitation Leaching Procedure; **TCLP**- Toxic Characteristic Leaching Procedure; **NA**-not analyzed; **mg/L** milligrams per liter; **<** indicates a non-detectable result at the detection level listed. **Bold values** indicate an exceedance of ground water quality criterion.

The East Boulder Mine's highest laboratory metals leaching results for waste rock, tailings, and ore are listed in **Table 2** (Kuipers and Associates 2006). It should be noted that only the SPLP leaching procedure was used to provide the results listed in Table 2. All of the laboratory SPLP leachable metals results are less than MT DEQ Circular 7 ground water quality criteria.

Table 2. **East Boulder Mine Maximum Laboratory Leachate Concentrations from Mine Waste compared to Ground Water Criteria.**

Parameter (all values mg/L)	**Laboratory Metals Leaching Maximum Results from SMC East Boulder Mine Waste Rock, Tailings, and Ore***			**MT DEQ Circular 7 Ground Water Criteria**
	Waste Rock SPLP 2006* n=5	**Tailings** SPLP 2006* n=1	**Ore** SPLP 2006* n=1	
Cadmium	<0.0001	<0.0001	<0. 0001	0.005
Chromium	<0.01	<0.01	<0.01	0.100
Copper	<0.01	<0.01	<0.01	1.3
Iron	NA	NA	NA	0.300
Lead	0.0002	<0.0001	<0.0001	0.015
Manganese	NA	NA	NA	0.050
Nickel	<0.01	<0.01	<0.01	0.1
Zinc	0.02	0.01	<0.01	2.000

* Maximum detectable concentration is listed in table (Kuipers and Associates 2006). Bold values indicate an exceedance of ground water quality criterion. Abbreviations: **SPLP**-Synthetic Precipitation Leaching Procedure; **NA**-not analyzed; **mg/L** milligrams per liter; **<** indicates a non-detectable result at the detection level listed.

Conclusion: Geochemical characterization data collected by SMC from 2001 through 2005 as part of the ongoing operational monitoring program, and reviewed by Kuipers and Associates under the GNA, indicate that ore, tailings, and waste rock have a very low potential to generate acid and leach metals (Kuipers and Associates 2006). Based on these data and SMC's ongoing operational monitoring program, if the rock types and geochemical data remain consistent with operational and historical data, the potential for leaching of metals is extremely low. These data suggest that metals leachability testing is unwarranted during post-closure.

Comment 3: *Disclosure of the operational concentrations of metals in adit and tailings waters at both the Stillwater and East Boulder mines with a comparison of the operational concentrations to applicable water quality standards.*

The agencies have compared the concentrations of metals in adit and tailings waters at both the Stillwater and East Boulder mines to MT DEQ Circular 7 ground water criteria. These are the appropriate criteria because the mines currently discharge mine waters to percolation ponds or LAD systems that infiltrate to ground water. These data are tabulated below.

The agencies have also compared the concentrations of metals in adit and tailings waters from both mines to the respective MPDES permit direct discharge effluent limits. Please note that the operational data are obtained using dissolved metals analyses. The MPDES permit would require total recoverable metals analyses of any direct-discharged waters. Dissolved and total recoverable metals analyses produce very different results, and as such, are not directly comparable. Conceding this primary difference in analytical technique, there is merit in comparing the order of magnitude of operational dissolved metals concentrations with MPDES permit surface water total recoverable metals effluent limits to estimate the potential effect that direct discharge of untreated (for metals) adit or tailings waters might have on surface water.

Potential for metals loading—Stillwater Mine operational waste water quality data: **Table 3** lists the median metals quality of the operational waste water at the Stillwater Mine in comparison to the ground water quality criteria. Both the operational waste water data and the MT DEQ Circular 7 ground water criteria are dissolved analyses. None of the operational wastewater streams violate DEQ Circular 7 metals criteria for ground water and are generally at least one order of magnitude less than the metals criteria. These data indicate that discharge of Stillwater Mine untreated adit or tailings waters at the mine percolation ponds or Hertzler Ranch LAD would not result in metals contamination of ground water.

Potential for metals loading—Stillwater Mine surface water effluent limits: For comparison purposes, **Table 4** lists the Montana Pollution Discharge Elimination System (MPDES) permit effluent limits for the Stillwater Mine that SMC would have to meet if treated mine waters were directly discharged to the Stillwater River. Although Stillwater Mine has a permitted outfall (001) for direct discharge to the Stillwater River, this outfall has not been constructed and is not used by the mine. Please note that the discharged water would require total recoverable metals analysis. SMC currently treats for nitrogen then land applies (discharges to ground water) most of its mine waters at the Hertzler Ranch LAD System (discharge to ground water) and the remainder is disposed of in the percolation ponds (discharge to ground water) at the Stillwater Mine. Conceding the difference between analytical methodologies, all of the adit and tailings waters are approximately equal to, or less than, the MPDES average monthly and instantaneous maximum metals limits for direct discharge to surface water without treatment for metals.

Table 3. **Stillwater Mine Operational Waste Water Quality Data compared to Ground Water Criteria.**

Parameter (all values mg/L)	**MT DEQ Circular 7 Ground Water Criteria**	**Adit Waters€**		**Tailings Waters€**		**Hertzler Ranch Tailings Underdrain€** 2003-2008
		East Side SMC-9 2001-2010	**West Side SMC-3** 2001-2010	**Stillwater SMC-4** 2000-2010	**Hertzler Ranch** 2001-2009	
Cadmium	0.005	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Chromium	0.100	0.010	0.001	<0.01	0.0012	<0.001
Copper	1.3	<0.001	<0.001	0.003	0.003	0.001
Iron	0.300	<0.01	<0.01	0.025	0.025	0.256
Lead	0.015	<0.003	<0.003	<0.003	<0.003	<0.003
Manganese	0.050	<0.005	0.0065	<0.003	0.007	1.26
Mercury	0.002	<0.00001	NA	NA	NA	NA
Nickel	0.1	<0.01	NA	NA	NA	NA
Silver	0.100	<0.0005	NA	NA	NA	NA
Zinc	2.000	<0.01	<0.01	<0.01	0.015	0.015

€ Median concentration reported from the SMC database for the period indicated. **Bold values** indicate an exceedance of ground water quality criterion. Abbreviations: **mg/L** milligrams per liter; **<** indicates a non-detectable result at the detection level listed; **NA**—not analyzed.

Table 4. **Comparison of Stillwater Mine MPDES Permit Metals Effluent Limits for Direct Discharge to the Stillwater River to Stillwater Waste Water Metals Quality Data.**

MPDES Permit MT0024716 Stillwater Mine Outfall 001 to Stillwater River Effluent Limits (expires 2013)			**Stillwater Mine Adit Water€**		**Tailings Waters€** Stillwater and Hertzler Impoundments
Parameter (all values in mg/L)	**Average Monthly Limit**	**Instantaneous Maximum Limit**	**East Side SMC-9** 2001-2010	**West Side SMC-3** 2001-2010	**Stillwater SMC-4** 2000-2010
Cadmium	<0.00008	<0.00008	<0.0001	<0.0001	<0.0001
Chromium	0.174	0.350	0.010	0.001	<0.01
Copper	0.012	0.025	<0.001	<0.001	0.003
Iron	6.1	12.23	<0.01	<0.01	0.025
Lead	0.000545	0.01398	<0.003	<0.003	<0.003
Manganese	0.35	0.53	<0.005	0.0065	<0.003
Mercury	0.00005	0.00008	<0.00001	NA	NA
Nickel	0.048	0.100	<0.01	NA	NA
Zinc	0.027	0.055	<0.01	<0.01	<0.01

€ Median dissolved metals concentration of the data for the date range indicated, from the SMC database. **Bold values** indicate an exceedance of ground water quality criterion. Abbreviations: **NA**—not analyzed; **<** indicates a non-detectable result at the detection level listed. Please note that the MPDES permit effluent limits would require a total recoverable metals analysis and the operational data are dissolved metals analyses.

<u>Potential for metals loading—East Boulder Mine operational waste water metals data</u>: **Table 5** lists the metals quality of the operational waste waters at the East Boulder Mine in comparison to the ground water quality criteria. None of the operational waste waters violate MT DEQ Circular 7 metals ground water criteria and most values are at least one order of magnitude less than the metals criteria. These data indicate that metals contamination of ground water would not result from discharge of East Boulder Mine adit or tailings waters.

Table 5. **East Boulder Mine Operational Metals Waste Water Quality Data compared to Ground Water Criteria.**

Parameter (all values mg/L)	**MT DEQ Circular 7 Ground Water Criteria**	**East Boulder Mine Operational Waste Stream Metals Data**	
		Adit Water€ 1998-2011	**Tailings Waters**€ 1998-2011
Arsenic	0.010	<0.003	<0.003
Barium	1.000	0.005	<0.2
Beryllium	0.004	<0.001	<0.001
Cadmium	0.005	<0.0001	<0.0001
Chromium	0.100	<0.001	<0.001
Copper	1.3	<0.001	0.002
Iron	0.300	0.04	0.025
Lead	0.015	<0.003	<0.002
Manganese	0.050	0.022	0.005
Mercury	0.002	<0.005	<0.005
Nickel	0.1	<0.02	<0.02
Selenium	0.050	0.002	0.005
Silver	0.1	<0.003	<0.003
Zinc	2.000	<0.02	<0.01

€Median dissolved metals concentration of the data for the date range indicated, from the SMC database. **Bold values** indicate an exceedance of ground water quality criterion. Abbreviations: **mg/L** milligrams per liter; **<** indicates a non-detectable result at the detection level listed; **NA**—not analyzed.

<u>Potential for metals loading —East Boulder Mine surface water effluent limits</u>: For comparison purposes, **Table 6** lists the MPDES permit effluent limits for the East Boulder Mine that SMC would have to meet if treated mine waters were directly discharged to the East Boulder River. Although East Boulder Mine has a permitted outfall (001) for direct discharge to the East Boulder River, this outfall has not been constructed and is not used by the mine. SMC currently percolates (discharges to ground water) mine waters that have been treated for nitrogen at the East Boulder Mine. Conceding the difference between analytical methodologies, all of the adit and tailings waters are approximately equal to, or less than, the MPDES average monthly and instantaneous maximum metals limits for direct discharge to surface water without treatment for metals.

<u>Conclusion</u>: Geologic interpretation of the Stillwater Complex J-M Reef, comparisons of geology and rock type/composition between the Stillwater and East Boulder Mines, probe holes drilled in advance of the heading/footwall underground, exploration drilling from the surface along the length of the deposit,

and extensive surface mapping all attest to the remarkable consistency of this Pt-Pd deposit (R. Weimer, personal communication). Due to this consistency, no change in rock type or mineralogy is anticipated

Table 6. **Comparison of East Boulder Mine MPDES Permit Metals Effluent Limits for Direct Discharge to the East Boulder River to East Boulder Waste Water Metals Quality Data**

MT0026808 East Boulder Mine Outfall 001 to East Boulder River Effluent Limits (administratively extended since 2005)			**East Boulder Mine**€	
Parameter (mg/L)	**Average Monthly Limit**	**Instantaneous Maximum**	**Adit Water** 1998-2011	**Tailings Waters** 1998-2011
Cadmium	0.0014	0.0021	<0.0001	<0.0001
Chromium	0.05	0.075	<0.001	<0.001
Copper	0.008	0.012	<0.001	0.002
Iron	0.43	0.65	0.04	0.025
Lead	0.001	0.0015	<0.003	<0.002
Manganese	0.19	0.28	0.022	0.005
Nickel	0.024	0.036	<0.02	<0.02
Zinc	0.03	0.045	<0.02	<0.01

€ Median concentration reported from SMC database; dissolved metals analysis. All values in **mg/L** milligrams per liter; **<** indicates a non-detectable result at the detection level listed; **NA**—not analyzed; Please note that the MPDES permit effluent limits would require a total recoverable metals analysis.

that would result in an adverse change in the quality of adit or tailings water over time. The results of SMC's operational monitoring program, in concert with historical data, suggest that SMC's disposal of adit and tailings waters would not cause loading of metals at a rate that would cause contamination of or degrade surface and ground water. The agencies believe that the current operational monitoring program, the MT DEQ ground water quality metals criteria, and the requirements of the MPDES permit are adequate to protect surface and ground water quality.

Comment 4: *Analysis of the effects of metals on surface and ground water at both mines, operationally and post-closure.*

In general, hardrock waste rock storage facilities, tailings impoundments, and LAD facilities have the potential to leach metals to ground water and surface runoff. The agencies have reviewed the ground water quality data up- and downgradient of the tailings impoundments and surface waste rock storage areas at both mines, and at the Hertzler Ranch LAD to determine whether metals have affected surface and ground water quality at the mines operationally. The agencies have also evaluated whether metals would affect surface and ground water quality at the mines post-closure.

Potential for metals loading—Stillwater Mine ground water quality data: Monitoring well MW-10A is upgradient of all facilities, including the Stillwater Tailings impoundment, on the west side of the Stillwater River. Monitoring well MW-T1A is upgradient of the ESWRS on the east side of the Stillwater River. Monitoring wells MW-15A and MW18A monitor the uppermost aquifer downgradient of the ESWRS. Monitoring wells MW-5A, MW-7A, and MW-9A monitor the uppermost aquifer downgradient of the Stillwater Tailings Impoundment. Please refer to Figures 2-3 and 3-1 in the 2010 DEIS for the location of these monitoring wells. **Table 7** lists the highest concentrations of metals in ground water monitoring wells up- and downgradient of the Stillwater Mine ESWRS and the Stillwater Tailings impoundment. The period of record is listed per monitoring well and extends through the 2009 Annual

Water Resources Monitoring Report (SMC 2010). All of the ground water metals data to date meet ground water quality criteria. It should be noted that detection limits have improved since ground water sampling began at the mine and current detection limits are lower than ground water criteria.

Table 7. **Stillwater Mine Operational Ground Water Quality€ Up- and Downgradient of the East Side Waste Rock Storage and Stillwater Tailings Impoundment.**

Parameter (all values mg/L)	MT DEQ Circular 7 Ground Water Criteria	Stillwater Mine Upgradient Monitoring Wells		East Side Waste Rock Storage[a] Downgradient Monitoring Wells		West Side Stillwater Tailings Impoundment¥ Downgradient Monitoring Wells		
		MW-10A West Side 1986-2009	**MW-T1A** East Side 1988-2009	**MW-18A** 1994-2009	**MW-15A** 1990-2009	**MW-5A** 1987-2009	**MW-7A** 1986-2009	**MW-9A** 1986-2009
Cadmium	0.005	<0.005	<0.005	0.002	0.001	<0.005	<0.005	<0.005
Chromium	0.100	<0.02	<0.05	0.007	0.008	<0.02	0.03	0.04
Copper	1.3	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	0.01
Iron	0.300	0.2	<0.03	0.08	0.08	0.16	0.16	0.06
Lead	0.015	<0.02	<0.02	<0.003	<0.001	<0.02	<0.01	<0.02
Manganese	0.050	0.03	<0.02	<0.01	<0.02	0.01	<0.02	<0.02
Mercury	0.002	NA	NA	NA	NA	NA	NA	NA
Nickel	0.1	NA	NA	NA	NA	NA	NA	NA
Zinc	2.000	0.04	0.02	0.04	0.04	<0.09	0.12	2.21

€ Maximum concentration reported from SMC database. [a]The East Side Waste Rock Dump was placed on top of the former chromite tailings piles from the Mouat Chromite Mine. ¥The tailings impoundment was placed on top of former mill facility for the Mouat Chromite Mine. **Bold values** indicate an exceedance of ground water quality criterion. Abbreviations: **<** indicates a non-detectable result at the detection level listed; **NA**—not analyzed.

Potential for metals loading—Hertzler Ranch LAD ground water quality data: The Hertzler Ranch LAD system is used for disposal of excess water produced at the Stillwater Mine. The facilities at the Hertzler Ranch as of 2011 include seven center pivots, a LAD water storage pond, and the Hertzler Ranch tailings impoundment. In 2010, 216 million gallons of water was disposed of using the LAD system. Ground water monitoring well HMW-5 is upgradient of the center pivots, LAD storage pond, and Hertzler Ranch tailings impoundment. Monitoring wells HMW-9 and HMW-14 are downgradient of the LAD storage pond and tailings impoundment, respectively. HMW-6 is located beneath the center pivots, and HMW-10 is the compliance well located downgradient of the pivots, storage pond, and tailings impoundment. Please refer to Figure 3-1 in the 2010 DEIS for the location of these monitoring wells. **Table 8** lists the highest concentrations of metals in ground water monitoring wells up- and downgradient of the Hertzler Ranch LAD facilities. The period of record is listed per monitoring well and extends through the 2009 Annual Water Resources Monitoring Report (SMC 2010). All of the ground water quality metals data to date meet ground water quality criteria.

Potential for metals loading—East Boulder Mine ground water quality data: **Table 8** lists the highest concentrations of metals in up- and downgradient ground water monitoring wells at the East Boulder Mine. The period of record is listed per monitoring well and extends through the first quarter 2011 (East Boulder Mine water quality database). With the exception of iron and manganese in the upgradient well WW-1 and in EBMW-2 located between the tailings impoundment and the East Boulder River, ground water quality metals criteria are met. Similar concentrations of iron and manganese were not detected in wells downgradient of the percolation pond and tailings impoundment. There is no evidence that ground water quality has been adversely affected by metals from the East Boulder Mine.

Table 8. **Hertzler Ranch Metals Water Quality Up- and Downgradient of the LAD Center Pivots, LAD Storage Pond and the Hertzler Ranch Tailings Impoundment.**

Parameter (all values mg/L)	**MT DEQ Circular 7 Ground Water Criteria**	**Hertzler Ranch LAD System Metals Ground Water Quality Data**				
		Upgradient Monitoring Well€	**Hertzler Tailings Impoundment and LAD Pond Downgradient Monitoring Wells €**		**Hertzler Ranch LAD Downgradient Monitoring Wells€**	
		HMW-5 1995-2009	**HMW-9** 1996-2009	**HMW-14** 1999-2009	**HMW-6** 1996-2009	**HMW-10** Compliance Well 1996-2009
Cadmium	0.005	0.0011	0.0009	0.0004	0.0007	0.0007
Chromium	0.100	0.001	0.006	0.004	0.002	0.002
Copper	1.3	0.003	0.005	0.003	0.002	0.002
Iron	0.300	0.19	0.03	0.07	0.02	0.03
Lead	0.015	<0.003	0.003	<0.003	<0.003	0.005
Manganese	0.050	0.037	0.032	0.045	0.01	0.007
Mercury	0.002	NA	NA	NA	NA	NA
Nickel	0.1	NA	NA	NA	NA	NA
Zinc	2,000	0.02	0.03	<0.01	0.04	0.03

€ Maximum concentration of the data for the date range indicated, from the SMC database. **Bold values** indicate an exceedance of ground water quality criterion. Abbreviations: **<** indicates a non-detectable result at the detection level listed; **NA**—not analyzed.

Post-closure potential for metals loading:
East Boulder Mine post-closure adit discharge: Post-closure, the East Boulder Mine workings would be free-draining and its stopes would not flood. The East Boulder underground sandfill would not become saturated to potentially leach constituents that could affect water quality. The quality of adit water post-closure is expected to approach that of ambient ground water, and would not adversely affect ground water quality (DEQ and USFS 2010).

Stillwater Mine post-closure off-shaft discharge to the Stillwater River: Four to eleven years after closure, ground water that fills the underground workings would begin to discharge from the off-shaft (a vertical shaft that extends 1,900 feet beneath the Stillwater River Valley floor through the lower workings that would be used to dewater workings below 5,000 feet). The discharge from the off-shaft is estimated to be 320 gallons per minute (gpm) which is about 0.7 cubic feet per second (cfs) to the Stillwater River (DEQ and USFS 2010).

To put this post-closure discharge in perspective, the lowest monthly streamflow over a 10-year period for the Stillwater River at SMC-11 occurred in 2006 at 84 cfs, which is about 37,700 gpm. The estimated discharge from the off-shaft is 0.8 percent of the 2006 low streamflow value. The average low monthly Stillwater River streamflow is 140 cfs (about 62,900 gpm) (SMC database). The estimated discharge from the off-shaft is 0.5 percent of the average low streamflow value. These streamflow and volumetric data indicate that adit water discharging from the off-shaft post-closure would be at such a low volume as to not be discernable (that is, 8/1,000 and 5/1,000 parts, respectively).

As discussed in the response to comment 3, the concentrations of metals in adit and tailings waters are approximately equivalent to, or less than, the 2008 MPDES permit effluent limits and would not cause contamination of or degrade surface water. These data indicate that adit water discharging from the off-shaft post-closure would not adversely affect aquatic life in the Stillwater River.

Table 9. **East Boulder Mine Operational Ground Water Quality Up- and Downgradient of the East Boulder Percolation Pond and Tailings Impoundment.**

Parameter (all values mg/L)	**MT DEQ Circular 7 Ground Water Criteria**	**East Boulder Mine Metals Ground Water Quality Data€**					
		Upgradient Monitoring Well	**Monitoring Wells Downgradient of the Percolation Pond**		**Monitoring Wells Downgradient East Boulder Tailings Impoundment**		
		WW-1 1989-2011	**EBMW-4** 1996-2010	**EBMW-4A** 2009-2011	**EBMW-2** 1989-2011	**EBMW-6** 1998-2011	**EBMW-7** 1998-2011
Arsenic	0.010	<0.005	0.003	<0.01	<0.005	NA	<0.001
Barium	1.0	<0.01	<0.1	0.016	NA	NA	0.017
Beryllium	0.004	<0.005	NA	NA	NA	NA	<0.001
Cadmium	0.005	0.001	0.0006	<0.0001	<0.001	0.0002	<0.0003
Chromium	0.10	<0.02	0.005	0.004	0.017	0.01	0.001
Copper	1.3	0.034	0.012	0.002	0.004	0.003	0.003
Iron[a]	0.300	**1.74**	0.05	0.05	**1.69**	0.03	<0.03
Lead	0.015	<0.01	<0.003	<0.002	<0.01	<0.003	<0.003
Manganese[a]	0.050	**0.052**	0.007	0.01	**0.071**	0.01	0.006
Mercury	0.002	<0.001	<0.0001	NA	<0.001	NA	<0.0001
Nickel	0.100	<0.03	<0.02	<0.01	<0.03	0.02	<0.001
Selenium	0.050	<0.005	<0.0001	NA	<0.005	NA	<0.001
Silver	0.1	<0.005	<0.001	NA	<0.05	NA	<0.001
Zinc	2.000	0.43	0.04	<0.01	0.04	0.43	0.02

€ Maximum concentration reported from SMC database. **Bold values** indicate an exceedance of the ground water quality criterion. [a] Secondary maximum contaminant level. Abbreviations: **mg/L** milligrams per liter; **<** indicates a non-detectable result at the detection level listed; **NA**—not analyzed.

Post-closure seepage through the reclamation covers: A post-closure discharge would occur from each of the three tailings impoundments: Stillwater Mine, Hertzler Ranch, and East Boulder Mine. Precipitation that infiltrates through the reclamation cover and mixes with tailings waters would eventually overflow the liners and discharge as seepage through the cover. The rate of seepage for each impoundment was estimated based on precipitation, evaporation, and impoundment size (cover thickness was not considered as a conservative assumption) (DEQ and USFS 2010). Because the tailings waters from all impoundments meet DEQ Circular 7 criteria without dilution from precipitation, and the volume of ground water available for dilution is much greater than the volume of surface water, ground water will not be discussed further with respect to this post-closure discharge. The specifics for each impoundment and its discharge to surface water are discussed separately below.

Stillwater Mine tailings impoundment: Seepage is estimated to discharge post-closure from the Stillwater Mine tailings impoundment at about 10 gpm (0.02 cfs) (DEQ and USFS 2010). As discussed in the response to comment 3, the concentrations of metals in tailings waters are approximately equivalent to, or less than, the 2008 MPDES permit effluent limits and ground water quality metals criteria. The quality of the seepage through the cover would be more dilute than tailings water quality because infiltrating precipitation would mix with tailings waters prior to seepage through the cover and discharge to ground water or the Stillwater River (DEQ and USFS 2010).

As also discussed in the response to comment 3, the lowest monthly Stillwater River streamflow averages 140 cfs (about 62,900 gpm). The estimated discharge from seepage through the reclamation cover is 0.02 percent of the average low streamflow value. These streamflow and volumetric data indicate that seepage through the cover discharging post-closure to the Stillwater River at its lowest average streamflow rate would be at such a small volume as to not be discernable (that is, 2/10,000 parts), and would not adversely affect aquatic life in the Stillwater River.

Hertzler Ranch tailings impoundment: Seepage is estimated to discharge post-closure from the Hertzler Ranch tailings impoundment at about 18 gpm (0.04 cfs) (DEQ and USFS 2010). As previously discussed, the concentrations of metals in tailings waters are approximately equivalent to, or less than, the MPDES permit effluent limits and ground water quality metals criteria. The quality of the seepage through the cover would be more dilute than tailings water quality because infiltrating precipitation would mix with tailings waters prior to seepage through the cover and discharge to ground water or the Stillwater River (DEQ and USFS 2010).

As discussed in the previous section, the lowest monthly Stillwater River streamflow averages 140 cfs (about 62,900 gpm). The estimated discharge from seepage through the Hertzler Ranch reclamation cover is 0.03 percent of the average low streamflow value. These streamflow and volumetric data indicate that seepage through the cover discharging post-closure to the Stillwater River at its lowest average streamflow rate would be at such a small volume as to not be discernable (that is, 3/10,000 parts), and would not adversely affect aquatic life in the Stillwater River.

East Boulder Mine tailings impoundment: Seepage is estimated to discharge post-closure from the East Boulder tailings impoundment ranging from an average of 7 gpm to a peak of 124 gpm (0.02 to 0.3 cfs) (DEQ and USFS 2010). The 10-year lowest streamflow downstream of the East Boulder Mine at EBR-004/4A occurred during the winter months and was about 4.5 cubic feet per second (cfs), which is about 2,020 gpm. The summer low streamflow averages about 15 cfs (about 6,730 gpm). As previously discussed, the concentrations of metals in tailings waters are approximately equivalent to, or less than, the MPDES permit effluent limits and ground water quality metals criteria. The quality of the seepage through the cover would be more dilute than tailings water quality because infiltrating precipitation would mix with tailings waters prior to seepage through the cover and discharge to ground water or the East Boulder River (DEQ and USFS 2010). The estimated average discharge from seepage through the East Boulder reclamation cover is 0.3 percent of the 10-year lowest streamflow value, and 0.1 percent of average low streamflow. Peak seepage discharge rates would typically occur in late spring or early summer when streamflow is highest (May through July streamflow maintains at least 50 cfs on average), and would equate to a maximum of 0.6 percent of spring streamflow. These streamflow and volumetric data indicate that seepage through the cover discharging post-closure to the East Boulder River at its lowest average streamflow rate would be about 3/1,000 parts, and would not adversely affect aquatic life in the East Boulder River.

Conclusion: Geologic interpretation of the Stillwater Complex J-M Reef, comparisons of geology and rock type/composition between the Stillwater and East Boulder Mines, probe holes drilled in advance of the heading/footwall underground, exploration drilling from the surface along the length of the deposit, and extensive surface mapping all attest to the remarkable consistency of this Pt-Pd deposit (R. Weimer, personal communication). Due to this consistency, no change in rock type or mineralogy is anticipated that would result in an adverse change in the quality of adit or tailings water over time. The operational quality of adit and tailings waters from the Stillwater Mine, Hertzler Ranch LAD, and East Boulder Mine during the entire period of record (13 to 23 years) indicate that these mine waters meet or are less than applicable surface (MPDES) and ground water (MT DEQ Circular 7) metals criteria. Discharges of these waters would not adversely affect the quality of surface and ground water during operations or post-closure.

Comment 5: *Documentation of the potential for acid generation and metals mobility based on a large-scale field column (humidity cell) test performed over a period of several years.*

Waste rock has been used in construction of the tailings impoundments at both the Stillwater (1985) and East Boulder (2005) mines, and as such, these locations represent in-situ, large-scale field column tests for metals leachability. Waste rock has been disposed of in the location of the Stillwater Mine ESWRS since 1997, and constitutes a 14-year large-scale field column test. The location for the ESWRS was sited on top of native soils and historic chrome tailings in an effort to reclaim the historic tailings. The early waste rock was not compacted and the thickness of the pile was comparatively “thin” so that precipitation falling on the waste rock could readily flow through and infiltrate to ground water. If metals would have leached from the waste rock to infiltrate to ground water, those metals concentrations would have been captured in the datasets presented in Table 7 for the Stillwater Mine and in Table 9 for the East Boulder Mine.

In 2006, as a voluntary effort, SMC performed an in-situ test of the ESWRS to evaluate the potential for metals mobility and acid generation within the waste rock disposal area. SMC located and drilled four sonic core holes through the ESWRS based on annual records of waste rock placement, to maximize spatial distribution and the length of time that waste rock was in place. The 80- to 100-foot long cores were used to evaluate the potential effects of waste rock on water quality by determining: whether a “wetting front” from precipitation existed at depth within the pile; nitrogen concentration with depth and leaching (nutrient mobility); and acid/base accounting and metals leachability information on weathered rock at depth.

Sonic drilling technology allows drilling of rock using high-frequency, resonant energy to advance the drill bit, precluding the need and use of water in the drilling process. The cores were advanced until native soils or chrome tailings were encountered at the base of the ESWRS. Moisture readings were taken from the cores and samples were collected for nutrient and metals mobility and acid/base accounting analysis.

Infiltration of precipitation is necessary to mobilize leachable constituents from the waste rock or facilitate acid generation. The infiltration rate of precipitation depends on particle-size distribution of the waste, compaction, surface texture and geometry of the waste pile, moisture content of the waste, and the rate and duration of precipitation. SMC contours the ESWRS surface to facilitate runoff and compacts the waste rock in 3-foot lifts. When waste rock placement is complete, topsoil is placed and the dump surface is vegetated. The Stillwater Mine is in an area of net evaporation, having 13.2 inches of precipitation and 29.8 inches of evaporation (SMC 2009).

Moisture readings from the 37 samples collected at the ESWRS indicate that the moisture content is drying from the average 5 percent of “just mined” material to an in-situ moisture content averaging 2.35 percent. The maximum moisture measurement was 4.66 percent. The data did not indicate any consistent trend in moisture content with depth in any of the boreholes. No “wetting front” of precipitation was present to mobilize nutrients or metals from waste rock (SMC 2009).

The potential to mobilize residual nitrogen from the dump was evaluated. Nitrogen is a conservative parameter, and would leach from the ESWRS given the necessary conditions. The concentrations of nitrate+nitrite from the 37 samples ranged from 1.66 to 42.2 mg/L with a mean concentration of 17.8 mg/L (SMC 2009). No trend was evident in the concentrations of nitrogen with depth in any of the boreholes, indicating that nutrients have not been mobilized by precipitation within the ESWRS.

Acid/base accounting results were consistent with historic and recently collected operational data (Kirk et al 2006 and SMC 2009). The neutralization potential varied from 21 to 48 T/kT as calcium carbonate. The acid generation potential for all waste rock was less than 1 and falls within the "not acid-generating" region of the acid generation potential plot (**Figure 10**). The pyrite sulfur content was ≤0.02 weight percent, an order of magnitude less than the 0.3 weight percent sulfide sulfur threshold for acid production (Jambor et al 2000). The chrome tailings underlying the ESWRD were sampled in 1994 and had less than detectable TCLP results for all metals analyzed (SMC 2009).

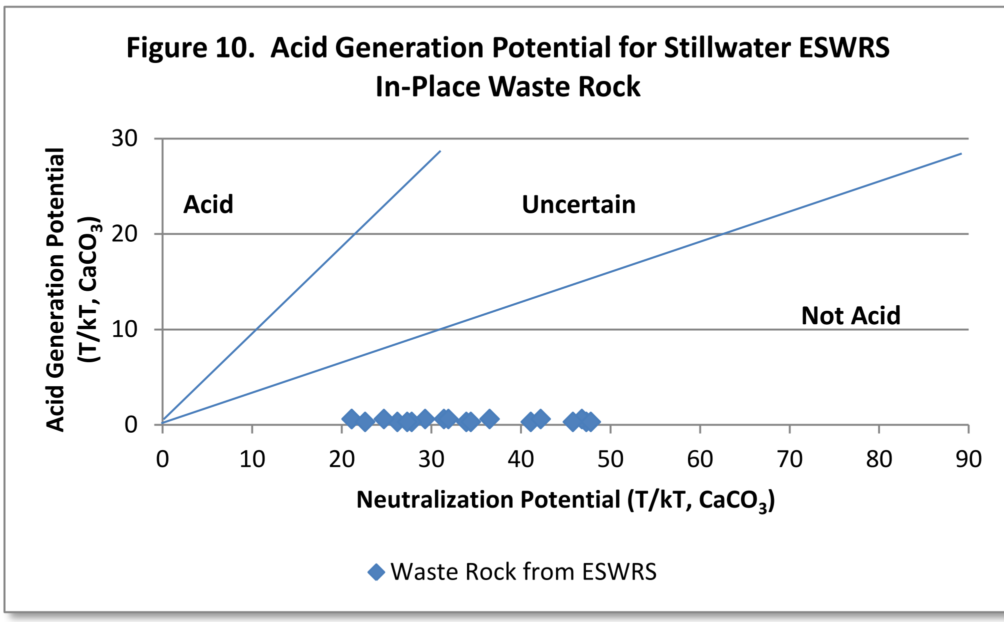


Figure 10. The acid generation potential for waste rock from drill cores taken from the ESWRS. The cores were taken from waste rock that had been placed in the ESWRS between 1997 and 2006.

The core samples produced leachable metals concentrations at or below the detection limit for all samples analyzed using the MWMP: beryllium; bismuth; cadmium; cobalt; gallium; iron; lead; lithium; mercury; phosphorous; scandium; silver; thallium; tin; and titanium. **Table 10** lists the leachable metals results for those parameters that had detectable concentrations and compares those results to ground water metals criteria. Only one detectable concentration was above the human health ground water standard for arsenic (SMC 2009). Given the fact that all other MWMP leaching arsenic results were at least an order of magnitude lower, the agencies believe that the exceedance is not consistent with other data, and as such, may be a remnant from the chrome tailings or an outlier.

Conclusion: The geochemical data collected from waste rock disposed of between 1997 and 2006 in the ESWRS indicate a very low potential to generate acid, leach metals, leach nitrogen, or adversely impact surface or ground water quality. Ground water quality data downgradient of the ESWRS, the Stillwater tailings impoundment, and the East Boulder tailings impoundments reflect the signature of upgradient water quality. Ground water at both mines is very high quality, with low sulfate concentrations, neutral pH, and metals concentrations near or below detection limits.

Geologic interpretation of the Stillwater Complex J-M Reef, comparisons of geology and rock type/composition between the Stillwater and East Boulder Mines, probe holes drilled in advance of the heading/footwall underground, exploration drilling from the surface along the length of the deposit, and extensive surface mapping all attest to the remarkable consistency of this Pt-Pd deposit (R. Weimer, personal communication). Due to this consistency, no change in rock type or mineralogy is anticipated that would result in an adverse change in the quality of adit or tailings water over time.

The agencies are satisfied that ESWRS core sampling performed by SMC provides data equivalent to a large-scale field column humidity cell test performed over a period of at least nine years. The agencies would not require another such test if the rock types, quarterly operational geochemical data, and water quality data remain consistent with current and historical data.

Table 10. **Field-scale Metals Leachability Results from the Stillwater East Side Waste Rock Storage.**

Parameter	**Number of Detectable Results**	**Laboratory Metals Leachability Results from Field-Scale Stillwater ESWRS** (mg/L)		**MT DEQ 7 Ground Water Quality Criteria** (mg/L)
		Lowest MWMP Detectable Result	Highest MWMP Detectable Result	
Aluminum	2	0.108	0.109	NC
Antimony	2	0.00697	0.0401	0.006
Arsenic	10	0.0033	**0.0167**	0.01
Boron	37	0.15	0.33	NC
Chromium	37	0.0013	0.029	0.1
Copper	27	0.001	0.0175	1.3
Manganese	2	0.005	0.007	0.05
Molybdenum	22	0.009	0.031	NC
Nickel	3	0.011	0.031	0.1
Selenium	6	0.001	0.0013	0.05
Strontium	34	0.007	0.046	4.0
Vanadium	5	0.0052	0.0074	NC
Zinc	1	0.011	0.011	2.0

* The analysis results are from 2009 SMC Waste Rock Core Analysis Report. Abbreviations**: MWMP**-Meteoric Water Mobility Procedure; **NC** - no criterion promulgated; **mg/L** milligrams per liter. **Bold values** indicate an exceedance of ground water quality criterion.

Comment 6: *Expansion of the list of metals for long-term monitoring (aluminum, arsenic, cadmium, copper, iron, manganese, mercury, selenium, silver, zinc, platinum, palladium), and inclusion of total hardness, calcium, magnesium, and sulfate for mine drainage and runoff.*

The list of metals that SMC operationally monitors at the Stillwater and East Boulder mines is based upon the whole rock analysis of its ores and waste rock, the efficiency of its beneficiation process, the potential of waste streams to contact contaminants, and the regulatory requirements of the agencies. At the Stillwater Mine, SMC monitors for cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc. Please refer to tables 1, 3, 4, 7, and 8. Please also see the extensive list of metals analyzed at the Stillwater Mine ESWRS for metals mobility in the response to Comment 5. At the East Boulder Mine, SMC monitors for arsenic, barium, beryllium, cadmium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc. Please refer to tables 2, 5, 6, and 9.

<u>Conclusion</u>*:* The agencies are satisfied with the adequacy of the current list of metals and, given the remarkable consistency of the geochemistry and mineralogy of the deposit, would not require the analysis of additional metals unless there was a change in the geochemistry of the rock encountered or other regulatory reason to expand the list of analytes.

Comment 7: *Evaluation of the effects of the mine during operations on downgradient surface (Nye Creek) and ground water with respect to metals loading.*

To evaluate whether the Stillwater Mine has had effects on surface water downgradient of mine facilities, specifically Nye Creek, the agencies analyzed total recoverable metals concentration data collected between 1997 and 2009 from upstream (SMC-7) and downstream (SMC-7D) monitoring stations along the creek. The statistics of the two data sets were calculated and the mean and median total recoverable metals concentrations are listed in **Table 11**. The two data sets appear similar, but the statistics are slightly different.

To further evaluate whether there is a difference between the up- and downstream sample results, the distribution of differences of sample proportions was calculated. If two values are the same, when subtracted, the result is zero. If two sample populations are the same, when the differences between values in the populations are calculated, the mean of those differences would be zero. It follows then that, if the Stillwater Mine is affecting the quality of Nye Creek, the downstream total recoverable metals concentrations would be different from upstream water quality, and that difference would not equal zero. If there is no difference in concentrations between up- and downstream sample results, the mean of the differences of the concentrations would equal zero, indicating that the Stillwater Mine is not affecting the quality of Nye Creek.

Table 11. **1997-2009 Comparison of Surface Water Quality between Upper and Lower Nye Creek Downgradient of the Stillwater Mine.**

Parameter	Upper and Lower Nye Creek Water Quality				
	Mean Concentration (total recoverable, mg/L)		Mean of Differences between samples€	Median Concentration (total recoverable, mg/L)	
	SMC-7 Upstream	SMC-7D Downstream		SMC-7 Upstream	SMC-7D Downstream
Cadmium	0.0001	0.001	0.00	<0.0001	<0.0001
Chromium	0.010	0.012	0.00	0.010	0.011
Copper	0.002	0.003	0.00	<0.001	0.002
Iron	0.04	0.21	**0.16**	0.03	0.065
Lead	<0.003	<0.003	0.00	<0.003	<0.003
Manganese	<0.005	0.010	0.00	<0.005	<0.005
Zinc	0.01	0.04	0.00	<0.01	<0.01

€ **Bold values** indicate a statistical difference between upstream and downstream samples.

The distribution of differences of sample proportions was calculated for the metals cadmium, chromium, copper, iron, lead, manganese, and zinc (sample size varied from 12 to 38). The means of the differences for cadmium, chromium, copper, lead, manganese, and zinc were equal to zero, indicating that there is no statistical difference between samples and Stillwater Mine is not affecting the quality of Nye Creek. The mean of the differences for iron, however, was not equal to zero, indicating that there is a statistical difference in iron concentration between the up- and downstream sampling locations. Because iron is the only metal that has a statistical difference between up- and downstream concentrations, and if the mine was affecting downstream water quality, several parameters would show mine influence, the difference in iron is likely attributable to a naturally-occurring geological source in the stream at the SMC-7D location. Please also see the response to comment 3.

Conclusion: There is no evidence that the Stillwater Mine has an adverse effect on the quality of water in Nye Creek.

For the reasons stated above, and barring an unforeseen change in the geochemistry/mineralogy of the J-M Reef or a regulatory reason to revisit this decision, the agencies have dismissed these seven issues regarding the potential for water quality impacts from metals and the potential for acid generation.

References

Environmental Protection Agency. 1995. Applicability of the toxicity characteristic leaching procedure to mineral processing wastes. p. 21. December. 25 pp. + appendices.

Montana Department of Environmental Quality and US Forest Service. 2010. Draft Environmental Impact Statement: Stillwater Mining Company's Revised Water Management Plans and Boe Ranch LAD. Helena, Montana.

Jambor, J.L, D.W. Blowes, and C.J. Ptacek. 2000. Mineralogy of Mine Wastes and Strategies for Remediation. Ch. 7 of Environmental Mineralogy. D.J. Vaughn and R.A. Wogelius, editors. EMU Notes in Mineralogy, Vol. 2. pp 255-290.

Kirk, L.B., M. McCleary, and R. Weimer. 2006. Operational validation of environmental geochemistry at the Stillwater Mine, Nye, MT. In 2006 Billings Land Reclamation Symposium Proceedings. Published jointly by BLRS and the American Society of Mining and Reclamation. R.I. Barnhisel, (ed.) 3134 Montavesta Rd., Lexington, KY 40502. pp 363-374.

Kuipers and Associates. 2006. Unpublished report: GNA Citizen Sampling Geochemical Characterization Results Stillwater Mining Company, Stillwater and East Boulder Mines. May. 43 pp. + tables and appendices.

Stillwater Mining Company. 2009. Unpublished report: Core Analysis—East Side Waste Rock Pile, Stillwater Mine, Nye, Montana. December. 8 pp. + appendices.

Stillwater Mining Company. 2010. Unpublished report: SMC Annual Water Resources Monitoring Report, Stillwater Mine. July. 37 pp. + appendices.

Weimer, R. Personal communication. July 5, 2011.

Wolfe, M. Personal communication. July 5, 2011.

TECHNICAL MEMORANDUM

Date: March 7, 2012

To: Kristi Ponozzo, MEPA Coordinator, Montana DEQ
Pat Pierson, NEPA Coordinator, Custer and Gallatin National Forests, USFS

From: Lisa M. Boettcher C. P.G., Reclamation Specialist, Montana DEQ LB

Re: EPA comment regarding appropriate criteria for nutrients at the Stillwater and East Boulder Mines

The Environmental Protection Agency (EPA) commented that "in-stream nitrogen levels less than 1 mg/L may promote creation of conditions which produce undesirable aquatic life. EPA is concerned that the current [Montana Pollution Discharge Elimination System] MPDES permit nitrogen loads based on the 1 mg/L in-stream nitrogen standard have potential to create aquatic conditions that may not be consistent with the narrative water quality standard. It is our understanding that Montana is developing numeric criteria for nitrogen in surface waters within the next year that may be lower than 1 mg/L total nitrogen. We encourage reevaluation of MPDES permit nitrogen loads based on the current scientific findings regarding nitrogen levels that are protective of beneficial uses in future MPDES permitting."

The MPDES permits for both mines set effluent discharge limits based on the $7Q_{10}$ streamflow[1] that would result in in-stream concentrations of 1 mg/L total nitrogen (TN[2]) at the Stillwater Mine (Stillwater River) and 1 mg/L total inorganic nitrogen (TIN[2]) at the East Boulder Mine (East Boulder River). For the Stillwater Mine, the MPDES statement of basis states on page 19, "The limit was based on an increase in background concentration from 0.4 mg/L to 1.0 mg/L (in the Stillwater River) at the $7Q_{10}$ of 31.1 cfs. It is believed that an increase of nitrogen to 1 mg/L would not [affect] the environment if phosphorus was limited to no increase." Stillwater Mine collects macroinvertebrate, periphyton, and diatom data to confirm that the nitrogen limit of 100 lb/day TN and "no increase" in total phosphorus (TP) do not create undesirable aquatic life in the Stillwater River. For the East Boulder Mine, the MPDES statement of basis states on page 16, "The Final Environmental Impact Statement (FEIS) competed in 1992 concluded that an increase in the [in-stream] nitrogen concentration to 1.0 mg/L at the $7Q_{10}$ would not cause undesirable or harmful algal growth." The rationale continues on page 19, "The agencies' environmental analysis of the East Boulder Project (FEIS 1992), recommended that the total nitrogen concentration not exceed 1.0 mg/L based on site-specific factors… boulder-cobble dominated substrate; high-gradient erosive environment; downstream dilution sources; the phosphorus-limiting condition of the East Boulder River; and lack of downstream lakes, reservoirs, or other nutrient-sensitive bodies." The concentration of TP is limited by the MPDES permit at the East Boulder Mine to 0.001 mg/L above the average background value of 0.02 mg/L. SMC has a bioassessment monitoring program in place to ensure that discharges from the East Boulder Mine do not create undesirable aquatic life in the East Boulder River. The Stillwater Mine MPDES permit expires October 31, 2013, and the East Boulder Mine MPDES permit expired July 31, 2005 and has been administratively extended.

MDEQ Water Quality Standards Section has prepared a preliminary technical analysis to address total nutrient concentrations that could represent an undesirable biological impact for streams in Montana

---

[1] The $7Q_{10}$ streamflow is the lowest streamflow over 7 consecutive days in a 10-year period.

[2] TIN is the nitrate+nitrite and inorganic ammonia concentration that is a component of TN, which also includes organically-bound nitrogen and organic ammonia-nitrogen species.

during the growing season from July 1 through September 30 (Suplee *et al*. 2008, Suplee and Suplee 2011a). The analysis is not yet complete and has not been developed sufficiently to begin the rulemaking process. The technical analysis seeks to determine seasonal criteria that would be generally applied on an ecoregion level, but would be further subject to reach-specific factors that affect algal growth.

EPA has indicated that TN and TP are the minimum acceptable nutrient criteria for evaluating the potential for nuisance algal growth (Suplee *et al*. 2008). Significant increases in algal growth may not occur in response to increases in TN concentration if phosphorus concentrations are sufficiently low that they limit algal growth when nitrogen is already present in surplus (Allan 1995, Steinman and Mulholland 1996). Light is also considered an important factor in increased eutrophication of Montana streams (Suplee *et al*. 2008). In streams with heavy canopy cover, systems can become "light limited" and can attenuate algal growth. However it should be noted that light is not a valid limiting factor for those reaches of the Stillwater or East Boulder rivers that would be affected by the closure of the mines. High flow events also affect algal growth by scouring algae from the streambed by high stream velocities alone, or the combination of stream velocity and bedload movement (Suplee *et al* 2008). The effects of scouring depend on the timing, magnitude, and frequency of the high flow event. How these site-specific factors would combine with nutrient concentrations to affect algal assemblages in stream reaches adjacent to the Stillwater and East Boulder mines and the Hertzler Ranch LAD system have not been quantified.

The TN and TP concentrations in the preliminary technical analysis were developed on an ecoregion basis (Suplee *et al*. 2008). The Stillwater and East Boulder mines are on the edge of the Middle Rockies Ecoregion 17, and the Hertzler Ranch and proposed Boe Ranch LAD systems are within the Northwestern Glaciated Plains Ecoregion 42 (NRIS). The preliminary technical analysis indicates that for the Middle Rockies Ecoregion 17, a TN concentration of 0.320 mg/L and a TP concentration of 0.048 mg/L could be appropriate numeric criteria for the Montana Board of Environmental Review to consider for adoption. The preliminary technical analysis indicates that for the Northwestern Glaciated Plains Ecoregion 42, a TN concentration of 1.311 mg/L and a TP concentration of 0.020 mg/L could be appropriate numeric criteria for the Montana Board of Environmental Review to consider for adoption (Suplee *et al*. 2008, Suplee and Suplee 2011). These TN and TP concentrations are based on maintaining in-stream chlorophyll *a* concentrations to less than 150 mg/m^2 as identified by MDEQ's nuisance algae public-perception survey. Nuisance algal levels were defined quantitatively in this survey using a benthic algae metric (*i.e.*, chlorophyll *a* density per unit area of stream bottom; Suplee et al. 2009). Further, it has been documented that elevated TN and TP can lead to significant seasonal dissolved oxygen decreases along a stream, which would be harmful to fish (Suplee and Suplee 2011b).

The agencies analyzed concentrations of nutrients and salts in surface and ground water that would result from the disposal of a range of adit flow rates and the dewatering of three tailings impoundments during capping at closure. Projected in-stream nitrogen concentrations have been disclosed in the 2010 Draft Environmental Impact Statement (DEIS). The agencies used the $7Q_{10}$ streamflow cited in the respective MPDES permits when calculating receiving stream concentrations. The $7Q_{10}$ streamflow would provide the least dilution for the mine waters discharged (*i.e.*, result in the highest concentration of a constituent in the stream) and as such, is generally conservative. The agencies' analyses show that the nitrogen concentration in the respective surface waters during the growing season from July 1 through September 30 would meet the respective MPDES limits of 1 mg/L TN or TIN in-stream concentrations for all of the agency-mitigated alternatives. The MPDES TN and TIN limits are less than the preliminary technical analysis Northwestern Glaciated Plains Ecoregion TN concentration, but greater than the Middle Rockies Ecoregion TN concentration. The MPDES permit limits in-stream phosphorus concentration increases between July 15 and October 15 to 0.001 mg/L for the East Boulder Mine and sets a load of no more than 1.1 lbs/day (based on non-degradation) for the Stillwater Mine. These permit limits are less than the preliminary technical analysis TP concentrations for both ecoregions.

The long-term statistics for average in-stream chlorophyll *a*, total Kjeldahl nitrogen (TKN), nitrite+nitrate ($NO_2 + NO_3$), and TP concentrations in the Stillwater River adjacent to the Stillwater Mine have been compiled for the period 1998 to 2009 (Environ 2010b) and are listed in Table 1. These data show that the in-stream chlorophyll *a* concentrations in the Stillwater River are at least an order of magnitude less than the 150 mg/m^2 reference threshold identified by MDEQ's nuisance algae public-perception survey (Suplee et al. 2009). The long-term average Stillwater River in-stream nitrogen concentrations are approximately equal to or less than the preliminary technical analysis Middle Rockies Ecoregion TN concentration of 0.320 mg/L and TP concentration of 0.048 mg/L. These data indicate that nutrient discharges from the Stillwater Mine do not cause nuisance algal growth in the Stillwater River, and the MPDES permit limits for TN and TP are protective of the beneficial use of this stream.

Table 1. **Stillwater River nutrients and chlorophyll *a* concentrations upstream, adjacent to, and downstream of the Stillwater Mine and the Hertzler Ranch LAD** (after Environ 2010b).

Period of Record: 1998-2009	**SMC-J** (upstream of mine)	**SMC-2** (adjacent to mine)	**SMC-11** (downstream of mine)	**DEQ Preliminary Technical Analysis Nutrient Total Concentration[2] Middle Rockies Ecoregion**	**WFSC** (upstream of Hertzler Ranch LAD)	**SMC-13** (downstream of Hertzler Ranch LAD)	**DEQ Preliminary Technical Analysis Nutrient Total Concentration[2] Northwestern Glaciated Plains Ecoregion**
N	110	80	131	150	100	97	150
Chlorophyll *a* Long-term mean[1] (mg/m^2)	12.9	12.7	11.6		16.2	17.1	
95% UCL	15.4	14.4	15.8		18.8	20.1	
TKN mean[3] (mg/L)	0.15	0.10	0.25	0.320	0.10	0.20	1.311
$NO_2 + NO_3$ mean[3] (mg/L)	0.09	0.2	0.12		0.17	0.088	
Total P mean[3] (mg/L)	0.010	0.009	0.011	0.048	0.011	0.014	0.020

[1] Long-term summary statistics show **N** - number of samples, arithmetic mean, and **UCL** upper 95% confidence limit for entire chlorophyll *a* database of non-transformed replicate samples from August 1 through September during the 1998-2009 monitoring period.

[2] TN and TP concentrations from the preliminary technical analysis by ecoregion (Suplee *et al*. 2008); chlorophyll *a* concentrations from MDEQ's nuisance algae public-perception survey (Suplee et al. 2009).

[3] Long-term summary statistics show the arithmetic mean for nutrients for the 2000-2009 monitoring period.

Abbreviations: **TKN** – total Kjeldahl nitrogen; **$NO_2 + NO_3$** - nitrite+ nitrate; **P** – phosphorus; **LAD-** Land Application Disposal facility.

The East Boulder River, like many streams in Montana (Bahls 2004), has been affected since 2003 by proliferation of the nuisance organism *Didymosphenia geminata.* The proliferation began above the mine at the confluence of the Dry Fork, and spread up- and downstream. *D. geminata* is a stalked, filamentous diatom that increases the chlorophyll *a* concentration in a stream, so between the years 2005 and 2009, visual estimates of in-stream algal growth of *D. geminata* were made rather than samples taken for chlorophyll *a* concentrations. The in-stream 2009 chlorophyll *a* concentrations (arithmetic mean) in the East Boulder River adjacent to the East Boulder Mine are listed in Table 2. The proliferation of *D. geminata* compromised the condition of the benthic substrate (sediment on the bed of the stream that aquatic organisms live on) and resulted in a decline of benthic integrity (lower bioassessment scores indicating reduced overall aquatic health). Recent surveys indicate the East Boulder River is returning to pre-proliferation levels. The 2009 95% upper confidence level values of in-stream chlorophyll *a* concentration in the East Boulder River are one-third that of the 150 mg/m^2 reference threshold identified by MDEQ's nuisance algae public-perception survey (Environ 2009a, Suplee et al. 2009). The long-term (2000-2009) average East Boulder River in-stream nitrogen and phosphorus concentrations are lower than the preliminary technical analysis Middle Rockies Ecoregion TN concentration of 0.320 mg/L and TP concentration of 0.048 mg/L. These data indicate that discharges of nutrients from the East Boulder Mine do not cause nuisance algal growth in the East Boulder River, and the MPDES permit limits for TIN and TP are protective of the beneficial use of this stream.

According to the reopener provisions of the MPDES permits described in the Administrative Rules of Montana, ARM 17.30.1361 (2) (b): "permits may be modified during their terms if…the department has received new information …indicating that cumulative effects on the environment are unacceptable, or (c) the standards or requirements on which the permit was based have been changed by amendment or judicial decision after the permit was issued." Consequently, the 1.0 mg/L TN or TIN limit for ambient surface waters currently in the MPDES permits could be modified by MDEQ at any time if nuisance algal growth attributable to the mines is observed or lower numeric standards for nutrients are adopted.

Table 2. **East Boulder River nutrients and 2009 chlorophyll *a* concentrations with 2000-2009 nutrient levels upstream, adjacent to, and downstream of the East Boulder Mine** (after Environ 2010a).

Period of Record: 2000-2009	EBR-002 (upstream)	EBR-003 (adjacent)	EBR-004 (downstream)	DEQ Preliminary Technical Analysis Nutrient Concentration[2]
$NO_2 + NO_3$ mean[1] (mg/L)	0.06	0.06	0.05	0.320
Total N mean[1] (mg/L)	0.44	0.29	0.23	
Total P mean[1] (mg/L)	0.02	0.01	0.01	0.048
Chlorophyll *a* 2009 mean (mg/m^2) 95% UCL	18.3 58.4	17.4 36.6	21.4 45.1	150
percent algal cover[3,4] study area average by year	100% (2005) 91% (2006) 75% (2007) 45% (2008) 32% (2009)			

[1] Long-term summary statistics show the arithmetic mean for nutrients for the 2000-2009 monitoring period.

[2] TN and TP concentrations from the preliminary technical analysis for the Middle Rockies Ecoregion (Suplee *et al*. 2008); chlorophyll *a* concentrations from MDEQ's nuisance algae public-perception survey (Suplee et al. 2009).

[3] Visual estimates of macroscopic growth of filaments and the diatom *Didymosphenia geminata* are unavailable prior to 2005. "While always present at sites EBR-001 and downstream to EBR-004, *D. geminata* demonstrated considerable growth between the August-September 2003 and August-September 2004 sampling events…" (AdventEnviron 2005)

[4] Long-term summary statistics show the study area average based on visual estimates of macroscopic growth of filaments and the diatom *Didymosphenia geminata.* Abbreviations: **$NO_2 + NO_3$** - nitrite+ nitrate; **N** – nitrogen; **P** – phosphorus.

In summary, data collected to date indicate that the TP concentrations in the Stillwater and East Boulder rivers are about 20 percent of those concentrations identified by the technical analysis as necessary to limit algal growth (Suplee 2008). The long-term average in-stream TN or TIN concentrations are approximately equal to or less than the preliminary technical analysis Middle Rockies Ecoregion TN concentration. In-stream TN or TIN MPDES permit limit concentrations of 1 mg/L are not anticipated to increase algal growth to the extent that it would be considered "nuisance" algae. The preliminary technical analysis could provide appropriate numeric criteria for the Montana Board of Environmental Review to consider for adoption;

however, the analysis is not yet complete and has not been developed sufficiently to begin the rulemaking process. The technical analysis seeks to determine seasonal criteria that would be generally applied on an ecoregion level, but these criteria would be further subject to reach-specific factors that affect algal growth. To address the uncertainty regarding the response of area streams to increased nutrients, SMC performs aquatic monitoring at both mines as part of the Hardrock Operating Permit requirements. In the absence of a numeric standard, if subsequent monitoring indicates nuisance algal growth has developed as a result of mine effluent discharge, then SMC's MPDES nitrogen effluent limit would be adjusted to become more restrictive in order to comply with the narrative standard.

References

Advent Environ. 2005. Technical Report: East Boulder River biological monitoring results: 1998-2004. May. 91 pages + tables + figures + appendices.

Allan, J.D. 1995. Nutrient Dynamics. Pp. 283-303. *In:* J.D. Allan. Stream ecology structure and function of running waters. Chapman and Hall, London, UK.

Bahls, L. 2004. Checklist of confirmed *Didymosphenia geminata* sites in Montana. USGS. Denver, Colorado.

Environ International Corporation. 2010a. Technical Report: East Boulder River biological monitoring report for September 2009. July. 16 pages + tables + figures + appendices.

Environ International Corporation. 2010b. Technical Report: Stillwater River chlorophyll a biological monitoring report for 2008 and 2009. August. 23 pages + tables + figures + appendices.

NRIS. Ecoregions of Montana. http://nris.mt.gov/gis/gisdatalib/downloads/ecoreg_2002.pdf. Draft 2. Accessed April 26, 2011.

Steinman, A.D., and P.J. Mulholland. 1996. Phosphorus limitation, uptake, and turnover in stream algae. Pp. 161-189. *In:* F.R. Hauer and G.A. Lamberti, editors. Methods in Stream Ecology. Academic Press, San Diego, CA.

Suplee, M., V, Watson, A. Varghese, and J. Cleland. 2008. Scientific and technical basis of the numeric nutrient criteria for Montana's wadeable streams and rivers. Montana Department of Environmental Quality, Helena, MT.

Suplee, M.J., V. Watson, M.Teply, and H. McKee. 2009. How green is too green? Public opinion of what constitutes undesirable algae levels in streams. Journal of the American Water Resources Association 45: 123-140.

Suplee, M., and R.S. Suplee. 2011a. Guidance Document: Assessment methodology for determining wadeable stream impairment due to excess nitrogen and phosphorus levels. Draft 6: April 2011. Montana Department of Environmental Quality, Helena, MT.

Suplee, M., and R.S. Suplee. 2011b. Guidance Document: Assessment methodology for determining wadeable stream impairment due to excess nitrogen and phosphorus levels. Appendix B. Draft 6: April 2011. Montana Department of Environmental Quality, Helena, MT.

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Stillwater 2,020 gpm CLOSURE scenarios**		**No Action Alternative 1A**	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A

No Action Alternative 1A Option 1, 2,020 gpm: *Tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm (24 hr) untreated east side adit water would be at the Stillwater Mine east side percolation ponds. Disposal of 1,650 gpm (24 hr) treated west side adit water and 105 MG Hertzler Ranch LAD storage pond treated adit water would be at the Hertzler Ranch LAD area. The closure time frame was not specified.*

NOTE: This option exceeds the hydraulic load at Hertzler Ranch LAD.

No Action Alternative 1A Option 2, 2,020 gpm : *Tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm (24 hr) untreated east side water would be at the Stillwater Mine percolation ponds. Disposal of 105 MG of Hertzler Ranch LAD storage pond treated adit water and 1,650 gpm (24 hr) of treated west side adit water would be at the Hertzler Ranch LAD area. The closure time frame was not specified.*

Stillwater Mine	criteria			
Nitrogen load to Stillwater River at Stillwater Mine, lbs/day	100	**81**		
Closure Nitrogen load to ground water, days 1-365, lbs/12-mo		**329**		
Nitrogen concentration in ground water below Stillwater Mine, mg/L	7.5	**meets MPDES Nitrogen load**		
Nitrogen concentration in Stillwater River below Stillwater Mine, mg/L	1	**meets MPDES Nitrogen load**		
EC in ground water at Stillwater Mine, µmhos/cm	1,000	**715**		
TDS in Stillwater River below Stillwater Mine, mg/L		**123**		
Hertzler Ranch LAD				
Nitrogen concentration in ground water below Hertzler Ranch LAD, mg/L	7.5	**0.6**		
Closure Nitrogen load to ground water at Hertzler Ranch LAD, lbs/12-mo		**3,590**		
Nitrogen concentration in Stillwater River below Hertzler Ranch LAD, mg/L	1	**0.4**		
EC in ground water at Hertzler Ranch LAD, µmhos/cm	1,000	**869**		
TDS in Stillwater River below Hertzler Ranch LAD, mg/L		**116**		

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Stillwater 2,020 gpm CLOSURE scenarios**		No Action Alternative 1A	**Proposed Action Alternative 2A**	Agency-Mitigated Alternative 3A

Proposed Action Alternative 2A, Option 1, 2,020 gpm: *The 370 gpm (24-hr) of untreated east-side adit water would be disposed of in the Stillwater Mine east-side percolation ponds. Up to 250 gpm (24-hr) Stillwater Tailings waters would be mixed and treated with 1,650 gpm (24-hr) west-side adit water and routed to 105 MG Hertzler Ranch LAD storage pond for disposal with 201 MG untreated Hertzler Ranch tailings waters. The closure time frame would be 12 months.*

NOTE: This option exceeds the hydraulic load at Hertzler Ranch LAD.

Proposed Action Alternative 2A Option 2, 2,020 gpm: The *370 gpm (24-hr) of untreated east-side adit water would be disposed in the Stillwater Mine east-side percolation ponds. Up to 250 gpm (24-hr) (53 MG) Stillwater tailings waters would be mixed and treated with 1,650 gpm (24-hr) west-side adit water and routed to the Stillwater Mine percolation ponds. Up to 201 MG of untreated Hertzler Ranch tailings waters would be routed to the Hertzler Ranch LAD storage pond containing 105 MG of treated adit water for disposal at the Hertzler Ranch LAD area. The closure time frame would be 12 months.*

Stillwater Mine	criteria	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Nitrogen load to Stillwater River at Stillwater Mine, lbs/day	100		**95**	
Closure Nitrogen load to ground water, days 1-365, lbs/12-mo			**12,645**	
Nitrogen concentration in ground water below Stillwater Mine, mg/L	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in Stillwater River below Stillwater Mine, mg/L	1		**meets MPDES Nitrogen load**	
EC in ground water at Stillwater Mine, µmhos/cm	1,000		**734**	
TDS in Stillwater River below Stillwater Mine, mg/L			**123**	
Hertzler Ranch LAD				
Nitrogen concentration in ground water below Hertzler Ranch LAD, mg/L	7.5		**2.9**	
Closure Nitrogen load to ground water at Hertzler Ranch LAD, lbs/12-mo			**17,363**	
Nitrogen concentration in Stillwater River below Hertzler Ranch LAD, mg/L	1		**0.7**	
EC in ground water below Hertzler Ranch LAD, µmhos/cm	1,000		**985**	
TDS in Stillwater River below Hertzler Ranch LAD, mg/L			**126**	

NOTE: Under this scenario a temporary exceedance of the 1,000 µmhos/cm Beneficial Use EC criterion for ground water would occur in the vicinity of the assumed Hertzler Ranch tailings impoundment seep (1,290 µmhos/cm) and beneath the upper LAD area (1,276 µmhos/cm) but the Beneficial Use criterion would be met at the down-gradient compliance point, HMW-10.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Stillwater 2,020 gpm CLOSURE scenarios**		No Action Alternative 1A	Proposed Action Alternative 2A	**Agency-Mitigated Alternative 3A**

Agency-Mitigated Alternative 3A Option 1, 2,020 gpm: Stillwater Mine first season: *The 370 gpm (24 hr) of untreated east-side adit water would be disposed in the Stillwater Mine percolation ponds days 1-90, then routed underground on day 91. The 250 gpm (24 hr) of Stillwater tailings waters would be mixed and treated with 1,650 gpm (24 hr) of west-side adit water and routed to the Stillwater Mine percolation ponds days 1-90, then routed underground on day 91 until the Stillwater tailings impoundment is dewatered.*
Hertzler Ranch first season: *Up to 260 gpm (24 hr) of the untreated 201 MG Hertzler Ranch tailings waters would be routed to the 105 MG of treated adit waters in Hertzler Ranch LAD storage pond, and the mixed adit and tailings waters would be disposed at the Hertzler Ranch LAD area. Hertzler Ranch second season: Any excess water that cannot be disposed the first year would be land applied at Hertzler Ranch. The closure time frame would be 18 months.*

Stillwater Mine	criteria	No Action Alternative 1A	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A
Nitrogen load to Stillwater River at Stillwater Mine, lbs/day	100			**95**
Closure Nitrogen load to ground water, days 1-548, lbs/18-mo				**7,966**
Nitrogen concentration in ground water below Stillwater Mine, mg/L	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in Stillwater River below Stillwater Mine, mg/L	1			**meets MPDES Nitrogen load**
EC in ground water at Stillwater Mine, µmhos/cm	1,000			**771**
TDS in Stillwater River below Stillwater Mine, mg/L				**133**
Hertzler Ranch LAD				
Nitrogen concentration in ground water below Hertzler Ranch LAD, mg/L	7.5			**4.5**
Closure Nitrogen load to ground water at Hertzler Ranch LAD, lbs/18-mo				**54,450**
Nitrogen concentration in Stillwater River below Hertzler Ranch LAD, mg/L	1			**0.9**
EC in ground water below Hertzler Ranch LAD, µmhos/cm	1,000			**986**
TDS in Stillwater River below Hertzler Ranch LAD, mg/L				**126**

NOTE: Under this scenario a temporary exceedance of the 1,000 µmhos/cm Beneficial Use EC criterion for ground water would occur in the vicinity of the assumed Hertzler Ranch tailings impoundment seep (1,276 µmhos/cm) and beneath the upper LAD area (1,131 µmhos/cm) but the Beneficial Use criterion would be met at the down-gradient compliance point, HMW-10.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised Stillwater 1,302 gpm CLOSURE scenarios		**No Action Alternative 1A**	Proposed Action Alternative 2A	Agency-Mitigated Alternative 3A

***No Action Alternative 1A Option 1, 1,302 gpm**: The tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm (24 hr) untreated east side adit water would be at the Stillwater Mine east side percolation ponds. Disposal of 932 gpm (24 hr) treated west side adit water and 105 MG of treated west side adit water stored in the Hertzler Ranch LAD storage pond waters would be at the Hertzler Ranch LAD area. The closure time frame was not specified.*

Stillwater Mine	criteria			
Nitrogen load to Stillwater River at Stillwater Mine, lbs/day	100	**0.9**		
Closure Nitrogen load to ground water, days 1-365, lbs/12-mo		**324**		
Nitrogen concentration in ground water below Stillwater Mine, mg/L	7.5	**meets MPDES Nitrogen load**		
Nitrogen concentration in Stillwater River below Stillwater Mine, mg/L	1	**meets MPDES Nitrogen load**		
EC in ground water at Stillwater Mine, µmhos/cm	1,000	**191**		
TDS in Stillwater River below Stillwater Mine, mg/L		**53**		
Hertzler Ranch LAD				
Nitrogen concentration in ground water below Hertzler Ranch LAD, mg/L	7.5	**0.6**		
Closure Nitrogen load to ground water at Hertzler Ranch LAD, lbs/12-mo		**3,590**		
Nitrogen concentration in Stillwater River below Hertzler Ranch LAD, mg/L	1	**0.4**		
EC in ground water below Hertzler Ranch LAD, µmhos/cm	1,000	**869**		
TDS in Stillwater River below Hertzler Ranch LAD, mg/L		**116**		

Revised Stillwater 1,302 gpm CLOSURE scenarios		No Action Alternative 1A	**Proposed Action Alternative 2A**	Agency-Mitigated Alternative 3A

***Proposed Action Alternative 2A Option 1, 1,302 gpm:** The 370 gpm (24-hr) of untreated east-side adit water would be disposed in the Stillwater Mine percolation ponds. The 932 gpm (24-hr) west-side adit water would be mixed and treated with 600 gpm (24-hr) Sillwater tailings waters and routed to Hertzler Ranch LAD storage pond containing 105 MG of treated adit water and 201 MG of Hertzler Ranch tailings waters. All these waters would be disposed at the Hertzler Ranch LAD area. The time frame for disposal is 12 months.*

This option is hydraulically infeasible with 201 MG supernatant plus tailings mass waters at the Hertzler Ranch LAD.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised Stillwater 1,302 gpm **CLOSURE scenarios**		No Action Alternative 1A	**Proposed Action Alternative 2A**	Agency-Mitigated Alternative 3A
Proposed Action Alternative 2A Option 2, 1,302 gpm: *The 370 gpm (24-hr) of untreated east-side adit water would be routed with 932 gpm (24-hr) treated west-side adit water and 600 gpm (24-hr) Sillwater tailings waters for disposal in the Stillwater Mine percolation ponds. No waters at the mine at closure would be routed to Hertzler Ranch LAD. The 105 MG of stored treated adit water in the Hertzler Ranch LAD storage pond and 201 MG of Hertzler Ranch tailings waters would be disposed of at the Hertzler Ranch LAD area. The time frame for disposal is 12 months.*				
Stillwater Mine	criteria			
Nitrogen load to Stillwater River at Stillwater Mine, lbs/day	100		**77**	
Closure Nitrogen load to ground water, days 1-365, lbs/12-mo			**4,299**	
Nitrogen concentration in ground water below Stillwater Mine, mg/L	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in Stillwater River below Stillwater Mine, mg/L	1		**meets MPDES Nitrogen load**	
EC in ground water at Stillwater Mine, µmhos/cm	1,000		**377**	
TDS in Stillwater River below Stillwater Mine, mg/L			**68**	
Hertzler Ranch LAD				
Nitrogen concentration in ground water below Hertzler Ranch LAD, mg/L	7.5		**2.9**	
Nitrogen concentration in Stillwater River below Hertzler Ranch LAD, mg/L	1		**0.7**	
EC in ground water below Hertzler Ranch LAD, µmhos/cm	1,000		**985**	
TDS in Stillwater River below Hertzler Ranch LAD, mg/L			**126**	

NOTE: The EC of ground water at Hertzler Ranch temporarily exceeds the 1,000 µmhos/cm Beneficial Use EC criterion for ground water in the vicinity of the assumed Hertzler Ranch tailings impoundment seep (1,267 µmhos/cm) and beneath the upper LAD area (1,129 µmhos/cm) but the Beneficial Use criterion would be met at the down-gradient compliance point, HMW-10.

Revised Stillwater 1,302 gpm **CLOSURE scenarios**	No Action Alternative 1A	Proposed Action Alternative 2A	**Agency-Mitigated Alternative 3A**

Agency-Mitigated Alternative 3A Option 1, 1,302 gpm: Stillwater Mine first season *The 370 gpm (24 hr) untreated east-side adit water would be disposed at east-side percolation ponds days 1-90. From day 91 on, all untreated east-side and 932 gpm (24 hr) west-side adit water would be routed to the underground workings. Days 1-41, the 932 gpm (24 hr) west side adit water would be mixed and treated with 600 gpm (24 hr) Stillwater tailings waters and routed to Hertzler Ranch LAD storage pond. From day 42 on, the Stillwater tailings impoundment would be dewatered and treated west side adit waters would be routed to the Hertzler Ranch LAD storage pond.*

Hertzler Ranch first LAD season days 1-41: *The mixed and treated 400 gpm (24 hr) of west side adit water and 600 gpm Stillwater tailings waters would be routed to the Hertzler Ranch LAD storage pond containing 105 MG of treated adit water. Days 42-90 up to 396 gpm (24 hr) of untreated Hertzler Ranch tailings waters would be routed to the Hertzler Ranch LAD storage pond and disposed at the Hertzler Ranch LAD area.*

Hertzler Ranch second LAD season*: Any excess water that could not be disposed the first year due to high precipitation, unforeseen circumstances where Stillwater would be unable to fulfill its obligations, etc. would be land applied at Hertzler Ranch. The time frame would be up to 18 months.*

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Hertzler Ranch LAD: The hydraulic load of disposal of treated adit and tailings waters plus 201 MG of Hertzler Ranch tailings water and 105 MG LAD storage pond waters exceeds the hydraulic capacity of the Hertzler Ranch LAD system. The adit and Stillwater tailings waters need to be managed at the Stillwater Mine.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Stillwater 1,302 gpm CLOSURE scenarios**		No Action Alternative 1A	Proposed Action Alternative 2A	**Agency-Mitigated Alternative 3A**

Agency-Mitigated Alternative 3A Option 2, 1,302 gpm: Stillwater Mine first season: *The 370 gpm (24 hr) untreated east-side adit water would be disposed of at the east-side percolation ponds days 1-90. From day 91 on, all untreated east-side and west-side adit water would be routed to the underground workings. Days 1-56, the 932 gpm (24 hr) west-side adit water would be mixed and treated with 600 gpm (24 hr) Stillwater tailings waters and would be routed to the east-side percolation ponds. The Stillwater tailings impoundment would be dewatered on Day 56. Some west-side adit water may be routed through the BTS to maintain the microbes through the second LAD season, or routed to the Hertzler Ranch and used to*

Hertzler Ranch first LAD season days 1-120: *Untreated Hertzler Ranch tailings waters would be routed to the Hertzler Ranch LAD storage pond and disposed of at the Hertzler Ranch LAD area. Additional treated west-side adit water may be needed to flush salts from soil for an extended first season or be placed in the LAD storage pond for application the second LAD*

Hertzler Ranch second LAD season*: Any excess water that could not be disposed the first year due to high precipitation, unforeseen circumstances where Stillwater would be unable to fulfill its obligations, etc. would be land applied at Hertzler Ranch. The time frame would be up to 18 months.*

Stillwater Mine	criteria	No Action Alternative 1A	Proposed Action Alternative 2A	**Agency-Mitigated Alternative 3A**
Nitrogen load to Stillwater River at Stillwater Mine, lbs/day	100			**47 to 63**
Closure Nitrogen load to ground water, days 1-548, lbs/18-mos				**4,950**
Nitrogen concentration in ground water below Stillwater Mine, mg/L	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in Stillwater River below Stillwater Mine, mg/L	1			**meets MPDES Nitrogen load**
EC in ground water at Stillwater Mine, µmhos/cm	1,000			**496 to 810**
TDS in Stillwater River below Stillwater Mine, mg/L				**85 to 115**
Hertzler Ranch LAD				
Closure Nitrogen load to ground water, days 1-548, lbs/18-mos				**54,450**
Nitrogen concentration in ground water below Hertzler Ranch LAD, mg/L	7.5			**4.5**
Nitrogen concentration in Stillwater River below Hertzler Ranch LAD, mg/L	1			**0.9**
EC in ground water below Hertzler Ranch LAD, µmhos/cm	1,000			**985**
TDS in Stillwater River below Hertzler Ranch LAD, mg/L				**126**

NOTE: Under this scenario a temporary exceedance of the 1,000 µmhos/cm Beneficial Use EC criterion for ground water would occur in the vicinity of the assumed Hertzler Ranch tailings impoundment seep (1,268 µmhos/cm) and beneath the upper LAD area (1,129 µmhos/cm) but the Class I Beneficial Use criterion would be met at the down-gradient compliance point, HMW-10.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 737 gpm CLOSURE scenarios**		**No Action Alternative 1B**	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B

No Action Alternative 1B Option 1, 737 gpm: *The Boe Ranch LAD system is not built and this analysis assumes that LAD areas 2, 3-Upper, and 4 have been built to manage water at East Boulder Mine. East Boulder tailings waters are evaporated over the tailings mass; 737 gpm (24 hr) treated adit water is land applied at LAD areas 2, 3-Upper, 4, and 6 at East Boulder Mine. The closure period for this alternative is not specified, but for the purposes of analysis, was assumed to occur in 12 months.*

NOTE: The hydraulic load of 737 gpm (24 hr) would exceed the capacity of the 0.7 MG storage pond and the disposal capability of the East Boulder Mine LAD areas 2, 3-Upper, 4 and 6. Additional water management measures would be necessary in both summer and winter. No time frame for the evaporation of tailings waters at closure was specified. The current volume of water in the tailings impoundment (98 MG) is more than double the original estimated volume (40 MG). An extended length of time would be necessary to evaporate the tailings waters.

No Action Alternative 1B Option 2, 737 gpm: *The Boe Ranch LAD system is not built and this analysis assumes that LAD areas 2, 3-Upper, and 4 have been built to manage water at East Boulder Mine. East Boulder tailings waters are evaporated over the tailings mass; 737 gpm (24 hr) treated adit water is land applied at LAD areas 2, 3-Upper, 4, and 6 at East Boulder Mine, and the excess waters are percolated. Summer and winter disposal scenarios were evaluated separately. Summer scenario: 725 gpm treated adit water would be land applied at LAD areas 2, 3-Upper, 4, and 6, and 12 gpm (24 hr) treated adit water would be percolated. Winter scenario: 285 gpm treated adit water would be disposed using snowmaking at LAD areas 3-Upper, 4, and 6, and 452 gpm (24 hr) treated adit water would be percolated. The closure period for this alternative is not specified, but for the purposes of analysis, all disposal of water was assumed to occur in 12 months.*

	criteria	No Action Alternative 1B	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B
Closure commences in summer using LAD				
Nitrogen load at East Boulder Mine, lbs/day summer	30	**0.7**		
Closure Nitrogen load to ground water, days 1-365, lbs/12-mos		**84**		
Nitrogen concentration in ground water at East Boulder Mine, mg/L summer	7.5	**meets MPDES Nitrogen load**		
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L summer	1	**0.6**		
EC in ground water at East Boulder Mine, µmhos/cm summer	1,000	**994**		
TDS in East Boulder River at East Boulder Mine, mg/L summer		**199**		
Closure commences in winter using snowmaking				
Nitrogen load at East Boulder Mine, lbs/day winter	30	**2.2**		
Closure Nitrogen load to ground water, days 1-365, lbs/12-mo		**293**		
Nitrogen concentration in ground water at East Boulder Mine, mg/L winter	7.5	**meets MPDES Nitrogen load**		
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L winter	1	**0.7**		
EC in ground water at East Boulder Mine, µmhos/cm winter	1,000	**822**		
TDS in East Boulder River at East Boulder Mine, mg/L winter		**191**		

NOTE: No time frame for the evaporation of tailings waters at closure was specified. The current volume of water in the tailings impoundment (98 MG) is more than double the original estimated volume (40 MG). An extended length of time would be necessary to evaporate the tailings waters.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 737 gpm CLOSURE scenarios**		No Action Alternative 1B	**Proposed Action Alternative 2B**	Agency-Mitigated Alternative 3B

Proposed Action Alternative 2B Option 1, 737 gpm: *The Boe Ranch LAD system is not built and this analysis assumes up to 737 gpm (24 hr) adit water and 263 gpm (24 hr) East Boulder tailings waters would be treated in the BTS/Anox system for nitrogen then preferentially disposed at the mine percolation pond. The time frame for closure is 12 months. Days 1-120, treated adit plus tailings waters would be percolated. Days 121-365, treated adit water would be percolated.*

East Boulder Mine	criteria	No Action Alternative 1B	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B
Nitrogen load at East Boulder Mine, lbs/day	30		**3.5 to 15.6**	
Closure Nitrogen load to ground water days 1-365, lbs			**4,414**	
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1		**meets MPDES Nitrogen load**	
EC in ground water at East Boulder Mine, µmhos/cm	1,000		**681 to 767**	
TDS in East Boulder River at East Boulder Mine, mg/L			**190 to 229**	

Proposed Action Alternative 2B Option 2, 737 gpm: *The Boe Ranch LAD system is not built and this analysis assumes up to 737 gpm (24 hr) adit and 263 gpm (24 hr) are disposed at the mine LAD areas. This analysis assumes that all East Boulder LAD areas 2, 3-Upper, 4, and 6, are constructed and operating to manage the adit water. For this option, no percolation would be used. Summer and winter disposal scenarios were evaluated separately. The time frame for closure would be 12 months.*

NOTE: For a closure scenario that commences in either summer or winter, there is insufficient hydraulic capacity at the East Boulder Mine LAD areas to manage the hydraulic load of 737 gpm (24 hr) treated adit and 263 gpm (24 hr) treated tailings waters. Additional water disposal methods must be used such as percolation.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 737 gpm CLOSURE scenarios**		No Action Alternative 1B	**Proposed Action Alternative 2B**	Agency-Mitigated Alternative 3B
Proposed Action Alternative 2B Option 3, 737 gpm: *The Boe Ranch LAD system is not built and this analysis assumes up to 737 gpm (24 hr) adit and 263 gpm (24 hr) are disposed maximizing the East Boulder Mine LAD areas with contingency disposal at the percolation pond. This analysis assumes that all East Boulder LAD areas 2, 3-Upper, 4, and 6, are constructed and operating to manage the adit water. Summer and winter disposal scenarios were evaluated separately. The time frame for closure would be 12 months.*				
Closure commences in summer using LAD	criteria			
Nitrogen load at East Boulder Mine, lbs/day summer	30		**6.1**	
Closure Nitrogen load to ground water days 1-365, lbs			**1,162**	
Nitrogen concentration in ground water at East Boulder Mine, mg/L summer	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L	1		**0.9**	
EC in ground water at East Boulder Mine, µmhos/cm summer	1,000		**685 to 892**	
TDS in East Boulder River at East Boulder Mine, mg/L summer			**191 to 261**	
Closure commences in winter using snowmaking				
Nitrogen load at East Boulder Mine, lbs/day winter	30		**21**	
Closure Nitrogen load to ground water days 1-365, lbs			**1,822**	
Nitrogen concentration in ground water at East Boulder Mine, mg/L winter	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L winter	1		**1.0**	
EC in ground water at East Boulder Mine, µmhos/cm winter	1,000		**685 to 729**	
TDS in East Boulder River at East Boulder Mine, mg/L winter			**174 to 191**	

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 737 gpm CLOSURE scenarios**		No Action Alternative 1B	Proposed Action Alternative 2B	**Agency-Mitigated Alternative 3B**
Agency-Mitigated Alternative 3B Option 1, 737 gpm: *The Boe Ranch LAD system and the East Boulder LAD areas 2, 3-Upper, and 4 are not built. The 737 gpm of treated adit waters plus 263 gpm treated tailings waters would be disposed in the East Boulder Mine percolation pond as in Proposed Action Alternative 2B, but over an 18-month closure time frame.*				
East Boulder Mine	criteria			
Nitrogen load at East Boulder Mine, lbs/day	30			**11.1**
Closure Nitrogen load to ground water, days 1-548, lbs/18-mo				**3,791**
EC in ground water at East Boulder Mine, µmhos/cm	1,000			**767**
TDS in East Boulder River at East Boulder Mine, mg/L				**229**

Agency-Mitigated Alternative 3B Option 2, 737 gpm: *The Boe Ranch LAD system is not built. All approved mine LAD areas would be constructed. The 737 gpm (24 hr) adit and 263 gpm (24 hr) treated East Boulder tailings waters would be preferentially disposed at the East Boulder LAD areas 2, 3-Upper, and 4. Summer and winter closure scenarios are evaluated separately. The closure time frame would be 18 months.*

NOTE: The hydraulic load of 737 gpm adit water plus 263 gpm tailings waters exceeds the capacity of the approved East Boulder Mine LAD areas in summer and winter and cannot be managed solely by land application at the East Boulder Mine. Some excess water would need to be percolated.

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 737 gpm CLOSURE scenarios**		No Action Alternative 1B	Proposed Action Alternative 2B	**Agency-Mitigated Alternative 3B**

Agency-Mitigated Alternative 3B Option 3, 737 gpm: *The Boe Ranch LAD system is not built. All approved mine LAD areas would be constructed. The 737 gpm (24 hr) adit and 263 gpm (24 hr) treated East Boulder tailings waters would be preferentially disposed at the East Boulder LAD areas 2, 3-Upper, and 4, and excess waters would be discharged to the East Boulder Mine percolation pond. Days 1-120, treated adit plus tailings waters would be LAD and the excess water percolated. Days 121-335, treated adit plus tailings waters would be percolated. Days 336-548, treated adit water would be percolated. Summer and winter closure scenarios are evaluated separately. The closure time frame would be 18 months.*

Closure commences in summer using LAD	criteria			
Nitrogen load at East Boulder Mine, lbs/day summer	30			**4.7 to 11.1**
Closure Nitrogen load to ground water, days 1-548, lbs/18-mos				**3,119**
Nitrogen concentration in ground water at East Boulder Mine, mg/L summer	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L summer	1			**0.4 to 0.8**
EC in ground water at East Boulder Mine, µmhos/cm summer	1,000			**682 to 892**
TDS in East Boulder River at East Boulder Mine, mg/L summer				**190 to 243**
Closure commences in winter using snowmaking				
Nitrogen load at East Boulder Mine, lbs/day winter	30			**3.5 to 9.5**
Closure Nitrogen load to ground water, days 1-548, lbs/18-mos				**3,702**
Nitrogen concentration in ground water at East Boulder Mine, mg/L winter	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L winter	1			**0.4 to 0.8**
EC in ground water at East Boulder Mine, µmhos/cm winter	1,000			**681 to 811**
TDS in East Boulder River at East Boulder Mine, mg/L winter				**170 to 235**

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 150 gpm CLOSURE scenarios**		**No Action Alternative 1B**	Proposed Action Alternative 2B	Agency-Mitigated Alternative 3B
No Action Alternative 1B Option 1, 150 gpm: *The Boe Ranch LAD system is not built; East Boulder Mine LAD areas 2, 3-Upper, 4 are not built; East Boulder tailings waters are evaporated over the tailings mass; 150 gpm (24 hr) treated adit water is land applied at LAD Area 6 at East Boulder Mine. Summer and winter disposal scenarios were evaluated separately.*				
Closure commences in summer using LAD	criteria			
Nitrogen load at East Boulder Mine, lbs/day summer	30	**0.7**		
Total summer closure Nitrogen load to ground water, days 1-365, lbs/12-mo		**2,250**		
Nitrogen concentration in ground water at East Boulder Mine, mg/L summer	7.5	**meets MPDES Nitrogen load**		
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L	1	**0.8**		
EC in ground water at East Boulder Mine, µmhos/cm summer	1,000	**617**		
TDS in East Boulder River at East Boulder Mine, mg/L summer		**133**		
Closure commences in winter using snowmaking				
Nitrogen load at East Boulder Mine, lbs/day winter	30	**0.7**		
Total summer closure Nitrogen load to ground water, days 1-365, lbs/12-mo		**2,250**		
Nitrogen concentration in ground water at East Boulder Mine, mg/L winter	7.5	**meets MPDES Nitrogen load**		
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L winter	1	**0.8**		
EC in ground water at East Boulder Mine, µmhos/cm winter	1,000	**617**		
TDS in East Boulder River at East Boulder Mine, mg/L winter		**133**		

Revised **East Boulder 150 gpm CLOSURE scenarios**		No Action Alternative 1B	**Proposed Action Alternative 2B**	Agency-Mitigated Alternative 3B
Proposed Action Alternative 2B Option 2, 150 gpm: *The Boe Ranch LAD system is not constructed. This analysis assumes up to 150 gpm (24 hr) treated adit water plus 350 gpm (24 hr) would be percolated at East Boulder Mine percolation pond. The time frame for closure would be 12 months.*				
Nitrogen load at East Boulder Mine, lbs/day	30		**0.7 to 16.8**	
Closure Nitrogen load to ground water, days 1-365, lbs/12-mo			**3,386**	
EC in ground water at East Boulder Mine, µmhos/cm	1,000		**378 to 700**	
TDS in East Boulder River at East Boulder Mine, mg/L			**102 to 176**	

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **East Boulder 150 gpm CLOSURE scenarios**		No Action Alternative 1B	Proposed Action Alternative 2B	**Agency-Mitigated Alternative 3B**
Agency-Mitigated Alternative 3B Option 1, 150 gpm: *The Boe Ranch and LAD areas 2, 3-Upper, 4 are not built. This analysis assumes up to 150 gpm treated adit water plus 350 gpm treated tailings waters would be disposed at the East Boulder Mine percolation pond. The closure time frame would be 18 months.*				
Nitrogen load at East Boulder Mine, lbs/day	30			**0.7 to 10.8**
Closure Nitrogen load to ground water, days 1-548, lbs/18-mo				**2,346**
EC in ground water at East Boulder Mine, µmhos/cm	1,000			**445 to 700**
TDS in East Boulder River at East Boulder Mine, mg/L				**105 to 176**
Agency-Mitigated Alternative 3B Option 2, 150 gpm: *The Boe Ranch and LAD areas 2, 3-Upper, 4 are not built. This analysis assumes up to150 gpm treated adit water plus 350 gpm treated tailings waters would be disposed at the East Boulder Mine LAD Area 6. No percolation would be used. The closure time frame would be 18 months.*				
NOTE: There is insufficient hydraulic capacity at the East Boulder Mine LAD Area 6 to manage the hydraulic load of 150 gpm (24 hr) treated adit and 350 gpm (24 hr) treated tailings waters. Additional water disposal methods must be used such as percolation.				
Agency-Mitigated Alternative 3B Option 3, 150 gpm: *The Boe Ranch and LAD areas 2, 3-Upper, 4 are not built. This analysis assumes up to 150 gpm treated adit water plus 350 gpm treated tailings waters would be preferentially disposed at the East Boulder Mine LAD Area 6, with excess waters disposed at the mine percolation pond. Closure commencing in summer and winter were evaluated separately. The closure time frame would be 18 months.*				
Closure commences in summer using LAD	criteria			
Nitrogen load at East Boulder Mine, lbs/day summer	30			**5.7 to 10.8**
Total summer closure Nitrogen load to ground water, days 1-548				**1,741**
Nitrogen concentration in ground water at East Boulder Mine, mg/L summer	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L summer	1			**0.3 to 0.9**
EC in ground water at East Boulder Mine, µmhos/cm summer	1,000			**764 to 939**
TDS in East Boulder River at East Boulder Mine, mg/L summer				**168 to 181**
Closure commences in winter using snowmaking				
Nitrogen load at East Boulder Mine, lbs/day winter	30			**0.7 to 7.2**
Total winter closure Nitrogen load to ground water, lbs/18 mos				**1,923**
Nitrogen concentration in ground water at East Boulder Mine, mg/L winter	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River at East Boulder Mine, mg/L winter	1			**0.5 to 0.9**
EC in ground water at East Boulder Mine, µmhos/cm winter	1,000			**494 to 936**
TDS in East Boulder River at East Boulder Mine, mg/L winter				**112 to 179**

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 737 gpm OPERATIONS scenarios**		**No Action Alternative 1C**	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C

No Action Alternative 1C OPERATIONS, 737 gpm: *the Boe Ranch LAD system is not constructed. There would be no effect from LAD at the Boe Ranch. Not Revised.*

Revised **Boe Ranch 737 gpm OPERATIONS scenarios**		No Action Alternative 1C	**Proposed Action Alternative 2C**	Agency-Mitigated Alternative 3C

Proposed Action Alternative 2C OPERATIONS Option 1, 737 gpm: *Preferential disposal of all 737 gpm (24 hr) adit water would occur at the Boe Ranch LAD at agronomic rates with contingency disposal of treated adit water at the East Boulder Mine percolation pond.*

NOTE: During the 120 day LAD season, the hydraulic load of 737 gpm (24 hr) adit water can be managed at Boe Ranch LAD if all 10 pivots are operating at agronomic rates as proposed by SMC. However, the LAD storage pond would fill the first 95 days of winter and excess adit waters would have to managed at the East Boulder Mine percolation ponds and by winter snowmaking. During the following LAD season, the hydraulic load of 737 gpm (24 hr) could be managed at Boe Ranch LAD, but no capacity would exist to dewater the LAD storage pond.

Revised **Boe Ranch 737 gpm OPERATIONS scenarios**		No Action Alternative 1C	**Proposed Action Alternative 2C**	Agency-Mitigated Alternative 3C

Proposed Action Alternative 2C OPERATIONS Option 2, 737 gpm: *During the LAD season days 1-120, up to 164 gpm (24 hr) treated adit water plus 579 gpm (24 hr) stored pond water is applied at Boe Ranch LAD at agronomic rates, and 573 gpm (24 hr) is disposed at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 283 gpm (24 hr) treated adit water can be routed to the Boe Ranch LAD storage pond and up to 454 gpm (24 hr) would be disposed of at the East Boulder Mine percolation pond.*

East Boulder Mine	criteria	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Nitrogen load East Boulder Mine, lbs/day	30		**2.2 to 2.7**	
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1		**meets MPDES Nitrogen load**	
EC in ground water below East Boulder Mine, µmhos/cm	1,000		**858 to 866**	
TDS in East Boulder River below East Boulder Mine, mg/L			**224 to 236**	
Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L	7.5		**0.1**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1		**0.1**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1		**0.1**	
EC in ground water below Boe Ranch, µmhos/cm	2,500		**1,103**	
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)			**425**	
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)			**318**	

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 737 gpm OPERATIONS scenarios**		No Action Alternative 1C	Proposed Action Alternative 2C	**Agency-Mitigated Alternative 3C**
Agency-Mitigated Alternative 3C OPERATIONS Option 1, 737 gpm: *To operationally address the hydraulic volume of 737 gpm adit water and dewater the Boe Ranch LAD storage pond annually, only 284 gpm (24 hr) treated adit water with 579 gpm (24 hr) Boe Ranch LAD stored waters could be land applied at Boe Ranch LAD with 7 pivots operating on 166 acres at greater than agronomic rates as is done at Hertzler Ranch LAD. The remaining 453 gpm (24 hr) adit water must be managed seasonally at the East Boulder Mine LAD areas (293 gpm 24 hr summer rate, 205 gpm 24 hr winter rate) and percolation pond (160 gpm 24-hr summer rate, 248 gpm 24-hr winter rate).*				
East Boulder Mine	criteria			
Nitrogen load East Boulder Mine, lbs/day	30			**0.8 to 2.2**
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1			**meets MPDES Nitrogen load**
EC in ground water below East Boulder Mine, µmhos/cm	1,000			**904 to 950**
TDS in East Boulder River below East Boulder Mine, mg/L				**323**
Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L summer	7.5			**0.3**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1			**0.2**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1			**0.1**
EC in ground water below Boe Ranch, µmhos/cm summer	2,500			**1,070**
TDS in East Boulder River below Boe Ranch, mg/L				**328**

Boe Ranch 150 gpm OPERATIONS scenarios		**No Action Alternative 1C**	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
No Action Alternative 1C, 150 gpm: *the Boe Ranch LAD system is not constructed. There would be no effect from LAD at the Boe Ranch. Not Revised.*				

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Boe Ranch 150 gpm OPERATIONS scenarios		No Action Alternative 1C	**Proposed Action Alternative 2C**	Agency-Mitigated Alternative 3C
Proposed Action Alternative 2C OPERATIONS Option 2, 150 gpm: *During the LAD season days 1-120, up to 150 gpm (24 hr) treated adit water plus 301 gpm (24 hr) stored pond water would be applied at Boe Ranch LAD at agronomic rates. No water would be disposed at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 150 gpm (24 hr) treated adit water would be routed to the Boe Ranch LAD storage pond. The capacity of the Boe Ranch LAD storage pond would be adequate to store eight months of treated adit water (52 MG).*				
days 1-120 East Boulder Mine			**no disposal at the East Boulder Mine days 1-120**	
LAD season days 1-120 Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L	7.5		**0.1**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1		**0.1**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1		**0.1**	
EC in ground water below Boe Ranch, µmhos/cm	2,500		**1,072**	
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)			**432**	
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)			**328**	
Days 121-365 Boe Ranch LAD			**adit water stored; no disposal occurs**	

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 150 gpm OPERATIONS scenarios**		No Action Alternative 1C	Proposed Action Alternative 2C	**Agency-Mitigated Alternative 3C**
Agency-Mitigated Alternative 3C OPERATIONS Option 1, 150 gpm: *During the LAD season days 1-120, up to 150 gpm (24 hr) treated adit water plus 301 gpm (24 hr) stored pond water would be applied at Boe Ranch LAD at greater than agronomic rates. No water would be disposed at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 150 gpm (24 hr) treated adit water would be routed to the Boe Ranch LAD storage pond. The capacity of the Boe Ranch LAD storage pond would be adequate to store eight months of treated adit water (52 MG).*				
days 1-365 East Boulder Mine LAD season days 1-120 Boe Ranch LAD				**no disposal at the East Boulder Mine**
Nitrogen load East Boulder Mine, lbs/day	30			**meets MPDES Nitrogen load**
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1			**0.1**
EC in ground water below Boe Ranch, µmhos/cm summer	2,500			**1,070**
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)				**432**
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)				**328**
days 121-365 water storage occurs at the Boe Ranch				**no disposal at the Boe Ranch LAD days 121-365**

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 737 gpm CLOSURE scenarios**		**No Action Alternative 1C**	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C

No Action Alternative 1C Option 1, 737 gpm: *The Boe Ranch LAD system is not built and this analysis assumes that LAD areas 2, 3-Upper, and 4 have been built to manage water at the East Boulder Mine. The East Boulder tailings waters are evaporated over the tailings mass. The 737 gpm (24 hr) treated adit water is land applied at LAD areas 2, 3-Upper, 4, and 6 at East Boulder Mine. Summer and winter disposal scenarios were evaluated separately. The results of this analysis are equivalent to the No Action Alternative 1B, Option 1, 737 gpm. No time frame was given for closure.*

Revised **Boe Ranch 737 gpm CLOSURE scenarios**		No Action Alternative 1C	**Proposed Action Alternative 2C**	Agency-Mitigated Alternative 3C

Proposed Action Alternative 2C Option 1, 737 gpm: *The Boe Ranch LAD system is built. The East Boulder tailings impoundment would be dewatered at 263 gpm (24 hr) and treated with 737 gpm (24 hr) adit water through the BTS/Anox system. Based on the hydraulic load calculations, only 743 gpm (24 hr) can be disposed of at the Boe Ranch LAD. During the LAD season, days 1-120, up to 164 gpm (24 hr) of treated adit and tailings waters plus 579 gpm (24 hr) stored pond water would be applied at the Boe Ranch LAD at agronomic rates. The remaining 833 gpm (24 hr) would be disposed at the East Boulder Mine (293 gpm would be routed to LAD Area 6, and 540 gpm would be routed to the percolation pond.) For the remainder of closure (days 121-365), 737 gpm (24 hr) treated adit water would be disposed at the East Boulder Mine percolation pond. The time frame for closure would be 12 months.*

East Boulder Mine	criteria	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Nitrogen load East Boulder Mine, lbs/day	30		**3.5 to 15.6**	
Closure Nitrogen load to ground water, lbs/12-mos			**3,635**	
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1		**meets MPDES Nitrogen load**	
EC in ground water below East Boulder Mine, µmhos/cm	1,000		**655 to 830**	
TDS in East Boulder River below East Boulder Mine, mg/L			**184 to 242**	
Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L summer	7.5		**0.1**	
Closure Nitrogen load to ground water, lbs/12-mos			**1,391**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1		**0.1**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1		**0.1**	
EC in ground water below Boe Ranch, µmhos/cm summer	2,500		**1,088**	
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)			**421**	
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)			**316**	

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 737 gpm CLOSURE scenarios**		No Action Alternative 1C	Proposed Action Alternative 2C	**Agency-Mitigated Alternative 3C**

Agency-Mitigated Alternative 3C, Option 1, 737 gpm: *At closure, SMC would treat 737 gpm adit water and 263 gpm tailings waters in the BTS. The closure time frame would be 18 months.* ***Days 1-120:*** *SMC would maximize disposal of 284 gpm treated adit and tailings waters with 579 gpm (24 hr) stored waters at the Boe Ranch LAD area at greater than agronomic rates. SMC would dispose of the remaining 716 gpm at the East Boulder Mine. LAD Area 6 would receive 293 gpm and the excess 423 gpm would be routed to the East Boulder Mine percolation pond during the first 120 day summer LAD season in the 18-month closure period.*

Days 121-365: *After day 120, the tailings impoundment would be closed and only 737 gpm of treated adit water would need disposal during the rest of the 18-month closure period. From days 121-365, up to 284 gpm would be routed to the Boe Ranch LAD storage pond, and 453 gpm would be disposed at the East Boulder Mine percolation pond.*

Days 366-548: *During the second year 120 day LAD season, 284 gpm would be routed and disposed at greater than agronomic rates with 579 gpm stored waters in the Boe Ranch LAD storage pond. After the second year LAD season, all 737 gpm of treated adit water would be disposed at the East Boulder Mine percolation pond.*

East Boulder Mine	criteria	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
Nitrogen load East Boulder Mine, lbs/day	30			**2.2 to 4.9**
Total Nitrogen load to ground water at East Boulder Mine during closure, lbs/18 mos				**2,330**
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1			**meets MPDES Nitrogen load**
EC in ground water below East Boulder Mine, µmhos/cm	1,000			**867 to 1,063**
TDS in East Boulder River below East Boulder Mine, mg/L				**207 to 268**
Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L summer	7.5			**0.1 to 0.3**
Total Nitrogen load to ground water at Boe Ranch LAD during closure, days 1-486				**604**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1			**0.1 to 0.2**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1			**0.1**
EC in ground water below Boe Ranch, µmhos/cm summer	2,500			**1,062 to 1,083**
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)				**426 to 432**
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)				**323 to 327**

Boe Ranch 150 gpm CLOSURE scenarios		**No Action Alternative 1C**	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

No Action Alternative 1C Option 1, 150 gpm: *The Boe Ranch LAD system is not built and this analysis assumes that East Boulder Mine LAD areas 2, 3-Upper, and 4 have not been built at the East Boulder Mine. The East Boulder tailings waters are evaporated over the tailings mass. The 150 gpm (24 hr) treated adit water is land applied at LAD Area 6 at East Boulder Mine. Summer and winter disposal scenarios were evaluated separately. The results of this analysis are equivalent to the No Action Alternative 1B, Option 1, 150 gpm. No time frame was given for closure. Not revised.*

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 150 gpm CLOSURE scenarios**		No Action Alternative 1C	**Proposed Action Alternative 2C**	Agency-Mitigated Alternative 3C
Proposed Action Alternative 2C Option 1, 150 gpm: *Days 1-120 Up to 150 gpm (24 hr) adit water would be mixed and treated with 286 gpm tailings waters and routed to the Boe Ranch LAD storage pond. The 436 gpm (24 hr) mixed, treated adit and tailings waters would mix with 52 MG of treated stored water in the LAD storage pond, then land applied at Boe Ranch LAD at agronomic rates 743 gpm (24 hr rate). Days 121-365: During the rest of the 12-month closure period, the 150 gpm (24 hr) would be routed to the East Boulder Mine percolation pond.*				
days 1-120 East Boulder Mine			**no disposal at the East Boulder Mine**	
LAD season days 1-120 Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L	7.5		**0.1**	
Total Nitrogen load to ground water at Boe Ranch LAD during closure, days 1-120			**1,391**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1		**0.1**	
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1		**0.1**	
EC in ground water below Boe Ranch, µmhos/cm	2,500		**1,088**	
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)			**421**	
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)			**316**	
days 121-365 East Boulder Mine				
Nitrogen load East Boulder Mine, lbs/day	30		**0.7 to 7.3**	
Total Nitrogen load to ground water at Boe Ranch LAD during closure, days 121-365			**916**	
Nitrogen concentration in ground water below East Boulder Mine, mg/L	7.5		**meets MPDES Nitrogen load**	
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1		**meets MPDES Nitrogen load**	
EC in ground water below East Boulder Mine, µmhos/cm	1,000		**408 to 599**	
TDS in East Boulder River below East Boulder Mine, mg/L			**150 to 238**	

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

Appendix E DEQ 2012
Revised Summary of Projected Water Quality by Alternative

Revised **Boe Ranch 150 gpm CLOSURE scenarios**		No Action Alternative 1C	Proposed Action Alternative 2C	**Agency-Mitigated Alternative 3C**

Agency-Mitigated Alternative 3C, Option 1, 150 gpm: SMC would treat 436 gpm (150 gpm adit water and 350 gpm of tailings waters) at closure to empty the East Boulder Mine tailings impoundment. The Boe Ranch LAD storage pond would contain 52 MG of treated adit waters on the first day of the 120-day LAD season. SMC would land apply water for disposal at greater than agronomic rates. After the first 120-day LAD season, 150 gpm of treated adit water would be routed to the Boe Ranch LAD storage pond for disposal during the second LAD season in the 18-month closure period. The 150 gpm of treated adit water would be disposed at the East Boulder Mine days 487 to 548 of the 18-month closure period.

	criteria	No Action Alternative 1C	Proposed Action Alternative 2C	Agency-Mitigated Alternative 3C
days 1-120 East Boulder Mine				**no disposal at the East**
LAD season days 1-120 Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L summer	7.5			**0.5**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)	1			**0.3**
Nitrogen concentration in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)	1			**0.2**
EC in ground water below Boe Ranch, µmhos/cm summer	2,500			**1,190**
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)				**466**
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)				**344**
days 121-365 East Boulder Mine				**no disposal at the East Boulder Mine**
Second year LAD season days 366-486 Boe Ranch LAD				
Nitrogen concentration in ground water below Boe Ranch, mg/L summer	7.5			**0.5**
EC in ground water below Boe Ranch, µmhos/cm summer	2,500			**796**
TDS in East Boulder River below Boe Ranch, mg/L (2.0 cfs flow)				**291**
TDS in East Boulder River below Boe Ranch, mg/L (5.0 cfs flow)				**238**
days 366-548 East Boulder Mine				
Nitrogen load East Boulder Mine, lbs/day	7.5			**0.7**
Total Nitrogen load to ground water at East Boulder Mine during closure, days 1-548				**45**
Nitrogen concentration in ground water below East Boulder Mine, mg/L	1			**meets MPDES Nitrogen load**
Nitrogen concentration in East Boulder River below East Boulder Mine, mg/L	1			**meets MPDES Nitrogen load**
EC in ground water below East Boulder Mine, µmhos/cm	1,000			**922**
TDS in East Boulder River below East Boulder Mine, mg/L				**378**

Note: These concentrations are projected values based on best available data.
TDS Total Dissolved Solids; EC Electrical Conductivity;
MG Million gallons

2012 Stillwater Mine Water Management Plan Final EIS
Formatting Key for the *Revised* Spreadsheet Analyses

What has changed for the FEIS

- The cell values that were revised are highlighted in mauve.
- Anchor cell values are highlighted in green and minor adjustments in the calculations were made so that these values are used in subsequent calculations.
- Redundant listings of input data have been removed and calculations adjusted accordingly to reduce the length of the spreadsheets.
- Revisions to text other than corrections of typographical errors are indicated in a navy blue font.
- Updated data/input values with citations are listed in navy blue font.
- Values that were revised as a result of comment include
  - Supernatant volumes
  - Nitrogen concentration of treated adit and tailings waters
  - Updated ambient concentrations of nitrogen and salts in ground water to better reflect current operating conditions
  - Average concentrations of adit and tailings waters recalculated to consider the last three years of data (2009 to 2011)

Electronic Microsoft Excel™ spreadsheets contain the formulas used to make the calculations for this environmental analysis. The pdf files included in this document do not contain the formulas. Every effort has been made to minimize error. For a summary of these results, please see the *Revised* Summary of Water Quality by Alternative Table, also found in Appendix E. This key will make the most sense if used by the reader while reviewing a printed or electronic spreadsheet.

- ***Title:*** The initial line shown in orange is the title of the spreadsheet. The spreadsheets are named by alternative and labeled “Nitrogen Calculations” for the analysis of total inorganic nitrogen or “Salts Calculations” for the analysis of salts. Two spreadsheets have been constructed for each alternative. All spreadsheets contain analyses of what the agencies considered reasonable, non-prescriptive options for the management of water at closure, and indicate whether the analysis is also applicable to operations or post-closure. Several options are listed on a given spreadsheet. Headers assist the reader in tracking which option is being evaluated.

- ***Assumptions made:*** Beneath the orange title box is a yellow box with blue text that describes the overarching assumptions for the calculations made in that spreadsheet. These overarching assumptions are consistent for each constituent (nitrogen or salts) and location (Stillwater Mine and Hertzler Ranch LAD system, East Boulder Mine, and Boe Ranch LAD System), regardless of the alternative.

- ***Options analyzed:*** The green boxes indicate which option has been analyzed for the calculations that follow. For some of the analyses, several options were evaluated. The options analyzed were not intended to be prescriptive, but are reasonable representations of the alternative. Often, there are multiple options possible for each alternative. The options analyzed provide a reasonable estimate of projected water quality and quantity impacts for the alternative, if chosen and implemented. In all options, the analysis is sequenced: first, the hydraulic capacity of the treatment and disposal systems is evaluated, then the nitrogen load/concentration or the salts as measured by electrical conductivity (ground water) and total dissolved solids (surface water).

- ***Adit water flow rate:*** Each spreadsheet analyzes the current operational and upper-most expected adit flow rate for each alternative. These are intended to give a range of potential water quality and quantity impacts.

- ***Hydraulic and loading analyses:*** The headers for each section are color-coded. The hydraulics analyses headers and conclusions are labeled pale blue, the loading analyses and results are pale green, the ground water headers and results are medium blue, and the surface water headers and results are aqua. As stated above, anchor cells are shown in green, and cell values that were changed are highlighted in mauve.

- ***Conclusions:*** Conclusions regarding the option analyzed are in yellow boxes. The adit flow rate analyzed is highlighted in purple. Red text is used where a hydraulic loading capacity or a contaminant standard or recommendation has been exceeded. Please note that for salts, the appropriate unit to determine compliance with ground water beneficial use standards is micromhos/centimeter (µmhos/cm) (electrical conductivity). Although both total dissolved solids and electrical conductivity values are calculated in the spreadsheets, the applicable projected concentration is highlighted in color.

- ***Option analyzed:*** Next to the headers for each section in grey boxes are descriptions of that portion of the option analyzed. Some options have been split into specific timeframes due to hydraulic or contaminant load sequencing.

- ***Input values and references:*** Below each of the headers are the specific input values used for that portion of the analysis. The values that were used in the calculations are listed in black text and have a descriptor. For the first analysis, and for subsequent analyses where space permits, a citation for the source of the data is listed to the right in blue text. In an effort to reduce the length of the spreadsheets, the citations for the data are not always located across from the value used, especially where there are several iterations of calculations. For the FEIS, input values are listed once in the spreadsheet and subsequent redundant values have been removed.

- ***Activity-specific flow rate:*** Both 12-hour and 24-hour flow rates were used, and are designated in the units column. This convention was necessary as some activities, such as adit flow and tailings impoundment dewatering rates, would occur over a 24-hour period, and other activities, such as land application, would occur over a 12-hour period. The volume calculations have been adjusted to reflect whether a 12-hour or 24-hour flow rate was used. For example, to calculate a volume based on a 12-hour rate, 720 minutes per day rate was used. To calculate a volume based on a 24-hour rate, 1,440 minutes per day rate was used. Similarly, loading calculations use the conversion factor 0.012 for a 24-hour gallon per minute rate, while the same calculation for a 12-hour gallon per minute pumping rate uses the conversion factor 0.006.

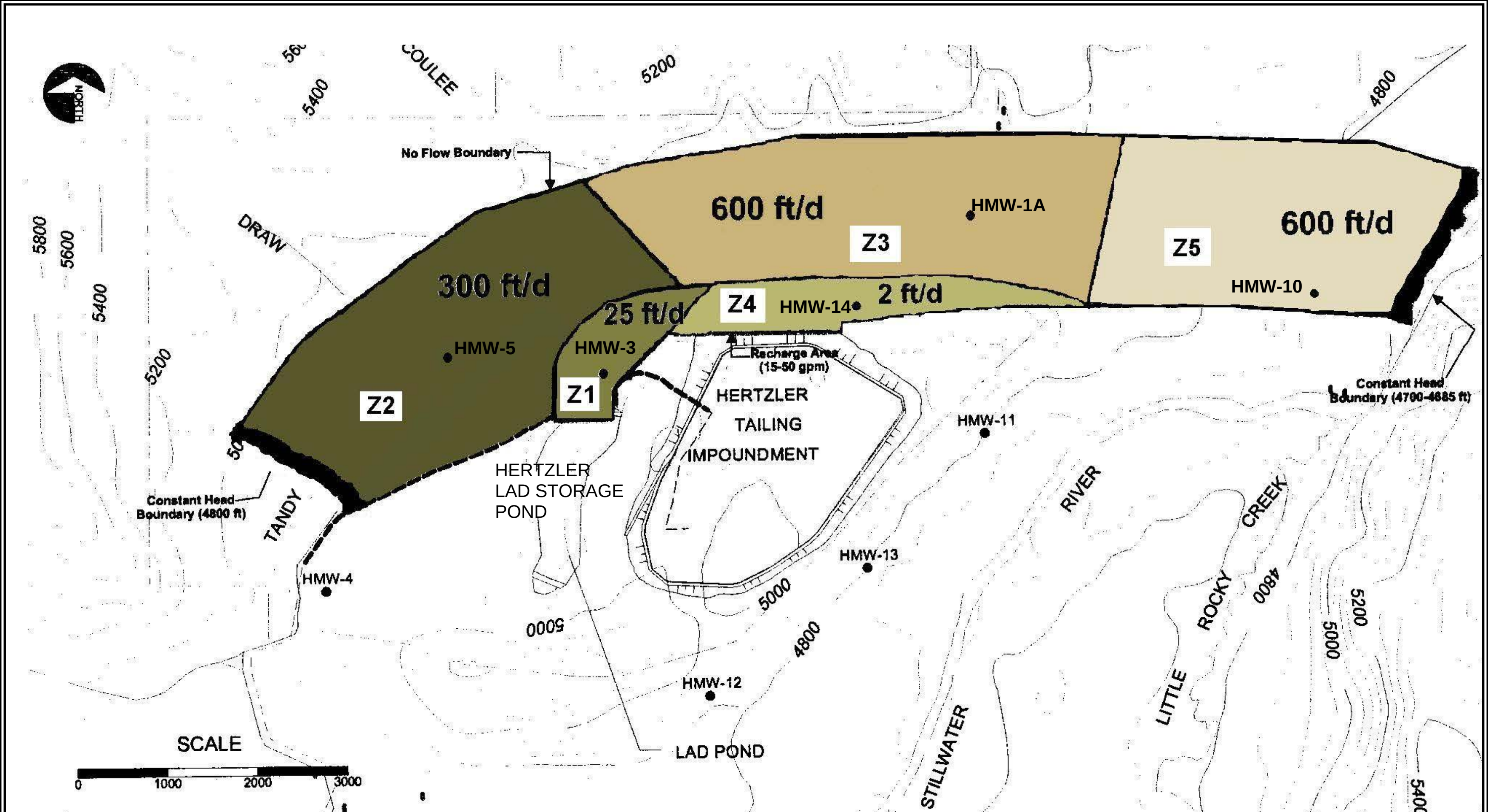
- ***Conversion factors:*** Standard conversion factors (weight, volume, time, loading) have been used.

- ***Significant figures:*** Minimal digits were displayed in an effort to address concerns relating to the precision of these calculations and the degree of accuracy inherently attributed to numbers with expansive extensions to the right of the decimal point. While not strictly adhering to the rules of significant figures, care has been taken to display digits appropriate to the calculation made.

- ***Plant uptake and snowmaking credits:*** The vegetation uptake of nitrogen during land application of mine waste waters has been quantified during tests at the Hertzler Ranch LAD system and snowmaking at the East Boulder Mine, so factors based upon the results of those tests have been applied to the appropriate calculations.

- ***Limitations:*** Please note that these calculations are reasonable projections of changes that can be expected in ground and surface water quality from the disposal of waste waters from SMC's mines. While spreadsheet modeling is valuable to provide good predictions within ground and surface water systems, it does have some limitations. These limitations are most apparent under the following circumstances: when aquifers are highly heterogeneous, which causes differences in permeability and the behavior of ground water; when a three-dimensional approach is needed (these models are two-dimensional); or when the contaminant concentration changes (is attenuated) due to interactions with soil, microbes, or ground and surface water. These types of situations are more accurately represented by a complex (potentially three-dimensional) model. Spreadsheet models are best used in situations such as this analysis, where the salts and nitrogen are conservative (that is, they do not degrade or are otherwise attenuated in the ground water system), temporal relationships are generally known, and for simple ground water or stream flow mixing calculations. These spreadsheet models do not provide temporal estimates, so the agencies have relied upon trends in water quality monitoring data.

L.M.B.



HERTZLER RANCH LAD GROUND WATER ZONES FIGURE

Stillwater Mine System Coordinates 532,000 N, 926,125 E

Appendix C

DEQ 2009

adapted from Hydrometrics 2003 Hertzler LAD Holding Pond Seepage Analysis Figure 4 Numerical Model Layout

Spreadsheet 1A Nitrogen: *Revised* Alternative 1A No Action Stillwater Mine and Hertzler Ranch Closure and Post-Closure Nitrogen Analyses

Per SMC 1994b, preferential disposal of adit waters is at the Stillwater Mine percolation ponds with the option to route to the Hertzler Ranch LAD for disposal. The calculations for these analyses have been made according to the regulatory requirements for surface and ground water mixing zones of the Montana Water Quality Act and Rules and Federal Clean Water Act. The Stillwater MPDES permit limit is for total nitrogen. No dilution from precipitation (recharge) was assumed. For the Hertzler Ranch LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer; no unsaturated zone was considered. To determine the concentration of total nitrogen in ground water, it was assumed that ground water in Zones 1 (Z_1), 2 (Z_2), and 4 (Z_4) flow into 3 (Z_3), then Z_3 flows into Zone 5 (Z_5) (see the Hertzler Ranch Ground Water Zones Figure). The subscript on input parameters for these calculations refers to the ground water zone, that is, k_1 refers to the hydraulic conductivity of Zone 1 (Z_1), k_2 refers to the hydraulic conductivity of Zone 2 (Z_2) etc. Z_1 is downgradient of the assumed LAD Storage Pond liner leak; Z_2 is the Upper LAD Area; Z_3 is the Lower LAD Area; Z_4 is downgradient of the assumed Hertzler Ranch tailings impoundment liner leak; Z_5 is downgradient of all contributing areas. If treated adit water is routed to Hertzler Ranch, water is routed to the LAD storage pond then to LAD pivots during closure. The existing volume of treated adit water in the LAD storage pond at closure would be 105 MG. Tailings waters for each impoundment would be evaporated over the tailings mass in this alternative and would not discharge to ground water. The concentration of treated adit water is based on historical nitrogen loading and will vary with flow rate. This spreadsheet has been revised to reflect changes in volumes and adit flow rates. Changes in text and input values are in blue font and orange highlight.

Closure: **No Action Alternative 1A, Option 1, 2,020 gpm: Tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm of untreated east side adit water would be at the Stillwater Mine percolation ponds. Disposal of 1,650 gpm treated west side adit water and 105 million gallons (MG) of Hertzler Ranch LAD storage pond treated adit water would be at Hertzler Ranch LAD area. The closure timeframe was not specified.**

concentration of east-side adit water at closure	0.2	mg/L	**0.9**	lbs/day	Load to ground water from percolation disposal of east-side adit water at Stillwater Mine
east-side adit flow rate at closure	370	gpm (24 hr)	**1,650**	gpm (24 hr)	west-side adit flow rate at closure
			4.1	mg/L	treated concentration of adit water from SMC BTS data (2011)

Hydraulic Input Parameters for Hertzler Ranch Ground Water Calculations

Parameter	Value	Unit	Source of Data
depth of aquifer, **D**	15	ft	allowed by 17.30.517(d)
hydraulic conductivity, $\mathbf{k_1}$ beneath Hertzler Ranch LAD Pond	25	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper Hertzler Ranch LAD	300	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_3}$ and $\mathbf{k_5}$ from lower Hertzler Ranch LAD	600	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_4}$ area beneath presumed tailings impoundment liner leakage	2	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
gradient, **i**	0.01		estimated, from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of source (Hertzler Ranch LAD storage pond liner leakage)	10	ft	assumed width based on point liner leak, Hydrometrics 2003
width of Hertzler Ranch LAD storage pond liner leakage mixing zone, $\mathbf{W_1}$	167	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
angle of dispersion	0.0874887	tan 5°	allowed by ARM 17.30.517(d)
length of presumed Hertzler Ranch LAD Storage Pond liner leakage area, $\mathbf{L_1}$	1,800	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
length upper Hertzler Ranch LAD, $\mathbf{L_2}$	4,800	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of upper Hertzler Ranch LAD at P3 and P7	2,700	ft	personal communication R Weimer 3/17/2009
width of Upper Hertzler Ranch LAD mixing zone $\mathbf{W_2}$	3,120	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of lower Hertzler Ranch LAD, $\mathbf{L_3}$	5,200	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of Lower Hertzler Ranch LAD at P4	1,610	ft	personal communication R Weimer 3/17/2009
Width of Lower Hertzler Ranch LAD mixing zone $\mathbf{W_3}$	2,065	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
Width of source (Hertzler Ranch tailings impoundment liner leakage)	10	ft	assumed width based on point liner leak, Hydrometrics 2003
width of mixing zone below Hertzler Ranch tailings impoundment liner leakage $\mathbf{W_4}$	124	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of presumed Hertzler Ranch Tailings Impoundment liner leakage zone, $\mathbf{L_4}$	1,300	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of mixing zone to Stillwater River $\mathbf{W_5}$	2,215	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length below zone to Stillwater River, $\mathbf{L_5}$	3,600	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width below zone to Stillwater River	1,900	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
cross sectional area of aquifer beneath presumed Hertzler Ranch LAD storage pond liner leakage, $\mathbf{A_1}$	2,512	ft^2	D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer beneath upper Hertzler Ranch LAD, $\mathbf{A_2}$	46,799	ft^2	D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer beneath lower Hertzler Ranch LAD, $\mathbf{A_3}$	30,974	ft^2	D * W, allowed by ARM 17.30.517(d)

cross sectional area of aquifer beneath presumed Hertzler Ranch tailings impoundment liner leakage, **A_4**	1,856 ft^2		D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer downgradient of all sources, **A_5**	33,224 ft^2		D * W, allowed by ARM 17.30.517(d)
Q_1=kiA, Ground water available for mixing in Zone 1; includes presumed Hertzler Ranch LAD storage pond liner leakage	628 ft^3/d	628	calculation per Rule 17.30.517(d)
Q_2=kiA, Ground water available for mixing in Zone 2; beneath upper Hertzler Ranch LAD	140,398 ft^3/d	140,398	calculation per Rule 17.30.517(d)
Q_3=kiA, Ground Water available for mixing in Zone 3, beneath lower Hertzler Ranch LAD	185,845 ft^3/d	185,845	calculation per Rule 17.30.517(d)
Q_4=kiA, Ground Water available for mixing in Zone 4, beneath presumed tailings impoundment liner leakage	37 ft^3/d	37	calculation per Rule 17.30.517(d)
Q_5=kiA, Ground Water available for mixing in zone 5, downgradient of all sources to Stillwater River	199,346 ft^3/d	199,346	calculation per Rule 17.30.517(d)

Hydraulic Loading to Hertzler Ranch LAD: all water disposed in this alternative was in the Hertzler Ranch LAD Storage Pond over the winter and is treated adit water

Hertzler Ranch LAD Storage Pond volume	105 MG	1,650 gpm (24 hr)	west side adit flow rate entering LAD storage pond
rate to dewater Hertzler Ranch LAD storage pond in 120 days	1,157 gpm (12 hr)	3,700 gpm (12 hr)	application rate; operational max total is 2,750 gpm based on maximum design for pivots
days to dewater the Hertzler Ranch LAD storage pond at remaining LAD capacity	365 days	1,850 gpm (24 hr)	24 hour rate of application discharged from Hertzler Ranch LAD storage pond

With an adit flow rate of 2,020 gpm plus stored LAD waters, the hydraulic load is greater than the LAD design flow to LAD in one 120-day season; these flows cannot be managed solely at Hertzler Ranch. To dispose of this hydraulic load at closure, other options would have to be implemented, such as disposing of some of the treated waters at the Stillwater Mine percolation ponds or extending the time frame for closure.

No Action Alternative 1A, Option 2, 2,020 gpm: Tailings waters would be evaporated over the tailings mass. Disposal of 2,020 gpm (370 gpm of untreated east side and 1,650 gpm of treated west side) adit water would be at the Stillwater Mine percolation ponds. Disposal of 105 MG of Hertzler Ranch LAD storage pond treated adit water would be at the Hertzler Ranch LAD area. The closure timeframe was not specified.

Ground water nitrogen concentrations at Hertzler Ranch LAD

The calculations in this section are made for the treated adit water stored in the Hertzler Ranch LAD storage pond, dewatered at the maximum LAD application rate

Ground Water nitrogen concentration area Z_1 (below presumed Hertzler Ranch LAD storage pond liner leak), **C_1**	1.1 mg/L	nitrogen concentration for Ground Water zone Z_1
Ground Water nitrogen concentration area Z_2 (below upper Hertzler Ranch LAD), **C_2**	0.7 mg/L	nitrogen concentration for Ground Water zone Z_2
Ground Water nitrogen concentration area Z_4 (below presumed Hertzler Ranch tailings impoundment liner leak), **C_4**	1.0 mg/L	nitrogen concentration for Ground Water zone Z_4
Ground Water nitrogen concentration in Z_3 at HMW-10 from Z_1, Z_2, Z_3, Z_4 (downgradient of all sources to Stillwater River), C_3	**0.6 mg/L**	nitrogen concentration for Ground Water zone Z_3 at TN compliance point HMW-10
nitrogen concentration in ground water at Z_5 from upgradient sources (Z_1, Z_2, Z_3, Z_4), **C_5**	0.5 mg/L	nitrogen concentration in ground water just prior to discharge into the Stillwater River at 2,750 gpm Hertzler Ranch LAD application rate

The concentration of total nitrogen in ground water below the Hertzler Ranch LAD meets DEQ-7 ground water criteria of 10 mg/L.

Surface water nitrogen concentrations in the Stillwater River below Hertzler Ranch LAD	**The calculations in this section are made for the treated adit water stored in the Hertzler Ranch LAD storage pond, dewatered at the maximum LAD application rate for one LAD season**			
receiving streamflow, $\mathbf{Q_s}$	2,695,680 ft^3/d	31.2 cfs		7Q10 at mine site 31.2 cfs; the actual concentration at Hertzler Ranch SMC-13 would be less due to higher streamflow
receiving stream ambient total nitrogen concentration, $\mathbf{C_s}$	0.4 mg/L			median ambient total nitrogen concentration at SMC-12A 1995-2008 SMC monitoring data, based on the MPDES permit for Stillwater Mine; ambient total inorganic nitrogen is 0.14 mg/L
discharge volume through aquifer, $\mathbf{Q_d}$	806,265 ft^3/d	9.3 cfs		
discharge concentration to Stillwater River, $\mathbf{C_d}$	0.5 mg/L			
Stillwater River total nitrogen concentration below Hertzler Ranch LAD	**0.4 mg/L**			
The concentration of total nitrogen in surface water below the Hertzler Ranch LAD is less than 1.0 mg/L				
Nitrogen Loading calculations for Hertzler Ranch LAD and Stillwater Mine				
total nitrogen load disposed at Hertzler Ranch LAD from stored treated adit waters	**3,590** lbs/yr			
contribution of adit water to Stillwater River nitrogen load	81 lbs/day			
Waste Rock Dump contribution	0 lbs/day			**Please see LMB Metals technical memo in Appendix E for discussion.**
total nitrogen load at Stillwater Mine	**81** lbs/day			no water quality implications; discharge meets MPDES permit 100 lbs/day nitrogen limit
The total nitrogen load at the Stillwater Mine is less than the MPDES permit limit of 100 lbs/day.				
total TN load disposed at Hertzler Ranch LAD from stored treated adit waters	**3,590** lbs/yr			
No Action Alternative 1A Option 1, 1,302 gpm: Tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm untreated east side adit water to the Stillwater Mine east side percolation ponds. Disposal of 932 gpm and 105 MG of treated west side adit water stored in the Hertzler Ranch LAD storage pond would be at the Hertzler Ranch LAD area. The closure timeframe was not specified.				
Hydraulic Loading to Hertzler Ranch LAD: all water disposed in this alternative was in the Hertzler Ranch LAD Storage Pond over the winter and is treated adit water				
volume of water in Hertzler Ranch LAD storage pond prior to closure	**105** MG	**370** gpm (24 hr)	east side adit waters	
rate to dewater Hertzler Ranch LAD storage pond in 120 days	**608** gpm (24 hr)	1,215 gpm (12 hr)	rate to dewater 105 MG Hertzler Ranch LAD Storage pond in 120 days	
west side adit flow rate	**932** gpm (24 hr)	1,864 gpm (12 hr)	west side adit flow rate (to compare with LAD rate)	
rate of LAD at Hertzler Ranch	**1,850** gpm (24 hr)	**3,700** gpm (12 hr)	rate of LAD at Hertzler Ranch	
rate to dewater Hertzler Ranch LAD storage pond at full capacity of LAD	**918** gpm (24 hr)	1,836 gpm (12 hr)	excess available LAD capacity to dewater Hertzler Ranch LAD storage pond (12 hr rate)	
number of days to dewater Hertzler Ranch LAD storage pond	79 days			
The hydraulic load of 932 gpm (24 hr) adit water plus 918 gpm (24 hr) Hertzler Ranch LAD storage pond water can be disposed of at Hertzler Ranch LAD				
		4.1 mg/L	projected concentration of adit water based on BTS treatment system (2011)	

Hydraulic Input Parameters for Hertzler Ranch Ground Water Calculations		Hydraulic Loading to Hertzler Ranch LAD: 105 MG was in the Hertzler Ranch LAD Storage Pond over the winter and is treated adit water plus 932 gpm treated adit water
depth of aquifer, **D**	15 ft	allowed by 17.30.517(d)
hydraulic conductivity, $\mathbf{k_1}$ beneath LAD Pond	25 ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper LAD	300 ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_3}$ and $\mathbf{k_5}$ from lower LAD	600 ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_4}$ area beneath presumed tailings impoundment liner leakage	2 ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
gradient, **i**	0.01	estimated, from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of source (presumed Hertzler Ranch LAD storage pond liner leakage)	10 ft	assumed width based on point liner leak, Hydrometrics 2003
width of Hertzler Ranch LAD storage pond liner leakage mixing zone, $\mathbf{W_1}$	167 ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
angle of dispersion	0.0874887 tan 5°	allowed by ARM 17.30.517(d)
length of presumed Hertzler Ranch LAD Storage Pond liner leakage area, $\mathbf{L_1}$	1,800 ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
length upper Hertzler Ranch LAD, $\mathbf{L_2}$	4,800 ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of upper Hertzler Ranch LAD at P3	1,749 ft	personal communication R Weimer 3/17/2009
width of Upper Hertzler Ranch LAD mixing zone $\mathbf{W_2}$	2,169 ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of lower Hertzler Ranch LAD, $\mathbf{L_3}$	5,200 ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of Lower Hertzler Ranch LAD at P4	1,610 ft	personal communication R Weimer 3/17/2009
Width of Lower Hertzler Ranch LAD mixing zone $\mathbf{W_3}$	2,065 ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
Width of source (Hertzler Ranch tailings impoundment liner leakage)	10 ft	assumed width based on point liner leak, Hydrometrics 2003
width of mixing zone below Hertzler Ranch tailings impoundment liner leakage $\mathbf{W_4}$	124 ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of presumed Hertzler Ranch Tailings Impoundment liner leakage zone, $\mathbf{L_4}$	1,300 ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of mixing zone to Stillwater River $\mathbf{W_5}$	2,215 ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length below zone to Stillwater River, $\mathbf{L_5}$	3,600 ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width below zone to Stillwater River	1,900 ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
cross sectional area of aquifer beneath presumed Hertzler Ranch LAD storage pond liner leakage, $\mathbf{A_1}$	2,512 ft^2	D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer beneath upper Hertzler Ranch LAD, $\mathbf{A_2}$	32,534 ft^2	D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer beneath lower Hertzler Ranch LAD, $\mathbf{A_3}$	30,974 ft^2	D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer beneath presumed Hertzler Ranch tailings impoundment liner leakage, $\mathbf{A_4}$	1,856 ft^2	D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer downgradient of all sources, $\mathbf{A_5}$	33,224 ft^2	D * W, allowed by ARM 17.30.517(d)
$\mathbf{Q_1=kiA}$, Ground Water available for mixing in Zone 1 beneath presumed Hertzler Ranch LAD storage pond liner leakage	628 ft^3/d	calculation per Rule 17.30.517(d)

Q_2=kiA, Ground Water available for mixing in Zone 2 beneath upper Hertzler Ranch LAD	140,398 ft^3/d		calculation per Rule 17.30.517(d)
Q_3=kiA, Ground Water available for mixing in Zone 3 beneath lower Hertzler Ranch LAD	185,845 ft^3/d		calculation per Rule 17.30.517(d)
Q_4=kiA, Ground Water available for mixing in Zone 4 beneath presumed tailings impoundment liner leakage	37 ft^3/d		calculation per Rule 17.30.517(d)
Q_5=kiA, Ground Water available for mixing in Zone 5 downgradient of all sources to Stillwater River	199,346 ft^3/d		calculation per Rule 17.30.517(d)
Hertzler Ranch LAD Storage Pond volume	105 MG		
rate to dewater Hertzler Ranch LAD storage pond in 120 days	1,215 gpm (12 hr)	4.1 mg/L	concentration of Hertzler Ranch LAD pond post BTS
maximum Hertzler Ranch LAD Pond volume	14,037,433 ft^3		
Nitrogen Concentration Input parameters and assumptions for calculations at Hertzler Ranch			
concentration of nitrogen in ambient ground water at Hertzler Ranch, $\mathbf{C_A}$	0.2 mg/L		SMC operational monitoring data
concentration of nitrogen in Hertzler Ranch Tailings impoundment liner leakage, $\mathbf{C_4}$	1.1 mg/L	2,225 gpm (12 hr)	12 hour application rate (720 min/day) of upper Hertzler Ranch LAD discharge
concentration of nitrogen in Hertzler Ranch LAD discharge post plant uptake (80% credit), $\mathbf{C_2}$, $\mathbf{C_3}$	1.2 mg/L	9,626 ft^3/d	P1; 100 gpm application rate in ft^3/day (2011)
concentration of nitrogen in Hertzler Ranch LAD storage pond liner leakage, $\mathbf{C_1}$	4.1 mg/L	31,283 ft^3/d	P2: 325 gpm application rate in ft^3/day (2011)
volume upper Hertzler Ranch LAD Discharge; P1, P2, P3, P7; assume 30% evaporates, $\mathbf{V_2}$	149,920 ft^3/d	96,257 ft^3/d	P3; 1,000 gpm application rate in ft^3/day (2011)
volume of Hertzler Ranch tailings impoundment liner leakage (1 gpm), $\mathbf{V_4}$	193 ft^3/d	62,567 ft^3/d	P4; 650 gpm application rate in ft^3/day (2011)
volume of Hertzler Ranch LAD Storage Pond liner leakage (1 gpm), $\mathbf{V_1}$	193 ft^3/d	60,160 ft^3/d	P5; 625 gpm application rate in ft^3/day (2011)
volume lower Hertzler Ranch LAD discharge: P4, P5, P6 assume 30% evaporates, $\mathbf{V_3}$	129,706 ft^3/d	19,251 ft^3/d	P6; 200 gpm application rate in ft^3/day (2011)
total load of nitrogen disposed at Hertzler Ranch during closure	**3,590** lbs./yr	77,005 ft^3/d	P7; 800 gpm application rate in ft^3/day
application rate (720 min/day) of lower Hertzler Ranch LAD discharge	1,475 gpm (12 hr)	0 gpm (12 hr)	volume percolated
Ground Water concentrations at Hertzler Ranch		**Nitrogen Loading to Hertzler Ranch LAD: all water disposed in this alternative was in the Hertzler Ranch LAD Storage Pond over the winter and is treated adit water**	
Ground Water concentration area $\mathbf{Z_1}$ (below presumed Hertzler Ranch LAD storage pond liner leak), $\mathbf{C_1}$	1.1 mg/L		nitrogen concentration for Ground Water zone Z_1
Ground Water concentration area $\mathbf{Z_2}$ (below upper Hertzler Ranch LAD), $\mathbf{C_2}$	0.7 mg/L		nitrogen concentration for Ground Water zone Z_2
Ground Water concentration area Z_4 (below presumed Hertzler Ranch tailings impoundment liner leak), $\mathbf{C_4}$	1.0 mg/L		nitrogen concentration for Ground Water zone Z_4
Ground Water concentration in Z_3 at HMW-10 from Z_1, Z_2, Z_3, Z_4 (downgradient of all sources to Stillwater River); C_3	**0.6 mg/L**		nitrogen concentration for Ground Water zone Z_3 at nitrogen compliance point HMW-10; Hertzler Ranch LAD application rate 2,750 gpm
concentration in ground water at $\mathbf{Z_5}$ from upgradient sources (Z_1, Z_2, Z_3, Z_4), $\mathbf{C_5}$	0.5 mg/L		nitrogen concentration in ground water just prior to discharge into the Stillwater River at 2,750 gpm Hertzler Ranch LAD application rate

The concentration of total nitrogen in ground water below the Hertzler Ranch LAD meets DEQ-7 ground water criteria of 10 mg/L.

Stillwater River nitrogen calculations below Hertzler Ranch LAD			**Nitrogen Loading to Hertzler Ranch LAD: all water disposed in this alternative was in the Hertzler Ranch LAD Storage Pond over the winter and is treated adit water**	
receiving streamflow, $\mathbf{Q_s}$	3,628,800 ft^3/d	42 cfs		7Q10 at mine site 31.2 cfs; actual conc. at Hertzler Ranch SMC-13 would be less; higher streamflow
receiving stream ambient total nitrogen concentration, $\mathbf{C_s}$	0.4 mg/L			median ambient total nitrogen concentration at SMC-12A 1995-2008 SMC monitoring data, based on the MPDES permit for Stillwater Mine; ambient TN is 0.14 mg/L
ground water discharge volume, $\mathbf{Q_d}$	806,266 ft^3/d	9.3 cfs		
discharge concentration to Stillwater River, $\mathbf{C_d}$	0.5 mg/L			
Stillwater River Nitrogen concentration below Hertzler Ranch LAD	**0.4 mg/L**			

The concentration of total nitrogen in the Stillwater River below the Hertzler Ranch LAD is less than 1.0 mg/L.

Stillwater River Nitrogen loading at the Stillwater Mine			**This nitrogen loading is from the 370 gpm (24 hr) east side adit water flow. No nitrogen load has been documented from the waste rock dumps due to net evaporation; see LMB technical memo on Metals in Appendix E for further explanation**
contribution of adit water to Stillwater River nitrogen load	0.9 lbs/day		
Waste Rock Dump contribution, estimated (see Appendix E Metals Technical Memo)	0.0 lbs/day		Hertzler Ranch LAD EIS
daily nitrogen load from adit water at Stillwater Mine	**1** lbs/day	**324** lbs/yr	no water quality or quantity implications because the load is less than the MPDES 100 lbs/day nitrogen limit

The nitrogen loading to the Stillwater River at the Stillwater Mine is less than the MPDES permit total nitrogen load limit of 100 lbs/day.

POST CLOSURE Total Nitrogen concentrations in surface and ground water at Stillwater Mine, 2,020 gpm adit water

2,020 gpm adit water: Based on the Nitrogen Decline Curve (see revised technical memo in Appendix E), west-side adit water quality at the beginning of post-closure (assumed to be subsequent to ramping down of production for voluntary closure, or, in the case of unplanned closure, the mine would have been placed on care and maintenance as a result of financial difficulty) is anticipated to be between 11 and 18 mg/L Total Nitrogen. East-side adit water quality is assumed to be at non-detectable concentrations. Analysis assumes all adit water is percolated at the East-Side and Stillwater Valley Ranch percolation ponds, or discharged directly to the Stillwater River.

post closure nitrogen higher expected concentration of untreated west side adit water, $\mathbf{C_{WPC}}$	**18.0** mg/L	**11.0** mg/L	**post closure** nitrogen lower expected concentration of untreated west side adit water, $\mathbf{C_{WPC}}$
post closure west side adit flow rate	**1,650** gpm (24 hr)	**370** gpm (24 hr)	post closure east side adit flow rate
post closure west side adit water flow rate	317,647 ft^3/d	71,230 ft^3/d	post closure east side adit flow rate
depth of aquifer, **D**	15 ft	0.01 mg/L	post closure total nitrogen concentration of untreated east side adit water, $\mathbf{C_{EPC}}$
hydraulic conductivity east side percolation ponds, $\mathbf{k_{SVR}}$	4076 ft/day		SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_E}$	539 ft/day		SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006 ft/ft		Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, $\mathbf{L_{SVR}}$	500 ft		2008 MPDES Permit page 3
width of mixing zone at downgradient extent, $\mathbf{W_{SVR}}$	507 ft		2008 MPDES Permit page 3
length of mixing zone, $\mathbf{L_E}$	2,000 ft		2008 MPDES Permit page 4
width of mixing zone at downgradient extent, $\mathbf{W_E}$	650 ft		2008 MPDES Permit page 4
cross sectional area of aquifer, $\mathbf{A_{SVR}}$	7,605 ft		D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_E}$	9,750 ft		D * W, allowed by 17.30.517(d)
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing	185,988 ft^3/d		calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
$\mathbf{Q_E=k_EiA_E}$, ground water available for mixing	31,532 ft^3/d		calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones

POST CLOSURE nitrogen concentration in ground water at Stillwater Mine

projected total nitrogen concentration of ground water at MW-17A if 1,650 gpm untreated west side adit water were percolated at the Stillwater Mine post closure

1996-2008 MW-10A median concentration of TN in Stillwater Mine ground water, C_A	0.1 mg/L	356 lbs/day	Nitrogen Load discharged via percolation for 2,020 gpm 18 mg/L nitrogen adit water **would exceed the 100 lbs/day nitrogen effluent limit set in the MPDES permit to prevent nuisance aquatic life at $7Q_{10}$ streamflow**
upper range value of projected ground water concentration at end of Stillwater East Side Percolation Pond mixing zone prior to entering second mixing zone	**10.9** mg/L	**6.7** mg/L	**lower range value of projected ground water concentration at end of Stillwater East Side Percolation Pond mixing zone prior to entering second mixing zone**
POST CLOSURE upper range value of ground water nitrogen concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine)	**9.5** mg/L	**7.6** mg/L	**POST CLOSURE lower range value of ground water nitrogen concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine)**

POST CLOSURE If 2,020 gpm untreated adit water were percolated at the Stillwater Mine, the concentration of Total Nitrogen in the ground water would not exceed the 10 mg/L DEQ-7 ground water standard at the end of the Stillwater Valley Ranch mixing zone.

projected total nitrogen concentration in the Stillwater River if 2,020 gpm untreated west side adit water were percolated at the Stillwater Mine

receiving streamflow, Q_s	2,695,680 ft^3/d		
receiving stream ambient total nitrogen concentration, C_s	0.3 mg/L	31.2 cfs	7Q10 at mine site 31.2 cfs
ground water discharge volume, Q_d	850,985 ft^3/d	9.8 cfs	discharge volume of ground water in cubic feet per second
ground water discharge concentration to Stillwater River, C_d	9.5 mg/L		projected concentration of ground water just prior to discharge
POST CLOSURE Stillwater River upper range value of nitrogen concentration at Stillwater Mine from PERCOLATION of 2,020 gpm untreated adit water	**2.5** mg/L	**2.1** mg/L	**POST CLOSURE Stillwater River lower range value of nitrogen concentration at Stillwater Mine from PERCOLATION of 2,020 gpm untreated adit water**

POST CLOSURE If 2,020 gpm untreated adit water were percolated at the Stillwater Mine, the concentration of total nitrogen in the Stillwater River would exceed the 1 mg/L limit set by the MPDES permit for $7Q_{10}$ streamflow. To meet the 1 mg/L limit in the Stillwater River at the $7Q_{10}$, the concentration of 1,650 gpm untreated west side adit water must be 8 mg/L or less.

POST CLOSURE Stillwater River TN upper range concentration at Stillwater Mine from DIRECT DISCHARGE of 2,020 gpm untreated adit water	**2.1** mg/L	**1.4** mg/L	**POST CLOSURE Stillwater River TN lower range concentration at Stillwater Mine from DIRECT DISCHARGE of 2,020 gpm untreated adit water**

POST CLOSURE If 2,020 gpm untreated adit water were directly discharged into the Stillwater River at the mine at $7Q_{10}$ streamflow, the concentration of total nitrogen in the Stillwater River would exceed the 1 mg/L limit set by the MPDES permit. To meet the 1 mg/L limit in the Stillwater River, the concentration of 1,650 gpm untreated west side adit water must be 6.5 mg/L or less.

POST CLOSURE Total Nitrogen concentrations in surface and ground water at Stillwater Mine, 1,302 gpm adit water

1,302 gpm adit water: Based on the Nitrogen Decline Curve (see revised technical memo in Appendix E), west-side adit water quality at the beginning of post-closure (assumed to be subsequent to ramping down of production for voluntary closure, or, in the case of unplanned closure, the mine having been placed on care and maintenance as a result of financial difficulty) is anticipated to be between 11 and 18 mg/L Total Nitrogen. East-side adit water quality is assumed to be at non-detectable concentrations. Analysis assumes all adit water is percolated at the East Side and Stillwater Valley Ranch percolation ponds, or discharged directly to the Stillwater River.

post closure nitrogen higher expected concentration of untreated west side adit water, C_{WPC}	**18.0** mg/L	**11.0** mg/L	**post closure** nitrogen lower expected concentration of untreated west side adit water, C_{WPC}
post closure west side adit flow rate	**932** gpm (24 hr)	**370** gpm (24 hr)	post closure east side adit flow rate
post closure west side adit flow rate	179,422 ft^3/d	71,230 ft^3/d	post closure east side adit flow rate
depth of aquifer, **D**	15 ft	0.01 mg/L	post closure nitrogen concentration of untreated east side adit water, C_{EPC}
hydraulic conductivity east side percolation ponds, k_{SVR}	4,076 ft/day	**201** lbs/day	Nitrogen Load discharged via percolation for 1,302 gpm 18 mg/L nitrogen adit water **would exceed the 100 lbs/day nitrogen effluent limit set in the MPDES permit to prevent nuisance aquatic life at $7Q_{10}$ streamflow**
hydraulic conductivity east side percolation ponds, k_E	539 ft/day	**123** lbs/day	Nitrogen Load discharged via percolation for 1,302 gpm 11 mg/L nitrogen adit water **would exceed the 100 lbs/day nitrogen effluent limit set in the MPDES permit to prevent nuisance aquatic life at $7Q_{10}$ streamflow**
gradient, **i**	0.006 ft/ft		Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, L_{SVR}	500 ft		2008 MPDES Permit page 3
width of mixing zone at downgradient extent, W_{SVR}	507 ft		2008 MPDES Permit page 3
length of mixing zone, L_E	2,000 ft		2008 MPDES Permit page 4
width of mixing zone at downgradient extent, W_E	650 ft		2008 MPDES Permit page 4

cross sectional area of aquifer, A_{SVR}	7,605 ft		D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, A_E	9,750 ft		D * W, allowed by 17.30.517(d)
$Q_{SVR}=k_{SVR}iA_{SVR}$, ground water available for mixing	185,988 ft^3/d		calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
$Q_E=k_EiA_E$, ground water available for mixing	31,532 ft^3/d		calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
POST CLOSURE nitrogen concentration in ground water at Stillwater Mine		**1,302 gpm untreated west side adit water were percolated at the Stillwater Mine post closure**	
projected ground water concentration at end of Stillwater East Side Percolation Pond mixing zone	**11.5** mg/L	0.1 mg/L	1996-2008 MW-10A median concentration of TN in ground water at Stillwater Mine, C_A
POST CLOSURE ground water upper range projected concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine) percolation of 1,302 gpm adit water	**6.9** mg/L	**4.3** mg/L	**POST CLOSURE ground waterlower range projected concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine) percolation of 1,302 gpm adit water**
receiving streamflow, Q_s	2,695,680 ft^3/d	31.2 cfs	7Q10 at mine site 31.2 cfs
receiving stream ambient TN concentration, C_s	0.3 mg/L		median ambient total nitrogen concentration at SMC-1A 1986-2008 SMC monitoring data
ground water discharge volume, Q_d	468,172 ft^3/d	5.4 cfs	ground water discharge volume in cubic feet per second
ground water discharge concentration to Stillwater River, C_d	6.9 mg/L		projected concentration of ground water just prior to discharge
POST CLOSURE Stillwater River $7Q_{10}$ upper range value of nitrogen concentration at Stillwater Mine from PERCOLATION of 1,302 gpm untreated adit water	**1.3** mg/L	**0.9** mg/L	**POST CLOSURE Stillwater River $7Q_{10}$ lower range value of nitrogen concentration at Stillwater Mine from PERCOLATION of 1,302 gpm untreated adit water**

POST CLOSURE If 1,302 gpm untreated adit water at the upper range nitrogen concentration were percolated at the Stillwater Mine, the concentration of Total Nitrogen in the Stillwater River would exceed the 1 mg/L limit set by the MPDES permit for $7Q_{10}$ streamflow. If the 1,302 gpm of untreated adit water at the lower range nitrogen concentration were percolated at the Stillwater Mine, the concentration of Total Nitrogen in the Stillwater River would meet the 1 mg/L limit set by the MPDES permit for $7Q_{10}$ streamflow.

POST CLOSURE Stillwater River $7Q_{10}$ upper range value of nitrogen projected concentration at Stillwater Mine from DIRECT DISCHARGE of 650 gpm untreated adit water	**1.4** mg/L	**1.0** mg/L	**POST CLOSURE Stillwater River $7Q_{10}$ lower range value of nitrogen projected concentration at Stillwater Mine from DIRECT DISCHARGE of 650 gpm untreated adit water**

POST CLOSURE If 1,302 gpm untreated adit water at the upper range nitrogen concentration directly discharged into the Stillwater River at the mine, the concentration of Total Nitrogen in the Stillwater River would exceed the 1 mg/L limit set by the MPDES permit for $7Q_{10}$ streamflow. If 1,302 gpm untreated adit water at the lower range nitrogen concentration were directly discharged to the Stillwater River, the concentration of Total Nitrogen in the river would meet the 1 mg/L limit set by the MPDES permit for $7Q_{10}$ streamflow.

Spreadsheet 1A Salts: *Revised* Alternative 1A No Action Stillwater Mine and Hertzler Ranch LAD Salinity Closure and Post-Closure Analyses

Per SMC 1994b, preferential disposal of adit waters is at the mine site via percolation ponds with the option to route to the Hertzler Ranch LAD for disposal. For Hertzler Ranch, the assumptions for these ground water mixing calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act. No dilution from precipitation (recharge) was assumed. For Hertzler Ranch LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer (no unsaturated zone was considered). To determine the concentration of TDS in ground water, it was assumed that Zone 1 (Z_1), Z_2, and Z_4 flow into Z_3, then Z_3 flows into Z_5 (see the Hertzler Ranch LAD Ground Water Zones Figure). The subscript on input parameters for these calculations refers to the ground water zone; that is, k_1 refers to the hydraulic conductivity of Zone 1, k_2 refers to the hydraulic conductivity of Zone 2 (Z_2). Z_1 is below a presumed Hertzler Ranch LAD storage pond leak; Z_2 is the upper Hertzler Ranch LAD area; Z_3 is the lower Hertzler Ranch LAD area, Z_4 is below the Hertzler tailings impoundment liner leak; Z_5 is downgradient of all contributing areas. Treated adit water is routed to the Hertzler Ranch LAD storage pond then to LAD pivots during closure. The existing volume of treated adit water in the LAD storage pond at closure is assumed to be 105 million gallons (MG). These analyses assume liner leakage contribution from the Hertzler Ranch Tailings impoundment and Hertzler Ranch LAD storage pond. The tailings waters for each impoundment would be evaporated over the tailings mass and not discharged to ground water. The concentration of TDS in adit water is assumed to be the median concentration based on SMC Monitoring data. The concentration of TDS in both tailings waters at closure is assumed to equal operational concentrations. TDS is used for surface waters and EC is used for ground waters. This sheet has been revised to reflect the addition of pivot P7 at Hertzler Ranch LAD, the increased volume of water in the Hertzler Ranch LAD storage pond, and the current east-side adit water flow rate. Changed input values and text are indicated in blue font and orange highlight.

No Action Alternative 1A, Option 1, 2,020 gpm: Tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm of untreated east side adit water would be at the Stillwater Mine percolation ponds. Disposal of 1,650 gpm treated west side adit water and 105 million gallons (MG) of Hertzler Ranch LAD storage pond treated adit water would be at Hertzler Ranch LAD area. The closure timeframe was not specified. Changed text and values are indicated in blue.

1,650	gpm (24 hr)	west side adit flow rate at closure
370	gpm (24 hr)	east side adit flow rate at closure
250	mg/L	average 2004-2008 Stillwater East side adit water TDS concentration, SMC Monitoring Data
763	mg/L	median Stillwater TDS west side adit water concentration, SMC Monitoring Data
946	mg/L	concentration of TDS in Hertzler tailings waters

concentration of TDS in ambient ground water at Hertzler Ranch LAD HMW-5, $\mathbf{C_A}$: 150 mg/L

Input Parameters for Hertzler Ground Water Calculations	Value	Unit	Source of Data
depth of aquifer, **D**	15	ft	allowed by 17.30.517(d)
hydraulic conductivity, $\mathbf{k_1}$ beneath LAD Pond	25	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper LAD	300	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_3}$ and $\mathbf{k_5}$ from lower LAD	600	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_4}$ from tailings impoundment liner leakage	2	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
gradient, **i**	0.01		estimated, from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of source (LAD storage pond liner leakage)	10	ft	assumed width based on point liner leak, Hydrometrics 2003
width of LAD storage pond liner leakage mixing zone, $\mathbf{W_1}$	167	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
angle of dispersion	0.087488664	tan 5°	allowed by ARM 17.30.517(d)
length of LAD Storage Pond liner leakage area, $\mathbf{L_1}$	1,800	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
length upper LAD, $\mathbf{L_2}$	4,800	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of upper LAD at P3 and P7	2,700	ft	personal communication R Weimer 3/17/2009; and 2010 Hertzler Facility Reclamation Map (2-25-2011)
width of Upper LAD mixing zone $\mathbf{W_2}$	3,120	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of lower LAD, $\mathbf{L_3}$	5,200	ft	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of Lower LAD at P4	1,610	ft	personal communication R Weimer 3/17/2009
Width of Lower LAD mixing zone $\mathbf{W_3}$	2,065	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)

Width of source (Hertzler tailings impoundment liner leakage)	10	ft			assumed width based on point liner leak, Hydrometrics 2003
width of mixing zone below Hertzler tailings impoundment liner leakage **W_4**	124	ft			width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of W_4 zone, **L_4**	1,300	ft			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width of Mixing Zone to Stillwater River **W_5**	2,215	ft			width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length below lower LAD, **L_5**	3,600	ft			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
width below lower LAD	1,900	ft			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
cross sectional area of aquifer, **A_1**	2,512	ft^2			D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer, **A_2**	46,800	ft^2			D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer, **A_3**	30,974	ft^2			D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer, **A_4**	1,856	ft^2			D * W, allowed by ARM 17.30.517(d)
cross sectional area of aquifer, **A_5**	33,224	ft^2			D * W, allowed by ARM 17.30.517(d)
Q_1=kiA, ground water available for mixing from Zone 1	628	ft^3/d			calculation per Rule 17.30.517(d)
Q_2=kiA, ground water available for mixing from Zone 2	140,383	ft^3/d			calculation per Rule 17.30.517(d)
Q_3=kiA, ground water available for mixing from Zone 3	185,845	ft^3/d			calculation per Rule 17.30.517(d)
Q_4=kiA, ground water available for mixing from Zone 4	37	ft^3/d			calculation per Rule 17.30.517(d)
Q_5=kiA, ground water available for mixing from Zone 5	199,346	ft^3/d			calculation per Rule 17.30.517(d)
concentration of TDS in Hertzler Tailings impoundment and impoundment liner leakage, **C_4**	946	mg/L	9,626	ft^3/d	Pivot P1; 100 gpm application rate (12 hr)
concentration of TDS in applied LAD discharge, **C_2, C_3**	1,090	mg/L	31,283	ft^3/d	Pivot P2: 325 gpm application rate (12 hr)
concentration of TDS in LAD storage pond liner leakage, **C_1**	763	mg/L	96,257	ft^3/d	Pivot P3; 1,000 gpm application rate (12 hr)
volume upper LAD Discharge; P1, P2, P3, P7; assume 30% evaporates **V_2**	149,920	ft^3/d	62,567	ft^3/d	Pivot P4: 650 gpm application rate (12 hr)
volume of Hertzler tailings impoundment liner leakage (1 gpm), **V_4**	193	ft^3/d	60,160	ft^3/d	Pivot P5; 625 gpm application rate (12 hr)
volume of LAD Storage Pond liner leakage (1 gpm), **V_1**	193	ft^3/d	19,251	ft^3/d	Pivot P6; 200 gpm application rate (12 hr)
volume lower LAD discharge: P4, P5, P6 assume 30% evaporates, **V_3**	99,385	ft^3/d	77,005	ft^3/d	Pivot P7; 800 gpm application rate (12 hr)

Hydraulic Loading to Hertzler LAD: all water disposed in this alternative was in the Hertzler Ranch LAD Storage Pond over the winter and is treated adit water.
The Hydraulic Loading calculations for this scenario are listed on Spreadsheet 1A Nitrogen. The calculations indicate that an adit flow rate of 2,020 gpm exceeds the hydraulic capacity of Hertzler Ranch LAD and other water balance options must be pursued. For brevity, those hydraulic loading calculations are not repeated here.

No Action Alternative 1A, Option 2, 2,020 gpm: Tailings waters would be evaporated over the tailings mass. Disposal of 2,020 gpm (370 gpm of untreated east side and 1,650 gpm of treated west side) adit water would be at the Stillwater Mine percolation ponds. Disposal of 105 MG of Hertzler Ranch LAD storage pond treated adit water would be at the Hertzler Ranch LAD area. The closure timeframe was not specified.

Ground Water salts concentrations at Hertzler Ranch LAD					**The calculations in this section are made for the 105 MG of treated adit water stored in the Hertzler Ranch LAD storage pond, dewatered at the maximum 3,700 gpm (12 hr) LAD application rate for 39 days.**
Ground Water concentration area Z_1 (below presumed Hertzler	294	mg/L	459	µmhos/cm	EC for Ground Water zone Z_1
Ground Water concentration area Z_2 (below upper Hertzler Ranch LAD), **C_2**	635	mg/L	991	µmhos/cm	EC for Ground Water zone Z_2
Ground Water concentration area Z_4 (below presumed Hertzler	818	mg/L	1,275	µmhos/cm	EC for Ground Water zone Z_4; this EC value would temporarily exceed the Class I Beneficial Use

Ground Water EC in Z_3 (HMW-10) from Z_1, Z_2, Z_3, Z_4 (downgradient of all sources, at compliance point before discharge to Stillwater River), C_3	557	mg/L	**869**	µmhos/cm	EC for Ground Water zone Z_3 at compliance point HMW-10 meets the Class I Beneficial Use criteria of 1,000 µmhos/cm
concentration in ground water at Z_5 from upgradient sources (Z_1, Z_2, Z_3, Z_4), C_5	452	mg/L	706	µmhos/cm	TDS concentration and EC in ground water just prior to discharge into the Stillwater River at 2,750 gpm Hertzler Ranch LAD application rate
The EC of ground water from disposal of stored water in the Hertzler Ranch LAD storage pond meets 1,000 µmhos/cm criterion protective of Class I Beneficial use at the compliance point and the point of discharge to the Stillwater River.					
Surface Water salts concentrations in the Stillwater River below Hertzler Ranch LAD			39	days	time to LAD 105 MG Hertzler LAD storage pond water at capacity of Hertzler Ranch LAD
receiving streamflow, $\mathbf{Q_s}$	3,628,800	ft³/d	42	cfs	$7Q_{10}$ at mine site 31.2 cfs; $7Q_{10}$ at Hertzler Ranch assumed
receiving stream median ambient concentration SMC-12, $\mathbf{C_s}$	44	mg/L	69	µmhos/cm	1995-2008 SMC Monitoring Data median TDS at SMC-12; EC calculated
ground water discharge volume, $\mathbf{Q_d}$	775,930	ft³/d	9.0	cfs	ground water flow to stream in cubic feet per second
ground water discharge concentration to Stillwater River, $\mathbf{C_d}$	452	mg/L			
Stillwater River TDS concentration below Hertzler Ranch LAD	**116**	**mg/L**			
west-side adit flow rate in cubic feet per day	317,647	ft³/d	1,650	gpm (24 hr)	west side adit flow rate
			763	mg/L	west side adit median TDS concentration
east-side adit flow rate in cubic feet per day	71,230	ft³/d	370	gpm (24 hr)	east side adit flow rate
Ground Water Salts Calculation Input Parameters for the Stillwater Mine			**250**	mg/L	east side adit average TDS concentration 2004-2008
depth of aquifer, **D**	15	ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
hydraulic conductivity east side percolation ponds (Stillwater Valley Ranch), $\mathbf{k_{SVR}}$	4,076	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_E}$	539	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006	ft/ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone (Stillwater Valley Ranch), $\mathbf{L_{SVR}}$	500	ft			2008 MPDES Permit page 3
width of mixing zone at downgradient extent (Stillwater Valley Ranch), $\mathbf{W_{SVR}}$	507	ft			2008 MPDES Permit page 3
length of mixing zone (east side), $\mathbf{L_E}$	2,000	ft			2008 MPDES Permit page 4
width of mixing zone at downgradient extent (east side), $\mathbf{W_E}$	650	ft			2008 MPDES Permit page 4
cross sectional area of aquifer, (Stillwater Valley Ranch) $\mathbf{A_{SVR}}$	7,605	ft			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer (east side), $\mathbf{A_E}$	9,750	ft			D * W, allowed by 17.30.517(d)
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing (Stillwater Valley Ranch)	185,988	ft³/d			calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
$\mathbf{Q_E=k_EiA_E}$, ground water available for mixing (east side)	31,532	ft³/d			calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
Ground Water salts at the Stillwater Mine			**Disposal of 370 gpm of untreated east side adit water and 1,650 gpm of treated west side adit water at the Stillwater Mine percolation ponds.**		

1986-2008 MW-10A median concentration of TDS in ambient ground water at Stillwater Mine, C_A	81	mg/L	125	µmhos/cm	average EC in ambient ground water at SMC MW-10A
ground water TDS concentration at the end of the Stillwater East Side Percolation Pond mixing zone	541	mg/L	844	µmhos/cm	average EC from percolation of 1,650 gpm west-side adit waters plus 370 gpm east-side adit waters
ground water EC at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine)	458	mg/L	**715**	µmhos/cm	EC from Stillwater East Side percolation plus percolation of 1000 gpm west side adit waters at Stillwater Valley Ranch just prior to discharge to Stillwater River

The EC of ground water at the Stillwater Mine meets the Class I Beneficial Use criterion of 1,000 µmhos/cm.

Surface Water salts concentrations at the Stillwater Mine					**Disposal of 370 gpm of untreated east side adit water and 1,650 gpm of treated west side adit water at the Stillwater Mine percolation ponds.**
receiving streamflow, $\mathbf{Q_s}$	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs
receiving stream ambient concentration, $\mathbf{C_s}$	45	mg/L	70	µmhos/cm	2008 MPDES Statement of Basis, p 9; EC calculated
ground water discharge volume, $\mathbf{Q_d}$	629,498	ft^3/d	7.3	cfs	ground water flow to stream in cubic feet per second
discharge concentration to Stillwater River, $\mathbf{C_d}$	458	mg/L	715	µmhos/cm	median Stillwater TDS adit water concentration, SMC Monitoring Data; EC calculated
Stillwater River TDS concentration at Stillwater Mine at 7Q$_{10}$	**123**	**mg/L**	192	µmhos/cm	assumes no treatment credit; uses mine site MPDES permit mixing zones for percolation ponds; EC calculated

No Action Alternative 1A Option 1, 1,302 gpm: Tailings waters would be evaporated over the tailings mass. Disposal of 370 gpm untreated east-side adit water to the Stillwater Mine east-side percolation ponds. Disposal of 932 gpm and 105 MG of treated west-side adit water stored in the Hertzler Ranch LAD storage pond would be at the Hertzler Ranch LAD area. The closure timeframe was not specified.

volume of water in Hertzler Ranch LAD storage pond prior to closure	105	MG			
rate to dewater Hertzler Ranch LAD storage pond at full capacity of LAD	918	gpm (24 hr)	**1,215**	gpm (12 hr)	rate to dewater 105 MG Hertzler Ranch LAD Storage pond at full capacity of LAD
west side adit flow rate	932	gpm (24 hr)	1,864	gpm (12 hr)	west side adit flow rate (to compare with LAD rate)
rate of LAD at Hertzler Ranch	1,850	gpm (24 hr)	3,700	gpm (12 hr)	rate of LAD at Hertzler Ranch
number of days to dewater Hertzler Ranch LAD storage pond at full capacity of Hertler Ranch LAD	**159**	days	763	mg/L	median concentration of west side adit water and Hertzler Ranch LAD Storage Pond

This hydraulic load can be disposed of at the Hertzler Ranch LAD.

Input parameters and assumptions for salts loading calculations at Hertzler Ranch LAD; all other parameters as above					**Disposal of 932 gpm adit water plus 105 MG of treated water in the LAD storage pond at Hertzler Ranch LAD area.**
$\mathbf{Q_1}$=kiA, Ground Water available for mixing	628	ft^3/d			calculation per Rule 17.30.517(d)
$\mathbf{Q_2}$=kiA, Ground Water available for mixing	140,383	ft^3/d			calculation per Rule 17.30.517(d)
$\mathbf{Q_3}$=kiA, Ground Water available for mixing	185,845	ft^3/d			calculation per Rule 17.30.517(d)
$\mathbf{Q_4}$=kiA, Ground Water available for mixing	37	ft^3/d			calculation per Rule 17.30.517(d)
$\mathbf{Q_5}$=kiA, Ground Water available for mixing	199,346	ft^3/d			calculation per Rule 17.30.517(d)
concentration of TDS in ambient ground water at Hertzler, $\mathbf{C_A}$	150	mg/L	234	µmhos/cm	SMC operational monitoring data; EC calculated
concentration of TDS in Hertzler Tailings impoundment and impoundment liner leakage, $\mathbf{C_4}$	946	mg/L			SMC operational monitoring data
concentration of TDS in LAD discharge, $\mathbf{C_2}$, $\mathbf{C_3}$	1,090	mg/L	1,425	gpm (12 hr)	application rate for upper LAD area
concentration of TDS in LAD storage pond liner leakage, $\mathbf{C_1}$	763	mg/L	9,626	ft^3/d	Pivot P1; 100 gpm application rate (12 hr)

volume upper LAD Discharge; P1, P2, P3, P7; **assume 30% evaporates V_2**	149,920	ft^3/d	31,283	ft^3/d	Pivot P2: 325 gpm application rate (12 hr)
volume of Hertzler tailings impoundment liner leakage (1 gpm), **V_4**	193	ft^3/d	96,257	ft^3/d	Pivot P3; 1,000 gpm application rate (12 hr)
volume of LAD Storage Pond liner leakage (1 gpm), **V_1**	193	ft^3/d	62,567	ft^3/d	Pivot P4: 650 gpm application rate (12 hr)
volume lower LAD discharge: P4, P5, P6 **assume 30% evaporates, V_3**	99,385	ft^3/d	60,160	ft^3/d	Pivot P5; 625 gpm application rate (12 hr)
total load of salt disposed at Hertzler during closure (932 gpm adit + 105 MG Hertzler LAD pond) for 71 days	**2,023,772**	**pounds**	19,251	ft^3/d	Pivot P6; 200 gpm application rate (12 hr)
			77,005	ft^3/d	Pivot P7; 800 gpm application rate (12 hr)
Ground Water salts concentrations at Hertzler Ranch			**Disposal of 932 gpm of treated west side adit water and 105 MG of stored treated adit water at the Hertzler Ranch LAD area.**		
Ground Water concentration area Z_1 (below presumed Hertzler Ranch LAD storage pond liner leak), **C_1**	294	mg/L	459	µmhos/cm	TDS concentration for Ground Water zone Z_1; EC calculated
Ground Water concentration area Z_2 (below upper Hertzler Ranch LAD), **C_2**	635	mg/L	991	µmhos/cm	TDS concentration for Ground Water zone Z_2; EC calculated
Ground Water concentration area Z_4 (below presumed Hertzler	818	mg/L	1,275	µmhos/cm	TDS concentration for Ground Water zone Z_4; EC calculated; **would temporarily exceed the Class I**
Ground Water EC in Z_3 (HMW-10) downgradient of all sources, C_3	557	mg/L	**869**	µmhos/cm	TDS concentration and EC for Ground Water zone Z_3 at compliance point HMW-10
concentration in ground water at Z_5 down gradient of all sources (Z_1, Z_2, Z_3, Z_4), **C_5**	452	mg/L	706	µmhos/cm	TDS concentration in ground water just prior to discharge to Stillwater River; EC calculated
The EC of ground water at Hertzler Ranch LAD meets the Class I Beneficial Use criterion of 1,000 µmhos/cm.					
Stillwater River TDS concentration below Hertzler Ranch LAD			**Disposal of 932 gpm of treated west side adit water and 105 MG of stored treated adit water at the Hertzler Ranch LAD area.**		
receiving streamflow, **Q_s**	3,628,800	ft^3/d	42	cfs	$7Q_{10}$ at mine site 31.2 cfs; $7Q_{10}$ at Hertzler Ranch assumed
receiving stream median ambient concentration SMC-12, **C_s**	44	mg/L	69	µmhos/cm	1995-2008 SMC Monitoring Data median TDS at SMC-12
ground water discharge volume, **Q_d**	775,930	ft^3/d	9.0	cfs	from mine site 2008 MPDES permit mixing zones
discharge concentration to Stillwater River, **C_d**	452	mg/L	706	µmhos/cm	TDS concentration in ground water just prior to discharge to Stillwater River
Stillwater River TDS concentration below Hertzler Ranch LAD	**116**	**mg/L**	181	µmhos/cm	assumes no treatment credit for salts
Ground water concentration at Stillwater Mine			**Disposal of 370 gpm untreated east side adit water to the Stillwater Mine east side percolation ponds.**		
$Q_{SVR}=k_{SVR}iA_{SVR}$, ground water available for mixing	185,988	ft^3/d	71,230	ft^3/d	east side adit flow rate
$Q_E=k_EiA_E$, ground water available for mixing	31,532	ft^3/d	370	gpm (24 hr)	east side adit flow rate
1986-2008 MW-10A median concentration of TDS in ambient ground water Stillwater Mine, **C_A**	81	mg/L	126	µmhos/cm	concentration of salt in ambient ground water
ground water discharge volume, **Q_d**	102,761	ft^3/d	250	mg/L	concentration of salt in east side adit water
ground water TDS concentration at end of Stillwater east side percolation pond mixing zone	198	mg/L	**309**	µmhos/cm	

ground water concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine)	123	mg/L	**191**	µmhos/cm	concentration of ground water just prior to discharge to Stillwater River near MW-17A

The EC of ground water at the Stillwater Mine meets the Class I Beneficial Use criterion of 1,000 µmhos/cm.

Stillwater River TDS concentration where ground water discharges to the Stillwater River at the Mine below the East side percolation ponds			**Disposal of 370 gpm untreated east side adit water to the Stillwater Mine east side percolation ponds.**		
receiving streamflow, $\mathbf{Q_s}$	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs
receiving stream ambient concentration, $\mathbf{C_s}$	45	mg/L	70	µmhos/cm	2008 MPDES Statement of Basis, p 9
ground water discharge volume, $\mathbf{Q_d}$	288,749	ft^3/d	3.3	cfs	from mine site 2008 MPDES permit mixing zones
ground water discharge concentration to Stillwater River, $\mathbf{C_d}$	123	mg/L	191	µmhos/cm	median Stillwater TDS adit water concentration, SMC Monitoring Data
Stillwater River TDS concentration at Stillwater Mine	**53**	**mg/L**	82	µmhos/cm	assumes no credit; uses mine site MPDES permit mixing zones for percolation ponds

POST CLOSURE salts concentrations in surface and ground water at Stillwater Mine, 2,020 gpm adit water disposal

2,020 gpm adit water disposal (370 gpm East-side adit water and 1,630 gpm West-side adit water): Water quality at the beginning of post-closure. Analysis assumes all adit water is percolated at the East Side and Stillwater Valley Ranch percolation ponds or discharged directly to the Stillwater River

post closure TDS concentration of untreated west side adit water, $\mathbf{C_{WPC}}$	763	mg/L	250	mg/L	projected post closure TDS concentration of untreated east side adit water, $\mathbf{C_{EPC}}$
post closure west side adit flow rate	1,630	gpm (24 hr)	370	gpm (24 hr)	post closure east side adit flow rate
post-closure west-side flow rate in cubic feet per day	313,797	ft^3/d	71,230	ft^3/d	post closure east side adit flow rate in cubic feet per day
depth of aquifer, **D**	15	ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
hydraulic conductivity east side percolation ponds, $\mathbf{k_{SVR}}$	4,076	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_E}$	539	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006	ft/ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, $\mathbf{L_{SVR}}$	500	ft			2008 MPDES Permit page 3
width of mixing zone at downgradient extent, $\mathbf{W_{SVR}}$	507	ft			2008 MPDES Permit page 3
length of mixing zone, $\mathbf{L_E}$	2,000	ft			2008 MPDES Permit page 4
width of mixing zone at downgradient extent, $\mathbf{W_E}$	650	ft			2008 MPDES Permit page 4
cross sectional area of aquifer, $\mathbf{A_{SVR}}$	7,605	ft			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_E}$	9,750	ft			D * W, allowed by 17.30.517(d)
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing	185,988	ft^3/d			calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
$\mathbf{Q_E=k_EiA_E}$, ground water available for mixing	31,532	ft^3/d			calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
POST CLOSURE salts concentration in ground water at Stillwater Mine			**Disposal of 2,020 gpm untreated east and west side adit waters to the Stillwater Mine percolation ponds.**		
1986-2008 MW-10A median concentration of TDS in ambient ground water at Stillwater Mine, $\mathbf{C_A}$	81	mg/L	126	µmhos/cm	
ground water concentration at end of Stillwater East Side Percolation Pond mixing zone	539	mg/L	**842**	µmhos/cm	discharge includes 370 gpm untreated east-side adit water plus 815 gpm untreated west side adit water
POST CLOSURE ground water concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine)	469	mg/L	**732**	µmhos/cm	cumulative discharge to the Stillwater River includes 1,010 gpm percolated into east-side ponds plus 1,010 gpm untreated west-side adit water percolated at the Stillwater Valley Ranch Ponds; projected concentrations just prior to discharge to the Stillwater River

POST CLOSURE EC of ground water just prior to discharge to the Stillwater River if 1,630 gpm untreated west side adit water and 370 gpm east-side adit water were percolated at the Stillwater Mine; meets Class I Beneficial Use criterion.

receiving streamflow, $\mathbf{Q_s}$	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs
receiving stream ambient concentration, $\mathbf{C_s}$	45	mg/L	70	µmhos/cm	2008 MPDES Statement of Basis, p 9
ground water discharge volume, $\mathbf{Q_d}$	602,546	ft^3/d	7.0	cfs	
discharge concentration to Stillwater River, $\mathbf{C_d}$	668	mg/L			
POST CLOSURE Stillwater River TDS concentration at Stillwater Mine from PERCOLATION of 2,020 gpm untreated adit water	**159**	mg/L	**projected TDS concentration in the Stillwater River if 2,020 gpm untreated adit water were percolated at the Stillwater Mine**		
POST CLOSURE Stillwater River TDS concentration at Stillwater Mine from DIRECT DISCHARGE of 2,020 gpm untreated adit water	**123**	mg/L	**projected TDS concentration in the Stillwater River if 2,020 gpm untreated adit water were directly discharged at the Stillwater Mine**		

POST CLOSURE salts concentrations in surface and ground water at Stillwater Mine, 1,302 gpm adit water disposal

1,302 gpm adit water disposal: Analysis assumes all adit water is percolated at the East Side and Stillwater Valley Ranch percolation ponds or discharged directly to the Stillwater River.

post closure TDS concentration of untreated west side adit	763	mg/L	250	mg/L	post closure TDS concentration of untreated east side adit water, $\mathbf{C_{EPC}}$
post closure west side adit flow rate	932	gpm (24 hr)	370	gpm (24 hr)	post closure east side adit flow rate
post closure west side adit flow rate	179,422	ft^3/d	71,230	ft^3/d	post closure east side adit flow rate
depth of aquifer, **D**	15	ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
hydraulic conductivity east side percolation ponds, $\mathbf{k_{SVR}}$	4,076	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_E}$	539	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006	ft/ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, $\mathbf{L_{SVR}}$	500	ft			2008 MPDES Permit page 3
width of mixing zone at downgradient extent, $\mathbf{W_{SVR}}$	507	ft			2008 MPDES Permit page 3
length of mixing zone, $\mathbf{L_E}$	2,000	ft			2008 MPDES Permit page 4
width of mixing zone at downgradient extent, $\mathbf{W_E}$	650	ft			2008 MPDES Permit page 4
cross sectional area of aquifer, $\mathbf{A_{SVR}}$	7,605	ft			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_E}$	9,750	ft			D * W, allowed by 17.30.517(d)
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing	185,988	ft^3/d			calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
$\mathbf{Q_E=k_EiA_E}$, ground water available for mixing	31,532	ft^3/d			calculation per 17.30.517(d); from mine site 2008 MPDES permit mixing zones
POST CLOSURE EC in ground water at Stillwater Mine			**projected EC in ground water at Stillwater Mine if 1,302 gpm untreated adit water were PERCOLATED at the east side percolation**		
1986-2008 MW-10A median concentration of TDS in ambient	81	mg/L	126	µmhos/cm	
ground water concentration at end of Stillwater East Side Percolation Pond mixing zone	150	mg/L	**234**	µmhos/cm	

POST CLOSURE ground water concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone (Stillwater Mine)	123	mg/L	**191**	µmhos/cm		

POST CLOSURE EC of ground water just prior to discharge to the Stillwater River if 1,302 gpm untreated west side adit water were percolated at the Stillwater Mine; meets Class I Beneficial Use criterion

receiving streamflow, $\mathbf{Q_s}$	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs
receiving stream ambient concentration, $\mathbf{C_s}$	45	mg/L	70	µmhos/cm	2008 MPDES Statement of Basis, p 9
ground water discharge volume, $\mathbf{Q_d}$	468,172	ft^3/d	5.4	cfs	
discharge concentration to Stillwater River, $\mathbf{C_d}$	617	mg/L			

POST CLOSURE Stillwater River TDS concentration at Stillwater Mine from PERCOLATION	**130**	mg/L	**projected EC in ground water at Stillwater Mine if 1,302 gpm untreated adit water were PERCOLATED at the east side percolation ponds**

If 1,302 gpm untreated west side adit water were percolated at the Stillwater Mine, the concentration of TDS in the Stillwater River would not exceed 500 mg/L.

POST CLOSURE Stillwater River TDS concentration at Stillwater Mine from DIRECT DISCHARGE	**94**	mg/L	**projected EC in ground water at Stillwater Mine if 1,302 gpm untreated adit water were DIRECTLY DISCHARGED at the east side percolation ponds**

If 1,302 gpm untreated west side adit water were DIRECTLY DISCHARGED into the Stillwater River at the Stillwater Mine, the concentration of TDS in the Stillwater River would not exceed 500 mg/L.

Spreadsheet 1B 1C Nitrogen: *Revised* East Boulder Mine Alternative 1B and Boe Ranch LAD System Alternative 1C No Action Closure Nitrogen Analyses

Per SMC 1998, preferential disposal of treated adit waters is at the mine LAD areas and percolation pond. The Boe Ranch LAD system would not be built. For the East Boulder Mine, the assumptions for these calculations have been made according to the regulatory requirements of the existing MPDES permit, Montana Water Quality Act and Rules, and Federal Clean Water Act regarding ground and surface water mixing zones. No dilution from precipitation (recharge) was assumed. For the East Boulder Mine LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer (no unsaturated zone was considered). To determine the concentration of total inorganic nitrogen (TIN) in ground water, it was assumed that all ground water flow parallels the East Boulder River and enters the river at a point at, or just downstream of, the permit boundary (EBR-004/4a). Tailings impoundment waters would be evaporated over the tailings mass and would not discharge to ground water. The nitrogen concentration of treated adit water will vary with flow rate. The calculations allow nitrogen treatment credit for snowmaking, evaporation, and plant uptake, but no treatment credit is given for percolation. The design capacities/assumed efficiencies are as follows:
the PoleCat evaporators in summer 30% evaporation, center pivots 30%; PoleCat snowmakers in winter 30% evaporation. The East Boulder Mine is permitted to discharge an average of 30 lbs/day total inorganic nitrogen into the East Boulder River. The existing treatment systems would be increased to meet hydraulic and nitrogen treatment requirements. All waters are treated prior to discharge. The MPDES permit nitrogen limit of 30 lbs/day is after all treatment (BTS/Anox, snowmaking, evaporation, plant uptake). These analyses assume a 1,000 gpm treatment capacity for the BTS/Anox system. The total inorganic nitrogen concentration in spring SP-11 is representative of ground water downgradient of the percolation pond. Revised text and changes to input values are shown in blue font or orange highlight.

No Action Alternative 1B and 1C Closure Option 1, 737 gpm: Tailings waters would be evaporated over the tailings mass. Adit water would be land applied at the East Boulder Mine LAD Areas 2, 3-Upper, 4 and 6. The Boe Ranch LAD system would not be built.

East Boulder MPDES Permit Source-Specific (percolation pond) mixing zone input values			**30**	lbs/day	East Boulder MPDES permitted nitrogen load
			737	gpm (24 hr)	East Boulder adit flow rate at closure (24 hr rate)
			0.4	mg/L	treated total inorganic nitrogen concentration of adit waters based on BTS/Anox system treatment capability (2009-2011)
depth of aquifer, **D**	80	ft			MPDES Statement of Basis, p. 25-26
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	385	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to wells, $\mathbf{L_1}$	3,600	ft			MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3				MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	400	gpm			MPDES Statement of Basis, p. 25-26
upgradient ambient concentration of nitrogen in ground water (WW-1), $\mathbf{C_A}$	0.1	mg/L			median value SMC Monitoring Data 2004-2008
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, $\mathbf{W_1}$	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_1}$	55,977	ft^2			D * W, allowed by 17.30.517(d)
70% of available Volume of ground water available for mixing $\mathbf{Q_1}$=kiA	76,955	ft^3/d			calculation per 17.30.517(d); MPDES statement of basis, p.25-26
East Boulder Hydraulic Loading Calculations			**737 gpm treated adit water applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6; tailings waters evaporated over the tailings mass**		
East Boulder Tailings Impoundment discharge volume	**93**	MG			volume of water to be discharged to install cover (KP); evaporated over tailings mass
Adit Flow rate	737	gpm (24 hr)	1,474	gpm (12 hr)	Adit flow rate
Summer LAD Area 6 maximum hydraulic load end of pipe	56,406	ft^3/d	586	gpm (12 hr)	evaporator maximum flow rate, 10.2 ac; CES 2008
Summer LAD Area 4 maximum hydraulic load end of pipe	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.2 ac; CES 2008
Summer LAD Area 3 Upper maximum hydraulic load end of pipe	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.3 ac; CES 2008
Summer LAD Area 2 maximum hydraulic load end of pipe	29,262	ft^3/d	304	gpm (12 hr)	center pivot maximum flow rate, 13.9 ac; CES 2008

Summer maximum hydraulic load end of pipe for LAD areas 2, 3-Upper, 4, 6	**139,572**	ft^3/d	**1,450**	gpm (12 hr)	total rate for all units
additional volume of adit water needing disposal in Summer	**12**	gpm (24 hr)	**24**	gpm (12 hr)	

Closure commencing in summer: Insufficient pond storage capacity exists at the East Boulder Mine for this adit flow rate. Approximately 1.1 MG is generated in 24 hours, the available storage is 0.7 MG, and the 12 hour summer LAD disposal is 1.0 MG). About 0.02 MG excess water must be percolated if it is to be handled solely at the East Boulder Mine. An unspecified time frame would be required for disposal of the tailings waters by evaporation, and the volume of water in the tailings impoundment is more than double the volume initially analyzed.

Winter LAD Area 6 snowmaking maximum hydraulic load end of pipe	39,465	ft^3/d	410	gpm (12 hr)	snowmaker maximum flow rate, 10.2 ac; CES 2008
Winter LAD Area 4 snowmaking maximum hydraulic load end of pipe	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate, 11.2 ac; CES 2008
Winter LAD Area 3 Upper snowmaking maximum hydraulic load end of pipe	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate, 11.3 ac; CES 2008
Winter maximum snowmaking hydraulic load end of pipe, LAD areas 3 Upper, 4, 6	**54,866**	ft^3/d	**570**	gpm (12 hr)	total rate for all units
additional volume of water needing disposal in Winter	**452**	gpm (24 hr)	**904**	gpm (12 hr)	

Closure commencing in winter: Insufficient pond storage capacity exists at the East Boulder Mine for this adit flow rate. Approximately 1.1 MG is generated in 24 hours, the available storage is 0.7 MG, and the 12 hour summer LAD disposal is 1.0 MG). About 0.3 MG excess water must be percolated if it is to be handled solely at the East Boulder Mine. An unspecified time frame would be required for disposal of the tailings waters by evaporation, and the volume of water in the tailings impoundment is more than double the volume initially analyzed.

No Action Alternative 1B and 1C Closure Option 2, 737 gpm: Tailings waters would be evaporated over the tailings mass. Adit water would be land applied at the East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6 and the excess adit water would be percolated at the mine site. The Boe Ranch LAD system would not be built.

Summer LAD nitrogen load East Boulder Mine, LAD areas 2, 3, 4, 6	0.7	lbs/day	0.4	mg/L	nitrogen concentration of treated adit waters
LAD Area 6 flow rate (30% hydraulic evaporation, 80% nitrogen credit)	39,484	ft^3/d	**0.3**	lbs/day	evaporator maximum flow rate, 10.2 ac; CES 2008
LAD Area 4 flow rate (30% hydraulic evaporation, 80% nitrogen credit)	18,866	ft^3/d	**0.1**	lbs/day	evaporator maximum flow rate, 11.2 ac; CES 2008
LAD Area 3 Upper flow rate (30% hydraulic evaporation, 80% nitrogen credit)	18,866	ft^3/d	**0.1**	lbs/day	evaporator maximum flow rate, 11.3 ac; CES 2008
LAD Area 2 flow rate (30% hydraulic evaporation, 80% nitrogen credit) center pivot	20,483	ft^3/d	**0.1**	lbs/day	center pivot maximum flow rate, 13.9 ac; CES 2008
Daily Summer nitrogen load to percolation (no nitrogen credit)	**0.0**	lbs/day	0.1	mg/L	nitrogen concentration of applied waters with 30% evaporation applied and post-LAD credit
Daily Summer LAD nitrogen load (post-plant uptake) plus percolation (no nitrogen credit)	**0.7**	lbs/day			nitrogen load of LAD plus percolated waters
Total Summer LAD nitrogen Load/ac	**1.9**	lbs/ac/yr	120	days	time LAD applied (length of LAD season)
Total Summer nitrogen Load (percolation plus LAD) days 1-120	**87**	lbs	46.6	ac	area of LAD
Winter Snowmaking East Boulder Mine site, nitrogen load LAD areas 3, 4, 6	**0.3**	lbs/day	0.4	mg/L	nitrogen concentration of mixed waters
LAD Area 6 snowmaking rate (30% hydraulic evaporation, 80% nitrogen credit)	27,626	ft^3/d	**0.2**	lbs/day	snowmaker maximum flow rate, 10.2 ac; CES 2008
LAD Area 4 snowmaking rate (30% hydraulic evaporation, 80% nitrogen credit)	5,390	ft^3/d	**0.0**	lbs/day	snowmaker maximum flow rate, 11.2 ac; CES 2008
LAD Area 3 snowmaking rate (30% hydraulic evaporation, 80% nitrogen credit)	5,390	ft^3/d	**0.0**	lbs/day	snowmaker maximum flow rate, 11.3 ac; CES 2008
Daily Winter nitrogen load to percolation (no nitrogen credit)	**2.2**	lbs/day			daily percolation nitrogen load
Daily Winter LAD nitrogen load (post snowmaking plus percolation no nitrogen credit)	**2.4**	lbs/day			daily snowmaking and percolation nitrogen load
Daily Winter LAD nitrogen load applied per acre	**1.0**	lbs/ac/yr	120	days	time LAD applied (length of LAD season)
Total Winter nitrogen load (percolation plus snowmaking) days 1-120	**554**	lbs	32.7	ac	area of snowmaking LAD

Percolation nitrogen load days 121-365	**4** lbs/day	**867** lbs	**Total percolation nitrogen load after LAD and snowmaking, days 121-365**

Ground Water Inputs Below East Boulder Mine LAD area at Closure					**737 gpm treated adit water applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6; tailings waters evaporated over the tailings mass**
depth of aquifer, D_2	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	700	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to river, L_2	2,900	ft			MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of zone, W_2	954	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_2	14,303	ft^2			D * W, allowed by 17.30.517(d)
70% of available volume of ground water available for mixing Q_1=kiA	76,955	ft^3/d	400	gpm (24 hr)	calculation per 17.30.517(d); MPDES statement of basis, p.25-26
Volume of ground water available for mixing (under LAD) Q_2=kiA	27,891	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d); ground water flowing beneath LAD area
concentration of nitrogen in adit waters	0.4	mg/L	0.1	mg/L	Summer nitrogen concentration in LAD waters, post plant uptake, 30% evaporation
upgradient ambient concentration of nitrogen in ground water (WW-1), C_A	0.1	mg/L	0.1	mg/L	Winter nitrogen concentration in LAD waters, post snowmaking, 30% evaporation
2011 operational concentration of nitrogen in ground water (EBMWs -6 and -7), C_{AM}	15.0	mg/L			SMC monitoring data 2011; EBMWs -6 and -7 are compliance wells in the alluvial aquifer at the end of the tailings impoundment and are considered representative of the existing loads of salt and nitrogen in the ground water during operations
Volume of water: **summer LAD**, V_{sL}	195,401	ft^3/d	1,015	gpm (24 hr)	summer volume adit water from LAD areas 2, 3, 4, 6 with evaporation taken
Volume of water: **summer percolation**, V_{sP}	2,310	ft^3/d	12	gpm (24 hr)	summer volume of adit water requiring percolation
Volume of water: **winter snowmaking**, V_{Ws}	38,406	ft^3/d	200	gpm (24 hr)	winter volume adit water from LAD areas 3, 4, 6 with snowmaking credit
Volume of water **percolated in winter**, V_{Wp}	87,016	ft^3/d	452	gpm (24 hr)	winter volume of adit water requiring percolation
projected summer concentration of nitrogen in ground water days 1-120, Z_s	**1.5**	**mg/L**			summer concentration of nitrogen in ground water near SP-11
projected winter concentration of nitrogen in ground water days 1-120, Z_W	**2.0**	**mg/L**			winter concentration of nitrogen in ground water near SP-11

The total inorganic nitrogen concentration in ground water is less than the DEQ-7 ground water criterion of 10 mg/L.

East Boulder River Concentration below LAD area at Closure					**737 gpm treated adit water applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6; tailings waters evaporated over the tailings mass**
receiving streamflow, Q_s	432,000	ft^3/d	5.0	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, C_s	0.1	mg/L			actual concentration at EBR-001, SMC monitoring data
summer ground water discharge volume, Q_{ds}	302,557	ft^3/d	3.5	cfs	credit for evaporative losses taken in volume calculations
winter ground water discharge volume, Q_{dw}	230,268	ft^3/d	2.7	cfs	credit for evaporative losses taken in volume calculations
summer ground water discharge concentration to East Boulder River, C_{ds}	1.5	mg/L			based on summer concentration of ground water at end of mixing zone
winter ground water discharge concentration to East Boulder River, C_{dw}	2.0	mg/L			based on winter concentration of ground water at end of mixing zone
projected Summer East Boulder River nitrogen concentration (5.0 cfs 7Q10)	**0.6**	**mg/L**			calculated concentration at $7Q_{10}$ low flow
projected Winter East Boulder River nitrogen concentration (5.0 cfs 7Q10)	**0.7**	**mg/L**			calculated concentration at $7Q_{10}$ low flow

The total inorganic nitrogen concentration in the East Boulder River is less than 1.0 mg/L.

No Action Alternative 1B and 1C Closure Option 1, 150 gpm: Tailings waters would be evaporated over the tailings mass. Adit water would be land applied at the East Boulder Mine LAD Area 6. The Boe Ranch LAD system would not be built.

			30	lbs/day	East Boulder MPDES permitted nitrogen load
East Boulder MPDES Permit Source-Specific (percolation pond) mixing input values			**150**	gpm (24 hr)	East Boulder adit flow rate at closure (24 hr rate)
			0.4	mg/L	treated total inorganic nitrogen concentration of adit waters based on BTS/Anox system treatment capability (2009-2011)
depth of aquifer, **D**	80	ft			MPDES Statement of Basis, p. 25-26
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	385	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to wells, L_1	3600	ft			MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3				MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	400	gpm (24 hr)			MPDES Statement of Basis, p. 25-26
upgradient ambient concentration of nitrogen in ground water (WW-1), C_A	0.1	mg/L			median value SMC Monitoring Data 1989-2008
2011 operational concentration of nitrogen in ground water (EBMWs -6 and -7), C_{AM}	15.0	mg/L			SMC monitoring data 2011; EBMWs -6 and -7 are compliance wells in the alluvial aquifer at the end of the tailings impoundment and are considered representative of the existing loads of salt and nitrogen in the ground water during operations
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, W_1	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_1	55,977	ft^2			D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing Q_1=kiA	76,955	ft^3/d	400	gpm (24 hr)	calculation per 17.30.517(d); MPDES statement of basis, p.25-26
Volume of ground water available for mixing Q_2=kiA	27,891	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d); ground water flowing beneath LAD area
East Boulder Hydraulic Loading Calculations					Design flow for evaporators, snowmakers, center pivot from KP 2000; acreage from CES 2008
Adit Flow rate	**150**	gpm (24 hr)	**300**	gpm (12 hr)	Adit flow rate
Summer LAD Area 6 maximum hydraulic load end of pipe	56,406	ft^3/d	**586**	gpm (12 hr)	evaporator max flow rate, 10.2 ac; CES 2008
Winter LAD Area 6 snowmaking maximum hydraulic load end of pipe	39,465	ft^3/d	**410**	gpm (12 hr)	snowmaker max flow rate, 10.2 ac; CES 2008

The hydraulic capacity of 150 gpm (24 hr) adit water can be managed at East Boulder Mine LAD Area 6 in winter or summer. No percolation is needed.

East Boulder Nitrogen Loading Calculations			28,877	ft^3/d	Adit water volume per day
Adit Flow rate	**150**	gpm (24 hr)	300	gpm (12 hr)	Adit flow rate
Summer nitrogen load to ground water; all waters LAD at Area 6 (30% evaporation, 80% nitrogen credit post-plant uptake)	**0.1**	lbs/day	0.1	mg/L	Summer nitrogen concentration of land applied waters
Summer/Winter nitrogen load: all waters percolated	**0.7**	lbs/day	0.1	mg/L	Winter nitrogen concentration of snowmaking waters
Total Summer LAD nitrogen Load	**17**	lbs	120	days	time LAD applied (length of LAD season)
Total Summer LAD nitrogen Load/ac	**2**	lbs/ac/yr	10.2	ac	area of LAD
Winter Snowmaking nitrogen load to ground water, LAD Area 6 (30% hydraulic evaporation, 80% snowmaking nitrogen credit)	**0.1**	lbs/day	0.4	mg/L	treated concentration of East Boulder adit waters based on MPDES permit 20 lbs/day nitrogen limit
Total Winter nitrogen snowmaking load	**17**	lbs/day	**2,074**	lbs	**Total nitrogen load from LAD and snowmaking, days 1-120**
Total Winter Snowmaking nitrogen load/ac	**2**	lbs/ac/yr	**176**	lbs	**Total percolation load after LAD and snowmaking, days 121-365**

The total inorganic nitrogen load for percolation and for a combination of percolation and LAD meets the 30 lb/day MPDES permit limit in both summer and winter.

Ground Water Inputs Below East Boulder Mine LAD area at Closure			**150 gpm treated adit water applied at East Boulder Mine LAD Area 6**	
depth of aquifer, $\mathbf{D_2}$	15	ft		allowed by 17.30.517(d)
hydraulic conductivity, **k**	75	ft/d		MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft		MPDES Statement of Basis, p. 25-26
width of source	700	ft		MPDES Statement of Basis, p. 25-26
length from percolation pond to river, $\mathbf{L_2}$	2900	ft		MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693	tan 5°		allowed by 17.30.517(d)
width of zone, $\mathbf{W_2}$	954	ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_2}$	14,303	ft^2		D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing $\mathbf{Q_1}$=kiA	76,955	ft^3/d	400 gpm (24 hr)	
Volume of ground water available for mixing $\mathbf{Q_2}$=kiA	27,891	ft^3/d	145 gpm (24 hr)	calculation per 17.30.517(d)
concentration of nitrogen in adit waters	0.4	mg/L	0.1 mg/L	Summer nitrogen concentration of land applied waters
upgradient concentration of nitrogen in aquifer (WW-1), CA	0.1	mg/L	0.1 mg/L	Winter nitrogen concentration of snowmaking waters
Volume of water applied: **summer LAD** at LAD area 6, $\mathbf{V_s}$	40,428	ft^3/d	210 gpm (24 hr)	summer volume applied at LAD 6; 30% evaporation credit taken; based on 150 gpm adit flow rate
Volume of water applied: **winter snowmaking** at LAD Area 6, $\mathbf{V_{W1}}$	40,428	ft^3/d	210 gpm (24 hr)	winter volume applied at LAD 6; 30% evaporation credit taken; based on 150 gpm adit flow rate
summer concentration of ground water, $\mathbf{Z_s}$	**2.9**	**mg/L**		projected summer ground water concentration near SP-11
winter concentration of ground water, $\mathbf{Z_W}$	**2.9**	**mg/L**		projected winter ground water concentration near SP-11
The total inorganic nitrogen concentration in ground water is less than the DEQ-7 ground water quality criterion of 10 mg/L.				
East Boulder River Concentration below LAD area at Closure			**150 gpm treated adit water applied at East Boulder Mine LAD Area 6**	
receiving streamflow, $\mathbf{Q_s}$	432,000	ft^3/d	5.0 cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, $\mathbf{C_s}$	0.1	mg/L		MPDES Statement of Basis page 24
summer discharge volume through aquifer, $\mathbf{Q_{dS}}$	145,273	ft^3/d	1.7 cfs	credit for evaporative losses taken in volume calculations
winter discharge volume through aquifer, $\mathbf{Q_{dW}}$	145,273	ft^3/d	1.7 cfs	credit for evaporative losses taken in volume calculations
summer discharge concentration to East Boulder River, $\mathbf{C_{dS}}$	2.9	mg/L		based on summer concentration of ground water near SP-11
winter discharge concentration to East Boulder River, $\mathbf{C_{dW}}$	2.9	mg/L		based on winter concentration of ground water near SP-11
Summer East Boulder River nitrogen concentration (5.0 cfs 7Q10)	**0.8**	**mg/L**		calculated concentration at $7Q_{10}$ low flow
Winter East Boulder River nitrogen concentration (5.0 cfs 7Q10)	**0.8**	**mg/L**		calculated concentration at $7Q_{10}$ low flow
The total inorganic nitrogen concentration in the East Boulder River is less than the MPDES permit limit of 1.0 mg/L.				

Spreadsheet 1B 1C Salts: *Revised* East Boulder Alternative 1B and Boe Ranch Alternative 1C No Action Closure Salinity Analyses

Per SMC 1998, preferential disposal of treated adit waters is at the mine LAD areas and percolation pond; the Boe Ranch LAD system is not built. For the East Boulder Mine, the assumptions for calculations were made according to the regulatory requirements of the existing MPDES permit, Montana Water Quality Act and Rules, and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the East Boulder Mine LAD area, any water that percolates below the root zone is assumed to immediately enter the ground water (no unsaturated zone was considered). To determine the concentration of salts in ground water, it was assumed that all ground water flow parallels the East Boulder River and enters the river at a point at, or just downstream of, the permit boundary (EBR-004/4A). Tailings impoundment waters would be evaporated over the tailings mass and would not discharge to ground water. The salts concentration of treated adit water will not vary with flow rate. The calculations do not allow salts treatment credit for snowmaking, evaporation, plant uptake, or percolation. The design capacities are as follows: PoleCat evaporators assume summer 30% evaporation, center pivots 30%; PoleCat winter 30% evaporation. The East
Boulder mine MPDES permit does not set a limit for TDS or EC. The salts load at the East Boulder Mine is calculated from TDS. The ground water beneath the East Boulder mine has a Class I Beneficial Use (up to 1,000 μmhos/cm EC). The hydraulic volume calculations allow a water volume reduction (evaporation credit) that has a corresponding increase in TDS concentration. The concentrations of TDS or measured EC at SP-11 (downgradient of the LAD area) are assumed to be representative of the ground water affected by application of mine waters. Revised input values are shown in blue font and/or orange highlight.

No Action Alternative 1B and 1C Closure Option 1, 737 gpm: Tailings waters would be evaporated over the tailings mass. Adit water would be land applied at East Boulder Mine LAD Areas 2, 3-Upper, 4 and 6. The Boe Ranch LAD system would not be built.

median adit water EC concentration derived from SMC monitoring data (2011)	944	μmhos/cm			
median adit TDS concentration derrived from SMC monitoring data (2011)	605	mg/L	**737**	gpm (24 hr)	adit flow rate at closure
East Boulder MPDES Source-Specific (percolation pond) mixing zone input values					
depth of aquifer, **D**	80	ft			MPDES Statement of Basis, p. 25-26
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	385	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to wells, $\mathbf{L_1}$	3,600	ft			MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3				MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	400	gpm			MPDES Statement of Basis, p. 25-26
upgradient concentration of TDS in ground water (WW-1)	106	mg/L	165	μmhos/cm	median value SMC Monitoring Data 1989-2008
2011 operational concentration of TDS in ground water (EBMW-6 and -7)	515	mg/L	803	μmhos/cm	SMC monitoring data 2011; EBMWs -6 and -7 are two of the compliance points at the end of the tailings impoundment and considered representative of the existing concentration of salt and nitrogen in the ground water during operations
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, $\mathbf{W_1}$	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_1}$	55,977	ft^2			D * W, allowed by 17.30.517(d)
70% of available Volume of Ground Water available for mixing $\mathbf{Q_1}$=kiA	76,955	ft^3/d			MPDES Statement of Basis, p. 25-26
East Boulder Hydraulic Loading Calculations			**737 gpm treated adit water applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6**		
East Boulder Tailings Impoundment discharge volume	40	MG			volume of water to be discharged to install cover (KP); evaporated over tailings mass
Adit Flow rate	737	gpm (24 hr)	**1,474**	gpm (12 hr)	Adit flow rate
Summer LAD Area 6 maximum hydraulic load end of pipe	56,406	ft^3/d	586	gpm (12 hr)	evaporator maximum flow rate, 10.2 ac; CES 2008
Summer LAD Area 4 maximum hydraulic load end of pipe	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.2 ac; CES 2008
Summer LAD Area 3 Upper maximum hydraulic load end of pipe	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.3 ac; CES 2008
Summer LAD Area 2 maximum hydraulic load end of pipe	29,262	ft^3/d	304	gpm (12 hr)	center pivot maximum flow rate, 13.9 ac; CES 2008
Summer maximum hydraulic load end of pipe, LAD areas 2, 3 Upper, 4, 6	**139,572**	$\mathbf{ft^3/d}$	**1,450**	gpm (12 hr)	total rate for all units
excess volume of water needing disposal in Summer	**12**	gpm (24 hr)	**24**	gpm (12 hr)	volume of water exceeding hydraulic capacity of Summer LAD

Insufficient pond storage capacity exists at this flow rate. Approximately 1.1 MG is generated in 24 hours, the available storage is 0.7 MG, and the 12 hour summer LAD disposal is 1.0 MG. About 0.02 MG excess water must be percolated if handled at East Boulder Mine. The tailings waters would be evaporated over the tailings mass. The volume of tailings waters is double of that initially modeled and the amount of time to evaporate the water from the tailings mass is unspecified.

Winter LAD Area 6 snowmaking maximum hydraulic load end of pipe	39,465	ft^3/d	410	gpm (12 hr)	snowmaker maximum flow rate, 10.2 ac; CES 2008
Winter LAD Area 4 snowmaking maximum hydraulic load end of pipe	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate, 11.2 ac; CES 2008
Winter LAD Area 3 Upper snowmaking maximum hydraulic load end of pipe	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate, 11.3 ac; CES 2008
Winter maximum snowmaking hydraulic load end of pipe, LAD areas 3 Upper, 4, 6	**54,866**	$\mathbf{ft^3/d}$	**570**	gpm (12 hr)	total rate for all units
excess volume of water needing disposal in Winter	**452**	gpm (24 hr)	**904**	gpm (12 hr)	volume of water exceeding hydraulic capacity of Winter snowmaking LAD

Insufficient pond storage capacity exists at this flow rate. Approximately 1.1 MG is generated in 24 hours, the available storage is 0.7 MG, and the 12 hour winter snowmaking LAD is 0.4 MG. About 0.3 MG excess water must be percolated if handled at East Boulder Mine. The tailings waters would be evaporated over the tailings mass. The volume of tailings waters is double of that initially modeled and the amount of time to evaporate the water from the tailings mass is unspecified.

No Action Alternative 1B and 1C Closure Option 2, 737 gpm: Tailings waters would be evaporated over the tailings mass. Adit water would be land applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6 and the excess adit water would be percolated at the mine site. The Boe Ranch LAD system would not be built.

East Boulder Salt Loading Input Parameters, CLOSURE			**737 gpm treated adit water applied at East Boulder Mine**		
median adit TDS concentration	**605**	mg/L	864	mg/L	TDS concentration adit water after 30% evaporation (evaporators Summer LAD)
Adit Flow rate	**737**	gpm (24 hr)	864	mg/L	TDS concentration adit water after 30% evaporation (Winter LAD snowmaking)
Daily Summer LAD Salts load East Boulder Mine, LAD areas 2, 3, 4, 6	**5,264**	lbs/day	**737 gpm treated adit water applied at East Boulder Mine Summer LAD Areas 2, 3-Upper, 4, and 6**		
LAD Area 6 flow rate (30% hydraulic evaporation)	56,406	ft^3/d	**2,127**	lbs/day	evaporator maximum flow rate, 10.2 ac; CES 2008
LAD Area 4 flow rate (30% hydraulic evaporation)	26,952	ft^3/d	**1,016**	lbs/day	evaporator maximum flow rate, 11.2 ac; CES 2008
LAD Area 3 Upper flow rate (30% hydraulic evaporation)	26,952	ft^3/d	**1,016**	lbs/day	evaporator maximum flow rate, 11.3 ac; CES 2008

LAD Area 2 flow rate center pivot (30% hydraulic evaporation)	29,262	ft^3/d	**1,104**	lbs/day	center pivot maximum flow rate, 13.9 ac; CES 2008
Summer Salts Load to percolation	**10,454**	lbs/yr			
Summer Salts LAD Load	**631,620**	lbs/yr	120	days	time LAD applied (length of LAD season)
Summer Salts LAD Load per acre	**13,554**	lbs/ac/yr	46.6	ac	area of LAD
Summer Salts LAD Load applied per square foot	**0.3**	lbs/ft2/yr			
total Summer Salt Load (LAD plus percolation)	**642,074**	lbs/yr			salt is concentrated by evaporation when land applied
Daily Winter Snowmaking Salts load East Boulder Mine, LAD areas 3, 4, 6	**2,069**	lbs/day	**737 gpm treated adit water applied at East Boulder Mine Winter snowmaking LAD Areas 3-Upper, 4, and 6**		
LAD Area 6 snowmaking rate (30% hydraulic evaporation)	39,465	ft^3/d	**1,488**	lbs/day	snowmaker maximum flow rate, 10.2 ac; CES 2008
LAD Area 4 snowmaking rate (30% hydraulic evaporation)	7,701	ft^3/d	**290**	lbs/day	snowmaker maximum flow rate, 11.2 ac; CES 2008
LAD Area 3 snowmaking rate (30% hydraulic evaporation)	7,701	ft^3/d	**290**	lbs/day	snowmaker maximum flow rate, 11.3 ac; CES 2008
Winter Salts load to percolation	**393,782**	lbs/yr			
Winter Salts LAD load	**248,292**	lbs/yr	120	days	time LAD applied (length of LAD season)
Winter Salts LAD load per acre	**7,593**	lbs/ac/yr	32.7	ac	area of LAD
Winter Salts LAD load per square foot	**0.2**	lbs/ft2/yr	**642,074**	lbs/yr	**Total Winter Salts Load (LAD plus percolation)**

Closure Ground Water Mixing Calculations for East Boulder Mine LAD Area			737 gpm treated adit water applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6		
depth of aquifer, D_2	15	ft			
hydraulic conductivity, **k**	75	ft/d			allowed by 17.30.517(d)
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	700	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to river, L_2	2,900	ft			MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693	tan 5°			MPDES Statement of Basis, p. 25-26
width of zone, W_2	954	ft			allowed by 17.30.517(d)
area of mixing zone, A_2	14,303	ft^2			width of source + (tan 5 * length) allowed by 17.30.517(d)
70% of available volume of ground water available for mixing Q_1=kiA	76,955	ft^3/d	400	gpm (24 hr)	ground water flowing into LAD from beneath tailings impoundment
Volume of ground water available for mixing Q_2=kiA	27,891	ft^3/d	145	gpm (24 hr)	D * W, allowed by 17.30.517(d)
median concentration of salt in adit waters, SMC monitoring data 2002-2006	605	mg/L			calculation per 17.30.517(d)
adit water TDS concentration when LAD in summer (30% hydraulic evaporation)	864	mg/L			all areas 30% evaporation
adit water TDS concentration when LAD in winter (30% hydraulic evaporation)	864	mg/L			all areas 30% evaporation
upgradient concentration of TDS in ground water (WW-1), C_A	106	mg/L	165	µmhos/cm	median value SMC Monitoring Data 1989-2008
receiving stream baseline ambient concentration at EBR-001	49	mg/L	76	µmhos/cm	1996-1999 median baseline EC from SMC monitoring data (Hydrometrics 2001)
Volume of water applied: summer LAD, V_s	195,401	ft^3/d	1,015	gpm (12 hr)	Summer adit water volume pumped to LAD areas 2, 3 Upper, 4, 6, minus evaporation
Volume of water: summer percolation, V_p	2,310	ft^3/d	12	gpm (12 hr)	Summer volume from percolation; excess water needing disposal
Volume of water: winter snowmaking, V_{W1}	76,813	ft^3/d	399	gpm (12 hr)	Winter adit water volume from LAD areas 3 Upper, 4, 6, minus evaporation
Winter volume of water applied: percolation, V_{W2}	87,016	ft^3/d	452	gpm (12 hr)	winter volume from percolation; excess water needing disposal
summer concentration of ground water at East Boulder Mine, Z_s	**637**	mg/L	**994**	µmhos/cm	projected **summer** concentration of TDS and EC in ground water at SP-11 just prior to discharging to East Boulder River
winter concentration of ground water at East Boulder Mine, Z_W	**527**	mg/L	**822**	µmhos/cm	projected **winter** concentration of TDS and EC in ground water at SP-11 just prior to discharging to East Boulder River

The EC in ground water meets the 1,000 µmhos/cm Class I Beneficial Use Criteria during summer LAD and winter snowmaking.

East Boulder River Concentration below LAD area			737 gpm treated adit water applied at East Boulder Mine LAD Areas 2, 3-Upper, 4, and 6		
receiving streamflow, Q_s	432,000	ft^3/d	5.0	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
irrigation season receiving streamflow, Q_s	172,800	ft^3/d	2.0	cfs	flow in stream during irrigation season
receiving stream ambient concentration, C_s	45	mg/L			median concentration SMC Monitoring Data 2004-2009
ground water discharge volume, Q_{dS}	302,557	ft^3/d	3.5	cfs	summer discharge volume
ground water discharge volume, Q_{dW}	268,674	ft^3/d	3.1	cfs	winter discharge volume
summer discharge concentration to Stillwater River, C_{dS}	637	mg/L			based on summer concentration of ground water at end of mixing zone
winter discharge concentration to Stillwater River, C_{dW}	527	mg/L			based on winter concentration of ground water at end of mixing zone
Summer East Boulder River TDS concentration (5.0 cfs 7Q10)	**199**	**mg/L**	310	µmhos/cm	calculated concentration at 7Q10 low flow
Winter East Boulder River TDS concentration (5.0 cfs 7Q10)	**191**	**mg/L**	298	µmhos/cm	calculated concentration at 7Q10 low flow

No Action Alternative 1B and 1C Closure Option 1, 150 gpm: Tailings waters would be evaporated over the tailings mass. Adit water would be land applied at the East Boulder Mine LAD Area 6. The Boe Ranch LAD system would not be built.

median adit water EC concentration calculated	944	µmhos/cm	605	mg/L	median adit TDS concentration derrived from SMC monitoring data
			150	gpm (24 hr)	adit flow rate at closure

East Boulder MPDES Source-Specific (percolation pond) mixing zone input values

depth of aquifer, **D**	80	ft	MPDES Statement of Basis, p. 25-26
hydraulic conductivity, **k**	75	ft/d	MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft	MPDES Statement of Basis, p. 25-26
width of source	385	ft	MPDES Statement of Basis, p. 25-26
length from percolation pond to wells, L_1	3,600	ft	MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3		MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d	MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	400	gpm (24 hr)	MPDES Statement of Basis, p. 25-26
upgradient concentration of TDS in ground water (WW-1), CA	106	mg/L	median value SMC Monitoring Data 1989-2008
angle of dispersion	0.087421693	tan 5°	allowed by 17.30.517(d)
width of mixing zone, W_1	700	ft	width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_1	55,977	ft^2	D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing Q_1=kiA	109,156	ft^3/d	calculation per 17.30.517(d); MPDES Statement of Basis, p. 25-26

East Boulder Hydraulic Loading Calculations			150 gpm treated adit water applied at East Boulder Mine LAD Area 6		
Adit Flow rate	150	gpm (24 hr)	**300**	gpm (12 hr)	Adit flow rate
Summer LAD Area 6 maximum hydraulic load end of pipe	56,406	ft^3/d	**586**	gpm (12 hr)	evaporator maximum flow rate, 10.2 ac; CES 2008
Winter LAD Area 6 snowmaking maximum hydraulic load end of pipe	39,465	ft^3/d	**410**	gpm (12 hr)	snowmaker maximum flow rate, 10.2 ac; CES 2008

The hydraulic capacity of 150 gpm (24 hr) adit water can be managed at East Boulder Mine via LAD in winter or summer.

East Boulder Salt Loading Input Parameters, closure			**150 gpm treated adit water applied at East Boulder Mine LAD Area 6**		
median adit TDS concentration, SMC monitoring data	605	mg/L	28,877	ft^3/d	adit water volume in cubic feet per day
East Boulder Adit flow rate	150	gpm (24 hr)	300	gpm (12 hr)	East Boulder adit flow rate
adit water TDS concentration when LAD in summer (30% hydraulic evaporation)	864	mg/L			no TDS credit given for evaporation
adit water TDS concentration when LAD in winter (30% hydraulic evaporation)	864	mg/L			no TDS credit given for evaporation
Daily Summer LAD Area 6 TDS load (30% hydraulic evaporation)	**545**	lbs/day			
Total Summer LAD TDS Load/ac/yr	**6,406**	lbs/ac/yr	120	days	time LAD applied (length of LAD season)
Total Summer LAD TDS Load/ft^2	**0.1**	lbs/ft2/yr	10.2	ac	area of LAD
Daily Winter LAD Area 6 TDS Load (30% hydraulic evaporation)	**545**	lbs/day			
Total Winter LAD TDS Load/ft^2	**6,406**	lbs/ac/yr			
Total Winter LAD TDS Load/ft^2	**0.1**	lbs/ft2/yr			
Closure Ground Water Salts Calculations for East Boulder Mine LAD Area			**150 gpm treated adit water applied at East Boulder Mine LAD Area 6**		
depth of aquifer, **D_2**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	700	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to river, **L_2**	2900	ft			MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of zone, **W_2**	954	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, **A_2**	14,303	ft^2			D * W, allowed by 17.30.517(d)
Volume of Ground Water available for mixing **Q_2**=kiA	27,891	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d)
Volume of Ground Water available for mixing **Q_1**=kiA	76,955	ft^3/d			calculation per 17.30.517(d); MPDES Statement of Basis, p. 25-26
concentration of salt in adit waters	605	mg/L			calculated above
adit water TDS concentration when LAD in summer or winter (30% hydraulic evaporation)	864	mg/L			
2011 operational concentration of TDS in ground water (EBMW-6 and -7)	515	mg/L	803	μmhos/cm	SMC monitoring data 2011; EBMWs -6 and -7 are two of the compliance points at the end of the tailings impoundment and considered representative of the existing concentration of salt and nitrogen in the ground water during operations
upgradient concentration of TDS in ground water (WW-1)	106	mg/L			median value SMC Monitoring Data 1989-2008
receiving stream baseline ambient concentration at EBR-001	49	mg/L	76	μmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
Volume of water: summer LAD, **V_s**	40,428	ft^3/d	210	gpm (12 hr)	summer volume disposed at LAD area 6 that reaches ground water (30% evaporation)
Volume of water: winter snowmaking, **V_{W1}**	40,428	ft^3/d	210	gpm (12 hr)	winter volume disposed at LAD area 6 that reaches ground water (30% evaporation)
summer concentration of ground water, Z_s	396	mg/L	**617**	μmhos/cm	projected **summer** concentration of TDS and EC in ground water at SP-11 just prior to discharging to East Boulder River
winter concentration of ground water, Z_W	396	mg/L	**617**	μmhos/cm	projected **winter** concentration of TDS and EC in ground water at SP-11 just prior to discharging to East Boulder River
The EC in ground water meets the 1,000 μmhos/cm Class I Beneficial Use Criterion during both summer LAD and winter snowmaking.					
East Boulder River Salts Concentration below LAD area			**150 gpm treated adit water applied at East Boulder Mine LAD Area 6**		
receiving streamflow, **Q_s**	432,000	ft^3/d	5.0	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
irrigation season receiving streamflow, **Q_s**	172,800	ft^3/d	2.0	cfs	flow in stream during irrigation season
receiving stream ambient concentration, **C_s**	45	mg/L			median concentration SMC Monitoring Data 2004-2009
ground water discharge volume, **Q_{dS}**	145,273	ft^3/d	1.7	cfs	
ground water discharge volume, **Q_{dW}**	145,273	ft^3/d	1.7	cfs	
summer discharge concentration to East Boulder River, **C_{dS}**	396	mg/L			summer concentration of salt in ground water just prior to discharging to East Boulder River
winter discharge concentration to East Boulder River, **C_{dW}**	396	mg/L			winter concentration of salt in ground water just prior to discharging to East Boulder River
Summer East Boulder River TDS concentration (5.0 cfs 7Q10)	133	**mg/L**	208	μmhos/cm	calculated concentration at 7Q10 low flow
Winter East Boulder River TDS concentration (5.0 cfs 7Q10)	133	**mg/L**	208	μmhos/cm	calculated concentration at 7Q10 low flow

Spreadsheet 2A Salts--*Revised* Alternative 2A Proposed Action Stillwater Mine and Hertzler Ranch Salinity Analyses

For Hertzler Ranch, the assumptions for calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For Hertzler Ranch LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer; that is, no unsaturated zone was considered to determine concentrations of salts in ground water. To determine the EC of ground water at Hertzler Ranch, the agencies assume that there is a leak in the Hertzler Ranch LAD Storage Pond liner in ground water zone Z_1; the upper LAD discharges to ground water zone Z_2; assume there is a leak from the Hertzler Ranch tailings impoundment in ground water zone Z_4; Z_1, Z_2, and Z_4 flow into Z_3 where the lower LAD is discharged, then Z_3 flows into Z_5 (see Hertzler Ground Water Zone Figure). Salts are not treated in the BTS or Hertzler Ranch LAD, so all salts are expected to eventually flush through the soil column and unsaturated zone to ground water. The agencies used the median adit water TDS concentration for the operational Stillwater Mine concentration. The Stillwater Mine MPDES permit has no TDS or EC limits.
Weighted concentrations of TDS or EC assume instantaneous mixing. Revisions to input values are in blue font and orange highlight.

Proposed Alternative 2A Option 1, 2,020 gpm: The 370 gpm of untreated east side adit water would be disposed in the Stillwater Mine east side percolation ponds. Up to 250 gpm Stillwater tailings waters would be mixed and treated with 1,650 gpm west side adit water and routed to the Hertzler Ranch LAD storage pond for disposal with 567 gpm of untreated Hertzler Ranch tailings waters.

TDS conversion 1 mg/L = 1.56 µmhos/cm EC			**1,650**	gpm (24 hr)	adit flow rate at closure
Volume of water in Stillwater Tailings impoundment plus 5 MG interstitial water (2011)	53	MG	**763**	mg/L	median Stillwater TDS west side adit water concentration, SMC Monitoring Data (2011)
volume of water in Hertzler Ranch LAD storage pond	105	MG	**250**	mg/L	average 2004-2008 Stillwater east side adit TDS concentration
Hertzler Ranch LAD area	320	ac	**946**	mg/L	concentration of TDS in tailings waters Stillwater Database 2011
time to dewater Stillwater tailings impoundment at given rate	**147**	days	**250**	gpm (24 hr)	Stillwater tailings flow rate at closure; (fixed by west side adit pumping rate plus BTS capacity)
volume of water in Hertzler Ranch tailings impoundment plus 5 MG interstitial water (2011)	201	MG	**1,163**	gpm (24 hr)	rate to dewater Hertzler Ranch Tailings Impoundment in one LAD season
weighted EC of mixed **adit plus Stillwater tailings waters**	1,228	µmhos/cm	**787**	mg/L	weighted TDS in mixed **adit plus Stillwater tailings waters** assume instantaneous mixing
weighted EC of mixed treated adit water in **Hertzler Ranch LAD storage pond with untreated Hertzler Ranch tailings waters**	1,378	µmhos/cm	**883**	mg/L	weighted TDS of mixed **Hertzler Ranch LAD storage pond water** (105 MG treated adit water) **with untreated Hertzler Ranch tailings waters;** assume instantaneous mixing

Input Parameters for Hertzler Ranch Ground Water Calculations			**Source of Data**
depth of aquifer, **D**	15	ft	allowed by 17.30.517(d)
hydraulic conductivity, $\mathbf{k_1}$ from Hertzler Ranch LAD storage pond	25	ft/d	from Hertzler Tailings Impoundment Seepage Analysis 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper Hertzler Ranch LAD	300	ft/d	from Hertzler Tailings Impoundment Seepage Analysis 2003
hydraulic conductivity, $\mathbf{k_3}$ and $\mathbf{k_5}$ from lower Hertzler Ranch LAD	600	ft/d	from Hertzler Tailings Impoundment Seepage Analysis 2003
hydraulic conductivity, $\mathbf{k_4}$ from tailings impoundment	2	ft/d	from Hertzler Tailings Impoundment Seepage Analysis 2003
gradient, **i**	0.01		estimated, from Hertzler Tailings Impoundment Seepage Analysis
width of source (Hertzler Ranch LAD storage pond liner leakage)	10	ft	assumed width based on point seep, Hydrometrics 2003
width of Hertzler Ranch LAD storage pond liner leakage mixing zone, $\mathbf{W_1}$	167	ft	width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°	allowed by 17.30.517(d)
length Hertzler Ranch LAD storage pond liner leakage area, $\mathbf{L_1}$	1,800	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map
length upper Hertzler Ranch LAD, $\mathbf{L_2}$	4,800	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map

width of upper Hertzler Ranch LAD at pivot P3 and P7	2,700	ft			personal communication R Weimer 2/18/2009
width of Upper Hertzler Ranch LAD mixing zone W_2	3,120	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length of lower Hertzler Ranch LAD, L_3	5,200	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of Lower Hertzler Ranch LAD at P4	1,610	ft			personal communication R Weimer 2/18/2009
Width of Lower Hertzler Ranch LAD mixing zone W_3	2,065	ft			personal communication R Weimer 2/18/2009
Width of source (Hertzler Ranch tailings impoundment liner leakage)	10	ft			assumed width based on point seep, Hydrometrics 2003
width of mixing zone below Hertzler Ranch tailings impoundment liner leakage W_4	124	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length of W_4 zone, L_4	1,300	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of Mixing Zone to Stillwater River W_5	2,215	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length below lower Hertzler Ranch LAD, L_5	3,600	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width below lower Hertzler Ranch LAD	1,900	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
cross sectional area of aquifer, A_1	2,510	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, A_2	46,794	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, A_3	30,969	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, A_4	1,855	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, A_5	33,221	ft^2			D * W, allowed by 17.30.517(d)
Q_1=kiA, ground water available for mixing	628	ft^3/d			calculation per 17.30.517(d)
Q_2=kiA, ground water available for mixing	140,383	ft^3/d			calculation per 17.30.517(d)
Q_3=kiA, ground water available for mixing	185,813	ft^3/d			calculation per 17.30.517(d)
Q_4=kiA, ground water available for mixing	37	ft^3/d			calculation per 17.30.517(d)
Q_5=kiA, ground water available for mixing	199,325	ft^3/d	120	days	length of LAD season
Hydraulic Loading to Hertzler Ranch LAD			105	MG	Hertzler Ranch LAD Storage Pond volume
Stillwater tailings impoundment waters volume	53	MG	201	MG	Hertzler Ranch tailings impoundment waters volume
rate to dewater **Hertzler Ranch tailings** impoundment in one LAD season (routed to Hertzler Ranch LAD storage pond)	1,163	gpm (24 hr)	**2,326**	gpm (12 hr)	rate to dewater Hertzler Ranch Tailings Impoundment in one LAD season (routed to Hertzler Ranch LAD storage pond)
rate to dewater **Hertzler Ranch LAD storage pond** in 120 days	608	gpm (24 hr)	**1,215**	gpm (12 hr)	rate to dewater Hertzler Ranch LAD storage pond in one LAD season
rate to dewater Stillwater tailings impoundment based on BTS capacity	250	gpm (24 hr)	**500**	gpm (12 hr)	rate to dewater Stillwater tailings impoundment based on BTS capacity (routed to Hertzler Ranch LAD storage pond)
adit flow rate at closure	1,650	gpm (24 hr)	**3,300**	gpm (12 hr)	**adit** flow rate at closure
maximum LAD rate from Hertzler Ranch LAD storage pond	**1,850**	gpm (24 hr)	**3,700**	gpm (12 hr)	maximum Hertzler Ranch LAD application rate
total rate of water needing disposal in 120 days (adit plus Stillwater tailings plus Hertzler tailings plus Hertzler LAD storage pond)	**3,671**	gpm (24 hr)	**7,342**	gpm (12 hr)	total rate of water needing disposal in one LAD season (adit plus Stillwater tailings plus Hertzler tailings plus Hertzler LAD storage pond)
total volume of water needing disposal at Hertzler at closure	**644**	MG	**320**	MG	volume that can be LAD at maximum rate for one LAD season

The hydraulic load for Option 1 of 1,650 gpm treated adit water plus 250 gpm treated Stillwater tailings waters plus 201 MG Hertzler Ranch tailings impoundment plus 105 MG Hertzler Ranch LAD storage pond waters exceeds the hydraulic capacity of the Hertzler Ranch LAD system by 324 MG and cannot be managed at Hertzler Ranch during one LAD season. Other options would have to be implemented such as disposing of some of the treated waters at the Stillwater Mine percolation ponds. The 2011 volume in the Stillwater the tailings impoundment would extend the time frame for closure beyond 120 days.

Proposed Alternative 2A Option 2, 2,020 gpm- The 370 gpm of untreated east-side adit water would be disposed of in the east side percolation ponds. Up to 250 gpm Stillwater tailings waters would be mixed and treated with 1,650 gpm west side adit water and routed to the Stillwater Mine percolation ponds. Up to 201 MG of untreated Hertzler Ranch tailings waters would be routed to the LAD storage pond containing 105 MG of treated adit water for disposal at the Hertzler Ranch LAD area.

total volume of water needing disposal at Hertzler Ranch LAD at closure	**306** MG	**320** MG	volume that can be LAD at maximum rate for one LAD season

The hydraulic load for Option 2 of 201 MG Hertzler Ranch tailings impoundment and 105 MG Hertzler Ranch LAD storage pond waters can be managed at Hertzler Ranch during one LAD season.

Input parameters and assumptions for salts calculations at Hertzler Ranch LAD			
		1,215 gpm (12 hr)	rate to dewater Hertzler LAD storage pond in 120 days
TDS in ambient ground water (HMW-4 SMC monitoring data), $\mathbf{C_A}$	150 mg/L	2,326 gpm (12 hr)	rate to dewater Hertzler Ranch Tailings Impoundment in 120 days (routed to Hertzler Ranch LAD storage pond)
TDS in Hertzler Ranch tailings impoundment liner leakage, $\mathbf{C_4}$	946 mg/L	**3,542** gpm (12 hr)	total rate of water needing disposal in 120 days (Hertzler LAD storage pond plus Hertzler Ranch tailings impoundment)
TDS in upper and lower Hertzler Ranch LAD discharge, evaporation taken, no credit for plant uptake, $\mathbf{C_2}$, $\mathbf{C_3}$	1,263 mg/L	1,317 gpm (12 hr)	excess rate that must be LAD at Hertzler Ranch **Lower LAD**
TDS in Hertzler Ranch LAD storage pond liner leakage (mixed adit plus Hertzler Ranch tailings waters), $\mathbf{C_1}$	883 mg/L	2,225 gpm (12 hr)	application 720 min/day at **upper LAD**
volume upper Hertzler Ranch LAD Discharge, assumes 30% evaporates; pivots P1, P2, P3, P7; $\mathbf{V_2}$	149,920 ft^3/d	9,626 ft^3/d	pivot P1; 100 gpm for 12 hour application rate SMC 2011
volume of Hertzler Ranch tailings impoundment liner leakage (1 gpm), $\mathbf{V_4}$	193 ft^3/d	31,283 ft^3/d	pivot P2: 325 gpm for 12 hour application rate SMC 2011
volume of Hertzler Ranch LAD storage pond liner leakage (1 gpm), $\mathbf{V_1}$	193 ft^3/d	96,257 ft^3/d	pivot P3; 1,000 gpm for 12 hour application rate SMC 2011
volume lower Hertzler Ranch LAD discharge, assumes 30% evaporates; $\mathbf{V_3}$	99,385 ft^3/d	62,567 ft^3/d	pivots P4; 650 gpm for 12 hour application rate SMC 2011
daily load of TDS disposed at closure at Hertzler Ranch	**37,536** lb/day	60,160 ft^3/d	pivots P5; 625 gpm for 12 hour application rate SMC 2011
total load of TDS disposed at Hertzler Ranch during closure	**4,504,350** lbs	19,251 ft^3/d	pivot P6; 200 gpm for 12 hour application rate SMC 2011
annual TDS load per acre per year (264 ac)	**14,089** lb/ac/yr	77,005 ft^3/d	pivot P7; 800 gpm for 12 hour application rate SMC 2011
annual TDS load per square foot per year (264 ac)	**0.3** lb/ft^2/yr		

Ground water salts concentrations at Hertzler Ranch		**201 MG Hertzler Ranch tailings impoundment and 105 MG Hertzler Ranch LAD storage pond waters LAD at Hertzler Ranch during one LAD season**	
ground water concentration area $\mathbf{Z_1}$	322 mg/L	503 µmhos/cm	ground water EC for zone Z_1
ground water concentration area $\mathbf{Z_2}$	725 mg/L	1,131 µmhos/cm	ground water EC for zone Z_2; **does not meet Class I Beneficial Use criterion**
ground water concentration area $\mathbf{Z_4}$	818 mg/L	1,276 µmhos/cm	ground water EC for zone Z_4; **does not meet Class I Beneficial Use criterion**
ground water EC concentration in $\mathbf{Z_3}$ at compliance point HMW-10	632 mg/L	986 µmhos/cm	projected ground water EC for zone Z_3 from Z_1, Z_2, Z_3, Z_4; compliance point HMW-10
EC concentration in $\mathbf{Z_5}$ from upgradient sources ($\mathbf{Z_1}$, $\mathbf{Z_2}$, $\mathbf{Z_3}$, $\mathbf{Z_4}$)	508 mg/L	792 µmhos/cm	projected ground water concentration prior to discharge to Stillwater River

The EC of ground water below Hertzler Ranch LAD at the compliance point (HMW-10) just prior to discharge into the Stillwater River meets the Class I Beneficial Use criterion. The Class I Beneficial Use criterion would be temporarily exceeded in ground water zones Z_2 (1,129 µmhos/cm) and Z_4 (1,276 µmhos/cm).

Stillwater River salts concentration below Hertzler Ranch			**201 MG Hertzler Ranch tailings impoundment and 105 MG Hertzler Ranch LAD storage pond waters LAD at Hertzler Ranch during one LAD season**		
receiving streamflow, $\mathbf{Q_s}$	3,628,800	ft^3/d	42	cfs	$7Q_{10}$ at mine site 31.2 cfs 2008 MPDES; Hertzler assumed value for streamflow
receiving stream ambient concentration, $\mathbf{C_s}$	44	mg/L	69	µmhos/cm	average concentration below Hertzler Ranch SMC-12; SMC Operational Monitoring Data
ground water discharge volume, $\mathbf{Q_d}$	775,877	ft^3/d	9.0	cfs	ground water discharge volume in cubic feet per second
ground water discharge concentration to Stillwater River, $\mathbf{C_d}$	508	mg/L	792	µmhos/cm	projected ground water concentration prior to discharge to Stillwater River
TDS Stillwater River concentration	**126**	**mg/L**	196	µmhos/cm	projected EC in Stillwater River at point of discharge
TDS loading at Stillwater Mine			**370 gpm untreated east side adit waters, 1,650 gpm treated west side adit waters, and 250 gpm treated Stillwater tailings waters are disposed of at the Stillwater Mine percolation ponds in greater than 120 days**		
rate untreated east-side plus **600 gpm** mixed treated west-side adit and tailings waters entering **east side percolation ponds**	230,053	ft^3/d	370	gpm (24 hr)	east side adit flow rate; personal communication R Weimer 2/18/2009
east side adit water TDS concentration	250	mg/L	158,824	ft^3/d	rate mixed treated west-side adit plus tailings waters entering **Stillwater Valley percolation ponds**
contribution of east side adit water to Stillwater River TDS load at Stillwater Mine during closure (no treatment credit)	1,110	pounds/day	787	mg/L	weighted TDS in mixed **adit plus Stillwater tailings waters** assume instantaneous mixing
contribution of west side adit water to Stillwater River TDS load at Stillwater Mine during closure (no treatment credit)	15,584	pounds/day	1,650	gpm (24 hr)	west-side adit flow rate at closure
contribution of Stillwater tailings impoundment water TDS load during closure (no treatment credit)	2,838	pounds/day	250	gpm (24 hr)	Stillwater tailings flow rate at closure; (fixed by west side adit pumping rate + BTS capacity)
daily TDS load discharged at Stillwater Mine during closure	**19,532**	pound/day	**147**	days	time to dewater the Stillwater tailings impoundment
total TDS load disposed at Stillwater Mine during closure	**2,875,568**	pound/year	48,128	ft^3/d	volume of Stillwater tailings waters
Ground Water Salts Calculation Input Parameters for the Stillwater Mine			**370 gpm untreated east side adit waters, 1,650 gpm treated west side adit waters, and 250 gpm treated Stillwater tailings waters are disposed of at the Stillwater Mine percolation ponds in greater than 120 days**		
depth of aquifer, **D**	15	ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
hydraulic conductivity east side percolation ponds, $\mathbf{k_{SVR}}$	4,076	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_E}$	539	ft/day			SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006	ft/ft			Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, $\mathbf{L_{SVR}}$	500	ft			2008 MPDES Permit page 3
width of mixing zone at downgradient extent, $\mathbf{W_{SVR}}$	507	ft			2008 MPDES Permit page 3
length of mixing zone, $\mathbf{L_E}$	2,000	ft			2008 MPDES Permit page 4
width of mixing zone at downgradient extent, $\mathbf{W_E}$	650	ft	621	mg/L	concentration of mixed untreated east-side adit water plus mixed treated west-side adit and Stillwater tailings waters
cross sectional area of aquifer, $\mathbf{A_{SVR}}$	7,605	ft	1,195	gpm (24 hr)	rate mixed treated west-side adit plus tailings waters entering **Stillwater Valley percolation ponds**
cross sectional area of aquifer, $\mathbf{A_E}$	9,750	ft	825	gpm (24 hr)	rate untreated east-side plus **600 gpm** mixed treated west-side adit and tailings waters entering **east side percolation ponds**
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing	185,988	ft^3/d			calculation per 17.30.517(d)
$\mathbf{Q_E=k_EiA_E}$, ground water available for mixing	31,532	ft^3/d			calculation per 17.30.517(d)

ambient TDS concentration in ground water at Stillwater Mine (MW-10A), $\mathbf{C_A}$	81 mg/L	126 µmhos/cm	average concentration of TDS in ambient ground water at SMC MW-10A

projected ground water concentration at end of Stillwater East Side Percolation Pond mixing zone	556 mg/L	**867** µmhos/cm	average concentration of TDS from percolation of half the west side adit waters + Stillwater tailings waters + east side adit waters
projected ground water concentration at end of Stillwater Valley Ranch Percolation Pond mixing zone	471 mg/L	**734** µmhos/cm	cumulative concentration of TDS from Stillwater East Side percolation plus percolation of half the west side adit waters at Stillwater Valley Ranch

The EC of ground water at Stillwater Mine meets Class I Beneficial Use criterion.

Stillwater River salts concentration below Stillwater Mine		**370 gpm untreated east side adit waters, 1,650 gpm treated west side adit waters, and 250 gpm treated Stillwater tailings waters are disposed of at the Stillwater Mine percolation ponds in greater than 120 days**	
receiving streamflow, $\mathbf{Q_s}$	2,695,680 ft^3/d	31.2 cfs	7Q10 at mine site 2008 MPDES
receiving stream ambient concentration, $\mathbf{C_s}$	45 mg/L	70 µmhos/cm	2008 MPDES Statement of Basis, p 9
ground water discharge volume, $\mathbf{Q_d}$	606,396 ft^3/d	7.0 cfs	ground water discharge volume in cubic feet per second
discharge concentration to Stillwater River, $\mathbf{C_d}$	471 mg/L	734 µmhos/cm	projected ground water EC prior to discharge to Stillwater River
projected Stillwater River TDS Concentration at Stillwater Mine	**123 mg/L**	192 µmhos/cm	projected EC in Stillwater River at point of discharge

Proposed Alternative 2A Option 1, 1,302 gpm - The 370 gpm of untreated east side adit water would be disposed of in the east side percolation ponds. The 932 gpm west side adit water would be mixed and treated with 600 gpm Stillwater tailings water and routed to Hertzler Ranch LAD storage pond containing 105 MG of treated adit water. All these waters would be routed for disposal at the Hertzler Ranch LAD area with the 201 MG of untreated Hertzler Ranch LAD tailings waters.

Hydraulic loading at Hertzler Ranch LAD		**932 gpm adit water mixed with 600 gpm Stillwater tailings waters would be treated and routed to the Hertzler Ranch to be land applied with 105 MG stored waters and 201 MG untreated Hertlzer Ranch tailings waters**	
total volume of water needing disposal at Hertlzer Ranch LAD at closure	**520** MG	**320** MG	volume that can be LAD at maximum rate for one LAD season
Volume of water in Hertzler Ranch tailings impoundment	201 MG	53 MG	Volume of water in Hertzler Ranch tailings impoundment
volume of water in Hertzler Ranch LAD storage pond	105 MG	932 gpm	west-side adit flow rate at closure

The hydraulic load for Option 1 of 1,302 gpm treated adit water plus 53 MG treated Stillwater tailings waters plus 201 MG Hertzler Ranch tailings impoundment plus 105 MG Hertzler Ranch LAD storage pond waters exceeds the hydraulic capacity of the Hertzler Ranch LAD system by 200 MG and cannot be managed at Hertzler Ranch during one LAD season. Other options would have to be implemented such as disposing of some of the treated waters at the Stillwater Mine percolation ponds or extending the time frame for closure.

Proposed Alternative 2A Option 2, 1,302 gpm - The 370 gpm of untreated east side adit water would be disposed of in the east-side percolation ponds. The 932 gpm west-side adit water would be mixed and treated with 600 gpm Stillwater tailings water and routed to the east-side percolation ponds for disposal. The 201 MG of untreated Hertzler Ranch tailings waters and 105 MG of stored waters would be land applied at the Hertzler Ranch LAD area.

Hydraulic loading to Stillwater Mine percolation ponds		**370 gpm untreated east-side adit waters plus 1,532 gpm mixed treated west-side adit plus Stillwater Tailings waters disposed of at the Stillwater Mine percolation ponds**	
total volume of Stillwater tailings water needing disposal	53 MG	600 gpm (24 hr)	rate to dewater the Stillwater tailings impoundment based on BTS capacity
east-side adit water flow rate	370 gpm (24 hr)	**61** days	time to dewater the Stillwater tailings impoundment
west-side adit water flow rate	932 gpm (24 hr)	1,902 gpm (24 hr)	total rate of water to be percolated at Stillwater Mine

The hydraulic load of 1,902 gpm (370 gpm untreated east side adit plus 1,532 gpm mixed treated west-side adit plus Stillwater tailings waters) can be managed at the east- side percolation ponds.

The hydraulic load of 201 MG Hertzler Ranch tailings impoundment waters and 105 MG Hertzler Ranch LAD storage pond waters can be managed at Hertzler Ranch during one LAD season as demonstrated above under 2,020 gpm Option 2.

TDS loading at Stillwater Mine	**370 gpm untreated east-side adit waters plus 1,532 gpm mixed treated west-side adit plus Stillwater Tailings waters disposed of at the Stillwater Mine percolation ponds**

volume of east side adit water--percolated at east side perc ponds	71,230 ft^3/d	370 gpm (24 hr)	east side adit flow rate; personal communication R Weimer 2/18/2009
east side adit water TDS concentration	250 mg/L	390 µmhos/cm	EC of untreated east side adit water
TDS concentration of west side adit waters (SMC monitoring data)	763 mg/L	1,190 µmhos/cm	west side adit water EC
TDS concentration of Stillwater tailings impoundment waters	946 mg/L	1,476 µmhos/cm	Stillwater tailings impoundment waters EC
volume of mixed treated west-side adit plus treated Stillwater tailings waters	294,930 ft^3/d	1,532 gpm (24 hr)	volume of mixed treated west side adit plus Stillwater tailings waters
TDS concentration of mixed untreated east-side adit plus treated west-side adit plus Stillwater tailings waters	721 mg/L	1,125 µmhos/cm	EC of mixed treated west side adit plus Stillwater tailings waters
daily TDS load discharged at Stillwater Mine during closure	13,254 lbs/day	120 days	length of closure (time to dewater both tailings impoundments)
total TDS load disposed at Stillwater Mine during closure	**1,590,438** lbs/day		
Salts calculations for ground water at Stillwater Mine		**370 gpm untreated east-side adit waters plus 1,532 gpm mixed treated west-side adit plus Stillwater Tailings waters disposed of at the Stillwater Mine percolation ponds**	
$Q_{SVR}=k_{SVR}iA_{SVR}$, ground water available for mixing	185,988 ft^3/d		calculation per 17.30.517(d)
$Q_E=k_EiA_E$, ground water available for mixing	31,532 ft^3/d		calculation per 17.30.517(d)
ambient TDS concentration in ground water at Stillwater Mine (MW-10A), C_A	81 mg/L	126 µmhos/cm	average concentration of TDS in ambient ground water at SMC MW-10A
projected ground water concentration at **end of Stillwater East Side Percolation Pond mixing zone**	608	949 µmhos/cm	meets the Class I Beneficial use criterion of 1,000 µmhos/cm
projected ground water concentration at end of **Stillwater Valley Ranch Percolation Pond mixing zone**	242	**377** µmhos/cm	projected concentration in ground water just prior to discharge to Stillwater River
The EC of ground water meets the Class I Beneficial Use criterion.			
Stillwater River salts concentration below Stillwater Mine		**370 gpm untreated east-side adit waters plus 1,532 gpm mixed treated west-side adit plus Stillwater Tailings waters disposed of at the Stillwater Mine percolation ponds**	
receiving streamflow, Q_s	2,695,680 ft^3/d	31.2 cfs	
receiving stream ambient concentration, C_s	45 mg/L	70 µmhos/cm	EC of receiving stream
ground water discharge volume, Q_d	355,359 ft^3/d	4.1 cfs	ground water discharge volume in cubic feet per second
ground water discharge concentration to Stillwater River, C_d	242 mg/L	377 µmhos/cm	projected EC of ground water just prior to discharge to Stillwater River
projected Stillwater River TDS Concentration at Stillwater Mine	**68 mg/L**	106 µmhos/cm	projected EC of Stillwater River at SMC-11

Hertzler Ranch LAD: The salts loading and concentrations are the same as analyzed above for the 2,020 gpm option 2. All criteria are met.

Spreadsheet 2A Nitrogen--*Revised* Proposed Action Alternative 2A Stillwater Mine and Hertzler Ranch LAD Closure Nitrogen Analyses

For these analyses, the calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the Hertzler Ranch LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer; that is, no unsaturated zone was considered to determine concentrations of nitrogen in ground water. To determine the total nitrogen concentration in ground water at Hertzler Ranch the agencies assume that there is a leak in the Hertzler Ranch LAD Storage Pond liner in ground water zone Z1; the upper LAD discharges to ground water zone Z_2; the agencies assume there is a leak from the Hertzler Ranch tailings impoundment in ground water zone Z_4; Zones Z_1, Z_2, and Z_4 flow into Z_3 where the lower LAD is discharged, then Z_3 flows into Z_5 (see Hertzler Ground Water Zone Figure). Treated adit water is routed to the Hertzler Ranch at closure until 100 lbs/day MPDES nitrogen limit can be met at the Stillwater Mine. Water routed to Hertzler Ranch would first be routed to the LAD storage pond then to LAD pivots during closure. These calculations assume the existing volume of treated adit water in the Hertzler Ranch LAD
storage pond at closure would be 105 MG (accumulated over the winter season) and 201 MG would be in the Hertzler Ranch tailings impoundment at the beginning of closure. The operational land application rate is (end-of-pipe) 10.4 gpm per acre. The concentration of treated adit water is assumed to equal the current operational capability of the BTS based on a three-year average.

Proposed Alternative 2A Option 1, 2,020 gpm: The 370 gpm of untreated east-side adit water would be disposed in the Stillwater Mine east side percolation ponds. Up to 250 gpm Stillwater tailings waters would be mixed and treated with 1,650 gpm west-side adit water and routed to the Hertzler Ranch LAD storage pond for disposal with 201 MG of untreated Hertzler Ranch tailings waters and 105 MG stored treated adit water in the LAD storage pond.

Stillwater tailings impoundment volume plus 5 MG tailings mass waters (SMC 2011)	53	MG	370	gpm (24 hr)	east-side adit flow rate at closure
Hertzler Ranch tailings impoundment waters volume plus 5 MG tailings mass waters (SMC 2011)	201	MG	1,650	gpm (24 hr)	west-side adit flow rate at closure
Hertzler Ranch LAD storage pond volume (SMC 2011)	105	MG	250	gpm (24 hr)	Stillwater tailings flow rate at closure; fixed by BTS capacity at 2,020 gpm
Number of acres available for land application at Hertzler	319.7	ac	4.1	mg/L	treated concentration of adit based on BTS system capabilities; 3-year average
capacity of Herzler Ranch LAD system (2011)	3,700	gpm (12 hr)	4.1	mg/L	weighted concentration of mixed treated west side adit water plus treated Stillwater tailings waters
treated tailings water TN concentration based on 92% BTS treatment efficiency (2011 SMC database)	4.3	mg/L	53.2	mg/L	TN concentration of Stillwater and Hertzler Ranch tailings impoundments waters
concentration of Hertzler Ranch LAD storage pond prior to dewatering tailings impoundments (SMC database 2011 data)	1.8	mg/L	35.6	mg/L	weighted concentration of mixed Hertzler Ranch LAD storage pond water plus untreated Hertzler Ranch tailings waters
length of LAD season	120	days	1,215	gpm (12 hr)	rate to dewater Hertzler Ranch storage pond in one LAD season
Hydraulic Loading to Hertzler Ranch LAD			2,175	gpm (12 hr)	rate to dewater Hertzler Ranch tailings impoundment in one LAD season
volume of water needing disposal in one LAD season	644	MG	320	MG	capacity of Herzler Ranch LAD system (2011)

The hydraulic load for Option 1 of 250 gpm Stillwater tailings waters mixed and treated with 1,650 gpm west-side adit water and routed to the Hertzler Ranch LAD storage pond containing 105 MG for disposal with 201 MG of untreated Hertzler Ranch tailings waters cannot be managed at Hertzler Ranch during one LAD season. Other options would have to be implemented such as disposing of some of the treated waters at the Stillwater Mine percolation ponds or extending the time frame for closure.

Proposed Alternative 2A Option 2, 2,020 gpm- The 370 gpm of untreated east side adit water would be disposed in the east side percolation ponds. Up to 250 gpm Stillwater tailings waters would be mixed and treated with 1,650 gpm west side adit water and routed to the Stillwater Mine percolation ponds. Up to 201 MG of untreated Hertzler Ranch tailings waters would be routed to the LAD storage pond containing 105 MG of treated adit water for disposal at the Hertzler Ranch LAD area.

Hydraulic Loading to Hertzler Ranch LAD					
volume of water needing disposal at closure	306	MG	320	MG	capacity of Herzler Ranch LAD system (2011)
Hydraulic Loading to Stillwater Mine Percolation Ponds					
volume of water needing disposal at closure	2,270	gpm (24 hr)	4,000	gpm (24 hr)	capacity of Stillwater Mine percolation ponds

The hydraulic load for Option 2 is within the capacity of the Hertzler Ranch LAD and the Stillwater Mine percolation ponds and can be managed.

Input Parameters for Hertzler Ranch Ground Water Calculations			**Source of Data**
depth of aquifer, **D**	15	ft	allowed by 17.30.517(d)
hydraulic conductivity, $\mathbf{k_1}$ from LAD storage pond	25	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper LAD	300	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003

Appendix E
DEQ 2012

hydraulic conductivity, **k_3** and **k_5** from lower LAD	600	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, **k_4** from tailings impoundment	2	ft/d	from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
gradient, **i**	0.01		estimated, from Hertzler Tailings Impoundment Seepage Analysis Hydrometrics 2003
width of source (Hertzler Ranch LAD storage pond liner leakage)	10	ft	assumed width based on point seep, Hydrometrics 2003
width of LAD storage pond liner leakage mixing zone, **W_1**	167	ft	width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°	allowed by 17.30.517(d)
length of LAD storage pond liner leakage area, **L_1**	1,800	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map
length upper LAD, **L_2**	4,800	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of upper LAD (pivots P3 and P7)	2,700	ft	SMC Annual Report 2010
width of Upper LAD mixing zone **W_2**	3,120	ft	width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of lower LAD, **L_3**	5,200	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map

width of Lower LAD at pivot P4	1,610	ft	personal communication R Weimer 3/17/2009
Width of Lower LAD mixing zone **W_3**	2,065	ft	personal communication R Weimer 2/18/2009
width of source (Hertzler Ranch tailings impoundment liner leakage)	10	ft	assumed width based on point seep, Hydrometrics 2003
width of mixing zone below Hertzler Ranch tailings impoundment liner leakage **W_4**	124	ft	width of source + (tan 5 * length) allowed by 17.30.517(d)
length of W_4 zone, **L_4**	1,300	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of Mixing Zone to Stillwater River **W_5**	2,215	ft	width of source + (tan 5 * length) allowed by 17.30.517(d)
length below lower LAD, **L_5**	3,600	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width below lower LAD	1,900	ft	from Hertzler Tailings Impoundment Seepage Analysis 2003 map
cross sectional area of aquifer, **A_1**	2,510	ft^2	D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_2**	46,794	ft^2	D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_3**	30,969	ft^2	D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_4**	1,855	ft^2	D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_5**	33,221	ft^2	D * W, allowed by 17.30.517(d)
Q_1 $=k_1iA_1$, ground water available for mixing	628	ft^3/d	calculation per 17.30.517(d)
Q_2 $=k_2iA_2$, ground water available for mixing	140,383	ft^3/d	calculation per 17.30.517(d)
Q_3 $=k_2iA_2$, ground water available for mixing	185,813	ft^3/d	calculation per 17.30.517(d)
Q_4 $=k_2iA_2$, ground water available for mixing	37	ft^3/d	calculation per 17.30.517(d)
Q_5 $=k_2iA_2$, ground water available for mixing	199,325	ft^3/d	calculation per 17.30.517(d)

Total Nitrogen loading at Stillwater Mine					**all 2,020 gpm adit plus 250 gpm Stillwater tailings waters are disposed at the Stillwater Mine percolation ponds; closure would require more than 120 days to complete due to the volumes of water in the tailings impoundments**
flow rate of **east-side adit** flow rate at closure (2011)	370	gpm (24 hr)	1,650	gpm (24 hr)	**west-side adit** flow rate at closure
east-side adit water **Total Nitrogen concentration**	0.2	mg/L	4.1	mg/L	treated concentration of adit based on BTS system capabilities; 3-year average
contribution of **east-side adit water** to Stillwater River total nitrogen load at Stillwater Mine	0.9	lbs/day	4.3	mg/L	treated tailings water TN concentration based on 92% BTS treatment efficiency (2011 SMC database)
contribution of **Stillwater East-Side Waste Rock** nitrogen load from percolating precipitation (see metals technical memo Appendix E)	0	lbs/day	250	gpm (24 hr)	Stillwater tailings waters pumping rate at closure
Nitrogen Load from **west-side adit water plus Stillwater tailings water**	94	lbs/day	**147**	days	time to dewater the Stillwater tailings impoundment
Daily total nitrogen load discharged at Stillwater Mine during closure	**95**	lbs/day	**13,962**	lbs	**total nitrogen load discharged at the Stillwater Mine percolation ponds during closure**

This load of total nitrogen at Stillwater Mine complies with the MPDES permit limit of 100 lbs/day to prevent nuisance aquatic organisms at a streamflow equivalent to the $7Q_{10}$.

Ground Water total nitrogen Calculation Input Parameters for the Stillwater Mine	**these calculations have been made to evaluate ground water concentrations within the mixing zone when the total nitrogen load approaches the maximum MPDES permit total nitrogen limit (100 lbs/day)**

Appendix E
DEQ 2012

depth of aquifer, **D**	15 ft		Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
hydraulic conductivity east side percolation ponds, $\mathbf{k_{SVR}}$	4076 ft/day		SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_{E}}$	539 ft/day		SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006 ft/ft		Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, $\mathbf{L_{SVR}}$	500 ft		2008 MPDES Permit page 3
width of mixing zone at downgradient extent, $\mathbf{W_{SVR}}$	507 ft		2008 MPDES Permit page 3
length of mixing zone, $\mathbf{L_{E}}$	2,000 ft		2008 MPDES Permit page 4
width of mixing zone at downgradient extent, $\mathbf{W_{E}}$	650 ft		2008 MPDES Permit page 4
cross sectional area of aquifer, $\mathbf{A_{SVR}}$	7,605 ft		D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_{E}}$	9,750 ft		D * W, allowed by 17.30.517(d)
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing calculation per 17.30.517(d)	185,988 ft^3/d	71,230 ft^3/d	**east-side adit** flow rate at closure (2011)
$\mathbf{Q_{E}=k_{E}iA_{E}}$, ground water available for mixing calculation per 17.30.517(d)	31,532 ft^3/d	317,647 ft^3/d	**west-side adit** flow rate at closure (2011)
median ambient TN concentration in ground water at MW-10A Stillwater Mine, $\mathbf{C_A}$	0.1 mg/L	48,128 ft^3/d	Stillwater tailings waters pumping rate at closure
projected ground water total nitrogen concentration at end of Stillwater East Side Percolation Pond mixing	**2.8** mg/L		average concentration of total nitrogen from percolation of half the load of west-side adit waters, plus treated Stillwater tailings waters plus east side adit waters
projected ground water total nitrogen concentration at end of Stillwater Valley Ranch Percolation Pond mixing	**2.5** mg/L		cumulative concentration of total nitrogen from percolation into east-side ponds plus remaining load of west-side adit waters at end of Stillwater Valley Ranch mixing zone

The concentration of total nitrogen at the edge of the mixing zone meets the DEQ-7 ground water criterion of 10 mg/L.

Stillwater River TN concentration below Stillwater Mine					these calculations have been made to evaluate surface water concentrations as a result of discharges from the mixing zone when the total nitrogen load approaches the maximum MPDES permit total nitrogen limit (100 lbs/day)
receiving streamflow, **Q_s**	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs
receiving stream total nitrogen ambient concentration, **C_s**	0.3	mg/L			median ambient total nitrogen concentration at SMC-1A 1986-2008 SMC monitoring data, based on the MPDES permit for Stillwater Mine; ambient total inorganic nitrogen concentration is 0.06 mg/L
ground water discharge volume, **Q_d**	606,396	ft^3/d	7.0	cfs	ground water discharge to stream in cubic feet per second
discharge concentration to Stillwater River, **C_d**	2.5	mg/L			total nitrogen concentration of ground water just prior to discharge to Stillwater River
projected Stillwater River total nitrogen concentration at Stillwater Mine at the $7Q_{10}$ streamflow	**0.7**	**mg/L**			

The concentration of total nitrogen in the Stillwater River at a $7Q_{10}$ streamflow at the Stillwater Mine is projected to be less than the 1 mg/L MPDES permitted surface water criterion to protect against nuisance algal growth. The total load in this option approaches the maximum permitted total nitrogen discharge to ground and surface water. The resulting concentrations in ground water are below the DEQ-7 ground water criterion of 10 mg/L. No further ground water or surface water concentration calculations will be made if the discharge meets the MPDES load limits.

Input parameters and assumptions for Total Nitrogen calculations at Hertzler Ranch					Land application disposal of 201 MG of Hertzler Ranch Tailings impoundment waters and 105 MG of Hertzler Ranch LAD storage pond waters
Total Nitrogen concentration in ambient ground water (HMW-4 SMC Monitoring Data), **C_A**	0.2	mg/L	**35.6**	mg/L	weighted average concentration of mixed LAD storage pond water and Hertzler Ranch tailings waters
concentration of Total Nitrogen in Hertzler Ranch LAD storage pond liner leakage, **C_1**	1.8	mg/L	161,230	gpm (12 hr)	for 12-hour application rate (720 min/day) upper LAD
concentration of Total Nitrogen in upper and lower LAD discharge, post plant uptake (80% credit), **C_2, C_3**	7.1	mg/L	141,979	gpm (12 hr)	for 12-hour application rate (720 min/day) lower LAD
Total Nitrogen concentration in Hertzler Ranch tailings impoundment liner leakage (equal to impoundment underdrain concentration), **C_4**	4	mg/L	9,626	ft^3/d	pivot P1; **100** gpm for 12 hour application rate
volume upper LAD Discharge; P1, P2, P3, P7; assume 30% evaporates, **V_2**	112,861	ft^3/d	31,283	ft^3/d	pivot P2: **325** gpm for 12 hour application rate
volume of Hertzler Ranch tailings impoundment liner leakage (1 gpm), **V_4**	193	ft^3/d	96,257	ft^3/d	pivot P3; **1,000** gpm for 12 hour application rate
volume of Hertzler Ranch LAD storage pond liner leakage (1 gpm), **V_1**	193	ft^3/d	62,567	ft^3/d	pivots P4; **650** gpm for 12 hour application rate
volume lower LAD discharge: P4, P5, P6 assume 30% evaporates, **V_3**	99,385	ft^3/d	60,160	ft^3/d	pivots P5; **625** gpm for 12 hour application rate
daily total nitrogen load to ground water at closure at Hertzler Ranch	**145**	lbs/day	19,251	ft^3/d	pivot P6; **200** gpm for 12 hour application rate
total nitrogen load disposed at Hertzler Ranch during closure	**17,363**	lbs	24,064	ft^3/d	pivot P7; **800** gpm for 12 hour application rate
total nitrogen load disposed at Hertzler Ranch per acre during closure	**54**	lbs/ac	319.7	ac	area of LAD at Hertzler Ranch

Ground Water total nitrogen concentrations at Hertzler Ranch		**Land application disposal of 201 MG of Hertzler Ranch Tailings impoundment waters and 105 MG of Hertzler Ranch LAD storage pond waters**	
ground water nitrogen concentration area $\mathbf{Z_1}$	0.6 mg/L		loading calculation for Ground Water zone Z_1
ground water nitrogen concentration area $\mathbf{Z_2}$	3.3 mg/L		loading calculation for Ground Water zone Z_2
ground water nitrogen concentration area $\mathbf{Z_4}$	3.4 mg/L		loading calculation for Ground Water zone Z_4
projected ground water Total Nitrogen concentration in $\mathbf{Z_3}$ from Z_1, Z_2, Z_3, Z_4, $\mathbf{C_d}$	**2.9 mg/L**		concentration at compliance point HMW-10 (1992 Hertzler Ranch EIS)
ground water Total Nitrogen concentration in $\mathbf{Z_5}$ from upgradient sources (Z_1, Z_2, Z_3, Z_4)	2.2 mg/L		projected ground water concentration prior to discharge to Stillwater River

The total nitrogen concentration in ground water at Hertzler Ranch meets the DEQ-7 ground water criterion of 10 mg/L.

Stillwater River TN concentration below Hertzler Ranch		**Land application disposal of 201 MG of Hertzler Ranch Tailings impoundment waters and 105 MG of Hertzler Ranch LAD storage pond waters**	
receiving streamflow, $\mathbf{Q_s}$	3,628,800 ft^3/d	42 cfs	$7Q_{10}$ at the mine site is 31.2 cfs; estimated $7Q_{10}$ below Hertzler Ranch LAD
receiving stream ambient total nitrogen concentration, $\mathbf{C_s}$	0.35 mg/L		median ambient total nitrogen concentration at SMC-12A 1995-2008 SMC monitoring data, based on the MPDES permit for Stillwater Mine; ambient TIN concentration is 0.14 mg/L
ground water discharge volume, $\mathbf{Q_d}$	738,818 ft^3/d	8.6 cfs	ground water discharge to stream in cubic feet per second
discharge concentration to Stillwater River, $\mathbf{C_d}$	2.2 mg/L		
projected Stillwater River nitrogen concentration below Hertzler Ranch at $7Q_{10}$	**0.7 mg/L**		

The total nitrogen concentration in the Stillwater River below Hertzler Ranch is less than 1.0 mg/L.

Proposed Alternative 2A Option 1, 1,302 gpm - The 370 gpm of untreated east-side adit water would be disposed of in the east side percolation ponds. The 932 gpm west-side adit water would be mixed and treated with 600 gpm Stillwater tailings water and routed to Hertzler Ranch LAD storage pond containing 105 MG of treated adit water for disposal with 201 MG of Hertzler Ranch tailings waters. All these waters would be routed for disposal at the Hertzler Ranch LAD area over a 120-day LAD season.

Hydraulic Loading to Hertzler Ranch LAD		**1,215** gpm (12 hr)	rate to dewater Hertzler Ranch storage pond in one LAD season
length of LAD season	120 days	**2,175** gpm (12 hr)	rate to dewater Hertzler Ranch tailings impoundment in one LAD season
volume of water needing disposal in one LAD season	**644** MG	**320** MG	capacity of Herzler Ranch LAD system (2011)

The hydraulic load for Option 1 of 53 MG Stillwater tailings waters mixed and treated with 1,650 gpm west-side adit water and routed to the Hertzler Ranch LAD storage pond containing 105 MG for disposal with 201 MG of untreated Hertzler Ranch tailings waters cannot be managed at Hertzler Ranch during one LAD season. Other options would have to be implemented such as disposing of some of the treated waters at the Stillwater Mine percolation ponds or extending the time frame for closure.

Appendix E
DEQ 2012

Proposed Alternative 2A Option 2, 1,302 gpm - The 370 gpm of untreated east-side adit water would be disposed in the east-side percolation ponds with 932 gpm west-side adit water would be mixed and treated with 600 gpm Stillwater tailings water and routed to the east percolation ponds for disposal. The 201 MG of untreated Hertzler Ranch tailings waters would be routed to the Hertzler Ranch LAD storage pond containing 105 MG of treated adit water for disposal at the Hertzler Ranch LAD area.

Hydraulic Loading to Hertzler Ranch LAD			1,215	gpm (12 hr)	rate to dewater Hertzler Ranch storage pond in one LAD season
length of LAD season	120	days	2,175	gpm (12 hr)	rate to dewater Hertzler Ranch tailings impoundment in one LAD season
volume of water needing disposal in one LAD season	306	MG	320	MG	capacity of Herzler Ranch LAD system (2011)
Hydraulic Loading to Stillwater Mine Percolation Ponds			370	gpm (24 hr)	east-side adit flow rate at closure (2011)
Volume of Stillwater tailings impoundment waters needing disposal based on BTS capacity	600	gpm (24 hr)	932	gpm (24 hr)	west-side adit flow rate at closure (2011)
volume of water needing disposal in one LAD season	1,902	gpm (24 hr)	4,000	gpm (24 hr)	capacity of Stillwater Mine percolation ponds

The hydraulic load for Option 2 is within the capacity of the Hertzler Ranch LAD and the Stillwater Mine percolation ponds and can be managed.

Ground Water concentrations at Hertzler Ranch

Stillwater River concentration below Hertzler Ranch

Land application disposal of 201 MG of Hertzler Ranch Tailings impoundment waters and 105 MG of Hertzler Ranch LAD storage pond waters

The impacts for this discharge were analyzed above and are the same. The applicable criteria are met in surface and ground water.

Total Nitrogen Loading to Stillwater Mine Percolation Ponds

1,532 gpm treated mixed west side adit waters plus Stillwater tailings waters plus 370 gpm untreated east side adit water percolated at Stillwater Mine

total nitrogen Loading to Stillwater Mine percolation ponds from adit and tailings waters Days 1-56	**77**	lbs/day	0.2	mg/L	nitrogen concentration of **east-side adit water** at closure (2011)
contribution of nitrogen from Stillwater East-Side Waste Rock to the total nitrogen load due to precipitation percolating through rock (See Appendix E Metals Technical Memo)	0	lbs/day	**4.1**	mg/L	nitrogen concentration of **west-side adit** water at closure (2011)
time to dewater the Stillwater tailings impoundment	**61**	days	**4.3**	mg/L	nitrogen concentration of **Stillwater tailings** waters based on BTS efficiency
daily Total Nitrogen load discharged to ground water at Stillwater Mine Site during closure	**4,747**	lbs/day			

This load of total nitrogen at Stillwater Mine complies with the MPDES total nitrogen permit limit of 100 pounds per day. No further analysis is required.

Spreadsheet 2B Nitrogen: *Revised* Proposed Action Alternative 2B East Boulder Mine Closure Nitrogen Analyses

Per KP 2000c, the preferential manner of disposal of treated adit and tailings waters is at the percolation pond and the mine LAD areas. For the East Boulder Mine, the calculations have been made according to the regulatory requirements of the existing MPDES permit, Montana Water Quality Act and Rules, and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the East Boulder Mine LAD area, any water that percolates below the root zone is assumed to immediately enter the ground water. No unsaturated zone was considered. To determine the concentration of total inorganic nitrogen (TIN) in ground water, it was assumed that all ground water flow parallels the East Boulder River and enters the river at a point at, or just downstream of, the permit boundary (near EBR-004/4A). Tailings impoundment waters would be treated and routed the same as adit water. East Boulder has a source-specific mixing zone at the mine per the MPDES permit for the percolation pond which includes the portion of the aquifer beneath the tailings impoundment. The MPDES permit does not allow evaporation or treatment credit when disposal is by percolation. The PoleCat evaporators and center pivots accomplish 30% evaporation in summer and winter. The scenarios evaluated

below consider the onset of closure in summer (Summer Closure) and in winter (Winter Closure), which are important with respect to the volume of water that may be disposed by land application (LAD or snowmaking LAD). The East Boulder Mine MPDES permit allows a monthly average 30 lbs/day total inorganic nitrogen limit on discharge. The water disposal design capacities are from CES 2008. The East Boulder Mine is required to maintain the 30 lbs/day or less average MPDES permit nitrogen limit, regardless of influent nitrogen concentrations. It is assumed that the existing treatment systems would be augmented to meet hydraulic load and contaminant requirements. All waters are treated prior to discharge. All treatment forms: evaporation, LAD, and BTS/Anox are totaled to meet the 30 lbs/day discharge limit The values listed below are projected values based on available data and limited spreadsheet modeling capability, and are reasonable estimates of what would be expected to occur during closure.

Proposed Alternative 2B, Option 1, 737 gpm: Up to 737 gpm (24 hr)adit water and 263 gpm (24 hr) East Boulder tailings would be treated in the BTX/Anox system for nitrogen then preferentially disposed at the mine percolation pond. The time frame for closure is 12 months.

For all analyses in this sheet:

BTS/Anox system capacity	**1,000**	gpm	**737**	gpm (24 hr)	adit flow rate at closure
Percolation pond capacity	**1,105**	gpm	**263**	gpm (24 hr)	tailings flow rate at closure; fixed by BTS/Anox system treatment rate
			0.4	mg/L	treated total inorganic nitrogen concentration of adit waters based on 3-year average BTS/Anox treatment rate (2009 to 2011)
influent total inorganic nitrogen concentration of adit and tailings waters	**47.8**	mg/L	**3.8**	mg/L	Current BTS/Anox 92% treatment efficiency for tailings water (2011)
			1.3	mg/L	weighted average post BTS/Anox concentration of adit water and tailings water
East Boulder Hydraulic Loading Input Parameters, closure			**259**	days	time to dewater the tailings impoundment at above rate
East Boulder Tailings Impoundment discharge volume includes 5 MG tailings mass waters (KP 87, SMC 93 2011)	**98**	MG	46.6	acres	total area of East Boulder Mine LAD areas 2, 3-Upper, 4 and 6 *Summer LAD*
Days 1-259 total inorganic nitrogen load of treated adit plus tailings waters disposed at the percolation pond	**15.6**	lbs/day	32.7	acres	total area of East Boulder Mine LAD areas 3-Upper, 4 and 6 *Wiinter Snowmaking*
Days 260-365 total inorganic nitrogen load of treated adit water disposed at the percolation pond	**3.5**	lbs/day	**4,414**	lbs/yr	Days 1-365 total inorganic nitrogen load percolated to ground water

Percolation of up to 737 gpm (24 hr) treated adit waters with 263 gpm (24 hr) treated tailings waters would not exceed the hydraulic capacity of the East Boulder Mine percolation pond.

Disposal of 737 gpm treated adit and 263 gpm treated tailings waters using only percolation meets the MPDES 30 lbs/day total inorganic nitrogen limit for $7Q_{10}$ streamflow. Disposal of 737 gpm treated adit water would meet the MPDES 30 lbs/day total inorganic nitrogen limit for $7Q_{10}$ streamflow.

Proposed Alternative 2B, Option 2, 737 gpm: Maximize LAD treatment of total inorganic nitrogen for adit and tailings waters disposal at the East Boulder Mine LAD areas. Due to the adit flow rate, the agencies assume that all LAD areas (2, 3-Upper, 4, and 6) are constructed and operating. At a flow rate of 737 gpm (24 hr) plus disposal of 98 MG of tailings at 263 gpm (24 hr), the water would be managed using a combination of percolation and LAD. The time frame for closure is 12 months.

the input parameters for adit and tailings flow rates and concentrations are the same as above

East Boulder MPDES Permit Source-Specific (percolation pond) mixing zone calculations			365	days	time frame for closure
depth of aquifer, **D**	80	ft	120	days	length of LAD season
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	385	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to compliance wells EBMW-6 and EBMW-7, L_1	3,600	ft			MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3				MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW, Q_1	77,005	ft^3/d	400	gpm (24-hr)	MPDES Statement of Basis, p. 25-26
upgradient concentration of total inorganic nitrogen in ground water at WW-1, C_A	0.15	mg/L			MPDES Statement of Basis, p. 24
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, W_1	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_1	55,977	ft^2			D * W, allowed by 17.30.517(d)

East Boulder Hydraulic Load Input Parameters, closure			**Dispose of the maximum amount of treated adit plus tailings waters at the mine LAD areas, then percolate any remaining waters. The volume of mixed treated water disposed at the LAD areas will depend on the timing of onset of Closure**		
East Boulder Tailings Impoundment discharge volume	**98**	MG	**259**	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**263**	gpm (24-hr)	**526**	gpm (12-hr)	rate to dewater the impoundment
East Boulder Adit Flow rate	**737**	gpm (24-hr)	**1,474**	gpm (12-hr)	Adit Flow rate
total combined flow rate of adit plus East Boulder tailings waters	**1,000**	gpm (24-hr)	**2,000**	gpm (12-hr)	total combined flow rate of adit plus East Boulder tailings waters
Summer LAD Area 6 maximum hydraulic load	**56,406**	**ft^3/d**	**586**	gpm (12-hr)	evaporator maximum flow rate, 10.2 ac (CES 2008)
Summer LAD Area 4 maximum hydraulic load	26,952	ft^3/d	280	gpm (12-hr)	evaporator maximum flow rate, 11.2 ac (CES 2008)
Summer LAD Area 3 Upper maximum hydraulic load	26,952	ft^3/d	280	gpm (12-hr)	evaporator maximum flow rate, 11.3 ac (CES 2008)
Summer LAD Area 2 maximum hydraulic load	29,262	ft^3/d	304	gpm (12-hr)	center pivot maximum flow rate, 13.9 ac (CES 2008)
Summer maximum hydraulic load: LAD areas 2, 3, 4, 6	**139,572**	**ft^3/d**	**1,450**	gpm (12-hr)	summer LAD total hydraulic load in gpm
Summer additional volume of water needing disposal, assume percolation	**52,941**	**ft^3/d**	**550**	gpm (12-hr)	assume additional water is percolated
Winter LAD Area 6 snowmaking maximum hydraulic load	**39,465**	**ft^3/d**	**410**	gpm (12-hr)	snowmaker maximum flow rate, 10.2 ac (CES 2008)
Winter LAD Area 4 snowmaking maximum hydraulic load	7,701	ft^3/d	80	gpm (12-hr)	snowmaker maximum flow rate, 11.2 ac (CES 2008)
Winter LAD Area 3 Upper snowmaking maximum hydraulic load	7,701	ft^3/d	80	gpm (12-hr)	snowmaker maximum flow rate 11.3 ac (CES 2008)
Winter maximum snowmaking hydraulic load LAD areas 3, 4, 6	**54,866**	**ft^3/d**	**570**	gpm (12-hr)	total snowmaking rate on LAD areas 3-upper, 4, and 6 over 32.7 ac
Winter additional volume of water needing disposal	**137,647**	**ft^3/d**	**1,430**	gpm (12-hr)	assume additional water is percolated

The hydraulic load of 737 gpm treated adit waters plus 263 gpm treated East Boulder tailings impoundment waters exceeds the capacity of the East Boulder Mine LAD in both summer and winter; additional water management measures such as percolation must be used. If the East Boulder tailings impoundment is dewatered during summer, up to 275 gpm (24 hr) would be percolated. If the East Boulder tailings impoundment is dewatered during winter, up to 715 gpm (24 hr) would be percolated.

Nitrogen Load at East Boulder Mine LAD and Percolation combined	**Calculations based on maximum evaporator flow rate over a 120-day LAD season; assumes all 120 available days would be acceptable for snowmaking during winter season**

Summer **LAD average daily load** LAD areas 2, 3-Upper, 4, 6	**2.3** lbs/day	**0.9** lbs/day	***Winter*** **Snowmaking LAD average daily load LAD areas 3-Upper, 4, 6**	
LAD Area 6 flow rate (30% hydraulic evaporation, 80% nitrogen credit post plant uptake)	**0.9** lbs/day	**0.6** lbs/day	**LAD Area 6 snowmaking** rate (30% hydraulic evaporation, 80% nitrogen post snowmaking credit)	
LAD Area 4 flow rate (30% hydraulic evaporation, 80% nitrogen credit post plant uptake)	**0.4** lbs/day	**0.1** lbs/day	**LAD Area 4 snowmaking** rate (30% hydraulic evaporation, 80% nitrogen post snowmaking credit)	
LAD Area 3 Upper flow rate (30% hydraulic evaporation, 80% nitrogen credit post plant uptake)	**0.4** lbs/day	**0.1** lbs/day	**LAD Area 3-Upper snowmaking** rate (30% hydraulic evaporation, 80% nitrogen post snowmaking credit)	
LAD Area 2 flow rate center pivot (30% hydraulic evaporation, 80% nitrogen credit post plant uptake)	**0.5** lbs/day	**0** lbs/day	no snowmaking at LAD Area 2; center pivots only--no evaporators installed	
daily total inorganic nitrogen **percolation load** during ***summer LAD*** season	**3.9** lbs/day	**20.1** lbs/day	**daily** total inorganic nitrogen **percolation load** during ***Winter Snowmaking LAD*** season	
daily Summer LAD plus percolation load during LAD season	**6.1** lbs/day	**21.0** lbs/day	**daily Winter Snowmaking LAD plus percolation load during LAD season**	
Summer CLOSURE total inorganic nitrogen Load from LAD to ground water	**272** lbs/yr	**107** lbs/yr	**Winter CLOSURE total inorganic nitrogen Load from Snowmaking to ground water**	
Summer CLOSURE total inorganic nitrogen Load to percolation	**891** lbs/yr	**1,715** lbs/yr	**Winter CLOSURE total inorganic nitrogen Load to percolation**	
Total Summer CLOSURE Load (LAD plus percolation)	**1,162** lbs/yr	**1,822** lbs/yr	**Total Winter CLOSURE Load (Snowmaking plus percolation)**	

The total inorganic nitrogen load produced from 737 gpm treated adit water and 263 gpm treated tailings waters during a closure that commenced in either summer or winter meet the MPDES permit 30 lbs/day total inorganic nitrogen limit at the mine.

Ground Water Inputs Beneath the East Boulder Mine LAD area, at Closure		**Disposal of up to 737 gpm (24 hr) treated adit water plus 263 gpm (24 hr) treated tailings waters at the maximum rates, with percolation of the excess treated mixed water.**	
depth of aquifer, $\mathbf{D_2}$	15 ft		allowed by 17.30.517(d)
hydraulic conductivity, **k**	75 ft/d		MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026 ft/ft		MPDES Statement of Basis, p. 25-26
width of source	700 ft		MPDES Statement of Basis, p. 25-26
length from perc pond to river, $\mathbf{L_2}$	2,900 ft		MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693 tan 5°		allowed by 17.30.517(d)
width of zone, $\mathbf{W_2}$	954 ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_2}$	14,303 ft^2		D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing $\mathbf{Q_2}$=kiA	27,891 ft^3/d	145 gpm (24-hr)	calculation per 17.30.517(d);
2011 operational concentration of total inorganic nitrogen in ground water below beneath tailings impoundment that flows to LAD area EBMW-6 and EBMW-7, $\mathbf{C_2}$	**15.0** mg/L		SMC Database 2011
concentration of total inorganic nitrogen in mixed waters needing disposal	1.3 mg/L		treated total inorganic nitrogen concentration of adit waters based on MPDES 30 lbs/day limit, flow rate
upgradient concentration of total inorganic nitrogen in ground water at WW-1, $\mathbf{C_A}$	0.2 mg/L		MPDES Statement of Basis, p. 24
assumed East Boulder tailings impoundment leak, $\mathbf{V_{TI}}$	193 ft^3/d	1 gpm (24-hr)	equivalent to the assumed leak at the Hertzler Ranch LAD for the Hertzler Ranch tailings impoundment

total inorganic nitrogen concentration of tailings impoundment water, $\mathbf{C_{TI}}$	4	mg/L		SMC Hertzler underdrain total inorganic nitrogen concentration, SMC monitoring data
Volume of water: summer LAD, $\mathbf{V_s}$	97,701	ft^3/d	508 gpm (24-hr)	summer volume from LAD areas 2, 3-Upper, 4, 6
Volume of water percolated in summer, $\mathbf{V_{Sp}}$	52,941	ft^3/d	275 gpm (24-hr)	
Volume of water: winter snowmaking, $\mathbf{V_{Ws}}$	38,406	ft^3/d	200 gpm (24-hr)	winter volume from LAD areas 3, 4, 6; adit plus tailings waters to capacity (evaporation credit taken)
Volume of water percolated in winter, $\mathbf{V_{Wp}}$	137,647	ft^3/d	715 gpm (24-hr)	winter volume from percolation; additional water
projected summer total inorganic nitrogen concentration of ground water, Z_s	**2.1**	**mg/L**		projected **summer** concentration of total inorganic nitrogen in ground water just prior to discharging to East Boulder River (at SP-11) days 1-120
projected winter total inorganic nitrogen concentration of ground water, Z_W	**2.3**	**mg/L**		projected **winter** concentration of total inorganic nitrogen in ground water just prior to discharging to East Boulder River (at SP-11) days 1-120

The projected total inorganic nitrogen concentrations in ground water from the disposal of 737 gpm (24 hr) treated adit water and 263 gpm (24 hr) treated tailings waters in both summer and winter would meet the DEQ-7 ground water standard of 10 mg/L.

Appendix E
DEQ 2012

East Boulder River Concentration below LAD area at Closure		**Disposal of up to 737 gpm (24 hr) treated adit water plus 263 gpm (24 hr) treated tailings waters at the maximum rates, with percolation of the excess treated mixed water.**		
receiving streamflow, $\mathbf{Q_s}$	432,000 ft^3/d	5.0 cfs		7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, $\mathbf{C_s}$	0.2 mg/L			MPDES Statement of Basis, p. 24
discharge volume through ground water, $\mathbf{Q_{ds}}$	255,730 ft^3/d	3.0 cfs		summer discharge volume through ground water in cubic feet per second
discharge volume through ground water, $\mathbf{Q_{dw}}$	281,142 ft^3/d	3.3 cfs		winter discharge volume through ground water in cubic feet per second
projected summer discharge concentration to East Boulder River, $\mathbf{C_{ds}}$	2.1 mg/L			based on summer concentration of ground water near SP-11, days 1-120
projected winter discharge concentration to East Boulder River, $\mathbf{C_{dw}}$	2.3 mg/L			based on winter concentration of ground water near SP-11, days 1-120
East Boulder River projected total inorganic nitrogen concentration in Summer, days 1-120	**0.9 mg/L**			projected total inorganic nitrogen concentration in the East Boulder River at EBR-004/004A for the summer closure scenario, days 1-120
East Boulder River projected total inorganic nitrogen concentration in Winter, days 1-120	**1.0 mg/L**			projected total inorganic nitrogen concentration in the East Boulder River at EBR-004/004A in winter closure scenario, days 1-120

The projected total inorganic nitrogen concentration produced in the East Boulder River during this summer closure scenario would meet the MPDES 1 mg/L total inorganic nitrogen limit for 7Q_{10} streamflow. The projected total inorganic nitrogen concentration produced in the East Boulder River during this winter closure scenario would be at the 1 mg/L total inorganic nitrogen limit in the East Boulder River for 7Q10 streamflow.

Proposed Alternative 2B, Option 1, 150 gpm: Up to 150 gpm (24-hr) treated adit water flow and 232 gpm (24-hr) treated tailings water would be percolated at the East Boulder Mine. The time frame for closure would be 12 months.

assumed BTS/Anox capacity at lower adit flow rate	**500** gpm (24-hr)	**150** gpm (24-hr)	adit flow rate at closure
Current BTS/Anox 92% treatment efficiency for tailings water (2011)	**3.8** mg/L	**350** gpm (24-hr)	tailings flow rate at closure; fixed by BTS/Anox system treatment rate
weighted average post BTS/Anox concentration of adit water and tailings water	**2.8** mg/L	**0.4** mg/L	treated total inorganic nitrogen concentration of adit waters based on 3-year average BTS/Anox treatment rate (2009 to 2011)
East Boulder Hydraulic Loading Input Parameters, closure			
East Boulder Tailings Impoundment discharge volume	**98** MG	**194** days	time to dewater the tailings impoundment at given rate
rate to dewater East Boulder tailings impoundment	**350** gpm (24-hr)	**700** gpm (12-hr)	rate to dewater the impoundment
East Boulder adit flow rate	**150** gpm (24-hr)	**300** gpm (12-hr)	adit flow rate
total flow rate to BTS/Anox	**500** gpm (24-hr)	**2,210** gpm (12-hr)	capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4
Days 1-194 total inorganic nitrogen load of treated adit plus tailings waters disposed of at the percolation pond	**16.8** lbs/day	365 days	time frame for closure
Days 194-365 total inorganic nitrogen load of treated adit water disposed of at the percolation pond	**0.7** lbs/day	**3,386** lbs/yr	

Percolation of up to 150 gpm (24 hr) treated adit waters with 350 gpm (24 hr) treated tailings waters would not exceed the hydraulic capacity of the East Boulder Mine percolation pond.

Disposal of up to 150 gpm (24-hr) treated adit and 350 gpm (24-hr) tailings waters using only percolation would meet the MPDES 30 lbs/day total inorganic nitrogen limit days 1-194. Disposal of up to 150 gpm (24-hr) treated adit water using only percolation would meet the MPDES 30 lbs/day total inorganic nitrogen limit days 195-365. No further analysis is necessary.

Spreadsheet 2B Salts: *Revised* Proposed Action Alternative 2B East Boulder Mine Closure Salinity Analyses

Per KP 2000c, the preferential manner of disposal of treated adit and tailings waters is at the percolation pond and the mine site LAD areas. For the East Boulder Mine, the calculations have been made according to the regulatory requirements of the existing MPDES permit, Montana Water Quality Act and Rules, and Federal Clean Water Act regarding ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the East Boulder Mine LAD area, any water that percolates below the root zone is assumed to immediately enter the ground water. The aquifer beneath the East Boulder mine has been designated as Class I Beneficial Use, and has an electrical conductivity (EC) less than 1,000 µmhos/cm. The MPDES permit does not set a limit for TDS or EC in surface water. The so the calculations assume that salts are concentrated by evaporation. The calculations do not allow evaporation credit for percolation. The BTS/Anox system does not treat salts. The salts load is calculated from the TDS concentration. These calculations allow LAD evaporation credit for water volume only. No treatment occurs by evaporation for salts. The tailings impoundment waters would be mixed and routed with the adit water. For hydraulic volume calculations, the PoleCat evaporators and center pivots both accomplish 30% evaporation in summer. PoleCat snowmakers accomplish 30% evaporation in winter. The water disposal design capacities cited below are from KP 2000c and CES 2008. The concentrations of TDS or measured EC at spring SP-11 (downgradient of East Boulder Mine percolation and LAD areas) are assumed to be representative of the aquifer affected by applied mine waters. The agencies assumed a 1 gpm (24 hr) leak in the tailings impoundment, as in the Stillwater Mine Alternatives.

Proposed Alternative 2B, Option 1, 737 gpm: Up to 737 gpm (24 hr) adit water and 263 gpm (24 hr) East Boulder tailings would be treated in the BTS/Anox system for nitrogen then preferentially disposed at the mine percolation pond. The time frame for closure is 12 months.

adit flow rate at closure	**737**	gpm (24-hr)	**605**	mg/L	median **adit** TDS concentration derrived from SMC monitoring data (2011)
tailings water flow rate at closure	**263**	gpm (24-hr)	**746**	mg/L	median **tailings waters** TDS concentration derived from SMC monitoring data (2011)
length of LAD season/snowmaking season (assumes conditions are acceptable for snowmaking every day of season)	**120**	days	**642**	mg/L	weighted average TDS concentration of **adit plus tailings waters** at closure
East Boulder MPDES Source-Specific (percolation pond) mixing zone input parameters			365	days	length of closure
depth of aquifer, **D**	80	ft			MPDES Statement of Basis, p. 25-26
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	385	ft			MPDES Statement of Basis, p. 25-26
length from perc pond to wells, **L_1**	3,600	ft			MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3				MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW, **Q_1**	400	gpm (24-hr)	77,005	ft^3/d	MPDES Statement of Basis, p. 25-26
upgradient/background concentration of TDS in ground water at WW-1, **C_A**	106	mg/L	165	µmhos/cm	SMC Monitoring Data
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, **W_1**	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, **A_1**	55,977	ft^2			D * W, allowed by 17.30.517(d)
East Boulder Hydraulic Loading Input Parameters, closure			**259**	days	time to dewater the tailings impoundment
East Boulder Tailings impoundment discharge volume	**98**	MG	**526**	gpm (12-hr)	rate to dewater the impoundment
24 hr rate to dewater East Boulder tailings impoundment	**263**	gpm (24-hr)	141,882	ft^3/d	volume of adit water in cubic feet per day
volume of water from East Boulder Tailings impoundment in cubic feet per day	50,631	ft^3/d	**1,474**	gpm (12-hr)	adit flow rate
East Boulder Adit Flow rate	**737**	gpm (24-hr)	**2,000**	gpm (12-hr)	total flow rate to BTS/Anox
total flow rate to BTS/Anox for nitrogen treatment	**1,000**	gpm (24-hr)	**2,210**	gpm (12-hr)	capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4

Percolation of up to 737 gpm (24 hr) treated adit waters with 263 gpm (24 hr) treated tailings waters would not exceed the hydraulic capacity of the East Boulder Mine percolation pond.

Salts load of treated, mixed adit plus tailings waters disposed of at the percolation pond (days 1-259)	**7,705**	lbs/day			**Option 1: Up to 737 gpm (24 hr) adit water and 263 gpm (24 hr) East Boulder tailings would be treated in the BTX/Anox system for nitrogen then preferentially disposed of at the mine site percolation pond.**
Salts load of treated adit water disposed of at the percolation pond (days 260-365)	**5,351**	lbs/day	**2,562,210**	lbs/yr	**Total salts load during 365 days of closure**
Ground Water Mixing Inputs Below East Boulder Mine LAD area, at Closure					**Option 1: Up to 737 gpm (24 hr) adit water and 263 gpm (24 hr) East Boulder tailings would be treated in the BTX/Anox system for nitrogen then preferentially disposed at the mine site percolation pond.**
depth of aquifer, **D_2**	15	ft			allowed by 17.30.517(d)

hydraulic conductivity, **k**	75 ft/d		MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026 ft/ft		MPDES Statement of Basis, p. 25-26
width of source	700 ft		MPDES Statement of Basis, p. 25-26
length from perc pond to river, $\mathbf{L_2}$	2,900 ft		MPDES Statement of Basis, p. 25-26
angle of dispersion	0.08742169 tan 5°		allowed by 17.30.517(d)
width of zone, $\mathbf{W_2}$	954 ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_2}$	14,303 ft^2		D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing $\mathbf{Q_2}$=kiA	27,891 ft^3/d	145 gpm (24-hr)	calculation per 17.30.517(d)
weighted concentration of salt in mixed adit plus tailings waters	**642** mg/L		calculated above
operational concentration of TDS in ground water downgradient of percolation pond at EBMW-6 and EBMW-7, $\mathbf{C_2}$	**515** mg/L	803 µmhos/cm	Operational value of salts in ground water in EBMW-6 and EBMW-7 (2011)
receiving stream baseline ambient concentration at EBR-001, $\mathbf{C_S}$	**49** mg/L	76 µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
assumed East Boulder tailings impoundment leak, $\mathbf{V_{TI}}$	193 ft^3/d	1 gpm (24-hr)	equivalent to the assumed leak at the Hertzler Ranch LAD for the Hertzler Ranch tailings impoundment
TDS concentration of tailings impoundment water, $\mathbf{C_{TI}}$	**746** mg/L	1,164 µmhos/cm	tailings waters EC calculated from TDS that was derived from SMC monitoring data
Volume of water: adit plus tailings waters percolated, $\mathbf{V_p}$	192,513 ft^3/d	1,000 gpm (24-hr)	Volume of water to be percolated
days 1-259 concentration of salt in ground water at Z_p	492 mg/L	**767** µmhos/cm	projected concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11) for days 1-259
days 260-365 concentration of salt in ground water at Z_p	437 mg/L	**681** µmhos/cm	projected concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11) for days 260-365

Percolation of up to 737 gpm (24 hr) treated adit water with 263 gpm (24 hr) treated tailings waters is projected to produce an Electrical Conductivity (EC) in ground water less than the 1,000 µmhos/cm Class I Beneficial use criterion during closure.

East Boulder River Concentration near EBR-004/4A		**Days 1-259, up to 737 gpm (24 hr) adit water and 263 gpm (24 hr) East Boulder tailings would be treated in the BTX/Anox system for nitrogen then preferentially disposed at the mine percolation pond. Days 260-365, up to 737 gpm (24 hr) treated adit water would be disposed at the mine percolation pond.**	
receiving streamflow, $\mathbf{Q_s}$	432,000 ft^3/d	5.0 cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, $\mathbf{C_s}$	49 mg/L	76 µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
days 1-259 discharge volume of ground water, $\mathbf{Q_d}$	297,409 ft^3/d		hydraulic evaporative losses taken in volume calculations
days 260-365 discharge volume of ground water, $\mathbf{Q_d}$	246,971 ft^3/d		
Days 1-259 ground water discharge TDS concentration to East Boulder River, $\mathbf{C_d}$	492 mg/L	767 µmhos/cm	concentration of salt in ground water just prior to discharging to the East Boulder River
Days 260-365 ground water discharge TDS concentration to East Boulder River, $\mathbf{C_d}$	437 mg/L	681 µmhos/cm	concentration of salt in ground water just prior to discharging to the East Boulder River
East Boulder River TDS concentration below East Boulder Mine days 1-259	**229 mg/L**	358 µmhos/cm	projected salt concentration of East Boulder River after percolation of mixed, treated East Boulder adit and tailings waters days 1-259
East Boulder River TDS concentration below East Boulder Mine days 260-365	**190 mg/L**	296 µmhos/cm	projected salt concentration of East Boulder River after percolation of treated East Boulder adit water days 260-365

Proposed Alternative 2B, Option 2, 737 gpm: Maximize LAD treatment of total inorganic nitrogen for adit and tailings waters disposal at the East Boulder Mine LAD areas (salts are not treated by LAD). Due to the adit flow rate, the agencies assume that all LAD areas (2, 3-Upper, 4, and 6) are constructed and operating. Adit water at 737 gpm (24 hr) is disposed with 98 MG of tailings at 263 gpm (24 hr). The time frame for closure is 12 months.

EC of adit waters based on median TDS concentration	944 µmhos/cm	**605** mg/L	median adit TDS concentration derived from SMC monitoring data
EC of tailings waters based on median TDS concentration	1,164 µmhos/cm	**746** mg/L	median tailings waters TDS concentration derived from SMC monitoring data
weighted average EC of mixed treated adit plus tailings waters	1,002 µmhos/cm	**737** gpm (24-hr)	**adit** flow rate at closure
weighted average concentration of TDS in mixed treated adit plus tailings waters	**642** mg/L	**263** gpm (24-hr)	**tailings waters** pumping rate at closure
East Boulder Hydraulic Loading Input Parameters, closure		**Closure commences in Summer: LAD 725 gpm (24-hr) treated adit plus tailings waters and percolate 275 gpm (24-hr) treated adit plus tailings waters. Winter Closure: Snowmaking LAD 285 gpm (24-hr) treated adit plus tailings waters and percolate 715 gpm (24-hr) treated adit plus tailings waters.**	

Appendix E
DEQ 2012

East Boulder Tailings impoundment discharge volume	98 MG	259 days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**263** gpm (24-hr)	**526** gpm (12-hr)	rate to dewater the impoundment
volume of water from East Boulder Tailings impoundment per day	50,631 ft^3/d	46.6 ac	area of applied LAD; summer LAD season
East Boulder Adit Flow rate	**1,474** gpm (12-hr)	32.7 ac	area of applied LAD; winter snowmaking season
total combined flow (adit plus East Boulder tailings waters)	**2,000** gpm (12-hr)	120 days	length of time for LAD season, both summer and winter
Summer LAD Area 6 maximum hydraulic load	**586** gpm (12-hr)	**410** gpm (12-hr)	**Winter LAD Area 6 snowmaking maximum hydraulic load**
Summer LAD Area 4 maximum hydraulic load	280 gpm (12-hr)	80 gpm (12-hr)	Winter LAD Area 4 snowmaking maximum hydraulic load
Summer LAD Area 3 Upper maximum hydraulic load	280 gpm (12-hr)	80 gpm (12-hr)	Winter LAD Area 3 Upper snowmaking maximum hydraulic load
Summer LAD Area 2 maximum hydraulic load	304 gpm (12-hr)	0 gpm (12-hr)	LAD Area 2 is center pivot and cannot be used for snowmaking
Summer maximum hydraulic load , LAD areas 2, 3, 4, 6	**1,450** gpm (12-hr)	**570** gpm (12-hr)	**Winter maximum snowmaking hydraulic load, LAD areas 3, 4, 6**
Summer additional volume of water needing disposal	**550** gpm (12-hr)	**1,430** gpm (12-hr)	**Winter additional volume of water needing disposal**

The hydraulic load of 737 gpm adit waters plus 263 gpm East Boulder tailings impoundment waters exceeds the capacity of the East Boulder Mine LAD in both summer and winter; additional water handling measures such as percolation must be used. If the East Boulder tailings impoundment is dewatered during summer, up to 275 gpm (24 hr) would be percolated. If the East Boulder tailings impoundment is dewatered during winter, up to 715 gpm (24 hr) would be percolated.

Closure Summer LAD Salt load East Boulder Mine, LAD areas 2, 3, 4, 6	**5,959** lbs/day	**2,343** lbs/day	**Closure Winter Snowmaking LAD Salts load East Boulder Mine, LAD areas 3, 4, 6**
LAD Area 6 salts loading (30% hydraulic evaporation)	2,408 lbs/day	1,685 lbs/day	LAD Area 6 salts loading (30% hydraulic evaporation)
LAD Area 4 salts loading (30% hydraulic evaporation)	1,151 lbs/day	329 lbs/day	LAD Area 4 salts loading (30% hydraulic evaporation)
LAD Area 3-Upper salts loading (30% hydraulic evaporation)	1,151 lbs/day	329 lbs/day	LAD Area 3-Upper salts loading (30% hydraulic evaporation)
LAD Area 2 salts loading (30% hydraulic evaporation)	1,249 lbs/day	0 lbs/day	LAD Area 2 salts loading (30% hydraulic evaporation) center pivots cannot be used for snowmaking
Summer salts LAD total load	**715,104** lbs/yr	**281,110** lbs/yr	**Winter snowmaking LAD salts total load**
Summer closure salts load to ground water from percolation	**1,116,709** lbs/yr	**1,116,709** lbs/yr	**Winter closure salts load to ground water from percolation**
Summer LAD salts load per acre per year	**15,346** lbs/ac/y	**8,597** lbs/ac/yr	**Winter snowmaking LAD salts load per acre**
Summer LAD salts load per square foot per year	**0.4** $lbs/ft^2/y$	**0.2** $lbs/ft^2/y$	**Winter snowmaking LAD salts load per square foot per year**
Summer Closure Total Salts Load (LAD plus percolation)	**1,831,813** lbs/yr	**1,397,819** lbs/yr	**Total Winter Salts Load (Snowmaking LAD plus percolation)**

Closure commences in Summer: LAD 725 gpm (24-hr) treated adit plus tailings waters and percolate 275 gpm (24-hr) treated adit plus tailings waters.
Winter Closure: Snowmaking LAD 285 gpm (24-hr) treated adit plus tailings waters and percolate 715 gpm (24-hr) treated adit plus tailings waters.

Ground Water Mixing Inputs Below East Boulder Mine LAD area, at Closure			
volume of ground water flux available for mixing from MODFLOW, Q_1	400 gpm (24 hr)	106 mg/L	MPDES Statement of Basis, p. 25-26; background concentration of TDS in ground water at WW-1
Volume of ground water available for mixing Q_2=kiA	27,891 ft^3/d	145 gpm (24 hr)	calculation per 17.30.517(d)
concentration of salt in mixed adit plus tailings waters	642 mg/L	605 mg/L	median adit TDS concentration derived from SMC monitoring data
effective concentration of salt applied during Summer and Winter LAD (hydraulic evaporation; no salts treatment credit)	**917** mg/L		30% evaporation credit for both LAD and snowmaking LAD areas 2, 3-Upper, 4, 6
operational concentration of TDS in ground water below percolation pond at EBMW-6, C_2	**515** mg/L	803 µmhos/cm	calculated value of EC at EBMW-6 at closure based on SMC Monitoring Data from 2000-2007 (pre 2007 spill)
receiving stream baseline ambient concentration at EBR-001, C_A	49 mg/L	76 µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
Volume of water: summer LAD (hydraulic evaporation included), V_s	195,401 ft^3/d	725 gpm (24 hr)	Volume of water disposed in summer at LAD areas 2, 3, 4, 6
Volume of water: summer percolation, V_p	52,941 ft^3/d	275 gpm (24 hr)	Volume of water needing to be percolated (above summer LAD capacity)
Volume of water: winter snowmaking (hydraulic evaporation included), V_{W1}	38,406 ft^3/d	285 gpm (24 hr)	winter volume from LAD areas 3, 4, 6; maximum capacity
Winter volume of water applied: percolation, V_{W2}	52,941 ft^3/d	275 gpm (24 hr)	winter volume from percolation; additional water needing disposal
projected summer closure salt concentration in ground water from LAD and percolation days 1-120	572 mg/L	**892** µmhos/cm	projected **summer** concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11)
projected winter closure salt concentration in ground water from LAD and percolation days 1-120	468 mg/L	**729** µmhos/cm	projected **winter** concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11)

projected closure salt concentration in ground water from percolation days 121-365	439 mg/L	**685** µmhos/cm	projected concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11)

These Summer and Winter closure scenarios are projected to produce an EC in ground water less than the Beneficial Use criterion during closure, days 1-120. The projected closure salt concentration in ground water ffrom percolation days 121-365 is projected to produce an EC in ground water less than the Beneficial Use criterion.

East Boulder River Concentration near EBR-004/4A

Closure commences in Summer: LAD 725 gpm (24-hr) treated adit plus tailings waters and percolate 275 gpm (24-hr) treated adit plus tailings waters.
Winter Closure: Snowmaking LAD 285 gpm (24-hr) treated adit plus tailings waters and percolate 715 gpm (24-hr) treated adit plus tailings waters.

receiving streamflow, Q_s	432,000 ft^3/d	5 cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, C_s	49 mg/L	76 µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
summer discharge volume of ground water, days 1-120 Q_{ds}	294,618 ft^3/d	3.4 cfs	ground water discharge volume in cubic feet per second; hydraulic evaporative losses taken in volume calculations
winter discharge volume of ground water, days 1-120 Q_{dw}	184,722 ft^3/d	2.1 cfs	ground water discharge volume in cubic feet per second; hydraulic evaporative losses taken in volume calculations
closure discharge volume of ground water, days 121-365 Q_{dw}	246,778 ft^3/d	2.9 cfs	ground water discharge volume in cubic feet per second; hydraulic evaporative losses taken in volume calculations
summer discharge concentration to East Boulder River, days 1-120 C_{ds}	572 mg/L	892 µmhos/cm	projected **summer** concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11) days 1-120
winter discharge concentration to East Boulder River, days 1-120 C_{dw}	468 mg/L	729 µmhos/cm	projected **winter** concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11)
closure discharge concentration to the East Boulder River, days 121-365 , C_d	439 mg/L	685 µmhos/cm	projected concentration of salt (EC) in ground water just prior to discharging to East Boulder River (at SP-11) days 121-365
projected summer closure East Boulder River salt concentration, days 1-120	**261 mg/L**	407 µmhos/cm	projected **summer** concentration of salt (TDS) in the East Boulder River at EBR-004/004A from LAD and percolation of treated adit plus tailings waters days 1-120
projected winter closure East Boulder River salt concentration, days 1-120	**174 mg/L**	272 µmhos/cm	projected **winter** concentration of salt (TDS) in the East Boulder River at EBR-004/004A from LAD and percolation of treated adit plus tailings waters days 1-120
projected closure salt concentration in the East Boulder River days 121-365	**191 mg/L**	297 µmhos/cm	projected closure concentration of salt (TDS) in the East Boulder River at EBR-004/004A from percolation of treated adit water days 121-365

Proposed Alternative 2B, Option 1, 150 gpm: Up to 150 gpm (24 hr) adit water and 350 gpm (24 hr) East Boulder tailings waters would be mixed and treated in the BTS/Anox system for nitrogen. The mixed treated waters would be preferentially disposed at the East Boulder Mine percolation pond. The time frame for closure is 12 months.

median adit EC calculated from SMC monitoring data	943.8 µmhos/cm	605 mg/L	median adit TDS concentration derived from SMC monitoring data
median tailings waters EC calculated from SMC monitoring data	1,164 µmhos/cm	746 mg/L	median tailings waters TDS concentration derived from SMC monitoring data
capacity of BTS/Anox	500 gpm	**150** gpm (24-hr)	**adit** flow rate at closure
rate to dewater the impoundment	**700** gpm (12-hr)	**350** gpm (24-hr)	**tailings waters** pumping rate at closure
time to dewater the tailings impoundment	**194** days	704 mg/L	weighted average concentration of TDS in mixed treated adit plus tailings waters
East Boulder Hydraulic Loading Input Parameters, closure			
East Boulder Tailings impoundment discharge volume	98 MG	**2,210** gpm (12-hr)	capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4
rate to dewater East Boulder tailings impoundment	**350** gpm (24-hr)		
volume of water from East Boulder Tailings impoundment	67,380 ft^3/d	28,877 ft^3/d	volume of adit water in cubic feet per day
East Boulder Adit Flow rate	**150** gpm (24-hr)	**300** gpm (12-hr)	adit flow rate
total flow rate to BTS/Anox	**500** gpm (24-hr)	**1,000** gpm (12-hr)	total flow rate to percolation

The hydraulic load of 150 gpm adit waters plus 350 gpm East Boulder tailings impoundment waters can be managed at the East Boulder Mine percolation pond.

East Boulder MPDES Source-Specific (percolation pond) mixing zone calculations

Up to 150 gpm (24 hr) adit water and 350 gpm (24 hr) East Boulder tailings would be treated in the BTX/Anox system for nitrogen then preferentially disposed at the East Boulder Mine percolation pond.

volume of ground water flux available for mixing from MODFLOW, Q_1	400 gpm		MPDES Statement of Basis, p. 25-26
upgradient/background concentration of TDS in ground water at WW-1, C_A	106 mg/L	165 µmhos/cm	SMC Monitoring Data
Volume of water percolated, days 1-120 V_p	96,257 ft^3/d	**500** gpm (24 hr)	volume of percolated treated adit plus tailings waters, days 1-120
Volume of water percolated, days 121-365 V_p	28,877 ft^3/d	**150** gpm (24 hr)	volume of percolated treated adit water days 121-365
concentration of salt in ground water at end of mixing zone days 1-120, Z_s	438 mg/L	**683** µmhos/cm	projected salt concentration in ground water near EBMW-6

concentration of salt in ground water at end of mixing zone days 121-365, Z_s	242 mg/L	**378** µmhos/cm	projected salt concentration in ground water near EBMW-6
concentration of salt in ground water near SP-11 days 1-120	449 mg/L	**700** µmhos/cm	projected salt concentration in ground water near SP-11 just prior to discharge to the East Boulder River
closure concentration of salt in ground water near SP-11 days 121-365	320 mg/L	**500** µmhos/cm	projected salt concentration in ground water near SP-11 just prior to discharge to the East Boulder River

Throughout the closure period, the salt concentration (EC) in ground water from the percolation of 150 gpm (24 hr) treated adit water plus 350 gpm (24 hr) treated tailings water is projected to be less than the 1,000 µmhos/cm Beneficial Use Criterion.

East Boulder River Concentration near EBR-004/4A		**Up to 150 gpm (24 hr) adit water and 350 gpm (24 hr) East Boulder tailings would be treated in the BTX/Anox system for nitrogen then preferentially disposed at the East Boulder Mine percolation pond.**	
receiving streamflow, Q_s	432,000 ft³/d	5 cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, C_s	49 mg/L	76 µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
discharge volume of ground water days 1-120, Q_d	201,153 ft³/d	2.3 cfs	discharge volume of ground water in cubic feet per second, days 1-120
discharge volume of ground water days 121-365, Q_d	105,882 ft³/d	1.2 cfs	discharge volume of ground water in cubic feet per second, days 121-365
Concentration of ground water near SP-11, days 1-120 C_d	449 mg/L	700 µmhos/cm	projected salt concentration in ground water near SP-11 just prior to discharge to the East Boulder River
Concentration of ground water near SP-11, days 121-365 C_d	320 mg/L	500 µmhos/cm	projected salt concentration in ground water near SP-11 just prior to discharge to the East Boulder River
projected East Boulder River salt concentration days 1-120	**176 mg/L**	274 µmhos/cm	projected salt concentration in the East Boulder River near EBR-004/004A
projected East Boulder River salt concentration days 121-365	**102 mg/L**	159 µmhos/cm	projected salt concentration in the East Boulder River near EBR-004/004A

Spreadsheet 2C Salts: Proposed Action Alternative 2C Boe Ranch LAD System Operations and Closure Salinity Analyses

Per KP 2000c, if the Boe Ranch LAD were constructed it would be the preferred disposal option for treated adit water during operations and for treated adit and tailings waters at closure. The East Boulder Mine percolation pond would be used for contingency disposal of treated adit water during operations. Monitoring well RMW-3A is located at Boe Ranch down-gradient of the proposed LAD and is considered to represent ambient electrical conductivity (EC) values. Based on EC measurements at RMW-3A, the ground water at Boe Ranch LAD is designated as Class II Beneficial Use with an electrical conductivity criterion of 1,000 to 2,500 µSiemens/cm (equivalent to µmhos/cm). The baseline median concentrations of TDS in the East Boulder River were 270 mg/L at EBR-007 and 340 mg/L at EBR-008. At closure, all adit and East Boulder tailings waters would be treated for nitrogen through the BTS/Anox system then routed to Boe Ranch LAD storage pond all year and disposed through LAD pivots during the summer LAD season. For the Boe Ranch LAD, calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from

precipitation (recharge) was assumed. For the Boe Ranch LAD any water that percolates below the root zone is assumed to immediately enter the aquifer. It is assumed that the Boe Ranch LAD area would not have an MPDES permit. Salts are not treated in the BTS/Anox system or during LAD, so all concentrations of salt are expected to flush through the soil column then to ground water. Ground water flows beneath the LAD area and LAD storage pond, flows down-gradient where it is recharged by the Mason Ditch, then discharges to the East Boulder River. These calculations assume that during operations, treated adit waters are preferentially routed to the Boe Ranch LAD storage pond then to the mine percolation pond. PoleCat evaporators accomplish summer 30% evaporation, center pivots 30%; PoleCat winter snowmaking 30% evaporation up slope of the lined LAD storage pond. At closure, treated adit and tailings waters would be routed to the Boe Ranch LAD storage pond which would hold 100 MG of adit waters, and mixing of

these waters occurs prior to disposal at the LAD pivots. A weighted average was used to determine the concentration of salts in the mixed LAD storage pond water. The East Boulder mine MPDES has no total dissolved solids (TDS) or electrical conductivity (EC) limits. Median adit and tailings TDS concentrations were used in these calculations. Salts loading is calculated using TDS concentrations. These calculations assume that there will be a leak in the Boe Ranch LAD storage pond, and the liner leakage, applied LAD, and Mason Ditch waters contribute to ground water quality prior to discharge into the East Boulder River. It is assumed that all 10 proposed Boe Ranch LAD center pivots on 194 acres in Section 17 will be developed for use at agronomic rates during operations and closure.

OPERATIONS CALCULATIONS

The Alternative 2C Salts OPERATIONS Option 1, 737 gpm: Preferential disposal of all 737 gpm adit water Boe Ranch LAD at agronomic rates with contingency disposal of treated adit water at the East Boulder Mine percolation pond. Treated adit water stored in the Boe Ranch LAD storage pond over fall, winter, and early spring would also have to be disposed during the LAD season.

Assume the BTS/Anox nitrogen treatment capacity is 1000 gpm for 24 hours

Boe Ranch LAD design capacity is 1,486 gpm for 12 hr rate (743 gpm for 24 hr rate)
1 ppm TDS = 1.56 µmhos/cm

OPERATIONS *Boe Ranch LAD* Hydraulic Loading Calculations					**assume Boe Ranch LAD storage pond contains 100 MG treated adit water on the first day of the LAD season; disposal of 737 gpm treated adit water at Boe Ranch LAD**
volume of LAD Storage Pond	100	MG	120	days	length of LAD season
area available for LAD in section 17, all pivots included	194	ac	95	days	time to fill the Boe Ranch LAD storage pond at 737 gpm after the LAD season
agronomic application rate (KP Apdx K 2000) 12 hr/day	7.7	gpm/ac	**1,486**	gpm (12 hr)	hydraulic load that can be land applied at agronomic rates on 194 acres, all ten pivots in Section 17
adit flow rate	**737**	gpm (24 hr)	1,474	gpm (12 hr)	adit flow rate
rate to dewater Boe Ranch LAD storage pond in one season	**579**	gpm (24 hr)	1,157	gpm (12 hr)	rate to dewater Boe Ranch LAD storage pond in one season
rate treated adit water must be **percolated** at East Boulder Mine to dewater the Boe Ranch LAD storage pond **(days 1-120)**	**573**	gpm (24 hr)	**164**	gpm (24 hr)	rate treated adit water can be disposed at **Boe Ranch LAD** to meet available capacity
rate treated adit water is pumped from East Boulder Mine to **fill Boe Ranch LAD storage pond (days 121-365)**	**283**	gpm (24 hr)	**454**	gpm (24 hr)	rate that treated adit water is **percolated** at East Boulder Mine percolation pond for the remainder of the year **(days 121-365)**

OPERATIONS *Boe Ranch LAD* During the LAD season, the hydraulic load of 737 gpm adit water can be managed at Boe Ranch LAD area if all 10 pivots are operating at agronomic rates as proposed by SMC (KP 2000c). However, the LAD storage pond would fill the first 95 days of winter and excess adit waters would have to be managed at the East Boulder Mine. During the following LAD season, the hydraulic load of 737 gpm adit water could be managed at Boe Ranch LAD area at agronomic rates, but the LAD storage pond could not be dewatered at the Boe Ranch LAD area. Essentially, the adit water would be managed as in Alternatives 1B and 2B at the East Boulder Mine with similar impacts.

OPERATIONS *Boe Ranch LAD* To operationally address the hydraulic volume of adit water and to annually dewater the Boe Ranch LAD storage pond during the LAD season, 164 gpm treated adit water can be land applied at Boe Ranch using agronomic rates, and the remaining 454 gpm must be disposed at the East Boulder Mine percolation pond. During the rest of the year, 283 gpm treated adit water would be routed to the Boe Ranch LAD storage pond, and 454 gpm treated adit water would be percolated at the East Boulder Mine percolation pond.

The Alternative 2C Salts OPERATIONS Option 2, 737 gpm: During the LAD season days 1-120, up to 164 gpm (24 hr) treated adit water plus 579 gpm (24 hr) stored pond water is applied at Boe Ranch LAD at agronomic rates, and 573 gpm (24 hr) is disposed of at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 283 gpm (24 hr) treated adit water can be routed to the Boe Ranch LAD storage pond and up to 454 gpm (24 hr) would be disposed at the East Boulder Mine percolation pond.

OPERATIONS *East Boulder Mine* Salinity Calculations			**The ground water at the East Boulder Mine meets the Class I Beneficial Use criterion. Percolation of treated adit waters at East Boulder Mine; Days 1-120, 573 gpm water in excess of the LAD capability at the Boe Ranch LAD; Days 121-365, 454 gpm water percolated in excess of water routed to the Boe Ranch LAD storage pond**		
East Boulder Source-Specific percolation pond mixing zone imputs			**573**	gpm (24 hr)	treated **adit water percolated** at East Boulder Mine percolation pond **days 1-120**
depth of aquifer, **D**	80	ft	**4,158**	lbs/day	Daily salts load from percolated adit water, days 1-120
hydraulic conductivity, **k**	75	ft/d	**498,922**	lbs/year	Total salts load from percolated water, days 1-120
gradient, **i**	0.026	ft/ft			MPDES Permit Statement of Basis, p. 25-26
width of source	385	ft			MPDES Permit Statement of Basis, p. 25-26
length from perc pond to wells, **L_1**	3600	ft			MPDES Permit Statement of Basis, p. 25-26
porosity, **ϕ**	0.3				MPDES Permit Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Permit Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	400	gpm			MPDES Permit Statement of Basis, p. 25-26
upgradient ground water TDS concentration in WW-1 is 106 mg/L EBMW-6 & -7 is , **C_A**	**515**	mg/L	803	μmhos/cm	CES 2008 Apdx D, EBoulder Mine TDS Table p 2, central value
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, **W_1**	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, **A_1**	55,977	ft^2			D * W, allowed by 17.30.517(d)
70% Volume of ground water available for mixing **Q_1**=kiA_1	109,156	ft^3/d			MPDES Permit Statement of Basis, p.25-26
Volume of adit water percolated during LAD season **days 1-120**, **V_p**	110,249	ft^3/d	87,315	ft^3/d	Volume of adit water percolated **days 121-365**, **V_p**
depth of aquifer, **D_2**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	75	ft/d			MPDES Permit Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Permit Statement of Basis, p. 25-26
width of source	700	ft			MPDES Permit Statement of Basis, p. 25-26
length from perc pond to river, **L_2**	2,900	ft			MPDES Permit Statement of Basis, p. 25-26
angle of dispersion	0.08742169	tan 5°			allowed by 17.30.517(d)
width of zone, **W_2**	954	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, **A_2**	14,303	ft^2			D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing **Q_2**=kiA	27,891	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d)
concentration of salt in adit water (SMC database 2011)	**605**	mg/L	944	μmhos/cm	2000-2008 median East Boulder adit TDS concentration; CES 2008 page 13
receiving stream baseline ambient concentration at EBR-001, **Q_c**	49	mg/L	76	μmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
receiving streamflow, **Q_s**	423,000	ft^3/d	5	cfs	7Q10 at Boulder River USGS gaging station; MPDES Permit Statement of Basis page 4
OPERATIONS *East Boulder Mine* (LAD Season days 1-120) Salt concentration in ground water	555	mg/L	**866**	μmhos/cm	projected salt concentration in ground water at SP-11

OPERATIONS *East Boulder Mine* (LAD Season days 1-120) Salt concentration in East Boulder River below East Boulder Mine	**236**	mg/L	367 µmhos/cm	projected salt concentration in the East Boulder River at EBR-004A

OPERATIONS *East Boulder Mine* (days 121-365) Salt concentration in ground water	550	mg/L	**858**	µmhos/cm	projected salt concentration in ground water at SP-11
OPERATIONS *East Boulder Mine* (days 121-365) Salt concentration in East Boulder River below East Boulder Mine	**224**	mg/L	350	µmhos/cm	projected salt concentration in the East Boulder River at EBR-004A
OPERATIONS *Boe Ranch LAD* Salinity Calculations, days 1-120			**During the LAD season days 1-120, up to 164 gpm (24 hr rate) treated adit water plus 579 gpm (24 hr rate) stored pond water is applied at Boe Ranch LAD at agronomic rates**		
volume of adit plus stored water applied at Boe Ranch LAD, **days 1-120**	**1,486**	gpm (12 hr)	**1,486**	gpm (12 hr)	hydraulic load that can be land applied at agronomic rates on 194 acres, all ten pivots
2000-2008 median East Boulder adit EC concentration calculated from SMC Monitoring Data	944	µmhos	605	mg/L	2000-2008 median East Boulder adit TDS concentration; SMC Monitoring Data
OPERATIONS *Boe Ranch LAD* Daily salt load	**5,394**	lbs/day	**3,337**	lbs/ac/yr	**OPERATIONS *Boe Ranch LAD Total LAD season* Salt load per acre**
OPERATIONS *Boe Ranch LAD* Total LAD season salt Load	**647,319**	lbs/yr	0.08	lbs/sf	one teaspoon of salt is 0.02 lbs
depth of aquifer, **D**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	0.283	ft/d			mid-range estimate, used by Hydrometrics (KP 2000c)
gradient, **i**	0.1				estimate, used by Hydrometrics (KP 2000c)
width of source (LAD storage pond liner leakage)	10	ft			assume point leakage from LAD pond exists for foreseeable impact to ground water
width of mixing zone LAD Storage Pond Liner Leakage, $\mathbf{W_1}$	229	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
length of LAD Storage Pond Liner Leakage, $\mathbf{L_1}$	2,500	feet			KP 2000c Apdx K, Tables
cross sectional area of aquifer at LAD Storage Pond Liner Leakage, $\mathbf{A_1}$	3,428	ft^2			D * W, allowed by 17.30.517(d)
$\mathbf{Q_1}$=kiA, ground water available for mixing at liner leakage	97	ft^3/d			allowed by 17.30.517(d)
concentration of EC in ambient ground water; median value from RMW-3a, $\mathbf{C_A}$	1,125	µmhos/cm	721	mg/L	median ambient ground water TDS concentration derrived from SMC monitoring data
width of LAD application	3,200	ft			KP 2000c Apdx K, Tables
length of LAD application, $\mathbf{L_2}$	4,500	ft			KP 2000c Apdx K, Tables
width of LAD application mixing zone, $\mathbf{W_2}$	3,593	ft			allowed by 17.30.517(d)
cross sectional area of aquifer at LAD application, $\mathbf{A_2}$	53,901	ft^2			D * W, allowed by 17.30.517(d)
$\mathbf{Q_2}$=kiA, ground water available for mixing at LAD application	1,525	ft^3/d			allowed by 17.30.517(d)
volume of applied LAD, $\mathbf{V_2}$	143,041	ft^3/d	**1,486**	gpm (24 hr)	hydraulic load that can be land applied at agronomic rates on 194 acres, all ten pivots
effective calculated EC in applied LAD waters (adit water); assume pivots 30% evaporation, $\mathbf{C_2}$	1,348	µmhos/cm	864	mg/L	effective applied LAD TDS concentration due to evaporation
volume of LAD Storage Pond liner leakage, $\mathbf{V_1}$	27	ft3/d	0.14	gpm	KP 2000c Apdx K, Tables
calculated EC in LAD Storage Pond liner leakage discharge (adit water), $\mathbf{C_1}$	944	µmhos/cm	**605**	mg/L	median adit TDS concentration derrived from SMC monitoring data
width of aquifer below LAD, includes area of Mason Ditch to East Boulder River	3,593	ft			KP 2000c Apdx K, Tables

length between end of pivots to East Boulder River, **L_3**	4,000 ft		KP 2000c Apdx K, Tables
width of mixing zone between end of pivots to East Boulder River, **W_3**	3,943 ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
cross sectional area of aquifer between pivots to East Boulder River, **A_3**	59,146 ft^2		D * W, allowed by 17.30.517(d)
Q_3=kiA, ground water available for mixing below Mason Ditch to East Boulder River	1,674 ft^3/d		allowed by 17.30.517(d)
25% of total volume of Mason Ditch that is assumed to infiltrate, **V_3**	43,200 ft^3/d	224 gpm (24 hr)	KP 2000c Apdx K, Tables
OPERATIONS *Boe Ranch LAD* Ground water salts concentration (LAD season)		**During the LAD season, up to 164 gpm (24 hr) plus 579 gpm (24 hr) stored pond water is applied at Boe Ranch LAD at agronomic rates. The ground water at Boe Ranch has a Class II Beneficial Use, 1,000 to 2,500 µmhos/cm.**	
assume TDS in Mason Ditch equivalent to median TDS concentration at EBR-007, **C_3**	290 µmhos/cm	**186** mg/L	median value for EBR-007 and EBR-008 SMC Monitoring data 2011
EC of ground water beneath Boe Ranch LAD storage pond from liner leakage	1,085 µmhos/cm	696 mg/L	TDS value calculated from EC
EC of ground water below LAD area from liner leakage plus applied LAD	1,345 µmhos/cm	862 mg/L	TDS value calculated from EC; hydraulic evaporation credit taken for LAD
EC of ground water below Mason Ditch from liner leakage, applied LAD, and Mason Ditch seepage	1,030 µmhos/cm	661 mg/L	TDS value calculated from EC; hydraulic evaporation credit taken for LAD
OPERATIONS EC of ground water below Mason Ditch (Boe Ranch), C_d	**1,103 µmhos/cm**	707 mg/L	TDS value calculated from EC; projected salts concentration in ground water just prior to discharge to East Boulder River above EBR-008
OPERATIONS *Boe Ranch LAD* Land application of 743 gpm (24 hr) treated adit water plus stored pond water at agronomic rates is less than the 2,500 µmhos/cm Class II Beneficial Use criterion.			
OPERATIONS *Boe Ranch LAD* East Boulder River salts concentrations, days 1-120		**During the LAD season, up to 164 gpm (24 hr) plus 579 gpm (24 hr) stored pond water is applied at Boe Ranch LAD at agronomic rates. The East Boulder River ambient TDS concentration at EBR-007 is 270 mg/L, and ambient concentration at EBR-008 is 340 mg/L.**	
receiving streamflow non-irrigation season, **Q_s**	432,000 ft^3/d	5.0 cfs	7Q10 value for East Boulder Mine streamflow assumed at EBR-008, non-irrigation season
receiving streamflow irrigation season, **Q_s**	172,800 ft^3/d	2.0 cfs	7Q10 value at EBR-008 streamflow after irrigation withdrawals below Boe Ranch LAD (CES 2008)
receiving stream ambient concentration, **C_s**	290 µmhos	186 mg/L	median value for EBR-007 and EBR-008 SMC Monitoring data 2011
ground water discharge volume, **Q_d**	146,652 ft^3/d	1.7 cfs	volume of ground water discharge to East Boulder River below Boe Ranch LAD
ground water concentration downgradient of Mason Ditch, **C_d**	1,103 µmhos/cm	707 mg/L	salt concentration in ground water just prior to discharge to East Boulder River
OPERATIONS East Boulder River TDS concentration downgradient of the Boe Ranch LAD area (2.0 cfs)	663 µmhos/cm	**425** mg/L	TDS value calculated from EC; projected salts concentration at EBR-008 during low flow at irrigation season
OPERATIONS East Boulder River TDS concentration downgradient of the Boe Ranch LAD area at $7Q_{10}$ flow (5.0 cfs)	496 µmhos/cm	**318** mg/L	TDS value calculated from EC; projected salts concentration at EBR-008 during $7Q_{10}$ low flow

The Alternative 2C Salts OPERATIONS Option 1, 150 gpm: During the LAD season days 1-120, up to 150 gpm (24 hr) treated adit water plus 301 gpm (24 hr) stored pond water would be applied at Boe Ranch LAD at agronomic rates. No water would be disposed of at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 150 gpm (24 hr) treated adit water would be routed to the Boe Ranch LAD storage pond. The capacity of the Boe Ranch LAD storage pond would be adequate to store eight months of treated adit water (52 MG).

OPERATIONS *Boe Ranch LAD* Hydraulic Loading Calculations days 1-120			**Assume Boe Ranch LAD storage pond contains 52 MG treated adit water on the first day of the LAD season; disposal of 150 gpm treated adit water plus 602 gpm (12 hr) stored waters at Boe Ranch LAD**		
capacity of LAD Storage Pond	100	MG	**Boe Ranch LAD storage pond capacity is sufficient for 8 months storage of adit water at 150 gpm**		
volume in LAD storage pond, assume 8 months stored at 150 gpm	52	MG	120	days	length of LAD season
pumping rate to empty LAD storage pond during the LAD season	301	gpm (24 hr)	602	gpm (12 hr)	pumping rate to empty LAD storage pond during the LAD season
area available for LAD in section 17, all pivots included	194	ac	**1,486**	gpm (12 hr)	hydraulic load that can be land applied at agronomic rates on 194 acres, all ten pivots in Section 17
agronomic application rate (KP Apdx K 2000) 12 hr/day	7.7	gpm/ac	300	gpm (12 hr)	adit flow rate at closure
adit flow rate at closure	**150**	gpm (24 hr)	**902**	gpm (12 hr)	hydraulic load of treated adit water plus stored LAD pond waters
amount of water that would be percolated at East Boulder Mine	**0**	gpm (24 hr)	**0**	gpm (12 hr)	amount of water that would be percolated at East Boulder Mine

OPERATIONS During the 120 day LAD season, the hydraulic load of 150 gpm (24 hr) adit water plus 602 gpm (12 hr) rate of dewatering 8 months stored water in the LAD storage pond (52 MG) can be managed at Boe Ranch LAD area if all 10 pivots are operating at the proposed agronomic rates.

OPERATIONS *Boe Ranch LAD* Salinity Calculations days 1-120			**Assume Boe Ranch LAD storage pond contains 52 MG treated adit water on the first day of the LAD season; disposal of 150 gpm treated adit water plus 602 gpm (12 hr) stored waters at Boe Ranch LAD**		
2000-2008 median adit EC, calculated from SMC Monitoring Data	944	μmhos/cm	**605**	mg/L	2000-2008 median adit TDS concentration SMC Monitoring Data
OPERATIONS *Boe Ranch LAD* Daily salt load	**3,274**	lbs/day	**2,025**	lbs/ac/yr	**OPERATIONS *Boe Ranch LAD Total LAD season* Salt load per acre**
OPERATIONS *Boe Ranch LAD* Total LAD season salt Load	**392,847**	lbs/yr	To prevent redundancy, the above values have been used in the calculations below.		
volume of applied LAD evaporation credit taken, V_2	121,533	ft^3/d	902	gpm (12 hr)	adit plus stored Boe Ranch LAD storage pond water; no evaporation credit taken
OPERATIONS *Boe Ranch LAD* ground water salts concentration below Mason Ditch, C_d	**1,072**	μmhos/cm	687	mg/L	TDS value calculated from EC; projected salts concentration in ground water just prior to discharge to East Boulder River above EBR-008

OPERATIONS *Boe Ranch LAD* the EC in ground water just prior to discharge to the East Boulder River meets the 2,500 μmhos/cm Class II Beneficial Use Criterion.

ground water discharge volume, Q_d	168,056	ft^3/d			
ground water concentration below Mason Ditch, C_d	1,072	μmhos/cm	687	mg/L	salt concentration in ground water just prior to discharge to East Boulder River
OPERATIONS *Boe Ranch LAD* East Boulder River TDS concentration during the irrigation season (2.0 cfs)	676	μmhos/cm	**433**	**mg/L**	TDS value calculated from EC; projected salts concentration at EBR-008 during low flow at irrigation season
OPERATIONS *Boe Ranch LAD* East Boulder River TDS concentration at 7Q10 flow (5.0 cfs)	462	μmhos/cm	**296**	**mg/L**	TDS value calculated from EC; projected salts concentration at EBR-008 during $7Q_{10}$ low flow
OPERATIONS *East Boulder Mine LAD* Salinity Calculations days 1-120			**No percolation would occur at East Boulder Mine days 1-120**		
OPERATIONS *East Boulder Mine LAD* Salinity Calculations days 121-365			**The remainder of the year (days 121-365), 150 gpm (24 hr) treated adit water would be routed to the Boe Ranch LAD storage pond.**		

CLOSURE CALCULATIONS

The Proposed Action Alternative 2C Salts CLOSURE Option 1, 737 gpm: The East Boulder tailings impoundment would be dewatered and tailings waters treated at 260 gpm (24 hr) with 737 gpm (24 hr) adit water through the BTS/Anox. Based on the Operations hydraulic load calculations, only 743 gpm (24 hr) can be disposed at Boe Ranch LAD. During the LAD season days 1-120, up to 164 gpm (24 hr) treated adit plus tailings water plus 579 gpm (24 hr) stored pond water is applied at Boe Ranch LAD at agronomic rates, and 833 gpm (24 hr) must be disposed of at the East Boulder Mine. All 833 gpm (24 hr) disposed of at the East Boulder Mine would be routed to the percolation pond. The remainder of the year (days 121-365), 737 gpm (24 hr) treated adit water would be disposed at the East Boulder Mine percolation pond. The time frame for closure is 12 months.

	944	μmhos/cm	**605**	mg/L	2011 median adit TDS concentration; SMC Monitoring Data
	1,164	μmhos/cm	**746**	mg/L	2011 median tailings waters TDS concentration SMC Monitoring Data
	1,002	μmhos/cm	**642**	mg/L	weighted average concentration of adit plus tailings waters; assume instantaneous mixing of mine waters; no salt treatment occurs in BTS/Anox system

CLOSURE *East Boulder Mine and Boe Ranch LAD* Hydraulic Loading days 1-120

Assume the Boe Ranch LAD storage pond contains 100 MG on the first day of the LAD season at closure

capacity to dispose of all treated mine waters during 120 day LAD season	743	gpm (24 hr)	**1,486**	gpm (12 hr)	total capacity to dispose of all treated mine waters during 120 day LAD season
adit flow rate at closure	**737**	gpm (24 hr)	1,000	gpm (24 hr)	capacity of BTS/Anox for nitrogen treatment; no salts treated
assumed volume in LAD storage pond at beginning of closure	100	MG	98	MG	volume of the East Boulder Tailings impoundment waters needing disposal; includes 5 MG tailings mass water
pumping rate to empty LAD storage pond in 120 days	579	gpm (24 hr)	**1,157**	gpm (12 hr)	rate to dewater LAD storage pond in 120 days
rate to dewater East Boulder tailings impoundment	**263**	gpm (24 hr)	**259**	days	number of days to dewater East Boulder tailings impoundment
rate that treated adit and tailings waters must be managed at East Boulder Mine to dewatered Boe Ranch LAD storage pond during one LAD season	**836**	gpm (24 hr)	**164**	gpm (24 hr)	capacity available to land apply treated adit and tailings water at Boe Ranch LAD areas if Boe Ranch LAD storage pond was dewatered at full rate
rate of percolation of treated adit plus tailings waters	**836**	gpm (24 hr)	**0**	gpm (24 hr)	rate of land application at East Boulder Mine LAD Area 6 (full capacity)

***CLOSURE Boe Ranch LAD* Days 1-120: The hydraulic load of 164 gpm (24 hr) treated adit water and tailings waters plus disposal of 579 gpm (24 hr) Boe Ranch LAD stored waters will empty the LAD storage pond and can be managed at Boe Ranch LAD during one LAD season. *East Boulder Mine* Days 1-120: The hydraulic load of 293 gpm (24 hr) can be disposed at LAD Area 6, and the remaining 540 gpm (24 hr) can be disposed at the East Boulder Mine percolation pond. East Boulder Mine Days 121-365: The hydraulic load of 737 gpm (24 hr) treated adit water can be disposed at the East Boulder Mine percolation pond.**

CLOSURE *East Boulder Mine* Days 1-120: Salinity Calculations

Up to 836 gpm adit plus tailings waters would be disposed of in the East Boulder Mine percolation pond.

area of East Boulder Mine LAD Area 6 (CES 2008)	10.2	ac	**245**	days	remainder of the year after the LAD season
CLOSURE *East Boulder Mine* Daily salt load disposed of at *LAD Area 6* (days 1-120)	**0**	lbs/day	**0**	lbs/ac/yr	**CLOSURE *East Boulder Mine* Daily salt load disposed of per acre at *LAD Area 6* (days 1-120)**
CLOSURE *East Boulder Mine* Daily salt load disposed of at the *percolation pond* (days 1-120)	**6,869**	lbs/day	**0**	lbs/sf/yr	**CLOSURE *East Boulder Mine* Daily salt load disposed of per square foot at *LAD Area 6* (days 1-120)**
CLOSURE *East Boulder Mine* Daily salt load disposed of at the *percolation pond* (days 121-365)	**5,351**	lbs/day	**2,135,179**	lbs/yr	**CLOSURE *East Boulder Mine* Total salt load disposed of (LAD plus percolation) Days 1-365**
Volume of adit water percolated days 1-120, V_p	160,880	ft^3/d			

Up to 836 gpm adit plus tailings waters would be disposed of in the East Boulder Mine percolation pond.

ground water discharge volume days 1-120, Q_d	337,411	ft^3/d	141,882	ft^3/d	Volume of adit water percolated days 121-365, V_p

effective calculated TDS in applied waters LAD Area 6; assume pivots 30% evaporation, C_2	1,431 mg/L	297,927		ground water discharge volume days 121-365, Q_d
volume of applied LAD with evaporation credit taken, V_2	39,484 ft^3/d	293	gpm (24 hr)	rate of land application at East Boulder Mine LAD Area 6 (full capacity)
CLOSURE *East Boulder Mine* Days 1-120: Salt concentration in ground water	550 mg/L	**859**	µmhos/cm	projected salt concentration in ground water at SP-11
CLOSURE *East Boulder Mine* Days 1-120 Salt concentration in East Boulder River below East Boulder Mine	**271** mg/L	423	µmhos/cm	projected salt concentration in the East Boulder River at EBR-004A
CLOSURE *East Boulder Mine* Days 121-365: Salt concentration in ground water	420 mg/L	**655**	µmhos/cm	projected salt concentration in ground water at SP-11
CLOSURE *East Boulder Mine* Days 121-365 Salt concentration in East Boulder River below East Boulder Mine	**202** mg/L	315	µmhos/cm	projected salt concentration in the East Boulder River at EBR-004A

CLOSURE 737 gpm (24 hr) Option 1 the EC of ground water at East Boulder Mine meets the Class I Beneficial Use Criterion of 1,000 µmhos/cm. The TDS concentration in the East Boulder River at the East Boulder Mine is less than 500 mg/L.

CLOSURE *Boe Ranch LAD* Days 1-120: Salinity Calculations		**Up to 164 gpm (24 hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 100 MG treated adit water and land applied at Boe Ranch. The ground water at Boe Ranch has a Class II Beneficial Use.**		
volume of applied LAD, 30% evaporation applied, V_2	100,129 ft^3/d	743	gpm (24 hr)	volume of applied treated mine waters during 120 day LAD season
calculated EC in applied LAD (mixed waters); evaporation applied, C_2	1,431 µmhos	642	mg/L	weighted TDS concentration of mixed adit, tailings, and stored waters in LAD storage pond days 1-120
CLOSURE *Boe Ranch LAD* Daily salt load	**5,725** lbs/day	**686,996**	lbs/yr	**CLOSURE *Boe Ranch LAD* Total Salt Load (120 days)**
CLOSURE *Boe Ranch LAD* Ground Water Salinity Calculations		**Up to 164 gpm (24 hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 100 MG treated adit water and land applied at Boe Ranch. The ground water at Boe Ranch has a Class II Beneficial Use.**		
EC in ground water downgradient of Mason Ditch, C_d	**1,088** µmhos/cm	697	mg/L	TDS value calculated from EC; projected concentration in ground water just prior to discharge to East Boulder River above EBR-008

CLOSURE *Boe Ranch LAD* The EC of ground water below the Boe Ranch LAD meets the Class II Beneficial Use Criterion.

CLOSURE *Boe Ranch LAD* East Boulder River Salinity Calculations		**Up to 164 gpm (24 hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 100 MG treated adit water and land applied at Boe Ranch. The ground water at Boe Ranch has a Class II Beneficial Use.**		
receiving streamflow, Q_s	172,800 ft^3/d	2.0	cfs	7Q10 value for East Boulder River streamflow during irrigation season at EBR-008 (CES 2000)
receiving stream ambient concentration, C_s	421 µmhos/cm	**270**	mg/L	median value, SMC monitoring data 2000-2004 at EBR-007
discharge volume, Q_d	146,652 ft^3/d	1.7	cfs	ground water discharge volume in cubic feet per second
EC in ground water below Mason Ditch, C_d	1,088 µmhos/cm	697	mg/L	TDS in ground water below Mason Ditch
CLOSURE *Boe Ranch LAD* East Boulder River TDS concentration area during the irrigation season (2.0 cfs)	656 µmhos/cm	**421**	**mg/L**	projected salt concentration in the East Boulder River at EBR-008
CLOSURE *Boe Ranch LAD* East Boulder River TDS concentration at 7Q10 flow (5.0 cfs)	492 µmhos/cm	**316**	**mg/L**	projected salt concentration in the East Boulder River at EBR-008

Alternative 2C Salts CLOSURE Option 1, 150 gpm: Days 1-120 Up to 150 gpm (24 hr) adit water would be mixed and treated with 286 gpm tailings waters and routed to the Boe Ranch LAD storage pond. The 436 gpm (24 hr) mixed, treated adit and tailings waters would mix with 52 MG of treated stored water in the LAD storage pond, then land applied at Boe Ranch LAD at agronomic rates 743 gpm (24 hr rate). Days 121-365 During the rest of the 12-month closure period, the 150 gpm (24 hr) would be routed to the East Boulder Mine percolation pond.

adit flow rate at closure	**150** gpm (24 hr)	605	mg/L	2011 median adit TDS concentration; SMC Monitoring Data
rate to dewater East Boulder tailings impoundment	**292** gpm (24 hr)	746	mg/L	2011 median tailings waters concentration, SMC Monitoring Data

pumping rate to empty LAD storage pond in 120 days	**301**	gpm (24 hr)	698	mg/L	weighted average concentration of adit plus tailings waters; assume instantaneous mixing of mine waters

CLOSURE *Boe Ranch LAD* Hydraulic Loading Input Parameters, Days 1-120

Days 1-120: Up to 436 gpm (24-hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 52 MG treated adit water and land applied at 737 gpm at the Boe Ranch LAD area. Day 121: Boe Ranch LAD would be decommissioned.

capacity to dispose of all treated mine waters during 120 day LAD season and total volume of water to be applied at Boe Ranch LAD	743	gpm (24 hr)	233	days	number of days to dewater East Boulder tailings impoundment

CLOSURE *Boe Ranch LAD* Days 1-120: The hydraulic load of 150 gpm (24 hr) treated adit water plus 293 gpm (24 hr) treated tailings waters and 301 gpm (24 hr) Boe Ranch LAD stored waters can be managed at Boe Ranch LAD in one 120-day LAD season without managing any waters at the East Boulder Mine. Days 121-365: The hydraulic load of 150 gpm (24 hr) treated adit water can be managed at the East Boulder Mine percolation pond.

CLOSURE *Boe Ranch LAD* Days 1-120: Salinity Calculations

Up to 436 gpm (24 hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 52 MG treated adit water and land applied at Boe Ranch. The ground water at Boe Ranch has a Class II Beneficial Use.

volume of applied LAD, 30% evaporation applied, $\mathbf{V_2}$	100,129	ft^3/d	**698**	mg/L	weighted TDS concentration of mixed adit, tailings, and stored waters in LAD storage pond
calculated EC in applied LAD (mixed waters); evaporation applied, $\mathbf{C_2}$	1,556	µmhos/cm	997	mg/L	calculated TDS in applied LAD (mixed waters), 30% evaporation applied
EC in ground water Days 1-120 downgradient of Mason Ditch, $\mathbf{C_d}$	**1,173**	µmhos/cm	752	mg/L	TDS value calculated from EC; projected concentration in ground water just prior to discharge to East Boulder River above EBR-008

CLOSURE *Boe Ranch LAD* The EC of ground water is less than the 2,500 µmhos/cm Class II Beneficial Use Criterion.

discharge volume, $\mathbf{Q_d}$	146,652	ft^3/d	1.7	cfs	
EC in ground water below Mason Ditch, $\mathbf{C_d}$	1,173	µmhos/cm	752	mg/L	
CLOSURE *Boe Ranch LAD* East Boulder River TDS concentration Days 1-120 (2.0 cfs)	696	µmhos/cm	**446**	**mg/L**	projected salt concentration in the East Boulder River at EBR-008 during irrigation withdrawals

Appendix E
DEQ 2012

CLOSURE *Boe Ranch LAD* East Boulder River TDS concentration at $7Q_{10}$ flows Days 1-120 (2.0 cfs)	514	µmhos/cm	**329**	**mg/L**	projected salt concentration in the East Boulder River at EBR-008 at $7Q_{10}$ streamflows
CLOSURE *East Boulder Mine* Days 121-365: Salinity Calculations			**Days 121-365: Up to 150 gpm treated adit waters would be disposed the East Boulder Mine percolation pond.**		
Volume of adit water percolated days 1-120, $\mathbf{V_p}$	0	ft^3/d	0	gpm (24 hr)	treated adit & tailings waters disposed at East Boulder Mine percolation pond days 1-120
Volume of adit water percolated days 121-233, $\mathbf{V_p}$	85,109	ft^3/d	442	gpm (24 hr)	
Volume of adit water percolated days 234-365, $\mathbf{V_p}$	28,877	ft^3/d	150	gpm (24 hr)	treated adit water disposed at East Boulder Mine percolation pond days 121-365
ground water discharge volume days 121-233, $\mathbf{Q_d}$	222,156	ft^3/d	165,924	mg/L	ground water discharge volume days 234-365, $\mathbf{Q_d}$
		ft^3/d	**Up to 150 gpm treated adit water would be disposed at the East Boulder Mine percolation pond.**		
CLOSURE *East Boulder Mine* Days 121-233: Salt concentration in ground water	384	mg/L	**599**	µmhos/cm	projected salt concentration in ground water at SP-11
CLOSURE *East Boulder Mine* Days 121-233 Salt concentration in East Boulder River below East Boulder Mine	**238**	mg/L	372	µmhos/cm	projected salt concentration in the East Boulder River at EBR-004A
CLOSURE *East Boulder Mine* Days 234-365: Salt concentration in ground water	262	mg/L	**408**	µmhos/cm	projected salt concentration in ground water at SP-11
CLOSURE *East Boulder Mine* Days 234-365 Salt concentration in East Boulder River below East Boulder Mine	**150**	mg/L	234	µmhos/cm	projected salt concentration in the East Boulder River at EBR-004A

Spreadsheet 2C Nitrogen: Proposed Action Alternative 2C Boe Ranch LAD System Operations and Closure Nitrogen Analyses

Per KP 2000c, if the Boe Ranch LAD system was constructed it would be the preferred disposal option for treated adit water during operations and for treated adit plus tailings waters during the first year of closure. The East Boulder Mine percolation pond would be used for contingency disposal of treated adit water during operations. Monitoring well RMW-3 is located at Boe Ranch downgradient of the proposed LAD area and is considered to represent ambient total inorganic nitrogen (TIN) values. Baseline concentrations of TIN in the East Boulder River average 0.1 mg/L. At closure, all adit and East Boulder tailings waters would be treated through the BTS/Anox system then routed to the Boe Ranch LAD storage pond all year and disposed through LAD pivots during the summer LAD season. For the Boe Ranch LAD, calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the Boe Ranch LAD area any water that percolates below the root zone is assumed to immediately enter the aquifer. It is assumed that the Boe Ranch LAD area would not

have an MPDES permit. The BTS/Anox system would be the same as in Alternative 2B, with treated water routed to Boe Ranch LAD during operations and 12 months of closure. For this analysis 20% of the applied TIN concentrations are expected to flush through the soil column/unsaturated zone to ground water at some point during the year. Ground water beneath the LAD area and LAD storage pond flows downgradient where it is recharged by the Mason Ditch, then discharges to the East Boulder River. These calculations assume that during operations treated adit waters are routed to the Boe Ranch LAD storage pond. During summer LAD, PoleCat evaporators accomplish 30% evaporation and the center pivots accomplish 30% evaporation. In the winter, PoleCat snowmaking accomplishes 30% evaporation up slope of the lined LAD storage pond. At closure, treated adit and tailings waters would be routed to the Boe Ranch LAD storage pond which would hold 100 million gallons (MG) of adit water, and mixing of these waters occurs prior to

disposal at the LAD pivots. A weighted average was used to determine the concentration of TIN in the mixed LAD storage pond water The East Boulder Mine MPDES Permit has an annual average TIN limit of 30 lbs/day. Historical maximum TIN load after BTS/Anox treatment of 20 pounds per day was used in this analysis. These calculations assume that there will be a leak in the Boe Ranch LAD storage pond, and the liner leakage, land-applied water, and Mason Ditch waters contribute to ground water quality prior to discharge into the East Boulder River. It is assumed that all 10 proposed Boe Ranch LAD center pivots on 194 acres in Section 17 will be developed for use during operations and closure, and application of water is at agronomic rates. The TIN concentration of the treated discharge will vary with total flow rate.

OPERATIONS CALCULATIONS

The Alternative 2C Nitrogen OPERATIONS Option 1, 737 gpm: Preferential disposal of all 737 gpm adit water would occur at the Boe Ranch LAD at agronomic rates with contingency disposal of treated adit water at the East Boulder Mine percolation pond.

BTS/Anox capacity	1,000	gpm (24-hr)			
Boe Ranch LAD design capacity	743	gpm (24-hr)	1,486	gpm (12-hr)	

OPERATIONS *Boe Ranch LAD* Hydraulic Loading Calculations					**Assume the Boe Ranch LAD storage pond is full on the first day of the LAD season**
assumed volume in Boe Ranch LAD storage pond	100	MG			
area available for LAD in section 17, all pivots included	194	ac	95	days	time to fill the Boe Ranch LAD storage pond at 737 gpm after the LAD season
agronomic application rate (SMC 2000 Apdx K)	**7.7**	gpm/ac	**1,486**	gpm (12-hr)	hydraulic load that can be land applied at agronomic rates for 120 days on 194 acres, all pivots in Section 17
adit flow rate at closure	**737**	gpm (24-hr)	1,474	gpm (12-hr)	adit flow rate at closure

OPERATIONS During the 120 day LAD season, the hydraulic load of 737 gpm adit water can be managed at Boe Ranch LAD area if all 10 pivots are operating at agronomic rates as proposed by SMC (KP 2000c). However, the LAD storage pond would fill the first 95 days of winter and excess adit waters would have to be managed at the East Boulder Mine and by winter snowmaking. During the following LAD season, the hydraulic load of 737 gpm adit water could be managed at Boe Ranch LAD area at agronomic rates, but the LAD storage pond could not be dewatered at the Boe Ranch LAD area. Essentially, the adit water would be managed as in Alternatives 1B and 2B at the East Boulder Mine with similar impacts.

The Alternative 2C Nitrogen OPERATIONS Option 2, 737 gpm: During the LAD season days 1-120, up to 164 gpm (24-hr) treated adit water plus 579 gpm (24-hr) stored pond water is applied at Boe Ranch LAD at agronomic rates, and 573 gpm (24-hr) is disposed at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 283 gpm (24-hr) treated adit water can be routed to the Boe Ranch LAD storage pond and up to 454 gpm (24-hr) would be disposed at the East Boulder Mine percolation pond.

OPERATIONS *Boe Ranch LAD* Hydraulic Loading Calculations					**Assume Boe Ranch LAD storage pond is full on the first day of the LAD season. During the LAD season days 1-120, up to 164 gpm (24 hr rate) treated adit water plus 579 gpm (24 hr rate) stored pond water is applied at Boe Ranch LAD at agronomic rates**
assumed volume in Boe Ranch LAD storage pond	100	MG	120	days	time to dewater Boe Ranch LAD storage pond in one season

area available for LAD in section 17, all pivots included	194	ac	579	gpm (24-hr)	rate to dewater Boe Ranch LAD storage pond in one season
agronomic application rate (SMC 2000 Apdx K) 12 hr/day	**7.7**	gpm/ac	**1,486**	gpm (12-hr)	hydraulic load that can be land applied at agronomic rates for 120 days on 194 acres, all Section 17 pivots
adit flow rate at closure	737	gpm (24-hr)	329	gpm (12-hr)	capacity available to land apply adit water at Boe Ranch LAD areas
rate treated adit water must be **percolated** at East Boulder Mine so Boe Ranch LAD storage pond can be dewatered during LAD season **(days 1-120)**	**573**	gpm (24-hr)	**164**	gpm (24-hr)	adit flow rate land applied at Boe Ranch to meet available capacity using Hertzler Ranch LAD average application rate
rate treated adit water is pumped from East Boulder Mine to **fill Boe Ranch LAD storage pond** for the remainder of the year **(days 121-365)**	**283**	gpm (24-hr)	**454**	gpm (24-hr)	rate that treated adit water is **percolated** at East Boulder Mine percolation pond for the remainder of the year **(days 121-365)**

OPERATIONS To operationally address the hydraulic volume of adit water and to annually dewater the Boe Ranch LAD storage pond during the LAD season, 164 gpm treated adit water can be land applied at Boe Ranch using agronomic rates, and the remaining 454 gpm must be disposed at the East Boulder Mine percolation pond. During the rest of the year, 283 gpm treated adit water would be routed to the Boe Ranch LAD storage pond, and 454 gpm treated adit water would be percolated at the East Boulder Mine percolation pond.

OPERATIONS *East Boulder Mine* total inorganic nitrogen Load Calculations

Percolation of treated adit waters at East Boulder Mine; Days 1-120, 573 gpm water in excess of the LAD capability at the Boe Ranch LAD; Days 121-365, 454 gpm water percolated in excess of water routed to the Boe Ranch LAD storage pond

OPERATIONS total inorganic nitrogen load at East Boulder Mine from **percolation during LAD season days 1-120**	**573**	gpm (24-hr)	**2.7**	lbs/day	treated adit waters load days 1-120
OPERATIONS total inorganic nitrogen load at East Boulder Mine from **percolation the rest of the year days 121-365**	**454**	gpm (24-hr)	**2.2**	lbs/day	treated adit waters load days 121-365

OPERATIONS The total inorganic nitrogen load from percolation of 454 to 573 gpm treated adit water at the East Boulder Mine percolation pond during operations would be 2.2 to 2.7 lbs/day which is less than the MPDES Permit total inorganic nitrogen 30 lbs/day load limit at 7Q10 streamflow.

OPERATIONS *Boe Ranch LAD* Ground Water total inorganic nitrogen Calculations Days 1-120

			737	gpm (24-hr)	adit flow rate at closure (24 hr rate)
OPERATIONS total inorganic nitrogen load at Boe Ranch LAD, **days 1-120**	**3.6**	lbs/day	**20**	lbs/day	historical maximum post BTS/Anox total inorganic nitrogen load
OPERATIONS total inorganic nitrogen load at Boe Ranch LAD per acre, **days 1-120**	**2.2**	lbs/ac	**0.4**	mg/L	treated concentration of adit waters based on average treatment of BTS/Anox
length of LAD season	120	days	**1,486**	gpm (12-hr)	hydraulic load that can be land applied at agronomic rates for 120 days on 194 acres
depth of aquifer, **D**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	0.283	ft/d			mid-range estimate, used by Hydrometrics (KP 2000c)
gradient, **i**	0.1				estimate, used by Hydrometrics (KP 2000c)
width of source (LAD storage pond liner leakage)	10	ft			assume point leakage from LAD pond exists for foreseeable impact to ground water
width of mixing zone LAD storage pond liner leakage, $\mathbf{W_1}$	229	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
length of LAD storage pond liner leakage, $\mathbf{L_1}$	2,500	feet			KP 2000c Apdx K, Tables
cross sectional area of aquifer at LAD storage pond liner leakage, $\mathbf{A_1}$	3,428	ft^2			D * W, allowed by 17.30.517(d)
$\mathbf{Q_1}$=kiA, ground water available for mixing at liner leakage	97	ft^3/d			allowed by 17.30.517(d)
concentration of total inorganic nitrogen in ambient ground water; median value from RMW-3a, $\mathbf{C_A}$	0.1	mg/L			median ambient total inorganic nitrogen concentration in ground water derived from SMC monitoring data

width of LAD application	3,200 ft	KP 2000c Apdx K, Tables
length of LAD application, $\mathbf{L_2}$	4,500 ft	KP 2000c Apdx K, Tables
width of LAD application mixing zone, $\mathbf{W_2}$	3,593 ft	allowed by 17.30.517(d)
cross sectional area of aquifer at LAD application, $\mathbf{A_2}$	53,901 ft^2	D * W, allowed by 17.30.517(d)
$\mathbf{Q_2}$=kiA, ground water available for mixing at LAD application	1,525 ft^3/d	allowed by 17.30.517(d)

volume of applied LAD end of pipe, no evaporation taken, $\mathbf{V_2}$	286,083 ft^3/d	**164** gpm (24-hr)	adit water applied; no evaporation credit taken
Concentration of total inorganic nitrogen in applied LAD waters (adit water); assume pivots 30% evaporation, 80% post plant uptake, $\mathbf{C_2}$	0.1 mg/L		treated adit water concentration with nitrogen removal credit given for evaporation and plant uptake; the amount of nitrogen that is expected to percolate to ground water
volume of Boe Ranch LAD storage pond liner leakage, $\mathbf{V_1}$	27 ft^3/d		KP 2000c Apdx K, Tables
calculated total inorganic nitrogen in LAD storage pond liner leakage discharge (adit water), $\mathbf{C_1}$	0.4	0.14 gpm (24-hr)	KP 2000c Apdx K, Tables
width of aquifer below LAD, includes area of Mason Ditch to East Boulder River	3,593 ft		KP 2000c Apdx K, Tables
length between end of pivots to East Boulder River, $\mathbf{L_3}$	4,000 ft		KP 2000c Apdx K, Tables
width of mixing zone between end of pivots to East Boulder River, $\mathbf{W_3}$	3,943 ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
cross sectional area of aquifer between pivots to East Boulder River, $\mathbf{A_3}$	59,146 ft^2		D * W, allowed by 17.30.517(d)
$\mathbf{Q_3}$=kiA, ground water available for mixing below Mason Ditch to East Boulder River	1,674 ft^3/d		allowed by 17.30.517(d)
25% of the total volume of Mason Ditch that is assumed to infiltrate, $\mathbf{V_3}$	43,200 ft^3/d	224 gpm (24-hr)	KP 2000c Apdx K, Tables
assume the total inorganic nitrogen in Mason Ditch is equivalent to the median concentration at EBR-007, $\mathbf{C_3}$	0.1 mg/L		SMC monitoring data
OPERATIONS Ground water calculations downgradient of Boe Ranch LAD days 1-120		**During the LAD season, up to 164 gpm (24-hr) plus 579 gpm (24-hr) stored pond water is applied at Boe Ranch LAD at agronomic rates.**	
total inorganic nitrogen concentration in ground water below Boe Ranch LAD storage pond from liner leakage	0.1 mg/L		projected total inorganic nitrogen concentration in ground water downgradient of the Boe Ranch LAD area
total inorganic nitrogen concentration in ground water down gradient of Boe Ranch LAD area from liner leakage and applied LAD	0.1 mg/L		30% hydraulic evaporation credit applied; projected total inorganic nitrogen concentration in ground water from assumed Boe Ranch LAD storage pond leakage and LAD area
total inorganic nitrogen concentration in ground water below Mason Ditch from liner leakage, applied LAD, and Mason Ditch seepage	0.1 mg/L		projected total inorganic nitrogen concentration in ground water below the Mason Ditch
OPERATIONS total inorganic nitrogen concentration in **ground water downgradient of Mason Ditch, $\mathbf{C_d}$**	**0.1** mg/L		projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River
OPERATIONS The concentration of total inorganic nitrogen in ground water at Boe Ranch from the LAD of 1,486 gpm (12-hr) would be less than the DEQ-7 ground water standard of 10 mg/L.			
OPERATIONS East Boulder River calculations downgradient of Boe Ranch LAD		**During the LAD season, up to 164 gpm (24-hr) plus 579 gpm (24-hr) stored pond water is applied at Boe Ranch LAD at agronomic rates.**	
receiving streamflow irrigation season, $\mathbf{Q_s}$	172,800 ft^3/d	2.0 cfs	7Q10 value at EBR-008 for East Boulder Mine streamflow after irrigation withdrawals below Boe Ranch LAD (CES 2008)
receiving streamflow non-irrigation season, $\mathbf{Q_s}$	432,000 ft^3/d	5.0 cfs	7Q10 value for East Boulder Mine streamflow assumed at EBR-008, non-irrigation season
receiving stream ambient concentration at EBR-007, $\mathbf{C_s}$	0.1 mg/L		SMC monitoring data
ground water discharge volume, $\mathbf{Q_d}$	246,781 ft^3/d	2.9 cfs	volume of ground water discharge to the East Boulder River in cubic feet per second
ground water concentration downgradient of Mason Ditch, $\mathbf{C_d}$	0.1 mg/L		projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River

OPERATIONS East Boulder River total inorganic nitrogen concentration, downgradient of Boe Ranch LAD **during the irrigation season (2.0 cfs)**	**0.1**	mg/L			projected total inorganic nitrogen concentration in the East Boulder River at EBR-008 during irrigation season
OPERATIONS East Boulder River total inorganic nitrogen concentration, downgradient of Boe Ranch LAD **non-irrigation season (>5.0 cfs)**	**0.1**	mg/L			projected total inorganic nitrogen concentration in the East Boulder River at EBR-008 during non-irrigation season

OPERATIONS The total inorganic nitrogen concentration in the East Boulder River below Boe Ranch from the application of 1,486 gpm (12-hr) LAD waters would be less than 1.0 mg/L.

The Alternative 2C Nitrogen OPERATIONS Option 1, 150 gpm: During the LAD season days 1-120, up to 150 gpm (24-hr) treated adit water plus 301 gpm (24-hr) stored pond water would be applied at Boe Ranch LAD at agronomic rates. No water would be disposed at the East Boulder Mine percolation pond. The remainder of the year (days 121-365), 150 gpm (24-hr) treated adit water would be routed to the Boe Ranch LAD storage pond. The capacity of the Boe Ranch LAD storage pond would be adequate to store eight months of treated adit water (52 MG).

Boe Ranch LAD storage pond capacity is sufficient for 8 months storage of adit water at 150 gpm

			120	days	length of LAD season at Boe Ranch
OPERATIONS *Boe Ranch LAD* Hydraulic Loading Calculations			100	MG	volume in the Boe Ranch LAD storage pond
volume in LAD storage pond, assume 8 months winter storage of adit water	**52**	MG	600	gpm (12-hr)	rate to dewater Boe Ranch LAD storage pond in one season
area available for LAD in section 17, all pivots included	194	ac	**1,486**	gpm (12-hr)	hydraulic load that can be land applied using agronomic rates for 120 days on 194 acres, all pivots in Section 17
agronomic application rate (KP Apdx K 2000) 12 hr/day	**7.7**	gpm/ac	**900**	gpm (12-hr)	hydraulic load to be applied at Boe Ranch during the 120 day LAD season to dewater the pond and dispose of all treated adit water
adit flow rate	**150**	gpm (24-hr)	463	days	time to fill the Boe Ranch LAD storage pond at 150 gpm after the LAD season

OPERATIONS During the 120 day LAD season, the hydraulic load of 150 gpm (24-hr) adit water plus 602 gpm (12-hr) rate of dewatering 8 months stored water in the LAD storage pond (52 MG) can be managed at Boe Ranch LAD area if all 10 pivots are operating at the proposed agronomic rates.

OPERATIONS *Boe Ranch LAD* total inorganic nitrogen Calculations days 1-120

Assume Boe Ranch LAD storage pond contains 52 MG treated adit water on the first day of the LAD season; disposal of 150 gpm treated adit water plus 602 gpm (12-hr) stored waters at Boe Ranch LAD

			150	gpm (24-hr)	adit flow rate at closure
hydraulic load actually applied at Boe Ranch during the 120 day LAD season to dewater the pond and dispose of all treated adit water	**900**	gpm (12-hr)	**0.4**	mg/L	treated concentration of adit waters based on historical maximum concentration
volume of applied LAD; evaporation credit taken, $\mathbf{V_2}$	60,642	ft^3/d	630	gpm (12-hr)	hydraulic load of treated adit plus Boe Ranch LAD storage pond water; evaporation credit taken
OPERATIONS total inorganic nitrogen concentration in **ground water below Mason Ditch,** $\mathbf{C_d}$	**0.1**	mg/L			projected total inorganic nitrogen concentration in ground water prior to discharge to East Boulder River

OPERATIONS The concentration of total inorganic nitrogen in ground water at Boe Ranch from the LAD of 902 gpm (12-hr) would be less than the DEQ-7 ground water standard of 10 mg/L.

OPERATIONS *Boe Ranch LAD* total inorganic nitrogen Concentrations in the East Boulder River

Assume Boe Ranch LAD storage pond contains 52 MG treated adit water on the first day of the LAD season; disposal of 150 gpm treated adit water plus 602 gpm (12-hr) stored waters at Boe Ranch LAD

ground water discharge volume, $\mathbf{Q_d}$	107,165	ft^3/d	1.3	cfs	ground water discharge volume in cubic feet per second
ground water concentration below Mason Ditch, $\mathbf{C_d}$	0.1	mg/L			projected total inorganic nitrogen concentration in ground water prior to discharge to East Boulder River
OPERATIONS East Boulder River total inorganic nitrogen concentration downgradient of the Boe Ranch LAD **during the irrigation season (2.0 cfs)**	**0.1**	mg/L			projected total inorganic nitrogen concentration in the East Boulder River during irrigation season
OPERATIONS East Boulder River total inorganic nitrogen concentration downgradient of the Boe Ranch LAD **during non-irrigation season (5.0 cfs)**	**0.1**	mg/L			projected total inorganic nitrogen concentration in the East Boulder River during non-irrigation season

OPERATIONS The total inorganic nitrogen concentration in the East Boulder River below the Boe Ranch LAD from disposal of 902 gpm (12-hr) would be less than 1.0 mg/L.

CLOSURE CALCULATIONS

The Alternative 2C Nitrogen CLOSURE Option 1, 737 gpm: The East Boulder tailings impoundment would be dewatered and tailings waters treated at 263 gpm with 737 gpm (24-hr) adit water through the BTS/Anox. Based on the Operations hydraulic load calculations, only 743 gpm (24-hr) can be disposed of at Boe Ranch LAD. During the LAD season days 1-120, up to 164 gpm (24-hr) treated adit plus tailings water plus 579 gpm (24-hr) stored pond water is applied at Boe Ranch LAD at agronomic rates, and 833 gpm (24-hr) must be disposed at the East Boulder Mine. The 836 gpm (24-hr) would be routed to the percolation pond. The remainder of the year (days 121-365), 737 gpm (24-hr) treated adit water would be disposed at the East Boulder Mine percolation pond. The time frame for closure is 12 months.

CLOSURE *Boe Ranch LAD and East Boulder Mine* Hydraulic Loading Calculations

Assume the Boe Ranch LAD storage pond contains 100 MG on the first day of the LAD season at closure; 164 gpm treated adit plus tailings waters applied at the Boe Ranch LAD; at the East Boulder Mine: 293 gpm routed to LAD Area 6 and 540 gpm percolated

assumed volume in Boe Ranch LAD storage pond	100	MG	**1,157**	gpm (12-hr)	rate to dewater **Boe Ranch LAD storage pond** in one season
volume of East Boulder tailings waters	98	MG	**263**	gpm (24-hr)	rate to dewater the East Boulder tailings impoundment maximizing BTS/Anox system capacity and not exceeding total inorganic nitrogen limit
area available for LAD in section 17, all pivots included	194	ac	259	days	time to dewater the East Boulder tailings impoundment
agronomic land application rate proposed by SMC (KP 2000c)	7.7	gpm/ac	**1,486**	gpm (12-hr)	hydraulic load that can be land applied at agronomic rates on 194 acres, all Section 17 pivots
adit flow rate at closure	737	gpm (24-hr)	**164**	gpm (12-hr)	capacity available to land apply treated adit and tailings water at Boe Ranch LAD areas if Boe Ranch LAD storage pond dewatered at full rate
rate that treated adit and tailings waters must be percolated at East Boulder Mine so Boe Ranch LAD storage pond can be dewatered during one LAD season	**836**	gpm (24-hr)	**0**	gpm (24-hr)	rate of land application at East Boulder Mine LAD Area 6 (full capacity)
rate of percolation of treated adit plus tailings waters at East Boulder Mine	**836**	gpm (24-hr)	120	days	length of LAD season at Boe Ranch

***Boe Ranch* LAD Days 1-120: The hydraulic load of 164 gpm (24-hr) treated adit water and tailings waters plus disposal of 579 gpm (24-hr) Boe Ranch LAD stored waters will empty the LAD storage pond and can be managed at Boe Ranch LAD during one LAD season.**
***East Boulder Mine* Days 1-120: The hydraulic load of 293 gpm (24-hr) can be disposed at LAD Area 6, and the remaining 543 gpm (24-hr) can be disposed of at the East Boulder Mine percolation pond. East Boulder Mine Days 121-259: The hydraulic load of 737 gpm (24-hr) treated adit water plus 263 gpm (24-hr) tailings waters can be disposed of at the East Boulder Mine percolation pond. East Boulder Mine Days 260-365: The hydraulic load of 737 gpm (24-hr) treated adit water can be disposed of at that East Boulder Mine percolation pond.**

CLOSURE East Boulder Mine Days 1-120: total inorganic nitrogen load at LAD Area 6	**0.0**	lbs/day	**13.0**	lbs/day	**CLOSURE East Boulder Mine Days 1-120: total inorganic nitrogen percolation load**
CLOSURE East Boulder Mine Days 1-120: total inorganic nitrogen load at percolation pond plus total inorganic nitrogen load at LAD Area 6	**836**	gpm (24-hr)	**13.0**	lbs/day	treated adit plus tailings waters **percolation plus LAD** load
CLOSURE East Boulder Mine Days 121-259: total inorganic nitrogen load at percolation pond	**1,000**	gpm (24-hr)	**15.6**	lbs/day	**percolation** load from treated adit plus tailings waters
CLOSURE East Boulder Mine Days 260-365: total inorganic nitrogen load at percolation pond	737	gpm (24-hr)	**3.5**	lbs/day	**percloation** load from treated adit waters
CLOSURE East Boulder Mine Total Load Days 1-365	**4,106**	lbs/yr	365	days	length of closure

CLOSURE Throughout closure at the East Boulder Mine, the total inorganic nitrogen load produced from the disposal of 737 gpm (24-hr) of treated adit water would be less than the MPDES permit total inorganic nitrogen limit of 30 lbs/day.

CLOSURE *Boe Ranch LAD* : total inorganic nitrogen calculations Days 1-120

Up to 164 gpm (24-hr) mixed treated adit and tailings waters would be mixed with 100 MG treated adit water in the Boe Ranch LAD storage pond and land applied at Boe Ranch at 1,486 gpm (12-hr).

Boe Ranch LAD mixing zone input parameters same as above			737	gpm (24-hr)	adit flow rate at closure (24 hr rate)
hydraulic load that can be land applied at Boe Ranch at agronomic rates for 120 days on 194 acres, all Section 17 pivots	**1,486**	gpm (12-hr)	**47.8**	mg/L	average concentration of tailings waters SMC database 2011
pumping rate of treated tailings waters	**263**	gpm (24-hr)	**0.4**	mg/L	average concentration of adit waters based on BTS/Anox capabilities
weighted concentration of mixed waters in Boe Ranch LAD storage pond; assumes instantaneous mixing of waters	**0.6**	mg/L	**3.8**	mg/L	treated concentration of tailings waters based on 92% total inorganic nitrogen treatment efficiency
total inorganic nitrogen load to soil from LAD during closure	**1,391**	lbs	**1.3**	mg/L	concentration of treated mixed adit plus tailings waters
volume of LAD applied, 30% evaporation credit taken, $\mathbf{V_2}$	100,129	ft^3/d	1,040	gpm (12-hr)	volume of LAD water applied; 30% evaporation credit taken
Days 1-120: Weighted average concentration of total inorganic nitrogen in applied LAD waters (adit water); assume 80% post plant uptake, $\mathbf{C_2}$	0.2	mg/L	**7.2**	lbs/ac/yr	**Total Load** of inorganic nitrogen disposed of **at Boe Ranch (120 days) per acre** during **CLOSURE**

CLOSURE *Boe Ranch LAD* Days 1-120:
total inorganic nitrogen load in **ground water**

Up to 164 gpm (24-hr) mixed treated adit and tailings waters would be mixed with 100 MG treated adit water in the Boe Ranch LAD storage pond and land applied at Boe Ranch at 1,486 gpm (12-hr).

CLOSURE total inorganic nitrogen concentration in **ground water downgradient of Mason Ditch, $\mathbf{C_d}$**	**0.1**	mg/L	projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River

CLOSURE The concentration of total inorganic nitrogen in ground water at Boe Ranch from the LAD of 1,486 gpm (12-hr) treated adit and tailings waters would be less than the DEQ-7 ground water standard of 10 mg/L.

CLOSURE Boe Ranch LAD Days 1-120:
East Boulder River total inorganic nitrogen concentration **downgradient of LAD**

Up to 164 gpm (24-hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 100 MG treated adit water and land applied at Boe Ranch at 1,040 gpm (12-hr).

ground water discharge volume, $\mathbf{Q_d}$	146,652	ft^3/d	1.7	cfs	ground water discharge volume in cubic feet per second
ground water concentration downgradient of Mason Ditch, $\mathbf{C_d}$	0.1	mg/L			projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River

CLOSURE East Boulder River total inorganic nitrogen concentration, **downgradient of Boe Ranch LAD (5.0 cfs)**	**0.1** mg/L	projected total inorganic nitrogen concentration in the East Boulder River during irrigation season
CLOSURE East Boulder River total inorganic nitrogen concentration, **downgradient of Boe Ranch LAD (2.0 cfs)**	**0.1** mg/L	projected total inorganic nitrogen concentration in the East Boulder River during non-irrigation season

CLOSURE The total inorganic nitrogen concentration in the East Boulder River below the Boe Ranch LAD from disposal of 1,486gpm (12-hr) would be less than 1.0 mg/L.

Alternative 2C CLOSURE Option 1, 150 gpm: Days 1-120 Up to 150 gpm (24-hr) adit water would be mixed and treated with 293 gpm tailings waters and routed to the Boe Ranch LAD storage pond. The 436 gpm (24-hr) mixed, treated adit and tailings waters would mix with 52 MG of treated stored water in the LAD storage pond, then land applied at Boe Ranch LAD at agronomic rates 737 gpm (24 hr rate). Days 121-365 During the rest of the 12-month closure period, the 150 gpm (24-hr) would be routed to the East Boulder Mine percolation pond.

CLOSURE *Boe Ranch LAD* Hydraulic Loading Calculations			**Days 1-120: Up to 436 gpm (24-hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 52 MG treated adit water and land applied at 737 gpm at the Boe Ranch LAD area. Day 121: Boe Ranch LAD would be decommissioned.**		
volume in LAD storage pond, assume 8 months winter storage of adit water	**52**	MG	**98**	MG	volume of the East Boulder Tailings impoundment waters needing disposal
pumping rate to empty **Boe Ranch LAD storage pond** at hydraulic capacity of LAD	**300**	gpm (24-hr)	600	gpm (12-hr)	Boe Ranch LAD storage pond dewatering rate
pumping rate to dewater East Boulder **tailings impoundment**	**293**	gpm (24-hr)	586	gpm (12-hr)	East Boulder Tailings impoundment dewatering rate
adit flow rate at closure	**150**	gpm (24-hr)	300	gpm (12-hr)	adit flow rate
rate to dispose of all treated mine waters during 120 day LAD season	**1,486**	gpm (12-hr)	**1,486**	gpm (12-hr)	hydraulic capacity of Boe Ranch at agronomic rates on 194 acres, all Section 17 pivots
weighted average of treated adit, tailings, and stored waters	**0.4**	mg/L	**232**	days	number of days to dewater **East Boulder tailings impoundment** at above rate

Days 1-120: The hydraulic load of 150 gpm (24-hr) treated adit water plus 293 gpm (24-hr) treated tailings waters and 300 gpm (24-hr) Boe Ranch LAD stored waters can be managed at Boe Ranch LAD in one 120-day LAD season without managing any waters at the East Boulder Mine. Days 121-365: The hydraulic load of 150 gpm (24-hr) treated adit water can be managed at the East Boulder Mine percolation pond.

CLOSURE *East Boulder Mine* Days 121-365 nitrogen loading calculations			**Days 121-232, 150 gpm of adit water plus 293 gpm treated tailings waters would be routed to the East Boulder Mine percolation pond. Days 233- 365: 150 gpm treated adit water would be routed to the East Boulder Mine percolation pond.**		
total inorganic nitrogen load to ground water from **percolation (days 121-232)**	**7.3**	lbs/day	**820**	lbs/yr	Total inorganic nitrogen load to ground water from percolation during closure days 121-232
total inorganic nitrogen load to ground water from **percolation (days 233-365)**	**0.7**	lbs/day	**96**	lbs/yr	Total inorganic nitrogen load to ground water from percolation during closure days 234-365
Total Load of inorganic nitrogen Load disposed at the East Boulder Mine during CLOSURE Days 1-365	**916**	lbs/yr			
CLOSURE *Boe Ranch LAD* Days 1-120 nitrogen loading calculations			**Days 1-120, up to 293 gpm (24-hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 52 MG treated adit water and land applied at Boe Ranch.**		
adit flow rate at closure	**150**	gpm (24-hr)	1.4	mg/L	weighted average of treated adit and tailings waters
Daily Load of total inorganic nitrogen disposed at **Boe Ranch LAD during CLOSURE**	**3.6**	lbs/day	**2**	lbs/ac/yr	**Total Load** of inorganic nitrogen disposed of **at Boe Ranch (120 days) per acre** during **CLOSURE**
Total Load of inorganic nitrogen Load disposed at **Boe Ranch LAD (120 days) during CLOSURE**	**428**	lbs/yr			

volume of applied LAD; end of pipe, pre-evaporation at adit flow rate, **V_2**	143,041 ft^3/d	**743** gpm (24-hr)	LAD application rate
Concentration of total inorganic nitrogen in applied LAD waters (treated adit, tailings, and stored waters); assume 80% post plant uptake, **C_2**	0.1 mg/L	**1,486** gpm (12-hr)	LAD application rate

CLOSURE ***Boe Ranch LAD*** **: Days 1-120** inorganic nitrogen concentration in **ground water**				**Up to 443 gpm (24-hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 52 MG treated adit water and land applied at 743 gpm (24-hr) at the Boe Ranch.**
CLOSURE total inorganic nitrogen ground water concentration downgradient of Mason Ditch, C_d	**0.1**	mg/L		projected total inorganic nitrogen concentration in ground water

CLOSURE The concentration of total inorganic nitrogen in ground water at Boe Ranch from the LAD of 743 gpm (24-hr) would be less than the DEQ-7 ground water standard of 10 mg/L.

CLOSURE ***Boe Ranch*** **LAD: Days 1-120** inorganic nitrogen concentration in the **East Boulder River**				**Up to 443 gpm (24-hr) mixed treated adit and tailings waters would be mixed in the Boe Ranch LAD storage pond containing 52 MG treated adit water and land applied at 743 gpm (24-hr) at the Boe Ranch.**
ground water discharge volume, $\mathbf{Q_d}$	143,041	ft^3/d	1.7 cfs	ground water discharge volume in cubic feet per second
ground water concentration below Mason Ditch, $\mathbf{C_d}$	0.1	mg/L		projected total inorganic nitrogen concentration in ground water
East Boulder River total inorganic nitrogen concentration **downgradient of Boe Ranch LAD during irrigation season (2.0 cfs)**	**0.1**	mg/L		projected total inorganic nitrogen concentration in the East Boulder River during irrigation season
East Boulder River total inorganic nitrogen concentration **downgradient of Boe Ranch LAD during non-irrigation season (5.0 cfs)**	**0.1**	mg/L		projected total inorganic nitrogen concentration in the East Boulder River during non-irrigation season

CLOSURE The total inorganic nitrogen concentration in the East Boulder River below the Boe Ranch LAD from disposal of 150 gpm (24-hr) would meet the 1.0 mg/L MPDES Permit nitrogen limit if the flow in the East Boulder River was less than 2.0 cfs.

Spreadsheet 3A Nitrogen--*Revised* Agency-Mitigated Alternative 3A Stillwater Mine and Hertzler Ranch LAD Closure Nitrogen Analyses

For Hertzler Ranch, these calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the Hertzler Ranch LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer; that is, no unsaturated zone was considered to determine concentrations of total nitrogen (TN) in ground water. To determine the concentration of TN in ground water at Hertzler Ranch, the agencies assume that there is a leak in the Hertzler Ranch LAD Storage Pond liner in ground water zone Z1; Pivot 7 discharges to ground water in zone Z_2; the upper LAD discharges to ground water zone Z2; the agencies assume there is a leak from the Hertzler Ranch tailings impoundment in ground water zone Z4; Z1, Z2, and Z4 flow into Z3 where the lower LAD is discharged, then Z3 flows into Z5. Total area for Hertzler Ranch LAD with the addition of Pivot P7 is 319.7 acres. The 11 lbs/day contribution to the total load from Stillwater Mine nitrogen discharge from the East Waste Rock Dump was included from projections made in the 1998 EIS, but recent data indicate that due to less precipitation than evaporation, no load from the dump exists (see memo Appendix E).
See Hertzler Ranch LAD Ground Water Figure. The concentration of treated adit water is based on actually achieved values through 2011. To address potential administrative timing concerns due to unanticipated closure of the mine, a high precipitation year, or other contingency, and to take advantage of the seasonal flushing of TN observed during operations at Hertzler Ranch LAD and the Stillwater Mine, the Agency-Mitigated Alternative 3A would extend the closure period over two LAD seasons. Adjustments made to spreadsheets in response to comments are highlighted in mauve cells below. Anchor cells are highlighted in green. Changed values in explanatory text are noted in blue.

Agency-Mitigated Alternative 3A Option 1, 2,020 gpm: disposal of tailings waters from both Stillwater and Hertzler impoundments. *Stillwater Mine First Season, Days 1-84:* The 370 gpm of untreated east-side adit water would be disposed of in the Stillwater Mine east-side percolation ponds then routed underground day 85. *Stillwater Mine First Season, Days 1-85:* 370 gpm Stillwater tailings waters mixed and treated with 1,650 gpm west-side adit water and routed to the Stillwater Mine percolation ponds. Stillwater Mine, First Season, From day 85, all adit water and slimes are untreated and would be routed underground. *Hertzler Ranch, First Season, Days 1-120:* Up to 260 gpm of the untreated 201 MG Hertzler Ranch tailings waters would be routed to the 105 MG of treated adit water in the Hertzler Ranch LAD storage pond and the mixed adit and tailings waters would be disposed of at the Hertzler Ranch LAD area. Hertzler Ranch, Second Season: Any excess water that cannot be disposed of the first year would be land applied at Hertzler Ranch.

this alternative assumes a LAD season of	**120**	**days**	**147**	days	time to **dewater Stillwater Tailings impoundment** at below rate
The BTS system is assumed to treat up to 2,020 gpm (24 hr)			**1,650**	gpm (24 hr)	**west side adit flow rate** at closure adjusted using 2011 east side adit flow rate
volume of **Stillwater tailings** waters plus 5 MG of tailings mass waters (NPRC 48; KP 37)	**53**	MG	250	gpm (24 hr)	**Stillwater tailings flow rate** at closure; fixed by pumping rate (based on available BTS capacity)
volume of Hertzler Ranch **LAD storage pond** (2010)	**105**	MG	4.1	mg/L	treated concentration of adit waters based on BTS data (2011 SMC data)
volume of **Hertzler Ranch tailings** impoundment plus 5 MG of tailings mass waters (NPRC 142; KP 196)	**201**	MG	4.3	mg/L	total nitrogen concentration of treated tailings waters based on 92% treatment efficiency
east side adit flow rate at closure 2011	**370**	gpm (24 hr)	4.1	mg/L	weighted total nitrogen concentration of treated west-side adit plus Stillwater tailings waters
rate of Hertzler Ranch **upper LAD** 2011	2,225	gpm (12 hr)	**2,326**	gpm (12 hr)	rate to dewater Hertzler Ranch Tailings Impoundment in **120** days
rate of Hertzler Ranch upper LAD	214,171	ft^3/d	53.2	mg/L	**Stillwater and Hertzler Ranch tailings** impoundment waters **TN concentration**, SMC Monitoring Data 2011
rate of Hertzler Ranch **lower LAD** 2011	1,150	gpm (12 hr)	**1,215**	gpm (12 hr)	rate to dewater the Hertzler Ranch LAD storage pond in **120** days
rate of Hertzler Ranch lower LAD	110,695	ft^3/d	2.4	mg/L	**concentration of Hertzler Ranch LAD storage pond** prior to dewatering tailings impoundments (SMC Database average since 2001)
Time to **dewater Hertzler Ranch tailings** impoundment	**120**	days	35.8	mg/L	weighted concentration of mixed Hertzler Ranch LAD storage pond water (treated adit water and untreated Hertzler Ranch tailings waters); instantaneous mixing assumed; (SMC Database 2001-2011 data average 2.4 mg/L)
Input Parameters for Ground Water Calculations Hertzler Ranch LAD					**Source of Data**
depth of aquifer, **D**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, $\mathbf{k_1}$ from LAD storage pond	25	ft/d			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper LAD	300	ft/d			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_3}$ and $\mathbf{k_5}$ from lower LAD	600	ft/d			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
hydraulic conductivity, $\mathbf{k_4}$ from tailings impoundment	2	ft/d			from Hertzler Tailings Impoundment Seepage Analysis, Hydrometrics 2003
gradient, **i**	0.01				estimated, from Hertzler Tailings Impoundment Seepage Analysis Hydrometrics 2003

Appendix E
DEQ 2012

width of source (assumed Hertzler Ranch LAD storage pond liner leakage)	10	ft			assumed width based on point seep, Hydrometrics 2003
width of assumed LAD storage pond liner leakage mixing zone, **W_1**	167	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
length of assumed LAD storage pond liner leakage area, **L_1**	1,800	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
length upper LAD, **L_2**	4,800	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of upper LAD (including pivots P7 and P3)	2,700	ft			personal communication R Weimer 3/17/2009 and 2010 Hertzler Facility Reclamation Map (2-25-2011)
width of upper LAD mixing zone **W_2**	3,120	ft			width of source + (tan 5 * length) allowed by ARM 17.30.517(d)
length of lower LAD, **L_3**	5,200	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of Lower LAD at pivot P4	1,610	ft			personal communication R Weimer 3/17/2009
width of Lower LAD mixing zone **W_3**	2,065	ft			personal communication R Weimer 2/18/2009
width of source (Hertzler Ranch tailings impoundment liner leakage)	10	ft			assumed width based on point seep, Hydrometrics 2003
width of mixing zone below Hertzler Ranch tailings impoundment liner leakage **W_4**	124	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length of W_4 zone, **L_4**	1,300	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of mixing zone to Stillwater River **W_5**	2,215	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length below lower LAD, **L_5**	3,600	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width below lower LAD	1,900	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
cross sectional area of aquifer, **A_1**	2,510	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_2**	46,794	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_3**	30,969	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_4**	1,855	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, **A_5**	33,221	ft^2			D * W, allowed by 17.30.517(d)
Q_1 $=k_1iA_1$, ground water available for mixing	628	ft^3/d			calculation per 17.30.517(d)
Q_2 $=k_2iA_2$, ground water available for mixing	140,383	ft^3/d			calculation per 17.30.517(d)
Q_3 $=k_3iA_3$, ground water available for mixing	185,813	ft^3/d			calculation per 17.30.517(d)
Q_4 $=k_4iA_4$, ground water available for mixing	37	ft^3/d			calculation per 17.30.517(d)
Q_5 $=k_5iA_5$, ground water available for mixing	199,325	ft^3/d			calculation per 17.30.517(d)
Hydraulic imput parameters			10.7	gpm/ac	Hertzler Ranch LAD operational application rate achieving 85% total nitrogen removal efficiency; SMC monitoring data
Stillwater tailings impoundment waters **volume**	53	MG	4.1	mg/L	weighted total nitrogen concentration of treated west-side adit plus Stillwater tailings waters
days to dewater Stillwater tailings impoundment at given rate	147	days	250	gpm (24 hr)	rate to dewater Stillwater tailings impoundment based on available BTS capacity
Hertzler Ranch tailings impoundment waters **volume**	201	MG	50	mg/L	total nitrogen concentration of untreated Hertzler tailings waters
rate to dewater Hertzler Ranch Tailings Impoundment in one LAD season	2,326	gpm (12 hr)	1,163	gpm (24 hr)	rate to dewater Hertzler Ranch Tailings Impoundment in one LAD season
Hertzler Ranch LAD **Storage Pond volume**	105	MG	116,979	ft^3/12 hr	LAD storage pond dewater rate used to compare with LAD application rate

rate to dewater Hertzler Ranch LAD storage pond in one LAD season	1,215	gpm (12 hr)	2.4	mg/L	concentration of LAD storage pond prior to tailings waters mixing
maximum Hertzler Ranch LAD storage pond volume	875,700,000	ft^3	35.8	mg/L	weighted concentration of mixed Hertzler Ranch LAD storage pond water (treated adit water and untreated Hertzler Ranch tailings waters); instantaneous mixing assumed; (SMC Database 2001-2011 data average 2.4 mg/L)
capacity of east side percolation pond (MPDES Statement of Basis, p 3)	2,000	gpm (24 hr)	2,000	gpm (24 hr)	capacity of Stillwater Valley Ranch percolation ponds (MPDES Statement of Basis, p. 3)

FIRST SEASON *Stillwater Mine* Closure Hydraulic Load — **Days 1-84: untreated east-side adit water and treated west-side adit waters plus treated Stillwater tailings waters would be routed to Stillwater Mine east-side and Stillwater Valley Ranch percolation ponds. Untreated adit water and slimes from the tailings impoundment would be routed underground after decommissioning on Day 85.**

east-side adit water (untreated)	370	gpm (24 hr)	0.2	mg/L	total nitrogen concentration of untreated east-side adit water
treated west-side adit water	1,650	gpm (24 hr)	71,230	ft^3/d	volume of adit water in cubic feet per day
treated Stillwater tailings waters	250	gpm (24 hr)	825	gpm (24 hr)	volume of water percolated at Stillwater Valley Ranch percolation ponds
total rate of waters to be percolated at Stillwater Mine	2,270	gpm (24 hr)	1,445	gpm (24 hr)	volume of water percolated at east-side percolation ponds

The percolation capacity of the Stillwater Mine percolation ponds (East-Side Ponds plus Stillwater Valley Ranch Ponds) is adequate to manage the hydraulic load of 2,020 gpm adit waters plus 250 gpm Stillwater tailings waters.

FIRST SEASON *Hertzler Ranch* Closure Hydraulic Load — **Days 1-120: 201 MG untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**

Days 1 - 120: water entering Hertzler Ranch LAD storage pond	2,326	gpm (12 hr)	1,163	gpm (24 hr)	Hertzler Ranch tailings waters pumped to Hertzler Ranch LAD storage pond
rate stored water pumped from Hertzler Ranch LAD storage pond	1,215	gpm (12 hr)	608	gpm (24 hr)	pumping rate of stored Hertzler Ranch LAD storage pond waters
total volume of waters to be LAD	**3,542**	gpm (12 hr)	1,771	gpm (24 hr)	required LAD application rate to dispose of waters
daily maximum LAD design capacity (2010 Hertzler Ranch LAD Report)	**3,700**	gpm (12 hr)	1,850	gpm (24 hr)	maximum application rate at Hertzler Ranch LAD to achieve 80% total nitrogen treatment efficiency; capacity increased by addition of Pivot 7 (P7) (R. Weimer pers. Comm.)

By percolating east and west side adit and Stillwater tailings waters at the Stillwater Mine, the hydraulic load all of the Hertzler Ranch waters may be managed at Hertzler Ranch in one season unless potential problems such as high precipitation year, unanticipated closure, etc. occur.

FIRST SEASON Stillwater Mine Closure total nitrogen load — **Days 1-84: 370 gpm untreated east-side adit water, 1,650 gpm treated wes- side adit water, plus 250 gpm treated Stillwater tailings waters would be routed to Stillwater Mine east-side and Stillwater Valley Ranch percolation ponds. Day 85, the underground would be decommisioned and all waters would be untreated and routed to the underground.**

east side adit water pumping rate	**370**	gpm (24 hr)	0.2	mg/L	total nitrogen concentration of untreated east side adit water from SMC Monitoring Data
contribution of east-side adit water to Stillwater River total nitrogen load at Stillwater Mine	0.9	lbs/day	4.1	mg/L	weighted total nitrogen concentration of treated west-side adit plus Stillwater tailings waters
Stillwater waste rock dumps total nitrogen load from infiltrating precipitation*	**0**	lbs/day	250	gpm (24 hr)	Stillwater tailings waters pumping rate at closure
treated west-side adit plus tailings waters total nitrogen load	94	lbs/day	**1,650**	gpm (24 hr)	adit flow rate at closure
Days 1-84 daily total nitrogen load percolated at Stillwater Mine	**95**	lbs/day	84	days	**The closure nitrogen load meets the MPDES total nitrogen limit of 100 pounds per day at the Stillwater Mine; protective of surface water, no exceedances of ground water standards are expected outside the mixing zone; on Day 85 the underground is decommissioned and all waters and tailings slimes are routed underground without treatment; no direct discharge occurs to surface water**
After Day 85 daily total nitrogen load infiltrating from waste rock dumps at Stillwater Mine (1998 EIS)*	**0**	lbs/day			

Total Nitrogen load percolated at the Stillwater Mine during closure (85 days)	**7,966**	lbs	*Hertzler Ranch EIS 1998 page 4-3; 2009 Waste Rock Dump Coring Report did not document a wetting front through the waste rock storage facility that would contribute a nitrogen load to ground water; also see 2011 LMB tech memo on metals in Appendix E		

The daily total nitrogen load at the Stillwater Mine complies with the MPDES total nitrogen permit limit of 100 pounds per day, which is protective of the Stillwater River at a $7Q_{10}$ streamflow at the Stillwater Mine.

FIRST SEASON Hertzler Ranch Input parameters and assumptions for total nitrogen load and concentrations			**Days 1-120: untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**		
concentration of total nitrogen in ambient ground water (HMW-4)	0.2	mg/L	3,700	gpm (12 hr)	FIRST SEASON LAD daily application rate;
Closure concentration of total nitrogen in Hertzler Ranch LAD storage pond liner leakage, $\mathbf{C_1}$	35.8	mg/L			weighted concentration of mixed Hertzler Ranch LAD storage pond water (treated adit water and untreated Hertzler Ranch tailings waters); instantaneous mixing assumed; (SMC Database 2001-2011 data average 2.4 mg/L)
concentration of total nitrogen in upper and lower LAD discharge (80% post plant uptake credit), $\mathbf{C_2}$, $\mathbf{C_3}$	10.2	mg/L	319.7	ac	area of Hertzler Ranch LAD application with the addition of pivot P7; SMC 2010 Annual Report
concentration of total nitrogen in Hertzler Ranch tailings impoundment liner leakage, $\mathbf{C_4}$	1.1	mg/L			assume equal to Hertzler Ranch tailings impoundment underdrain concentration, SMC Monitoring Data 2011
volume upper LAD Discharge; P1, P2, P3, P7; assume 30% evaporates, $\mathbf{V_2}$	149,920	ft^3/d	**2,225**	gpm (12 hr)	Upper LAD Discharge total application rate from pivots P1, P2, P3 CES 2008; Pivot 7 P7 added for spring 2011: 800 gpm (12 hr)
volume of Hertzler Ranch tailings impoundment liner leakage (1 gpm), $\mathbf{V_4}$	193	ft^3/d	9,626	ft^3/d	pivot P1; **100** (350) gpm 12 hour maximum application rate; SMC 2010 Hertzler LAD Report
volume of Hertzler Ranch LAD storage pond liner leakage (1 gpm), $\mathbf{V_1}$	193	ft^3/d	31,283	ft^3/d	pivot P2: **325** (400) gpm 12 hour maximum application rate; SMC 2010 Hertzler LAD Report
volume lower LAD discharge: P4, P5, P6 assume 30% evaporates, $\mathbf{V_3}$	99,385	ft^3/d	96,257	ft^3/d	pivot P3; **1,000** (850) gpm 12 hour maximum application rate; SMC 2010 Hertzler LAD Report
daily load of total nitrogen disposed at closure at Hertzler Ranch	**454**	lb/day	62,567	ft^3/d	pivot P4 **650** (450) gpm 12 hour maximum application rate; SMC 2010 Hertzler LAD Report
total total nitrogen load disposed at Hertzler Ranch during closure (120 days)	**54,450**	lbs	60,160	ft^3/d	pivot P5 **625** (450) gpm 12 hour maximum application rate; SMC 2010 Hertzler LAD Report
Annual total nitrogen load per acre per year (319.7 ac)	**170**	lb/ac/yr	19,251	ft^3/d	pivot P6 **200** (250) gpm for 12 hour application rate; SMC 2010 Hertzler LAD Report
Lower LAD discharge total application rate from pivots P4, P5, P6 SMC 2010 Hertzler LAD Report	**1,475**	gpm (12 hr)	77,005	ft^3/d	pivot P7; **800** gpm for 12 hr application rate per R Weimer pers. com.; loading calculation based on flow rates and weighted average concentration of mixed LAD storage pond water

Ground Water concentrations at Hertzler Ranch			**Days 1-120: untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**
ground water concentration area $\mathbf{Z_1}$	8.6	mg/L	loading calculation for Ground Water zone Z_1
ground water concentration area $\mathbf{Z_2}$	5.4	mg/L	loading calculation for Ground Water zone Z_2
ground water concentration area $\mathbf{Z_4}$	1.0	mg/L	loading calculation for Ground Water zone Z_4
ground water concentration in $\mathbf{Z_3}$ from $\mathbf{Z_1}$, $\mathbf{Z_2}$, $\mathbf{Z_3}$, $\mathbf{Z_4}$	**4.5**	**mg/L**	cumulative loading calculation for Ground Water zone Z_3, at compliance point HMW-10 from 1992 Hertzler Ranch EIS; the 2 mg/L above background operational trigger level does not apply at closure; DEQ-7 ground water criteria apply
ground water total nitrogen concentration in $\mathbf{Z_5}$ from upgradient sources ($\mathbf{Z_1}$, $\mathbf{Z_2}$, $\mathbf{Z_3}$, $\mathbf{Z_4}$)	3.4	mg/L	ground water concentration prior to discharge to Stillwater River

The total nitrogen concentration in ground water meets the DEQ-7 ground water criteria of 10 mg/L.

Stillwater River concentration below Hertzler Ranch	**Days 1-120: untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**

receiving streamflow, Q_s	3,628,800	ft^3/d	42	cfs	7Q10 at mine site 31.2 cfs; receiving streamflow below the Hertzler Ranch LAD estimated
receiving stream ambient total nitrogen concentration, C_s	0.4	mg/L			median ambient total nitrogen concentration at SMC-12A 1995-2008 SMC monitoring data, based on the MPDES permit for Stillwater Mine; ambient TIN is 0.14 mg/L
ground water discharge volume, Q_d	775,877	ft^3/d	9.0	cfs	ground water discharge in cubic feet per second
ground water discharge concentration to Stillwater River, C_d	3.4	mg/L			
Stillwater River concentration at $7Q_{10}$	**0.9**	**mg/L**	140	cfs	$30Q_{10}$ at mine site in cfs based on data collected annually by SMC for the month of September
Stillwater River concentration at $30Q_{10}$	**0.5**	**mg/L**	12,096,000	ft^3/d	30Q10 at mine site in cf per day based on data collected annually by SMC for the month of September

The total nitrogen concentration in the Stillwater River below the Hertzler Ranch would not exceed 1.0 mg/L MPDES permit effluent limit during closure.

Alternative 3A: 1,302 gpm adit water; disposal of tailings waters from both impoundments *FIRST SEASON. Stillwater Mine.* Days 1-61: untreated east-side adit waters (370 gpm) percolated in east-side percolation ponds; treated west-side adit water (932 gpm) plus treated Stillwater tailings waters (600 gpm) routed to Hertzler Ranch LAD Storage Pond. Days 62-84: untreated east-side adit water (370 gpm) percolated in east-side percolation ponds; treated west-side adit water (932 gpm) routed to Hertzler Ranch LAD Storage Pond. From day 85, all untreated adit water is routed underground. Some west-side adit water may be routed through the BTS to maintain the microbes through the second season. *FIRST SEASON Hertzler Ranch.* Days 1-41: treated west-side adit water (932 gpm) plus treated Stillwater tailings waters (600 gpm) routed to Hertzler Ranch LAD storage pond. Days 42-84: Untreated Hertzler Ranch tailings waters (396 gpm) plus treated west-side adit water (932 gpm) routed to Hertzler Ranch LAD storage pond. Day 85-120, LAD of all waters remaining in the Hertzler Ranch storage pond. *SECOND LAD SEASON.* Any excess water that could not be disposed of the first year due to high precipitation, financial instability, etc. would be land applied at Hertzler Ranch.

assumed capacity of BTS system	2,000	gpm (24 hr)	**370**	gpm (24 hr)	untreated **east-side adit flow** rate at closure
			932	gpm (24 hr)	Stillwater Mine **west-side adit flow** rate at closure
			600	gpm (24 hr)	**Stillwater tailings impoundment** pumping rate at closure
			4.1	mg/L	treated concentration of adit waters based on BTS data (2011 SMC database)
			4.2	mg/L	mixed total nitrogen concentration of treated west-side adit plus Stillwater tailings waters
			1,163	gpm (24 hr)	rate to **dewater Hertzler Ranch tailings** impoundment
Length of LAD season and available time to **dewater Hertzler Ranch tailings impoundment**	120	days	53.2	mg/L	**Hertzler Ranch tailings impoundment** waters concentration
			4.1	mg/L	total nitrogen concentration of Hertzler Ranch LAD storage pond prior to dewatering tailings impoundments
Time until adit water is discharged underground	84	days	4.1	mg/L	**Days 1-61: total nitrogen concentration of mixed Hertzler Ranch LAD storage pond water with treated adit water plus treated Stillwater tailings waters and untreated Hertzler Ranch tailings waters; assumes instantaneous mixing of total volumes**
			39	mg/L	**Days 85-120: total nitrogen concentration of remaining mixed Hertzler Ranch LAD storage pond water with Hertzler Ranch tailings waters; assumes instantaneous mixing of total volumes**

FIRST SEASON *Hertzler Ranch* Hydraulic Capacity		**120 day LAD Season**	**Days 1-61: Mixed treated west side adit plus Stillwater tailings waters routed to Hertzler Ranch LAD storage pond until impoundment dewatered; mixed with Hertzler Ranch tailings waters and LAD stored waters; Days 57-90: Treated west side adit waters routed to Hertzler Ranch LAD storage pond to be mixed with untreated Hertzler Tailings waters; no adit water after day 90 (routed underground); Days 91-120: untreated Hertzler tailings waters routed to Hertzler Ranch LAD storage pond for land application**		
Stillwater tailings impoundment waters volume	53	MG	**600**	gpm (24 hr)	rate to dewater Stillwater tailings impoundment
Time to dewater Stillwater tailings impoundment based on volume of supernatant and BTS capacity	**61**	days	**932**	gpm (24 hr)	Stillwater Mine west side adit flow rate at closure
Hertzler Ranch **tailings** impoundment waters volume **Day 1**	**201**	MG	1,163	gpm (24 hr)	rate to dewater Hertzler Ranch Tailings Impoundment **in 120 days**

Hertzler Ranch **tailings** impoundment waters volume **on day Stillwater impoundment is dewatered**	201	MG	**0**	gpm (24 hr)	**R**ate to dewater Hertzler Ranch LAD storage pond with Stillwater impoundment plus adit water based on LAD capacity
Hertzler Ranch LAD **storage pond** initial stored volume on **Day 1**	**105**	MG	932	gpm (24 hr)	Rate to dewater Hertzler Ranch LAD storage pond with adit water and Hertzler tailings waters based on LAD capacity (after Stillwater impoundment is dewatered)
volume in Hertzler Ranch LAD **storage pond** on **day Stillwater impoundment is dewatered**	**105**	MG	**31**	MG	volume in Hertzler Ranch tailings impoundment when Stillwater tailings impoundment is dewatered
Days 85-120: Rate to dewater Hertzler Ranch **tailings** impoundment	**621**	gpm (24 hr)	**0**	gpm (24 hr)	rate to dewater Hertzler Ranch tailings impoundment days **1-56**
Days 85 - 120: Rate to dewater Hertzler Ranch LAD **storage pond**	598	gpm (24 hr)	918	gpm (24 hr)	west side adit water and Hertzler Ranch tailings waters days **57-90;** Stillwater tailings impoundment is dewatered
volume in Hertzler Ranch LAD **storage pond** on **Day 91**	**73**	MG	24	days	number of days adit water is routed to Hertzler Ranch LAD pond after dewatering Stillwater impoundment (before underground is decommissioned and water can be routed underground)
daily maximum LAD design capacity rate Days 1-120	356,150	ft^3/d	**1,850**	gpm (24 hr)	maximum application rate at Hertzler Ranch LAD to achieve 80% total nitrogen treatment efficiency
			35	days	time remaining to dewater Hertzler Ranch tailings impoundment in 120 days

The hydraulic load of adit and tailings waters from both impoundments is too great to be managed at the Hertzler Ranch LAD. To dewater and cap both impoundments the first year, the mine site water needs to be managed at the mine.

FIRST SEASON *Hertzler Ranch* Hydraulic Capacity Option 2 — **120 day LAD Season**

FIRST SEASON: Days 1-61: Mixed untreated east-side adit and treated west-side adit plus Stillwater tailings waters routed to Stillwater east-side percolation ponds until impoundment dewatered. Days 62-84: untreated eas- side and treated west-side adit waters routed to Stillwater eas- side percolation ponds; no adit water would be percolated after day 84 (routed underground). Days 1-120: 201 MG untreated Hertzler tailings waters routed to Hertzler Ranch LAD storage pond containing 105 MG of stored waters for land application. SECOND SEASON: Excess waters remaining in LAD storage pond would be land applied at the Hertzler Ranch.

Hertzler Ranch **tailings** impoundment waters volume **Day 1**	**201**	MG	1,163	gpm (24 hr)	rate to dewater Hertzler Ranch Tailings Impoundment **one LAD season**
Hertzler Ranch **tailings** impoundment waters volume **Day 90**	**60.3**	MG	687	gpm (24 hr)	Available land application capacity for disposal of Hertzler Ranch LAD storage pond waters **Days 1-120**
Hertzler Ranch LAD **storage pond** initial stored volume on **Day 1**	**105**	MG	1,631	gpm (24 hr)	Rate that Hertzler Ranch tailings impoundment and storage pond waters must be land applied to dispose of remaining volume **Days 91-120**
Hertzler Ranch **LAD storage pond** volume **Day 90**	**22**	MG	**1,850**	gpm (24 hr)	maximum application rate at Hertzler Ranch LAD to achieve 80% total nitrogen treatment efficiency

FIRST SEASON *Stillwater Mine* Hydraulic Capacity Option 2

Based on the analysis for 1,770 gpm (east- and west-side) adit plus Stillwater tailings waters, the hydraulic load of 1,302 gpm adit plus Stillwater tailings waters can be managed at the Mine percolation ponds.

The hydraulic load of Hertzler Ranch tailings waters and stored Hertzler Ranch LAD storage pond waters may be managed at Hertzler Ranch in one season unless potential problems such as high precipitation year, bankruptcy, etc. occur.

***HERTZLER RANCH:* The nitrogen load and ground water concentration data are the same as analyzed above for 2,020 gpm adit water and will not be analyzed further here.**

FIRST SEASON Stillwater Mine Closure total nitrogen load

Days 1-90: 370 gpm untreated east-side adit water, 932 gpm treated wes- side adit water, plus 600 gpm treated Stillwater tailings waters would be routed to Stillwater Mine east-side (up to 940 gpm) and Stillwater Valley Ranch (up to 1,330 gpm) percolation ponds.

east-side adit water pumping rate	**370**	gpm (24 hr)	0.2	mg/L	total nitrogen concentration of untreated east side adit water from SMC Monitoring Data
Daily total nitrogen load potentially infiltrating from East-Side Waste Rock Storage at Stillwater Mine (1998 EIS) *	**0**	lbs/day			*Hertzler Ranch EIS 1998 page 4-3; 2009 Waste Rock Dump Coring Report did not document a wetting front through the waste rock storage facility that would contribute a nitrogen load to ground water; also see 2011 LMB tech memo on metals in Appendix E

Days 1-61 daily total nitrogen load percolated at Stillwater Mine from mixed east side adit water plus treated west side adit and tailings waters	**63**	lbs/day	3.4	mg/L	Days 1-61 weighted average concentration of mixed treated Stillwater tailings plus stored waters)
Days 61-84 daily total nitrogen load percolated at Stillwater Mine from untreated east side water and treated west side adit water	**47**	lbs/day			**The closure nitrogen load meets the MPDES total nitrogen limit of 100 pounds per day (for $7Q_{10}$ streamflow) at the Stillwater Mine; protective of surface water, no exceedances of ground water standards are expected outside the mixing zone; on day 84 the underground would be decommissioned and all adit waters would be routed underground; no direct discharge occurs to surface water**
From Day 85 nitrogen load percolated at the Stillwater Mine	**0**	lbs/day			
Total maximum nitrogen load percolated at the Stillwater Mine during closure (84 days)	**4,950**	lbs/18 mo closure	**4,950**	lbs/18 mo closure	**Total nitrogen load percolated at the Stillwater Mine during closure (90 days); no waste rock contribution included based on less precipitation than evaporation**

The daily total nitrogen load at the Stillwater Mine complies with the MPDES total nitrogen permit limit of 100 pounds per day, which is protective of the Stillwater River at $7Q_{10}$ streamflow at the Stillwater Mine.

Spreadsheet 3A Salts--*Revised* Agency-Mitigated Alternative 3A Stillwater Mine and Hertzler Ranch Salinity Analyses

For Hertzler Ranch, the calculations have been made according to the regulatory requirements (Montana Water Quality Act and Rules and Federal Clean Water Act) regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the Hertzler Ranch LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer; that is, no unsaturated zone was considered to determine the concentrations of total dissolved solids--salts (TDS) in ground water. In ground water, the standard is based on electrical conductivity; in surface water, the goal is concentration in mg/L. The agencies used the factor 1 mg/L TDS = 1.56 umhos/cm EC to convert between units. To determine the concentration of TDS in ground water at Hertzler Ranch, the agencies assume that there is a leak in the Hertzler Ranch LAD Storage Pond liner in ground water zone Z_1; Pivot 7 discharges to ground water in zone Z_2; the upper LAD discharges to ground water zone Z_2; assume there is a leak from the Hertzler Ranch tailings impoundment in ground water zone Z_4; zones Z_1, Z_2, and Z_4 flow into Z_3 where the lower LAD is discharged, then Z_3 flows into Z_5. Salts are not treated in the BTS/Anox or in the Hertzler Ranch LAD, so all salts are expected to flush through the soil column and unsaturated zone to ground water. The agencies assumed that the adit water TDS concentration will equal the median operational Stillwater Mine concentration. The Stillwater Mine MPDES has no TDS or electrical conductivity (EC) limit. The total area for Herzler Ranch LAD with the addition of Pivot 7 is 319.7 acres.

To address potential administrative timing concerns due to unexpected closure of the mine, a high precipitation year, or other contingency, and to take advantage of the seasonal flushing of TDS observed during operations at Hertzler Ranch LAD and the Stillwater Mine, the Agency-Mitigated Alternative 3A would extend the closure period over two summer LAD seasons (18 months). Adjustments made to the spreadsheets in response to current information and comments are highlighted in mauve cells below. Anchor cells are highlighted in green. Changed values in explanatory text are noted in blue.

CLOSURE Agency-Mitigated Alternative 3A Option 1, 2,020 gpm: disposal of tailings waters from both Stillwater and Hertzler impoundments. *Stillwater Mine First Season, Days 1-84*: The 370 gpm of untreated east-side adit water would be disposed of in the Stillwater Mine east side percolation ponds then routed underground day 85. Up to 250 gpm Stillwater tailings waters would be mixed and treated with 1,650 gpm west-side adit water and routed to the Stillwater Mine percolation ponds. *Stillwater Mine, First Season*, From day 85, all adit water and slimes are untreated and would be routed underground. *Hertzler Ranch, First Season, Days 1-120:* Up to 260 gpm of the untreated 201 MG Hertzler Ranch tailings waters would be routed to the 105 MG of treated adit water in the Hertzler Ranch LAD storage pond and the mixed adit and tailings waters would be disposed of at the Hertzler Ranch LAD area. *Hertzler Ranch, Second Season:* Any excess water that cannot be disposed of the first year would be land applied at Hertzler Ranch.

1 mg/L TDS = 1.56 µmhos/cm conversion used	**120**	**days**	**370**	gpm (24 hr)	east-side adit flow rate at closure (SMC database 2011)
Application area under Hertzler Ranch LAD pivots P1-P7 (2011)	319.7	ac	**1,650**	gpm (24 hr)	west-side adit flow rate at closure
rate untreated east-side plus **600 gpm** mixed treated west-side adit and tailings waters entering **east side percolation ponds** (MPDES Statement of Basis p. 3 permits up to 2,000 gpm total disposal)	**970**	gpm (24 hr)	**1,300**	gpm (24 hr)	rate mixed treated west-side adit plus tailings waters entering **Stillwater Valley percolation ponds** (MPDES Statement of Basis p. 3 permits up to 2,000 gpm total disposal)
calculated median west-side adit water EC SMC Data 2011	1,190	µmhos/cm	763	mg/L	median Stillwater TDS west-side adit water concentration, SMC Database 2011
average 2004-2008 Stillwater east-side adit EC (calculated)	390	µmhos/cm	250	mg/L	average 2004-2008 Stillwater east-side adit TDS concentration
EC in both tailings impoundments: Stillwater and Hertzler Ranch (calculated)	1,476	µmhos/cm	946	mg/L	concentration of TDS in both tailings impoundments: Stillwater and Hertzler Ranch (SMC database; 2011)
weighted TDS concentration in mixed eas- side adit plus west-side adit plus Stillwater tailings waters (percolated at east-side ponds)	582	mg/L	250	gpm (24 hr)	**Stillwater tailings flow rate** at closure; fixed by BTS capacity for TN treatment
calculated EC of mixed east- and west-side adit, and tailings waters	908	µmhos/cm	2,326	gpm (12 hr)	rate to dewater Hertzler Ranch tailings Impoundment in **120** days
calculated EC in **mixed west-side adit plus Stillwater tailings** waters	1,228	µmhos/cm	787	mg/L	weighted TDS concentration in **mixed west-side adit plus Stillwater tailings** waters (percolated at Stillwater Valley Ranch Ponds)
Stillwater tailings impoundment waters volume plus 5 MG tailings mass waters (NPRC 48 MG; KP 37 MG 2011)	**53**	MG	883	mg/L	weighted TDS concentration of mixed **Hertzler Ranch LAD storage pond** water (treated stored adit water) and untreated Hertzler Ranch tailings waters; assumes instantaneous mixing
Hertzler Ranch tailings impoundment waters volume plus 5 MG tailings mass waters (NPRC 142 MG; KP 196 MG 2011)	**201**	MG	**105**	MG	**Hertzler LAD Storage Pond volume** (2010)
***Hertzler Ranch LAD* Input Parameters for Ground Water Calculations**					**Source of Data**

depth of aquifer, **D**	15	ft	**147**	**days**	time to dewater Stillwater Tailings Impoundment at given rate
hydraulic conductivity, $\mathbf{k_1}$ from Hertzler Ranch LAD storage pond	25	ft/d			from Hertzler Tailings Impoundment Seepage Analysis 2003
hydraulic conductivity, $\mathbf{k_2}$ from upper Hertzler Ranch LAD	300	ft/d			from Hertzler Tailings Impoundment Seepage Analysis 2003
hydraulic conductivity, $\mathbf{k_3}$ and $\mathbf{k_5}$ from lower Hertzler Ranch LAD	600	ft/d			from Hertzler Tailings Impoundment Seepage Analysis 2003
hydraulic conductivity, $\mathbf{k_4}$ from tailings impoundment	2	ft/d			from Hertzler Tailings Impoundment Seepage Analysis 2003
gradient, **i**	0.01				estimated, from Hertzler Tailings Impoundment Seepage Analysis
width of source (Hertzler Ranch LAD storage pond liner leakage)	10	ft			assumed width based on point seep, Hydrometrics 2003
width of Hertzler Ranch LAD storage pond liner leakage mixing zone, $\mathbf{W_1}$	167	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
length Hertzler Ranch LAD storage pond liner leakage area, $\mathbf{L_1}$	1,800	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
length upper Hertzler Ranch LAD, $\mathbf{L_2}$	4,800	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of upper Hertzler Ranch LAD (including pivots P3 and P7)	2,700	ft			personal communication R Weimer 3/17/2009 and 2010 Hertzler Facility Reclamtion map (2-25-2011)
width of Upper Hertzler Ranch LAD mixing zone $\mathbf{W_2}$	3,120	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length of lower Hertzler Ranch LAD, $\mathbf{L_3}$	5,200	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of Lower Hertzler Ranch LAD at P4	1,610	ft			personal communication R Weimer 2/18/2009
width of Lower Hertzler Ranch LAD mixing zone $\mathbf{W_3}$	2,065	ft			personal communication R Weimer 2/18/2009
width of source (Hertzler Ranch tailings impoundment liner leakage)	10	ft			assumed width based on point seep, Hydrometrics 2003
width of mixing zone below Hertzler Ranch tailings impoundment liner leakage $\mathbf{W_4}$	124	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length of W_4 zone, $\mathbf{L_4}$	1,300	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width of Mixing Zone to Stillwater River $\mathbf{W_5}$	2,215	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
length below lower Hertzler Ranch LAD, $\mathbf{L_5}$	3,600	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
width below lower Hertzler Ranch LAD	1,900	ft			from Hertzler Tailings Impoundment Seepage Analysis 2003 map
cross sectional area of aquifer, $\mathbf{A_1}$	2,510	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_2}$	46,794	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_3}$	30,969	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_4}$	1,855	ft^2			D * W, allowed by 17.30.517(d)
cross sectional area of aquifer, $\mathbf{A_5}$	33,221	ft^2			D * W, allowed by 17.30.517(d)
$\mathbf{Q_1}$=kiA, ground water available for mixing	628	ft^3/d			calculation per 17.30.517(d)
$\mathbf{Q_2}$=kiA, ground water available for mixing	140,383	ft^3/d			calculation per 17.30.517(d)
$\mathbf{Q_3}$=kiA, ground water available for mixing	185,813	ft^3/d			calculation per 17.30.517(d)
$\mathbf{Q_4}$=kiA, ground water available for mixing	37	ft^3/d			calculation per 17.30.517(d)
$\mathbf{Q_5}$=kiA, ground water available for mixing	199,325	ft^3/d			calculation per 17.30.517(d)

Stillwater tailings impoundment waters volume	53	MG	946	mg/L	TDS concentration of untreated Stillwater and Hertzler Ranch tailings waters
days to dewater Stillwater Tailings Impoundment at given rate	147	days	250	gpm (24 hr)	Stillwater tailings flow rate at closure; fixed by BTS capacity for TIN treatment
Hertzler Ranch tailings impoundment waters volume	201	MG	1,476	mg/L	EC of untreated Stillwater and Hertzler Ranch tailings waters
rate to dewater Hertzler Ranch Tailings Impoundment in **120** days	2,326	gpm (12 hr)	1,163	gpm (24 hr)	rate to dewater Hertzler Ranch Tailings Impoundment in **120** days
Hertzler LAD Storage Pond volume	105	MG	116,979	ft^3/12 h	Hertzler Ranch LAD storage pond dewater rate used to compare with Hertzler Ranch LAD application rate
rate to dewater Hertzler LAD storage pond in **120** days	1,215	gpm (12 hr)	763	mg/L	concentration of Hertzler Ranch LAD storage pond prior to tailings waters mixing
maximum Hertzler Ranch LAD storage pond volume	875,700,000	ft^3	883	mg/L	weighted TDS concentration of mixed Hertzler Ranch LAD storage pond water (treated stored adit water) and untreated Hertzler Ranch tailings waters; assumes instantaneous

***Stillwater Mine* FIRST SEASON Hydraulic Capacity**

Days 1-84: untreated east side adit water and treated west side adit waters plus treated Stillwater tailings waters would be routed to Stillwater Mine percolation ponds (east side and Stillwater Valley Ranch). From Day 85: Stillwater tailings waters would be routed underground. (time frames would change based upon TI volume)

east-side adit water	370	gpm (24 hr)	250	mg/L	TDS concentration of east-side adit water percolated at east-side percolation ponds
treated west-side adit water	1,650	gpm (24 hr)	787	mg/L	weighted TDS concentration of mixed west-side adit plus Stillwater tailings treated water from BTS percolated at east-side percolation ponds
treated Stillwater tailings waters	250	gpm (24 hr)	147	days	days to dewater Stillwater Tailings Impoundment at given rate
total rate of waters to be percolated at Stillwater Mine	2,270	gpm (24 hr)	4,000	gpm (24 hr)	minimum capacity for both east-side and Stillwater Valley Ranch percolation ponds; MPDES Statement of Basis p.3

The percolation capacity of the east-side percolation ponds (East-Side Ponds plus Stillwater Valley Ranch Ponds) is adequate to manage the hydraulic load of 2,020 gpm adit waters plus 250 gpm Stillwater tailings waters.

***Hertzler Ranch LAD* FIRST SEASON Hydraulic Capacity**

Days 1-120: 201 MG untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD. (time frame changes based upon TI volume)

Days 1 - **120**: water entering Hertzler Ranch LAD storage pond	2,326	gpm (12 hr)	1,163	gpm (24 hr)	Hertzler Ranch tailings waters pumped to Hertzler Ranch LAD storage pond for mixing with stored adit waters
rate stored water pumped from Hertzler Ranch LAD storage pond to be land applied	1,215	gpm (12 hr)	608	gpm (24 hr)	pumping rate of **105** MG stored Hertzler Ranch LAD storage pond waters
total volume of waters to be LAD	3,542	gpm (12 hr)	1,771	gpm (24 hr)	required LAD application rate to dispose of waters
daily maximum LAD design capacity (2010 Hertzler Ranch LAD Report) **(see cells D109-D115)**	3,700	gpm (12 hr)	1,850	gpm (24 hr)	maximum application rate at Hertzler Ranch LAD to achieve 80% TIN treatment efficiency; **capacity increased by Pivot 7 (P7)** (2010 Hertzler Ranch LAD Report)

By percolating adit and Stillwater tailings waters at the Stillwater Mine, the hydraulic load of the Hertzler Ranch waters may be managed at Hertzler Ranch in one season unless potential problems such as high precipitation year, bankruptcy, etc. occur.

***Stillwater Mine* FIRST SEASON TDS load**

Days 1-84: untreated east-side adit water and treated west-side adit waters plus treated Stillwater tailings waters would be routed to Stillwater Mine east-side and Stillwater Valley Ranch percolation ponds. After Day 85, all waters would be routed underground.

east-side adit water pumping rate	370	gpm (24 hr)	250	mg/L	TDS concentration of east-side adit water from SMC Monitoring Data
east-side adit water TDS load to Stillwater River at Stillwater Mine	1,110	lbs/day	787	mg/L	weighted TDS concentration in mixed west-side adit plus Stillwater tailings waters

Stillwater East-Side Waste Rock Storage TDS load from percolating precipitation; assumed to be *deminimis* based on nitrogen and metals loading analysis (See Appendix E technical memo on Metals)	0 lbs/day	1,650 gpm (24 hr)	west-side adit flow rate at closure
treated west side adit water TDS load	15,584 lbs/day	250 gpm (24 hr)	Stillwater tailings waters pumping rate at closure
Stillwater tailings water TDS load	2,361 lbs/day	**147** days	time to dewater the Stillwater Tailings Impoundment at given rate
Days 1-84 daily TDS load percolated at Stillwater Mine	19,055 lbs/day	**time frames changed based on higher volumes in the Stillwater Tailings impoundment; affects the total load disposed of through percolation**	
After Day 85 daily TDS load percolated at Stillwater Mine	0 lbs/day		no discharge at Stillwater Mine after day **85**; Stillwater tailings impoundment dewatered and all adit waters routed underground
Total salts load percolated at Stillwater Mine during closure	**1,600,654** lbs/18 months		

There is no MPDES permit concentration limit or load limit for salt at the Stillwater Mine.

***Stillwater Mine* Ground Water Salts Calculation Input Parameters**		**Days 1-84: untreated east side adit water and treated west side adit waters plus treated Stillwater tailings waters would be routed to Stillwater Mine east side and Stillwater Valley Ranch percolation ponds.**	
depth of aquifer, **D**	15 ft		Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
hydraulic conductivity east side percolation ponds, $\mathbf{k_{SVR}}$	4,076 ft/day		SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
hydraulic conductivity east side percolation ponds, $\mathbf{k_{E}}$	539 ft/day		SMC MPDES Permit Renewal Information (Hydrometrics 1995) used for 2008 renewal
gradient, **i**	0.006 ft/ft		Original Stillwater MPDES Permit calculations penciled in Hydrometrics 1995
length of mixing zone, $\mathbf{L_{SVR}}$ (2008 MPDES Permit page 3)	500 ft	71,230 ft^3/d	volume of east side adit water at closure
width of mixing zone at downgradient extent, $\mathbf{W_{SVR}}$ (2008 MPDES Permit page 3)	507 ft	48,128 ft^3/d	volume of Stillwater Tailings waters at closure
length of mixing zone, $\mathbf{L_{E}}$ (2008 MPDES Permit page 4)	2,000 ft	186,738 ft^3/d	East-side and west-side adit water percolated with tailings water at east side percolation ponds
width of mixing zone at downgradient extent, $\mathbf{W_{E}}$ (2008 MPDES Permit page 4)	650 ft	250,267 ft^3/d	West-side adit water percolated at Stillwater Valley Ranch percolation ponds
cross sectional area of aquifer, $\mathbf{A_{SVR}}$	7,605 ft	582 mg/L	weighted TDS concentration in mixed east-side adit plus west-side adit plus Stillwater tailings waters (percolated at east-side ponds)
cross sectional area of aquifer, $\mathbf{A_{E}}$	9,750 ft	787 mg/L	weighted TDS concentration in **mixed west side adit plus Stillwater tailings** waters (percolated at Stillwater Valley Ranch Ponds)
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing	185,988 ft^3/d		calculation per 17.30.517(d)
$\mathbf{Q_{E}=k_{E}iA_{E}}$, ground water available for mixing	31,532 ft^3/d		calculation per 17.30.517(d)
ambient TDS concentration in ground water at MW-10A Stillwater Mine	81 mg/L	126 μmhos/cm	median concentration of TDS in ambient ground water at SMC MW-10A (calculated)
ground water TDS concentration at end of Stillwater east-side percolation pond mixing zone	510 mg/L	**795** μmhos/cm	weighted EC from percolation of half the west-side adit waters plus 250 Stillwater Tailings plus 370 gpm east-side adit waters
ground water TDS concentration at end of Stillwater Valley Ranch percolation pond mixing zone	494 mg/L	**771** μmhos/cm	**cumulative EC** from Stillwater East-Side percolation plus percolation of half the west-side adit waters at Stillwater Valley Ranch

The EC in ground water meets the 1,000 μmhos/cm Class I Beneficial Use criterion at the Stillwater Mine.

***Stillwater Mine* Stillwater River salts concentration**			**Days 1-84: untreated east-side adit water and treated west-side adit waters plus treated Stillwater tailings waters would be routed to Stillwater Mine east-side and Stillwater Valley Ranch percolation ponds.**		
receiving streamflow, $\mathbf{Q_s}$	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs
receiving stream ambient concentration, $\mathbf{C_s}$	45	mg/L	70	µmhos/cm	2008 MPDES Statement of Basis, p 9 (calculated EC)
ground water discharge volume, $\mathbf{Q_d}$	654,525	ft^3/d	7.6	cfs	ground water volume in cubic feet per second
discharge concentration to Stillwater River, $\mathbf{C_d}$	494	mg/L	771	µmhos/cm	ground water concentration prior to discharge to Stillwater River
Stillwater River TDS Concentration at Stillwater Mine at $7Q_{10}$	**133**	**mg/L**	207	µmhos/cm	calculated EC
Stillwater River TDS Concentration at Stillwater Mine at $30Q_{10}$	**68**	**mg/L**	12,096,000	ft^3/d	$30Q_{10}$ at mine site is 140 cfs based on data collected annually by SMC for the month of September
***Hertzler Ranch LAD* FIRST SEASON Input parameters and assumptions for salts calculations**			**Days 1-120: 201 MG untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**		
concentration of TDS in ambient ground water (HMW-4)	150	mg/L	234	µmhos/cm	SMC Monitoring Data (calculated EC)
TDS concentration of Hertzler Ranch tailings impoundment liner leakage, $\mathbf{C_4}$ (2011)	946	mg/L	1,970	µmhos/cm	weighted TDS and EC of mixed Hertzler Ranch LAD storage pond water when concentrated by evaporation; no TDS credit for plant uptake
TDS concentration of upper and lower Hertzler Ranch LAD discharge at $\mathbf{C_2}$, $\mathbf{C_3}$	1,263	mg/L	1,378	µmhos/cm	weighted TDS and EC of mixed Hertzler Ranch LAD storage pond water (treated stored adit water) and untreated Hertzler Ranch tailings waters; assumes instantaneous mixing
TDS concentration in Hertzler Ranch LAD storage pond liner leakage, $\mathbf{C_1}$	883	mg/L	2,225	gpm (12 hr)	application rate of upper LAD P1, P2, P3, P7
volume upper Hertzler Ranch LAD Discharge, assumes 30% evaporates; P1, P2, P3, P7; $\mathbf{V_2}$	149,920	ft^3/d	1,475	gpm (12 hr)	application rate of lower LAD P4, P5, P6
volume of Hertzler Ranch tailings impoundment liner leakage (1 gpm), $\mathbf{V_4}$	193	ft3/d	9,626	ft^3/d	P1: **100** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
volume of Hertzler Ranch LAD storage pond liner leakage (1 gpm), $\mathbf{V_1}$	193	ft3/d	31,283	ft^3/d	P2: **325** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
volume lower Hertzler Ranch LAD discharge, assumes 30% evaporates: P4, P5, P6; $\mathbf{V_3}$	99,385	ft^3/d	96,257	ft^3/d	P3: **1,000** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
average daily TDS load disposed at closure at Hertzler Ranch	**31,522**	lbs/day	62,567	ft^3/d	P4: **650** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
total TDS load disposed at Hertzler Ranch during closure, first LAD season	**3,782,654**	lbs	60,160	ft^3/d	P5: **625** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
annual (120 days)TDS load per acre per year (320 ac)	**11,832**	lbs/ac/yr	19,251	ft^3/d	P6: **200** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
annual (120 days) TDS load per square foot per year (265 ac)	**0.3**	$lbs/ft^2/yr$	77,005	ft^3/d	P7: **800** gpm for 12-hour application rate (2010 Hertzler Ranch LAD Report)
***Hertzler Ranch LAD* Ground Water salts concentrations**			**Days 1-120: 201 MG untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**		
ground water concentration area $\mathbf{Z_1}$	322	mg/L	503	µmhos/cm	loading calculation Ground Water zone Z_1; TDS conversion 1 mg/L = 1.56 µmhos/cm
ground water concentration area $\mathbf{Z_2}$	725	mg/L	1,131	µmhos/cm	loading calculation for Ground Water zone Z_2, **does not meet Class I Beneficial Use**
ground water concentration area $\mathbf{Z_4}$	818	mg/L	1,276	µmhos/cm	loading calculation for Ground Water zone Z_4, **does not meet Class I Beneficial Use**

ground water concentration in Z_3 at compliance point HMW-10	632 mg/L	**986** µmhos/cm	cumulative loading calculation for Ground Water zone Z_3 from upgradient sources (Z_1, Z_2, Z_3, Z_4); compliance point HMW-10 per 1998 Hertzler Ranch EIS
concentration in Z_5 from upgradient sources (Z_1, Z_2, Z_3, Z_4)	508 mg/L	**792** µmhos/cm	ground water concentration prior to discharge to Stillwater River

The EC in ground water in zones 2 and 4 (Hertzler Ranch LAD) would temporarily exceed the 1,000 µmhos/cm Class I Beneficial Use criterion. Ground water Class I Beneficial Use Criterion is met at compliance well HMW-10 prior to discharge to the Stillwater River

Hertzler Ranch LAD **Stillwater River salts concentration**		**Days 1-120: 201 MG untreated Hertzler Ranch tailings waters plus up to 105 MG treated adit water in the Hertzler Ranch LAD storage pond would be routed to Hertzler Ranch LAD.**	
receiving streamflow, Q_s	3,628,800 ft³/d	**42** cfs	7Q10 at mine site 31.2 cfs; receiving streamflow below Hertzler Ranch LAD is estimated
receiving stream ambient concentration, C_s	44 mg/L	69 µmhos/cm	median concentration at Hertzler Ranch SMC-12, SMC monitoring data
ground water discharge volume, Q_d	775,877 ft³/d	9.0 cfs	ground water discharge volume in cubic feet per second
discharge concentration to Stillwater River, C_d	508 mg/L	**792** µmhos/cm	ground water concentration prior to discharge to Stillwater River
TDS Stillwater River concentration at $7Q_{10}$	**126 mg/L**	**196** µmhos/cm	actual concentration at Hertzler Ranch SMC-13 would be less; higher streamflow
TDS Stillwater River concentration at $30Q_{10}$	**72 mg/L**	12,096,000 ft³/d	$30Q_{10}$ at mine site is 140 cfs based on data collected annually by SMC for the month of September; the actual streamflow below Hertzler Ranch LAD is higher and would result in lower in-stream TDS concentrations

Agency-Mitigated Alternative 3A Option 1, 1,302 gpm - *Stillwater Mine FIRST SEASON*, Days 1-84: The 370 gpm of untreated east-side adit water would be disposed of in the east-side percolation ponds; treated west-side adit water (932 gpm) plus treated Stillwater tailings waters (600 gpm) would be routed to Hertzler Ranch LAD storage pond until the Stillwater impoundment is dewatered. Untreated east-side adit water (370 gpm) and treated west-side adit water (932 gpm) would be routed to Hertzler Ranch LAD storage pond until the underground is decommissioned. *From day 85 on, the untreated east-side adit water would be routed to the underground workings.* Some west-side adit water may be routed through the BTS to maintain the microbes through the second season. *Hertzler Ranch FIRST SEASON:* The 932 gpm of treated west-side adit water would be mixed and treated with 600 gpm of Stillwater tailings water and routed to Hertzler Ranch LAD storage pond containing 105 MG of treated adit water until the Stillwater impoundment is dewatered. Untreated Hertzler Ranch tailings waters would be routed with 932 gpm of treated west-side adit water to the 105 MG of treated adit water in the Hertzler Ranch LAD storage pond for disposal at the Hertzler Ranch

LAD area. Water remaining in the Hertzler Ranch LAD storage pond would be land applied through the end of the first LAD season (120 days). *Hertzler Ranch SECOND LAD SEASON*. Any excess water that could not be disposed the first year due to high precipitation, bankruptcy, etc. would be land applied at Hertzler Ranch.

Hertzler Ranch LAD: **The hydraulic load of disposal of treated adit and tailings waters plus 201 MG of Hertzler Ranch tailings waters and 105 MG LAD storage pond waters exceeds the hydraulic capacity of the Hertzler Ranch LAD system. The mine site waters need to be managed at the Stillwater Mine. For the hydraulic calculations, please see the Revised Agency-Mitigated 3A Nitrogen sheet, option 1: 932 gpm adit water.**

Agency-Mitigated Alternative 3A Option 2, 1,302 gpm - *Stillwater Mine FIRST SEASON*, Days 1-56: The 370 gpm of untreated east-side adit water would be disposed of in the east-side percolation ponds. The 932 gpm west-side adit waters would be mixed with 600 gpm Stillwater tailings waters and treated prior to percolation in the east-side percolation ponds. The Stillwater tailings impoundment would be dewatered on Day 56. From Days 56 - 84, the 370 gpm untreated east-side adit water and 932 gpm treated west-side adit water would be percolated in east-side percolation ponds. From Day 85 on, all adit waters would be untreated and routed to the underground workings. Some west-side adit water may be routed through the BTS to maintain the microbes through the second season, or routed to the Hertzler Ranch and used to flush salts as needed at the Hertzler Ranch LAD. *Hertzler Ranch LAD FIRST SEASON Days 1-120:* Untreated Hertzler Ranch tailings waters would be routed to the LAD storage pond for disposal through the LAD system. *Hertzler Ranch LAD SECOND SEASON:* Excess waters remaining in the LAD storage pond would be land applied at Hertzler Ranch; potentially, adit waters could be routed to the LAD storage pond to provide water to flush salts from soils, if needed.

Hertzler Ranch LAD: **Based on the previous analysis of 1,770 gpm (east- and west-side) adit plus Stillwater tailings waters, the hydraulic load of 932 gpm west-side adit and 370 gpm east-side adit plus Stillwater tailings waters can be managed at the Mine percolation ponds. By percolating adit and Stillwater tailings waters at the Stillwater Mine, the hydraulic load of the Hertzler Ranch waters may be managed at Hertzler Ranch in one season unless potential problems such as high precipitation year, bankruptcy, etc. occur. Potentially, adit waters could be routed to the LAD storage pond rather than underground to provide water to flush salts from soils, if needed.**

Stillwater tailings impoundment waters volume plus 5 MG tailings mass waters **(NPRC 48 MG; KP 37 MG 2011)**	**53**	MG	**370**	gpm (24 hr)	untreated **Stillwater east-side adit** flow rate at closure
Hertzler Ranch tailings impoundment waters volume plus 5 MG tailings mass waters	**201**	MG	120	days	time to **dewater Hertzler tailings impoundment** and **length of LAD season**
Hertzler LAD Storage Pond volume (2010)	**105**	MG	250	mg/L	average 2004-2008 **Stillwater east-side adit TDS** concentration
rate to **dewater Hertzler Ranch Tailings** Impoundment	1,163	gpm (24 hr)	390	µmhos/cm	average 2004-2008 **Stillwater east-side adit EC** (calculated)
calculated median Stillwater EC west-side adit water concentration (SMC Monitoring Data)	1,190	µmhos/cm	**932**	gpm (24 hr)	Stillwater Mine treated **west-side adit flow** rate at closure
concentration of **TDS in both tailings impoundments:** Stillwater and Hertzler Ranch (median value SMC database; 2010-2011)	**946**	mg/L	763	mg/L	median Stillwater **TDS west-side adit** water concentration, SMC Monitoring Data
EC in both **tailings** impoundments: Stillwater and Hertzler Ranch (calculated)	1,476	µmhos/cm	**600**	gpm (24 hr)	Days 1-56 **Stillwater tailings impoundment pumping** rate at closure
Days 1-120.: TDS mixed Hertzler Ranch LAD storage pond water with untreated Hertzler Ranch tailings waters; assumes instantaneous mixing	883	mg/L	835	mg/L	Days 1-56 **weighted TDS** concentration in mixed **west-side adit plus Stillwater tailings** waters
Days 1-120.: EC mixed Hertzler Ranch LAD storage pond water with untreated Hertzler Ranch tailings waters; assumes instantaneous mixing	1,378	µmhos/cm	1,302	µmhos/cm	Days 1-56 weighted **EC in mixed west-side adit plus Stillwater tailings waters** (calculated)
TDS concentration of **Hertzler Ranch LAD storage pond** prior to dewatering tailings impoundments	763	mg/L	**61**	days	number of days to **dewater Stillwater tailings im**poundment
			90	days	time until **adit water is discharged underground** at the mine

FIRST SEASON *Hertzler Ranch* Hydraulic Capacity Option 2		**120 day LAD Season**	***FIRST SEASON:* Days 1-120: untreated Hertzler tailings waters routed to Hertzler Ranch LAD storage pond for mixing prior to land application. SECOND SEASON: Excess waters remaining in LAD storage pond would be land applied at the Hertzler Ranch.**		
Hertzler Ranch tailings impoundment waters volume **Day 1**	**201**	MG	1,163	gpm (24 hr)	rate to dewater Hertzler Ranch tailings impoundment in **120 days**
volume in **Hertzler Ranch tailings** impoundment on **Day 90**	**50.25**	MG	687	gpm (24 hr)	Available land application capacity for disposal of Hertzler Ranch LAD storage pond waters **Days 1-120**
Hertzler Ranch LAD **storage pond** initial stored volume, **Day 1**	**105**	MG	511	gpm (24 hr)	Rate that Hertzler Ranch tailings impoundment and storage pond waters must be land applied to dispose of remaining volume **Days 91-120**
volume in Hertzler Ranch LAD **storage pond** on Day **90**	**16**	MG	**1,850**	gpm (24 hr)	maximum application rate at Hertzler Ranch LAD to achieve 80% TN treatment efficiency

Hertzler Ranch: **FIRST SEASON: The salts load and ground water concentration data are the same as analyzed above for the 2,020 gpm adit water scenario. Potentially, west side adit waters could be routed to the LAD storage pond rather than underground to provide water to flush salts from soils, if needed.**

Stillwater Mine **FIRST SEASON: Days 1-56: Mixed untreated 370 gpm east side adit and 932 gpm treated west side adit plus 600 gpm Stillwater tailings waters routed to Stillwater east side percolation ponds until impoundment dewatered. Days 57-90: 370 gpm untreated east side and 932 gpm treated west side adit waters routed to Stillwater east side percolation ponds; no adit water percolated after day 90 (routed underground unless needed to prevent soil or ground water salinity concerns at Hertzler Ranch LAD).**

time to dewater Stillwater tailings impoundment	61	days	**370**	gpm (24 hr)	untreated **east-side adit** flow rate at closure **Days 1-90**
average 2004-2008 Stillwater east-side adit EC (calculated)	390	µmhos/cm	**600**	gpm (24 hr)	Stillwater **tailings impoundment pumping** rate at closure
average 2004-2008 Stillwater east-side adit TDS concentration	250	mg/L	**932**	gpm (24 hr)	Stillwater Mine treated **west-side adit** flow rate at closure **Days 1-90**

calculated median Stillwater EC west-side adit water concentration, from SMC TDS Monitoring Data	1,190	μmhos/cm	763	mg/L	median Stillwater **TDS west-side adit** water concentration, SMC Monitoring Data 2011
EC in both tailings impoundments: Stillwater and Hertzler Ranch	1,476	μmhos/cm	946	mg/L	concentration of **TDS in both tailings impoundments**: Stillwater and Hertzler Ranch (SMC Database 2010-2011)
calculated EC in mixed west-side adit plus Stillwater tailings waters	1,302	μmhos/cm	835	mg/L	weighted **TDS** concentration in **mixed west-side adit plus Stillwater tailings waters** **Days 1-56**
rate untreated **east-side adit plus** mixed treated **west-side adit and tailings** waters entering **east-side percolation ponds** **Days 1-56**	468	gpm (24 hr)	372	mg/L	weighted **TDS** concentration in **mixed east-side adit, west-side adit, plus Stillwater tailings waters** **Days 1-56**
volume of **mixed west-side adit plus tailings waters mixing with east-side adit** waters to use percolation capacity **Days 1-56**	98	gpm (24 hr)	1,532	gpm (24 hr)	rate mixed treated west-side adit plus tailings waters entering **Stillwater Valley percolation ponds** (MPDES Statement of Basis p. 3 permits up to 2,000 gpm total disposal) **Days 1-56**
Stillwater Mine **Ground Water Salts Calculation Input Parameters**					**Days 1-56: 370 gpm untreated east-side adit water and 932 gpm treated west-side adit plus 600 gpm treated Stillwater tailings waters would be routed to Stillwater Mine east-side and Stillwater Valley Ranch percolation ponds. On day 56 the Stillwater impoundment would be dewatered. Days 57-84: 370 gpm untreated east-side adit and 932 gpm treated west-side adit water would be routed to the east-side percolation ponds. On day 85, all adit water would be routed underground unless needed to prevent soil or ground water salinity concerns at Hertzler Ranch LAD.**
The aquifer parameters are linked to above cells.			**370**	gpm (24 hr)	untreated east-side adit flow rate at closure
untreated east side adit flow rate at closure	71,230	ft^3/d	179,422	ft^3/d	treated west-side adit flow rate at closure
rate untreated **east-side adit plus** mixed treated **west-side adit and tailings** waters entering **east-side percolation ponds** **Days 1-56**	90,096	ft^3/d	294,930	ft^3/d	rate mixed treated west-side adit plus tailings waters entering **Stillwater Valley percolation ponds** **Days 1-56**
$\mathbf{Q_{SVR}=k_{SVR}iA_{SVR}}$, ground water available for mixing	185,988	ft^3/d	250,652	ft^3/d	untreated east-side adit plus treated west-side adit flow rate at closure **Days 57-84**
$\mathbf{Q_E=k_EiA_E}$, ground water available for mixing	31,532	ft^3/d	34	days	time after Stillwater impoundment dewatered until adit water can be routed underground **Days 57-84**
ambient TDS concentration in **ground water at MW-10A Stillwater Mine**	81	mg/L	126	μmhos/cm	median concentration of TDS in ambient ground water at SMC MW-10A
Days 1-56 ground water TDS concentration at end of Stillwater **east-side percolation pond** mixing zone	280	mg/L	**436**	μmhos/cm	weighted concentration of TDS from percolation of **1,532** gpm west-side adit and Stillwater tailings waters with **370** gpm east-side adit waters
Days 57-84 ground water TDS concentration at end of Stillwater **east-side percolation pond** mixing zone	198	mg/L	**309**	μmhos/cm	
Days 1-56 ground water TDS concentration at end of **Stillwater Valley Ranch percolation pond** mixing zone	519	mg/L	**810**	μmhos/cm	**cumulative concentration** of TDS from percolation of east-side adit waters plus west-side adit plus tailings waters measured at the end of the Stillwater Valley Ranch mixing
Days 57-84 ground water TDS concentration at end of **Stillwater Valley Ranch percolation pond** mixing zone	318	mg/L	**496**	μmhos/cm	**cumulative concentration** of TDS from percolation of east-side adit waters plus west-side adit plus tailings waters measured at the end of the Stillwater Valley Ranch mixing
For this scenario Days 1-90, the EC in ground water at the Stillwater Mine meets the 1,000 μmhos/cm Class I Beneficial Use criterion.					
Stillwater Mine **Stillwater River TDS concentration Days 1-84**					**Days 1-56: 370 gpm untreated east-side adit water and 932 gpm treated west-side adit plus 600 gpm treated Stillwater tailings waters would be routed to Stillwater Mine east-side and Stillwater Valley Ranch percolation ponds. On day 56 the Stillwater impoundment would be dewatered. Days 57-84: 370 gpm untreated east-side adit and 932 gpm treated west-side adit water would be routed to the east-side percolation ponds. On day 85, all adit water would be routed underground unless needed to prevent soil or ground water salinity concerns at Hertzler Ranch LAD.**
receiving streamflow, $\mathbf{Q_s}$	2,695,680	ft^3/d	31.2	cfs	7Q10 at mine site 31.2 cfs

Appendix E
DEQ 2012

receiving stream ambient concentration, $\mathbf{C_s}$	45	mg/L	70	µmhos/cm	median concentration at Hertzler Ranch SMC-12, SMC monitoring data
Days 1-56 ground water discharge volume, $\mathbf{Q_d}$	673,776	ft^3/d	7.8	cfs	weighted average ground water discharge volume in cubic feet per second
Days 57-84 ground water discharge volume, $\mathbf{Q_d}$	468,172	ft^3/d	5.4	cfs	weighted average ground water discharge volume in cubic feet per second
Days 1-56 ground water concentration prior to discharge to Stillwater River, $\mathbf{C_d}$	519	mg/L	810	µmhos/cm	ground water concentration prior to discharge to Stillwater River
Days 57-84 ground water concentration prior to discharge to Stillwater River, $\mathbf{C_d}$	318	mg/L	496	µmhos/cm	ground water concentration prior to discharge to Stillwater River
Stillwater River TDS concentration at the 7$\mathbf{Q_{10}}$ streamflow Days 1-56	**115**	**mg/L**	180	µmhos/cm	
Stillwater River TDS concentration at the 30$\mathbf{Q_{10}}$ streamflow Days 1-56	**63**	**mg/L**	12,096,000	ft^3/d	**Days 1-56** 30Q_{10} at mine site is 140 cfs based on data collected annually by SMC for the month of September
Stillwater River TDS concentration at the 7$\mathbf{Q_{10}}$ streamflow Days 57-84	**85**	**mg/L**			
Stillwater River TDS concentration at the 30$\mathbf{Q_{10}}$ streamflow Days 57-84	**55**	**mg/L**			**Days 57-84** 30Q_{10} at mine site is 140 cfs based on data collected annually by SMC for the month of September

Spreadsheet 3B Nitrogen--*Revised* Agency-Mitigated Alternative 3B East Boulder Closure Nitrogen Analyses

The agencies' preferred disposal of treated adit waters is at the mine site LAD areas and then at the percolation pond. For the East Boulder Mine, the calculations have been made according to the regulatory requirements of the existing MPDES permit, Montana Water Quality Act and Rules, and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the East Boulder Mine LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer (no unsaturated zone was considered). To determine the concentration of total inorganic nitrogen (TIN) in ground water, it was assumed that all ground water flow parallels the East Boulder River and enters the river at a point at, or just downstream of, the permit boundary. Tailings impoundment waters would be treated and routed the same as adit water. The East Boulder Mine MPDES permit has a source-specific mixing zone for the percolation pond that enters the aquifer flowing beneath the tailings impoundment. The MPDES permit calculations do not allow evap-oration credit in discharge to percolation. For the PoleCat evaporators and center pivots, the agencies assume 30% evaporation. For the PoleCat snowmakers, the agencies assume 30% evaporation in winter. The MPDES permitted annual average is 30 lbs/day TIN limit. The water disposal design capacities cited below are from CES 2008. The East Boulder Mine is required by the MPDES permit to maintain the 30 lbs/day average total inorganic nitrogen limit, regardless of inflow nitrogen concentrations. The existing treatment systems would be increased to meet hydraulic and TIN treatment requirements. All waters are treated prior to discharge. All forms of total inorganic nitrogen treatment, such as evaporation, LAD, and BTS/Anox are included to accomplish the 30 lbs/day MPDES total inorganic nitrogen permit limit. The spreadsheet has been edited to account for updated volumes, concentrations, and timeframes. All edited cells are highlighted in mauve; all changed text is highlighted in red; all anchor cells that carry through the spreadsheet are highlighted in green.

Agency-Mitigated Alternative 3B, Option 1, 737 gpm: This option would percolate the entire treated 737 gpm (24 hr) adit flow with the maximum volume of treated tailings waters that could be treated in the BTS/Anox and would meet the 30 lbs/day MPDES permit nitrogen limit. The 737 gpm (24 hr) treated adit water and 263 gpm (24 hr) of East Boulder tailings waters would be mixed and treated in the BTS/Anox system. All 1,000 gpm (24 hr) would be disposed in the East Boulder Mine percolation pond as in Proposed Action Alternative 2B. The time frame for closure would be two LAD seasons (18 months). The time frame for closure would be affected by the volume of water in the tailings impoundment.

For all options analyzed in this spreadsheet:			**548**	days	length of 18-month closure period
Maximum rate BTS/Anox system assumed to treat nitrogen	1,000	gpm (24 hr)	**737**	gpm (24 hr)	adit flow rate at closure (24 hr rate)
Volume that can be accomodated by percolation pond	1,105	gpm (24 hr)	**263**	gpm (24 hr)	East Boulder tailings pumping rate at closure; **fixed by nitrogen load in MPDES permit and BTS/Anox system capacity**
nitrogen effluent limit based on the MPDES permit	**30**	lbs/day	0.4	mg/L	treated total inorganic nitrogen concentration of adit waters based on BTS/Anox system treatment (2009-2011);
untreated total inorganic nitrogen concentration of adit waters (SMC 2011)	47.8	mg/L	2.4	mg/L	Current BTS/Anox end of pipe treatment efficiency of **95%** for tailings water; Demonstation has been made by SMC that tailings waters can be adequately treated in the BTS/Anox (2009-2011)
East Boulder Percolation total inorganic nitrogen Loading, closure			0.9	mg/L	weighted average post BTS/Anox concentration of adit water and tailings water
East Boulder Tailings Impoundment discharge volume (KP 87; SMC 93)	**98**	MG	**259**	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**263**	gpm (24 hr)	526	gpm (12 hr)	rate to dewater the impoundment
East Boulder adit flow rate	**737**	gpm (24 hr)	1,474	gpm (12 hr)	adit flow rate
total combined adit plus East Boulder tailings waters flow needing disposal	1,000	gpm (24 hr)	2,000	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
total inorganic nitrogen load of treated adit plus tailings waters percolated	**11.1**	lbs/day	2,210	gpm (12 hr)	capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4
Total total inorganic nitrogen load to ground water during 18-month closure	**3,890**	lbs/18-mos	**120**	days	length of LAD season

Disposal of adit and tailings waters using only percolation meets the MPDES permit 30 pound/day total inorganic nitrogen limit; however, dewatering of the tailings impoundment would take 246 days.

Agency-Mitigated Alternative 3B, Option 2, 737 gpm: The 737 gpm (24 hr) of treated adit water and 263 gpm (24 hr) of treated East Boulder tailings waters would be preferentially disposed of at the East Boulder Mine LAD areas during an 18-month closure period. All approved LAD areas would be constructed. No water would be discharged to the mine percolation pond.

East Boulder LAD Areas 2, 3-Upper, 4, and 6 Hydraulic Loading, closure			**LAD of 737 gpm treated adit water with 263 gpm treated tailings waters at the East Boulder LAD Areas 2, 3-Upper, 4, and 6; no percolation would be used**		
East Boulder Tailings Impoundment discharge volume	**98**	MG	259	days	time to dewater the tailings impoundment

rate to dewater East Boulder tailings impoundment	**263**	gpm (24 hr)	526	gpm (12 hr)	rate to dewater the impoundment
East Boulder Adit Flow rate	**737**	gpm (24 hr)	1,474	gpm (12 hr)	Adit Flow rate
total combined hydraulic load (adit plus East Boulder tailings waters)	**1,000**	gpm (24 hr)	**2,000**	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
Summer hydraulic capacity of East Boulder Mine LAD Area 6	293	gpm (24 hr)	**1,450**	gpm (12 hr)	hydraulic capacity of all East Boulder Mine LAD Areas
Summer LAD Area 6 maximum hydraulic load	56,406	ft^3/d	586	gpm (12 hr)	evaporator maximum flow rate, 10.2 ac (CES 2008)
Summer LAD Area 4 maximum hydraulic load	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.2 ac (CES 2008)
Summer LAD Area 3 Upper maximum hydraulic load	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.3 ac (CES 2008)
Summer LAD Area 2 maximum hydraulic load	29,262	ft^3/d	304	gpm (12 hr)	center pivot maximum flow rate, 13.9 ac (CES 2008)
Summer total LAD hydraulic load	139,572	ft^3/d	**550**	gpm (12 hr)	**Summer excess volume of water that must be percolated**
Summer area available for LAD	46.6	ac	32.7	ac	**Winter** area available for LAD
Winter hydraulic capacity of East Boulder Mine LAD Area 6	39,465	ft^3/d	410	gpm (12 hr)	snowmaker maximum flow rate, 10.2 ac (CES 2008)
Winter LAD Area 4 snowmaking maximum hydraulic load	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate, 11.2 ac (CES 2008)
Winter LAD Area 3 Upper snowmaking maximum hydraulic load	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate 11.3 ac (CES 2008)
Winter total LAD hydraulic load	54,866	ft^3/d	**1,430**	gpm (12 hr)	**Winter excess volume of water that must be percolated**

The hydraulic load of 737 gpm adit water plus 263 gpm East Boulder tailings waters exceeds the capacity of the approved LAD areas in summer and winter and cannot be managed solely by land application at East Boulder Mine; some excess waters must be percolated.

Agency-Mitigated Alternative 3B, Option 3, 737 gpm: The 737 gpm (24 hr) of adit water and 263 gpm of tailings waters would be treated and preferentially disposed at the mine LAD areas during an 18-month closure period. All approved LAD areas would be constructed. Excess treated waters would be discharged to the East Boulder Mine percolation pond.

length of LAD season	120	days	**737**	gpm (24 hr)	
time to dewater the tailings impoundment	259	days	**263**	gpm (24 hr)	tailings flow rate at closure; fixed by BTS/Anox system treatment rate 1000 gpm
remaining time in 18-month closure period after dewatering tailings	289	days	0.4	mg/L	treated total inorganic nitrogen conc of adit waters based on historical BTS/Anox treatment and flow rate
			2.4	mg/L	Current BTS/Anox end of pipe treatment efficiency of 95% for tailings water
East Boulder MPDES Source-Specific (percolation pond) mixing zone calculations			0.9	mg/L	weighted average post BTS/Anox concentration of adit water and tailings water

depth of aquifer, **D**	80	ft	MPDES Statement of Basis, p. 25-26;
hydraulic conductivity, **k**	75	ft/d	MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft	MPDES Statement of Basis, p. 25-26
width of source	385	ft	MPDES Statement of Basis, p. 25-26
length from percolation pond to compliance wells EBMW-6 and EBMW-7, L_1	3,600	ft	MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3		MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d	MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	400	gpm	MPDES Statement of Basis, p. 25-26
upgradient concentration of total inorganic nitrogen in ground water (WW-1), C_{AWW}	0.11	mg/L	SMC Monitoring Data 2011
angle of dispersion	0.087421693	tan 5°	allowed by 17.30.517(d)
width of mixing zone, W_1	700	ft	width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_1	55,977	ft^2	D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing Q_1=kiA	77,005	ft^3/d	calculation per 17.30.517(d);

Volume of ground water available for mixing Q_2=kiA_2	27,914 ft^3/d	145 gpm (24 hr)	calculation per 17.30.517(d)
depth of aquifer, D_2	15 ft		allowed by 17.30.517(d)
width of source	700 ft		MPDES Statement of Basis, p. 25-26
length from perc pond to river, L_2	2,900 ft		MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693 tan 5°		allowed by 17.30.517(d)
width of zone, W_2	954 ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_2	14,303 ft^2		D * W, allowed by 17.30.517(d)
2011 operational concentration of total inorganic nitrogen in ground water **beneath tailings impoundment that flows to LAD area (EBMW-6 and -7), C_{AM}**	15.0 mg/L		SMC Monitoring Data 2011; EBMWs -6 and -7 are compliance wells in the alluvial aquifer at the end of the tailings impoundment and is considered representative of the existing loads of salt and nitrogen in the ground water during operations.

East Boulder Hydraulic Loading Input Parameters, closure		**LAD of maximum volume of treated adit plus tailings waters at the East Boulder Mine LAD Areas during the 120 day LAD season with percolation of the excess water at the mine percolation pond for the remainder of closure**	
East Boulder Tailings Impoundment discharge volume	98 MG	**259** days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**263** gpm (24 hr)	**526** gpm (12 hr)	rate to dewater the East Boulder tailings impoundment
East Boulder Adit Flow rate	**737** gpm (24 hr)	**1,474** gpm (12 hr)	adit flow rate
total combined hydraulic load (adit plus East Boulder tailings waters)	**1,000** gpm (24 hr)	**2,000** gpm (12 hr)	total combined hydraulic load (adit plus East Boulder tailings waters)
Summer LAD Area 6 maximum hydraulic load	56,406 ft^3/d	586 gpm (12 hr)	evaporator maximum flow rate, 10.2 ac (CES 2008)
Summer LAD Area 4 maximum hydraulic load	26,952 ft^3/d	280 gpm (12 hr)	evaporator maximum flow rate, 11.2 ac (CES 2008)
Summer LAD Area 3-Upper maximum hydraulic load	26,952 ft^3/d	280 gpm (12 hr)	evaporator maximum flow rate, 11.3 ac (CES 2008)
Summer LAD Area 2 maximum hydraulic load	29,262 ft^3/d	304 gpm (12 hr)	center pivot maximum flow rate, 13.9 ac (CES 2008)
Summer total LAD hydraulic load	139,572 ft^3/d	1,450 gpm (12 hr)	hydraulic capacity of all LAD areas (end of pipe)
Summer area available for LAD	46.6 ac	32.7 ac	**Winter** area available for LAD
Summer total inorganic nitrogen load **to soil** for microbial degradation and plant uptake Days 1-120	6.4 lbs/day	1.6 lbs/day	**Summer LAD** total total inorganic nitrogen load **to ground water**
Winter hydraulic capacity of East Boulder Mine LAD Area 6	39,465 ft^3/d	410 gpm (12 hr)	snowmaker maximum flow rate, 10.2 ac (CES 2008)
Winter LAD Area 4 snowmaking maximum hydraulic load	7,701 ft^3/d	80 gpm (12 hr)	snowmaker maximum flow rate, 11.2 ac (CES 2008)
Winter LAD Area 3 Upper snowmaking maximum hydraulic load	7,701 ft^3/d	80 gpm (12 hr)	snowmaker maximum flow rate 11.3 ac (CES 2008)
Winter total LAD hydraulic load	54,866 ft^3/d	570 gpm (12 hr)	maximum hydraulic snowmaking load at all LAD areas
Winter total inorganic nitrogen load **to ground water** after evaporation and snowmaking Days 1-120	1.6 lbs/day	1,430 gpm (12 hr)	excess water percolated
Summer volume of excess water that must be percolated **Days 1-120**	**275** gpm (24 hr)	**715** gpm (24 hr)	**Winter** volume of excess water that must be percolated **Days 1-120**
volume of water that must be percolated Days 121-370	1000 gpm (24 hr)	737 gpm (24 hr)	volume of water that must be percolated Days 371-548
Summer percolation total inorganic nitrogen load **to ground water days 1-120**	3.0 lbs/day	7.9 lbs/day	**Winter** percolation total inorganic nitrogen load **to ground water Days 1-120**
Summer total (LAD plus percolation) total inorganic nitrogen load **to ground water days 1-120**	**4.7** lbs/day	**9.5** lbs/day	**Winter total** (Snowmaking plus percolation) total inorganic nitrogen load **to ground water Days 1-120**
days 121-370 total inorganic nitrogen load to ground water	**11.1** lbs/day	**3.5** lbs/day	**days 371-548 total inorganic nitrogen load to ground water**

Total total inorganic nitrogen **load to ground water** during closure that commences in **summer**	**3,119** lbs/18 mos	**3,702** lbs/18 mos	**Total** total inorganic nitrogen **load to ground water** during closure that commences in **winter**

For a closure that commences in summer, up to 737 gpm (24 hr) treated adit water and 263 gpm (24 hr) treated tailings waters can be LAD at a rate of 1,450 gpm (12 hr) with percolation of up to 275 gpm (24 hr), the hydraulic capacities of the LAD areas and percolation pond are not exceeded. For a closure that commences in winter, up to up to 737 gpm (24 hr) treated adit water and 263 gpm (24 hr) treated tailings waters can be disposed by snowmaking at a rate of 570 gpm (24 hr) with percolation of up to 715 gpm (24 hr), the hydraulic capacities of the LAD areas and percolation pond are not exceeded.

The MPDES permit 30 lbs/day total inorganic nitrogen limit is met for closure that commences in summer or winter.

Ground Water Inputs East Boulder Mine LAD areas		**LAD of maximum volume of treated adit plus tailings waters at the East Boulder Mine LAD Areas with percolation of the excess water at the mine percolation pond**	
depth of aquifer, **D_2**	15 ft	0.9 mg/L	weighted average post BTS/anox concentration of adit water and tailings water
hydraulic conductivity, **k**	75 ft/d		MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026 ft/ft		MPDES Statement of Basis, p. 25-26
width of source	700 ft		MPDES Statement of Basis, p. 25-26
length from percolation pond to river, **L_2**	2,900 ft		MPDES Statement of Basis, p. 25-26
angle of dispersion	0.087421693 tan 5°		allowed by 17.30.517(d)
width of zone, **W_2**	954 ft		width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, **A_2**	14,303 ft^2		D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing **Q_1**=kiA	77,005 ft^3/d		calculation per 17.30.517(d);
Volume of ground water available for mixing **Q_2**=kiA_2	27,914 ft^3/d	145 gpm (24 hr)	calculation per 17.30.517(d)
2011 operational concentration of total inorganic nitrogen in ground water **beneath tailings impoundment that flows to LAD area (EBMWs -6 and -7), C_{AM}**	15.0 mg/L	0.3 mg/L	concentration of total inorganic nitrogen in weighted mixed land applied waters; 80% nitrogen treatment credit applied,C_2
upgradient concentration of total inorganic nitrogen in ground water (WW-1), **C_{AWW}**	0.11 mg/L		SMC Monitoring Data 2011
Volume of water: summer LAD (evaporation credit applied), **V_{SL}**	97,701 ft^3/d	508 gpm (24 hr)	summer volume from LAD areas 2, 3, 4, 6 (evaporation credit applied)
Volume of water percolated in summer (no evaporation or treatment credit), **V_{SP}**	52,941 ft^3/d	275 gpm (24 hr)	summer volume from percolation; excess water needing disposal days 1-120
Volume of water: winter snowmaking (evaporation credit applied), **V_{WL}**	38,406 ft^3/d	200 gpm (24 hr)	winter volume from LAD areas 3, 4, 6 (evaporation credit applied)
Volume of water percolated in winter (no evaporation or treatment credit), **V_{WP}**	137,647 ft^3/d	715 gpm (24 hr)	winter volume from percolation; excess water needing disposal days 1-120
Volume of water that is percolated after the LAD season days 121-335	192,513 ft^3/d	1,000 gpm (24 hr)	adit plus tailings waters until impoundment is dewatered Days 121-335
Volume of adit water percolated for remainder of closure period days 336-548	141,882 ft^3/d	737 gpm (24 hr)	adit water; to end of closure period days 336-548
Summer total inorganic nitrogen concentration in ground water, **Days 1-120 Z_1**	**2.0 mg/L**		projected concentration of total inorganic nitrogen in ground water near SP-11
Summer total inorganic nitrogen concentration in ground water, **Days 121-355, Z_2**	**0.8 mg/L**		projected concentration of total inorganic nitrogen in ground water near SP-11
Summer total inorganic nitrogen concentration in ground water, **Days 336-548 Z_3**	**0.4 mg/L**		projected concentration of total inorganic nitrogen in ground water near SP-11
Winter total inorganic nitrogen concentration in ground water, **Days 1-120 Z_1**	**2.0 mg/L**		projected concentration of total inorganic nitrogen in ground water near SP-11

Winter total inorganic nitrogen concentration in ground water, **Days 121-335, Z_3**	**0.8 mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11
Winter total inorganic nitrogen concentration in ground water, **Days 336-548 Z_3**	**0.4 mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11

Total inorganic nitrogen concentrations in ground water in both of these summer and winter closure scenarios meet the DEQ-7 nitrogen ground water standard of 10 mg/L.

East Boulder River Concentration below LAD area at Closure					**LAD of maximum volume of treated adit plus tailings waters at the East Boulder Mine LAD Areas with percolation of the excess water at the mine percolation pond; the highest seasonal total inorganic nitrogen concentration in ground water was used for this calculation**
receiving streamflow, $\mathbf{Q_s}$	432,000	ft^3/d	5	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, $\mathbf{C_s}$	0.15	mg/L	255,561	ft^3/d	discharge volume of ground water corresponding to Summer days 1-120, $\mathbf{Q_{d2}}$
discharge volume of ground water corresponding to Summer days 121-370, Qd2	297,433	ft^3/d	3.5	cfs	credit for evaporative losses taken in volume calculations
discharge volume of ground water corresponding to Winter days 121-370, Qd2	297,433	ft^3/d	3.5	cfs	
lowest discharge total inorganic nitrogen concentration of ground water	2.0	mg/L	**4.6**	cfs	low value of streamflow from SMC database
highest summer discharge total inorganic nitrogen concentration of ground water , $\mathbf{C_{ds}}$	0.8	mg/L			based on projected winter concentration of ground water near SP-11 days 121-370
highest winter discharge total inorganic nitrogen concentration of ground water, $\mathbf{C_{dw}}$	0.8	mg/L	397,440	ft^3/d	low streamflow value in cubic feet per day SMC database 2011
projected East Boulder River total inorganic nitrogen concentration in Summer days 1-120 (5.0 cfs)	**0.8**	**mg/L**			
projected East Boulder River total inorganic nitrogen concentration in Summer days 121-370 (5.0 cfs)	**0.4**	**mg/L**			
projected East Boulder River total inorganic nitrogen concentration in Winter days 121-370 (5.0 cfs)	**0.4**	**mg/L**			

The total inorganic nitrogen concentration produced during these summer and winter closure options meet the MPDES permit limit of 1 mg/L for the East Boulder River

Agency-Mitigated Alternative 3B, Option 1, 150 gpm: This option evaluates the feasibility of the East Boulder Mine WMP Proposed Action Alternative 2B 12-month closure period. This option would percolate the entire treated 150 gpm of adit water with the maximum volume of East Boulder tailings waters that could be treated through the BTS/Anox and would meet the 30 lbs/day MPDES permit nitrogen limit. The 150 gpm adit and 350 gpm tailings waters would be treated in the BTS/Anox system and be preferentially disposed in the mine percolation pond during the closure period. No water would be land applied at closure.

days past the LAD season that mixed treated tailings and adit waters would be percolated	74	days	**150**	gpm (24 hr)	adit flow rate at closure
capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4	2,210	gpm (12 hr)	**350**	gpm (24 hr)	tailings flow rate at closure based on current BTS capacity
capacity of East Boulder Mine BTS in spring 2012	**500**	gpm (24 hr)	0.4	mg/L	treated concentration of adit waters based on current efficiency of the BTS (SMC Database 2011)
time remaining in the 18-month closure period after dewatering the tailings impoundment	**354**	days	2.4	mg/L	Current BTS/Anox end of pipe treatment efficiency of 95% for tailings water
East Boulder Percolation total inorganic nitrogen Loading, closure			1.8	mg/L	weighted average post BTS/Anox concentration of adit water and tailings water flows
East Boulder Tailings Impoundment discharge volume	**98**	MG	**194**	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**350**	gpm (24 hr)	67,380	ft^3/d	volume of tailings water per day
East Boulder Adit Flow rate	**150**	gpm (24 hr)	28,877	ft^3/d	volume of adit water per day

total combined flow (adit plus East Boulder tailings waters)	**500**	gpm (24 hr)	96,257	ft^3/d	total combined flow (adit plus East Boulder tailings waters)
Total inorganic nitrogen load of all treated adit and tailings waters disposed at the percolation pond Days 1-185	**10.8**	lbs/day	**2,346**	lbs/18 months	**Closure total inorganic nitrogen load of all treated adit and tailings waters disposed at the percolation pond, days 1-548**
Total inorganic nitrogen load of all treated adit and tailings waters disposed at the percolation pond Days 185-548	**0.7**	lbs/day			

Disposal of 150 gpm adit and 350 gpm tailings waters using only percolation meets the MPDES permit 30 pound/day total inorganic nitrogen limit.

East Boulder Hydraulic Loading Calculations, Percolation Pond

Percolation of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder percolation pond.

The 500 gpm (24 hr) of treated adit plus tailings waters needing disposal is within the hydraulic capacity (1,105 gpm - 24 hr) of the percolation pond.

Agency-Mitigated Alternative 3B, Option 2, 150 gpm: The 150 gpm (24 hr) of adit water would be treated with 350 gpm (24 hr) of East Boulder tailings waters and be preferentially disposed at the East Boulder Mine LAD Area 6 during the closure period. No other LAD areas would be built. No percolation would be used.

East Boulder LAD Area 6 Hydraulic Loading, closure

LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; no percolation would be used

East Boulder Tailings Impoundment discharge volume	**98**	MG	**194**	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**350**	gpm (24 hr)	700	gpm (12 hr)	rate to dewater the impoundment
East Boulder adit flow rate	**150**	gpm (24 hr)	300	gpm (12 hr)	East Boulder adit flow rate
total combined hydraulic load (adit plus East Boulder tailings waters)	**500**	gpm (24 hr)	1,000	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
Summer hydraulic capacity of East Boulder Mine LAD Area 6	293	gpm (24 hr)	205	gpm (24 hr)	**Winter** hydraulic capacity of East Boulder Mine LAD Area 6 10.2 ac (CES 2008)
Summer hydraulic load that must be **percolated Days 1-120**	**207**	gpm (24 hr)	**295**	gpm (24 hr)	**Winter** hydraulic load of water that must be **percolated Days 1-120**

The hydraulic load of 150 gpm (24 hr) adit water plus 350 gpm (24 hr) tailings waters cannot be managed solely at LAD Area 6 during closure that commences in summer or winter. Percolation must be used to dispose of up to 290 gpm (24 hr) during the LAD season and for the entire 500 gpm during seasons when LAD cannot be used.

Agency-Mitigated Alternative 3B, Option 3, 150 gpm: The 150 gpm (24 hr) of adit water would be treated with 350 gpm (24 hr) of East Boulder tailings waters and be preferentially disposed at the East Boulder Mine LAD Area 6 during the closure period, with excess waters percolated at the mine pond. No other LAD areas would be built.

East Boulder LAD Area 6 Hydraulic Loading, closure

LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; the excess volume of water would be percolated

As shown in Option 2, 150 gpm (24 hr) Hydraulic Loading, the hydraulic load of 150 gpm (24 hr) adit water plus 350 gpm (24 hr) tailings waters can be managed at LAD Area 6 during closure that commences in summer or winter when percolation is used to dispose of up to 208 gpm (24 hr) during the 120-day LAD season and for the entire 500 gpm during seasons when LAD cannot be used.

East Boulder LAD Area 6 total inorganic nitrogen Loading, closure

LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; the excess volume of water would be percolated

Summer total inorganic nitrogen load to ground water disposed at **LAD Area 6**, days 1-120	**1.3**	lbs/day	**0.9**	lbs/day	**Winter total inorganic nitrogen** load to ground water disposed at **LAD Area 6,** days 1-120
Summer total inorganic nitrogen load **percolated** days 1-120	**4.5**	lbs/day	**6.3**	lbs/day	**Winter** total inorganic nitrogen load **percolated** days 1-120
Summer Total total inorganic nitrogen load, days 1-120	**5.7**	lbs/day	**7.2**	lbs/day	**Winter Total** total inorganic nitrogen load, days 1-120
total inorganic nitrogen load percolated, days 121-185	**10.8**	lbs/day	**0.7**	lbs/day	total inorganic nitrogen load percolated, days 185-548
Summer closure total inorganic nitrogen load to ground water, days 1-548	**1,741**	lbs/18 mos	**1,923**	lbs/18 mos	**Winter closure** total inorganic nitrogen load to ground water, days 1-548

Disposal of 150 gpm adit and 350 gpm tailings waters using land application at LAD Area 6 during both summer and winter with percolation of the excess waters meets the MPDES permit 30 lbs/day total inorganic nitrogen limit.

Ground Water Mixing Inputs Below East Boulder Mine LAD Area 6, at Closure

Please note: all input values used for the following calculations are the same as above for **k**, **i**, lengths, widths, areas, and angle of dispersion. Aquifer depth is 15 feet.

Appendix E
DEQ 2012

Volume of ground water available for mixing Q_1=kiA	77,005	ft^3/d			calculation per 17.30.517(d)
Volume of ground water available for mixing Q_2=kiA$_2$	27,914	ft^3/d			calculation per 17.30.517(d)
concentration of total inorganic nitrogen in treated adit plus tailings waters, C_1	**1.8**	mg/L	**0.5**	mg/L	concentration of total inorganic nitrogen in land applied waters; 80% nitrogen treatment credit applied, C_2
concentration of total inorganic nitrogen in ambient ground water, C_A	0.11	mg/L			Stillwater 2011 data
2011 operational concentration of total inorganic nitrogen in ground water **beneath tailings impoundment that flows to LAD area (EBMW-6),** C_{am}	15.0	mg/L	**0.4**	mg/L	treated concentration of adit waters calculated based on historical maximum nitrogen load
Volume of water: summer LAD days 1-120, V_{S1}	39,484	ft^3/d	**410**	gpm (12 hr)	summer volume from LAD areas 6; 30% evaporation credit taken
Volume of water percolated in summer days 1-120, V_{S2}	39,850	ft^3/d	**207**	gpm (24 hr)	Summer volume of excess water percolated
Volume of water: winter snowmaking days 1-120, V_{W1}	27,626	ft^3/d	**287**	gpm (12 hr)	winter volume from LAD area 6; 30% evaporation credit taken
Volume of water percolated in winter days 1-120, V_{W2}	28,396	ft^3/d	**295**	gpm (12 hr)	winter volume of excess water percolated
volume of water that must be percolated Days 121-185	96,257	ft^3/d	**500**	gpm (24 hr)	adit plus tailings waters until impoundment is dewatered Days 121-185
volume of water that must be percolated Days 186-548	28,877	ft^3/d	**150**	gpm (24 hr)	adit water to end of closure period days 186-548
Summer total inorganic nitrogen concentration in ground water, **Days 1-120 Z_1**	**2.8**	**mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11
Summer total inorganic nitrogen concentration in ground water, **Days 121-185, Z_2**	**1.3**	**mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11
Summer total inorganic nitrogen concentration in in ground water, **Days 186-548 Z_3**	**0.7**	**mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11
Winter total inorganic nitrogen concentration in ground water, **Days 1-120 Z_1**	**3.1**	**mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11
Winter total inorganic nitrogen concentration in ground water, **Days 121-185, Z_3**	**1.3**	**mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11
Winter total inorganic nitrogen concentration in in ground water, **Days 186-548, Z3**	**0.4**	**mg/L**			projected concentration of total inorganic nitrogen in ground water near SP-11

Concentrations of total inorganic nitrogen in ground water are less than the DEQ-7 water quality standard of 10 mg/L.

East Boulder River Concentration below LAD area at Closure

Only the lowest and highest total inorganic nitrogen concentrations in ground water were used for the following calculations.

receiving streamflow, Q_s	432,000	ft^3/d	5	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, C_s	0.15	mg/L	397,440	ft^3/d	4.6 cfs in cubic feet per SMC database 2011
discharge volume of ground water corresponding to **Summer days 1-120, Q_{dw}**	184,255	ft^3/d	2.2	cfs	volume corresponds to **lowest** projected ground water total inorganic nitrogen concentration, **summer** closure
discharge volume of ground water corresponding to Summer days 121-185, Q_{ds}	201,176	ft^3/d	2.4	cfs	volume corresponds to **highest** projected ground water total inorganic nitrogen concentration, **summer** closure
discharge volume of ground water corresponding to **Winter days 1-120, Q_{dw}**	160,941	ft^3/d	1.9	cfs	volume corresponds to **lowest** projected ground water total inorganic nitrogen concentration, **winter** closure
discharge volume of ground water corresponding to Winter days 121-185, Q_{dw}	201,176	ft^3/d	2.4	cfs	volume corresponds to **highest** projected ground water total inorganic nitrogen concentration, **winter** closure
projected **highest summer** discharge total inorganic nitrogen concentration of ground water	2.8	mg/L		projected concentration of total inorganic nitrogen in ground water near SP-11	

projected **lowest summer** discharge total inorganic nitrogen concentration of ground water , $\mathbf{C_{ds}}$	0.7	mg/L	projected concentration of total inorganic nitrogen in ground water near SP-11
projected **highest winter** discharge total inorganic nitrogen concentration of ground water	3.1	mg/L	projected concentration of total inorganic nitrogen in ground water near SP-11
projected **lowest winter** discharge total inorganic nitrogen concentration of ground water, $\mathbf{C_{dW}}$	1.3	mg/L	projected concentration of total inorganic nitrogen in ground water near SP-11
projected East Boulder River total inorganic nitrogen concentration in summer **days 1-120 (5.0 cfs 7Q_{10})**	**0.9**	mg/L	
projected East Boulder River total inorganic nitrogen concentration in winter **days 121-185 (5.0 cfs 7Q_{10})**	**0.5**	mg/L	
projected East Boulder River total inorganic nitrogen concentration in winter **days 1-120 (5.0 cfs 7Q_{10})**	**0.9**	mg/L	
projected East Boulder River total inorganic nitrogen concentration in summer **days 186-548 (5.0 cfs 7Q_{10})**	**0.3**	mg/L	

The total inorganic nitrogen concentration produced during these summer and winter closure options meet the MPDES permit limit of 1 mg/L for the East Boulder River for streamflows equal to or greater than the 7$Q_{10\ of}$ 5 cfs.

Spreadsheet 3B Salts: *Revised* Agency-Mitigated Alternative 3B East Boulder Closure Salinity Analyses

The agencies' preferred manner of disposal of treated adit and tailings waters is at the East Boulder Mine LAD areas, then at the East Boulder Mine percolation pond. For the East Boulder Mine site, the calculation assumptions have been made according to the regulatory requirements of the existing MPDES permit, Montana Water Quality Act and Rules, and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the East Boulder Mine site LAD area, any water that percolates below the root zone is assumed to immediately enter the aquifer. The aquifer beneath the East Boulder mine site has Class I Beneficial Use (less than 1000 µmhos/cm EC). The MPDES permit does not set a limit for TDS or EC. The salts load is calculated from TDS. The calculations allow LAD evaporation credit for water volume only and do not allow treatment credit for salts. The calculations do not allow evaporation credit for percolation. No salts treatment occurs in BTS/Anox or LAD. Tailings impoundment waters would be routed the same as adit water. For hydraulic volume calculations, the PoleCat evaporators (summer) accomplish 30% evaporation, center pivots 30%; PoleCat (winter) 30% evaporation. The agencies have used the conversion factor of 1 mg/L TDS equating to 1.56 µmhos/cm EC. The concentrations of TDS or measured EC at spring SP-11 (downgradient of East Boulder Mine LAD area) are assumed to be representative of actual aquifer affected by applied mine waters. The agencies have become aware that the 250 mg/L TDS concentration cited in the 2010 DEIS as protective of trout eggs was based upon Arctic Grayling and incorrectly applied to the East Boulder River. EC values are calculated from the TDS concentration to evaluate ground water quality standards. The spreadsheet has been edited to account for updated volumes, concentrations, and timeframes. All edited cells are highlighted in mauve; changed text is highlighted in blue; all anchor cells that carry through the spreadsheet are highlighted in green.

Agency-Mitigated Alternative 3B, Option 1, 737 gpm: This option would percolate the entire treated 737 gpm (24 hr) adit flow with the maximum volume of treated tailings waters that could be treated in the BTS/Anox and would meet the 30 lbs/day MPDES permit nitrogen limit. The 737 gpm (24 hr) treated adit water and 263 gpm (24 hr) of East Boulder tailings waters would be mixed and treated in the BTS/Anox system. All 1,000 gpm (24 hr) would be disposed in the East Boulder Mine percolation pond as in Proposed Action Alternative 2B. The time frame for closure would be two LAD seasons (18 months). The time frame for closure would be affected by the volume of water in the tailings impoundment.

for all of the calculations in this spreadsheet:	944	µmhos/cm	605	mg/L	adit TDS concentration (SMC monitoring data 2011)
Percolation pond can accommodate at least 1,105 gpm rate	1,164	µmhos/cm	746	mg/L	tailings waters TDS concentration (SMC monitoring data 2011)
BTS/Anox system assumed capacity to treat total inorganic nitrogen	1,000	gpm (24 hr)	**737**	gpm (24 hr)	adit flow rate at closure
18-month closure time frame	**548**	days	**263**	gpm (24 hr)	tailings water pumping rate at closure **fixed by BTS/Anox treatment capacity for total inorganic nitrogen**
weighted average EC (calculated) of adit plus tailings waters	1,002	µmhos/cm	642	mg/L	weighted average TDS concentration of adit plus tailings waters at closure
East Boulder Hydraulic Loading Input Parameters, closure			**120**	days	length of LAD season
East Boulder Tailings Impoundment discharge volume (KP 87; SMC 93)	**98**	MG	**259**	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**263**	gpm (24 hr)	526	gpm (12 hr)	rate to dewater the impoundment
volume of water from East Boulder Tailings impoundment per day	50,631	ft^3/d	141,882	ft^3/d	volume of adit water per day
East Boulder Adit Flow rate days 1-548	**737**	gpm (24 hr)	1,474	gpm (12 hr)	adit flow rate
total combined hydraulic load (adit plus East Boulder tailings waters) days 1-335	1,000	gpm (24 hr)	2,000	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
Volume of adit plus tailings waters to be percolated in cubic feet per day	192,513	ft^3/d	**2,210**	gpm (12 hr)	capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4

The volume of treated adit plus tailings waters needing disposal is within the hydraulic capacity of the percolation pond; however, dewatering of the tailings impoundment would take 246 days.

East Boulder MPDES permit source-specific (percolation pond) mixing zone calculations			**Percolation of 737 gpm treated adit water with 263 gpm treated tailings waters at the East Boulder percolation pond.**
depth of aquifer, **D**	80	ft	MPDES Statement of Basis, p. 25-26
hydraulic conductivity, **k**	75	ft/d	MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026		MPDES Statement of Basis, p. 25-26
width of source	385	ft	MPDES Statement of Basis, p. 25-26
length from percolation pond to wells, L_1	3,600	ft	MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3		MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d	MPDES Statement of Basis, p. 25-26

volume of ground water flux available for mixing from MODFLOW	400	gpm			MPDES Statement of Basis, p. 25-26
upgradient concentration of TDS in ground water (avg at WW-1), C_{AWW}	106	mg/L	170	μmhos/cm	MPDES Statement of Basis, p. 24
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
width of mixing zone, W_1	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, A_1	55,977	ft^2			
Volume of ground water available for mixing Q_1=kiA	77,005	ft^3/d	400	gpm	MPDES Statement of Basis, p.25-26
2011 operational concentration of TDS in ground water **beneath tailings impoundment that flows to LAD area (EBMW-6), C_{AM}**	515	mg/L	803	μmhos/cm	SMC Monitoring Data 2011; **EBMWs -6 and -7 are two of the compliance points at the end of the tailings impoundment and considered representative of the existing loads of salt and nitrogen in the ground water during operations.**
Volume of ground water available for mixing beneath **LAD** area Q_2=kiA	27,914	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d)
Projected salts concentration in ground water near SP-11	491	mg/L	**767**	μmhos/cm	projected EC of ground water at SP-11 just prior to discharge to the East Boulder River
receiving streamflow, Q_s	432,000	ft^3/d	5	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, C_{EBR}	49	mg/L	76	μmhos/cm	calculated EC
discharge volume of ground water and percolated water, Q_{ds}	297,433	ft^3/d	397,440	ft^3/d	receiving streamflow at 4.6 cfs (SMC 2011)
discharge concentration of ground water to East Boulder River, C_{ds}	491	mg/L	767	μmhos/cm	projected EC of ground water near SP-11 just prior to discharge to the East Boulder River
Projected salts concentration in the East Boulder River at EBR-004/4A (at 5 cfs)	**229**	mg/L	358	μmhos/cm	projected EC in the East Boulder River at EBR-004 or EBR-004A (5 cfs)
Projected salts concentration in the East Boulder River at EBR-004/4A (at 4.6 cfs)	**238**	mg/L	372	μmhos/cm	projected EC in the East Boulder River at EBR-004 or EBR-004A (4.6 cfs)
East Boulder Percolation Salts Loading, closure					**Percolation of 737 gpm treated adit water with 263 gpm treated tailings waters at the East Boulder percolation pond days 1-246; percolation of 737 gpm adit water days 247-548.**
Daily salts load to ground water from percolation days 1-246	**7,705**	**lbs/day**	**3,541,373**	**lbs/18 mos**	**Total salts load to ground water from closure (548 days)**

The projected salts concentrations in ground water at SP-11 from the percolation of 737 gpm (24 hr) treated adit water plus 263 gpm (24 hr) treated tailings water is less than the Class I beneficial use criterion of 1,000 μmhos/cm EC. The closure time frame would be 18-months to accomodate for dewatering of the tailings impoundment and ensure two LAD seasons, if needed.

Agency-Mitigated Alternative 3B, Option 2, 737 gpm: The 737 gpm (24 hr) of treated adit water and 263 gpm (24 hr) of treated East Boulder tailings waters would be preferentially disposed at the East Boulder Mine LAD areas during an 18-month closure period. All approved LAD areas would be constructed. No water would be discharged to the mine percolation pond.

East Boulder LAD Areas 2, 3-Upper, 4, and 6 Hydraulic Loading, closure					**LAD of 737 gpm treated adit water with 263 gpm treated tailings waters at the East Boulder LAD Areas 2, 3-Upper, 4, and 6; no percolation would be used**
East Boulder Tailings Impoundment discharge volume	**98**	MG	259	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**263**	gpm (24 hr)	526	gpm (12 hr)	rate to dewater the impoundment
East Boulder Adit Flow rate	**737**	gpm (24 hr)	1,474	gpm (12 hr)	adit flow rate
total combined hydraulic load (adit plus East Boulder tailings waters)	1,000	gpm (24 hr)	**2,000**	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
Summer hydraulic capacity of East Boulder Mine LAD Area 6	293	gpm (24 hr)	**1,450**	gpm (12 hr)	hydraulic capacity of all East Boulder Mine LAD Areas
Summer LAD Area 6 maximum hydraulic load	56,406	ft^3/d	586	gpm (12 hr)	evaporator maximum flow rate, 10.2 ac (CES 2008)
Summer LAD Area 4 maximum hydraulic load	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.2 ac (CES 2008)

Summer LAD Area 3 Upper maximum hydraulic load	26,952	ft^3/d	280	gpm (12 hr)	evaporator maximum flow rate, 11.3 ac (CES 2008)
Summer LAD Area 2 maximum hydraulic load	29,262	ft^3/d	304	gpm (12 hr)	center pivot maximum flow rate, 13.9 ac (CES 2008)
Summer total hydraulic load that must be percolated	52,941	ft^3/d	**550**	gpm (12 hr)	**Summer** excess volume of water that must be **percolated**
Summer area available for LAD	46.6	ac	32.7	ac	Winter area available for LAD
Winter hydraulic capacity of East Boulder Mine LAD Area 6	39,465	ft^3/d	410	gpm (12 hr)	snowmaker maximum flow rate, 10.2 ac (CES 2008)
Winter LAD Area 4 snowmaking max hydraulic load	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate, 11.2 ac (CES 2008)
Winter LAD Area 3 Upper snowmaking max hydraulic load	7,701	ft^3/d	80	gpm (12 hr)	snowmaker maximum flow rate 11.3 ac (CES 2008)
Winter total hydraulic load that must be percolated	137,647	ft^3/d	**1,430**	gpm (12 hr)	**Winter** excess volume of water that must be **percolated**

The hydraulic load of 737 gpm adit water plus 263 gpm East Boulder tailings waters exceeds the capacity of the approved LAD areas in summer and winter and cannot be managed solely by land application at East Boulder Mine; some excess waters must be percolated.

Agency-Mitigated Alternative 3B, Option 3, 373 gpm: The 737 gpm (24 hr) of adit water and 263 gpm of tailings waters would be treated and preferentially disposed at the mine LAD areas during an 18-month closure period. All approved LAD areas would be constructed. Excess treated waters would be discharged to the East Boulder Mine percolation pond.

East Boulder Salt Loading Input Parameters, closure			**LAD of maximum volume of treated adit plus tailings waters at the East Boulder Mine LAD Areas during the 120-day LAD season with percolation of the excess water at the mine percolation pond**		
Summer LAD and percolation daily salts load during closure **Days 1-120**	7,705	lbs/day	**508**	gpm (24 hr)	total summer LAD rate
Summer volume of excess water that must be percolated Days 1-120	**275**	gpm (24 hr)	84	lbs/ac/day	**Summer LAD salts** application rate per acre per day
Winter snowmaking & percolation daily salts load during closure **Days 1-120**	7,705	lbs/day	**200**	gpm (24 hr)	total winter snowmaking rate
Winter volume of excess water that must be percolated Days 1-120	**715**	gpm (24 hr)	47	lbs/ac/day	**Winter Snowmaking salts** application rate per acre per day
Daily salts load during closure days 121-246	7,705	lbs/day	**289**	days	time between the LAD season and end of closure period
volume of water that must be percolated Days 121-246	**1,000**	gpm (24 hr)	52,941	ft^3/d	summer volume of percolated water in cubic feet per day, days 1-120
Daily salts load during closure days 247-548	5,351	lbs/day	137,647	ft^3/d	winter volume of percolated water in cubic feet per day, days 1-120
volume of water that must be percolated Days **247**-548	**737**	gpm (24 hr)	192,513	ft^3/d	volume of percolated water in cubic feet per day, days 121-246
Total combined salts loading (LAD plus percolation) during summer closure	**6,402,734**	lbs/18 mos	141,882	ft^3/d	volume of percolated water in cubic feet per day, days 247-548
Total combined salts loading (Snowmaking plus percolation) during winter closure	**6,402,734**	lbs/18 mos	139	days	time after the LAD season to dewater the tailings impoundment

Ground Water Inputs Below East Boulder Mine LAD area, at Closure			**LAD of maximum volume of treated adit plus tailings waters at the East Boulder Mine LAD Areas during the 120-day LAD season with percolation of the excess water at the mine percolation pond**		

all input values used are the same as above for **k**, **i**, lengths, widths, areas, and angle of dispersion. Aquifer depth is 15 feet.

70% Volume of ground water available for mixing $\mathbf{Q_1}$=kiA	77,005	ft^3/d			MPDES Statement of Basis, p.25-26
Volume of ground water available for mixing beneath LAD area $\mathbf{Q_2}$=kiA	27,914	ft^3/d			calculation per 17.30.517(d)
concentration of salt in mixed adit plus tailings waters in percolated waters, $\mathbf{C_P}$	642	mg/L	605	mg/L	concentration of salt in adit water
2011 operational concentration of TDS in ground water **beneath tailings impoundment that flows to LAD area (EBMW-6),** $\mathbf{C_{am}}$	515	mg/L	803	µmhos/cm	SMC Monitoring Data 2011; **EBMWs -6 and -7 are two of the compliance points at the end of the tailings impoundment and considered representative of the existing loads of salt and nitrogen in the ground water during operations.**
effective concentration of salt applied during LAD (hydraulic evaporation applied; no salts treatment credit), $\mathbf{C_{LAD}}$	917	mg/L	1,431	µmhos/cm	calculated EC
upgradient concentration of TDS in ground water (avg at WW-1), $\mathbf{C_{AWW}}$	106	mg/L	165	µmhos/cm	calculated EC

Appendix E
DEQ 2012

receiving stream ambient concentration at EBR-001, **C_{EBR}**	49	mg/L	76	µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
Volume of water: **summer LAD** (hydraulic evaporation applied) **days 1-120**, **V_{SL}**	97,701	ft^3/d	508	gpm (24 hr)	Volume of water applied at LAD areas 2, 3, 4, 6 (evaporation applied)
Volume of water: **summer percolation** (no evaporation or treatment credit) **days 1-120**, **V_{SP}**	52,941	ft^3/d			
Volume of water: **winter snowmaking** (hydraulic evaporation applied) **days 1-120**, **V_{WL}**	38,406	ft^3/d	200	gpm (24 hr)	winter volume from LAD areas 3, 4, 6; maximum capacity (evaporation applied)
Volume of water: **winter percolation** (no evaporation or treatment credit) **days 1-120**, **V_{WP}**	137,647	ft^3/d			
Volume of water that is percolated after the LAD season days 121-370	192,513	ft^3/d			
Volume of adit water percolated for remainder of closure period days 371-548	141,882	ft^3/d			
Summer salt concentration in ground water near SP-11, **Days 1-120**	572	mg/L	**892**	µmhos/cm	days 1-120 projected concentration of salts in ground water near SP-11, summer closure
Summer salt concentration in ground water near SP-11, Days 121-370	497	mg/L	**775**	µmhos/cm	days 121-370 projected concentration of salts in ground water near SP-11, summer closure
Summer salt concentration in in ground water near SP-11, Days 371-548	437	mg/L	**682**	µmhos/cm	days 371-548 projected concentration of salts in ground water near SP-11, summer closure
Winter salt concentration in ground water near SP-11, **Days 1-120**	520	mg/L	**811**	µmhos/cm	days 1-120 projected concentration of salts in ground water near SP-11, winter closure
Winter salt concentration in ground water near SP-11, Days 121-370	492	mg/L	**767**	µmhos/cm	days 121-370 projected concentration of salts in ground water near SP-11, winter closure
Winter salt concentration in in ground water near SP-11, Days 371-548	437	mg/L	**681**	µmhos/cm	days 371-548 projected concentration of salts in ground water near SP-11, winter closure

The EC of ground water during summer and winter closure scenarios meets 1,000 µmhos/cm Class I Beneficial use from the LAD and percolation of 737 gpm (24 hr) treated adit water and 174 gpm (24 hr) treated tailings waters.

East Boulder River Concentration below LAD area

LAD of maximum volume of treated adit plus tailings waters at the East Boulder Mine LAD Areas during the 120 day LAD season with percolation of the excess water at the mine percolation pond for the remainder of closure; the highest projected concentration (summer closure days 1-120) was used for this calculation

receiving streamflow, **Q_s**	432,000	ft^3/d	5	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, **C_{EBR}**	49	mg/L	76	µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
summer discharge volume of ground water at **highest projected salts** concentration, **Q_{dS}**	255,561	ft^3/d	3.0	cfs	hydraulic evaporative losses taken; highest summer salt concentration days 1-120
winter discharge volume of ground water at **highest projected salts** concentration, **Q_{dS}**	280,973	ft^3/d	3.3	cfs	hydraulic evaporative losses taken; highest winter salt concentration days 1-121
highest summer projected discharge **concentration** of salts to East Boulder River, **C_{ds}**	572	mg/L	892	µmhos/cm	highest projected EC of ground water during summer closure days 1-120
highest winter projected discharge **concentration** of salts to East Boulder River, **C_{dW}**	520	mg/L	811	µmhos/cm	highest projected EC of ground water during winter closure days 1-121
lowest projected East Boulder River salts concentration (5 cfs)	**190**	**mg/L**	**197**	**mg/L**	**lowest projected East Boulder River salts concentration (4.6 cfs)**

highest summer projected East Boulder River salts concentration (5 cfs)	**243**	**mg/L**	**254**	**mg/L**	**highest summer projected East Boulder River salts concentration (4.6 cfs)**
highest winter projected East Boulder River salts concentration (5 cfs)	**235**	**mg/L**	**244**	**mg/L**	**highest winter projected East Boulder River salts concentration (4.6 cfs)**

Agency-Mitigated Alternative 3B, Option 1, 150 gpm: This option evaluates the feasibility of the East Boulder Mine WMP Proposed Action Alternative 2B 12-month closure period. This option would percolate the entire treated 150 gpm of adit water with the maximum volume of East Boulder tailings waters that could be treated through the BTS/Anox and would meet the 30 lbs/day MPDES permit nitrogen limit. The 150 gpm adit and 350 gpm tailings waters would be treated in the BTS/Anox system and be preferentially disposed in the mine percolation pond during the closure period. No water would be land applied at closure.

median **adit TDS concentration** SMC monitoring data	605	mg/L	944	μmhos/cm	calculated EC
median **tailings waters TDS concentration** SMC monitoring data	746	mg/L	1,164	μmhos/cm	calculated EC
weighted average concentration of TDS (adit plus tailings waters)	704	mg/L	**150**	gpm (24 hr)	adit flow rate at closure
calculated EC of weighted adit plus tailings waters	1,098	μmhos/cm	**350**	gpm (24 hr)	**tailings flow rate at closure** based on the spring 2012 500 gpm capacity of the BTS (SMC 2011)

East Boulder Hydraulic Loading Calculations, Percolation Pond			**Percolation of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder percolation pond.**		
East Boulder Tailings Impoundment discharge volume	**98**	MG	**194**	**days**	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**350**	gpm (24 h)	700	gpm (12 hr)	rate to dewater the impoundment
volume of water from East Boulder Tailings impoundment per day	67,380	ft^3/d	28,877	ft^3/d	volume of adit water per day
total combined hydraulic load (adit plus East Boulder tailings waters)	**500**	gpm (24 h)	1,000	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
Volume of adit plus tailings waters to be percolated in cubic feet per day	96,257	ft^3/d	2,210	gpm (12 hr)	capacity of East Boulder Mine percolation pond MPDES Statement of Basis p. 4

The 500 gpm (24 hr) of treated adit plus tailings waters needing disposal is within the hydraulic capacity (1,105 gpm - 24 hr) of the percolation pond.

East Boulder MPDES permit source-specific (percolation pond) mixing zone calculations			**Percolation of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder percolation pond.**		

all input values used are the same as above for **k**, **i**, lengths, widths, areas, and angle of dispersion. Aquifer depth is 15 feet.

Volume of ground water available for mixing $\mathbf{Q_1}$=kiA	77,005	ft^3/d	27,914	ft^3/d	Volume of ground water available for mixing beneath LAD area $\mathbf{Q_2}$=kiA
upgradient concentration of TDS in ground water (avg at WW-1), $\mathbf{C_{AWW}}$	106	mg/L	515	mg/L	**2011 operational concentration** of TDS in ground water **beneath tailings impoundment that flows to LAD area (EBMW-6),** $\mathbf{C_{AM}}$
projected salts concentration in ground water near SP-11, Days 1-185	449	mg/L	**700**	μmhos/cm	projected EC of ground water at SP-11 just prior to discharge to the East Boulder River
projected salts concentration in ground water near SP-11, Days 186-548	285	mg/L	**445**	μmhos/cm	projected EC of ground water at SP-11 just prior to discharge to the East Boulder River
receiving streamflow, $\mathbf{Q_s}$	432,000	ft^3/d	5.0	cfs	7Q10 MPDES Statement of Basis p. 4
receiving stream ambient concentration, $\mathbf{C_{EBR}}$	49	mg/L	76	μmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
discharge volume of ground water and percolated water days 1-185, Q_{DS1}	201,176	ft^3/d	2.3	cfs	no credit for evaporative losses taken in volume calculations, adit plus tailings
discharge volume of ground water and percolated water days 186-548, Q_{DS2}	133,797	ft^3/d	1.5	cfs	no credit for evaporative losses taken in volume calculations, adit water

discharge concentration of ground water to East Boulder River days 1-185, C_{DS1}	449	mg/L	700	µmhos/cm	projected EC of ground water near SP-11 just prior to discharge to the East Boulder River
discharge concentration of ground water to East Boulder River days 186-548, C_{DS2}	285	mg/L	397,440	ft^3/d	receiving streamflow at 4.6 cfs (SMC 2011)
Projected salts concentration in the East Boulder River at EBR-004/4A days 1-370 (5.0 cfs)	**176**	mg/L	**183**	mg/L	**Projected salts concentration in the East Boulder River at EBR-004/4A days 1-370 (4.6 cfs)**
Projected salts concentration in the East Boulder River at EBR-004/4A days 371-548 (5.0 cfs)	**105**	mg/L	**108**	mg/L	**Projected salts concentration in the East Boulder River at EBR-004/4A days 371-548 (4.6 cfs)**
East Boulder Percolation Salts Loading, closure					**Percolation of 737 gpm treated adit water with 83 gpm treated tailings waters at the East Boulder percolation pond.**
Daily salts load to ground water from percolation, days 1-185	**4,222**	lbs/day			
Daily salts load to ground water from percolation, days 186-548	**1,089**	lbs/day	**1,407,539**	**lbs/18 mos**	**Total salts load to ground water from closure (548 days)**

The salts concentrations in ground water from the percolation of 150 gpm (24 hr) treated adit water plus 350 gpm (24 hr) treated tailings water is less than the Class I beneficial use criterion of 1,000 µmhos/cm EC. The salts concentration in surface water from the percolation of 150 gpm (24 hr) treated adit water plus 350 gpm (24 hr) treated tailings water is less than 250 mg/L TDS. The closure time frame would be 18-months to account for potential delays or equipment break-downs.

Agency-Mitigated Alternative 3B, Option 2, 150 gpm: The 150 gpm (24 hr) of adit water would be treated with 350 gpm (24 hr) of East Boulder tailings waters and be preferentially disposed at the East Boulder Mine LAD Area 6 during the closure period. No other LAD areas would be built. No percolation would be used.

East Boulder LAD Area 6 Hydraulic Loading, closure					**LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; no percolation would be used**
East Boulder Tailings Impoundment discharge volume	**98**	MG	**194**	days	time to dewater the tailings impoundment
rate to dewater East Boulder tailings impoundment	**350**	gpm (24 hr)	700	gpm (12 hr)	rate to dewater the impoundment
East Boulder adit flow rate	**150**	gpm (24 hr)	300	gpm (12 hr)	East Boulder adit flow rate
total combined hydraulic load (adit plus East Boulder tailings waters)	**500**	gpm (24 hr)	1,000	gpm (12 hr)	total combined flow (adit plus East Boulder tailings waters)
Summer hydraulic capacity of East Boulder Mine LAD Area 6	**293**	gpm (24 hr)	**205**	gpm (24 hr)	**Winter** hydraulic capacity of East Boulder Mine LAD Area 6
Summer excess volume of water that must be **percolated Days 1-120**	**207**	gpm (24 hr)	**295**	gpm (12 hr)	**Winter** excess volume of water that must be **percolated Days 1-120**

The hydraulic load of 150 gpm (24 hr) adit water plus 174 gpm (24 hr) tailings waters cannot be managed solely at LAD Area 6 during closure that commences in summer or winter. Percolation must be used to dispose of up to 295 gpm (24 hr) during the LAD season and for the entire 500 gpm during seasons when LAD cannot be used.

Agency-Mitigated Alternative 3B, Option 3, 150 gpm: The 150 gpm (24 hr) of adit water would be treated with 350 gpm (24 hr) of East Boulder tailings waters and be preferentially disposed at the East Boulder Mine LAD Area 6 during the closure period, with excess waters percolated at the mine pond. No other LAD areas would be built.

East Boulder LAD Area 6 Hydraulic Loading, closure	**LAD of 150 gpm treated adit water with 350gpm treated tailings waters at the East Boulder LAD Area 6; the excess volume of water would be percolated**

As shown in Option 2, 150 gpm (24 hr) Hydraulic Loading, the hydraulic load of 150 gpm (24 hr) adit water plus 350 gpm (24 hr) tailings waters can be managed at LAD Area 6 during closure that commences in summer or winter when percolation is used to dispose of up to 295 gpm (24 hr) during the 120-day LAD season and for the entire 500 gpm during seasons when LAD cannot be used.

East Boulder LAD Area 6 salts loading, closure					**LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; the excess volume of water would be percolated**
Summer salts load to soil and ground water disposed at **LAD Area 6,** days 1-120	2,474	lbs/day	1,731	lbs/day	**Winter** salts load to soil and ground water disposed at **LAD Area 6,** days 1-120

Appendix E
DEQ 2012

Summer salts load to soil and ground water disposed at **LAD Area 6,** days 1-120 per acre	0.01	lbs/ft^2	0.00	lbs/ft^2	**Winter** salts load to soil and ground water disposed at **LAD Area 6,** days 1-120 per acre
Summer salts load **percolated** days 1-120	1,748	lbs/day	2,491	lbs/day	**Winter** salts load **percolated** days 1-120
salts load percolated, days 121-185	4,222	lbs/day	10.2	ac	LAD Area 6
salts load percolated, days 186-548	1,089	lbs/day	120	days	length of LAD season
Total Summer closure salts load to ground water, days 1-548	**1,206,005**	lbs/18 mos	**1,206,005**	lbs/18 mos	**Winter closure** salts load to ground water, days 1-548

The salts loading (0.01 lbs/ft^2) to soil would not adversely affect soil quality unless salts buildup occurs. LAD application rate should be adjusted to adequately flush soil annually.

Ground Water Inputs Below East Boulder Mine LAD area, at Closure

LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; the excess volume of water would be percolated

all input values used are the same as above for k, i, lengths, widths, areas, and angle of dispersion. Aquifer depth is 15 feet.

70% Volume of ground water available for mixing **Q_1**=kiA	77,005	ft^3/d	500	gpm (24 hr)	total combined hydraulic load (adit plus East Boulder tailings waters)
Volume of ground water available for mixing beneath LAD area **Q_2**=kiA	27,914	ft^3/d		gpm (24 hr)	
concentration of salt in mixed adit plus tailings waters (percolated waters), **C_P**	704	mg/L	1,098	µmhos/cm	calculated above
2011 operational concentration of TDS in ground water **beneath tailings impoundment that flows to LAD area (EBMW-6), C_{am}**	515	mg/L	803	µmhos/cm	calculated from TDS
effective salt concentration applied as LAD (evaporation applied; no treatment credit), **C_{LAD}**	1,005	mg/L	1,568	µmhos/cm	calculated
upgradient concentration of TDS in ground water (avg at WW-1), **C_{AWW}**	106	mg/L	165	µmhos/cm	MPDES Statement of Basis, p. 24
receiving stream ambient concentration at EBR-001, **C_{EBR}**	49	mg/L	76	µmhos/cm	1996-1999 median baseline EC calculated from SMC monitoring data (Hydrometrics 2001)
Volume of water: **summer LAD** (hydraulic evaporation applied) days 1-120, **V_s**	39,484	ft^3/d	27,626	ft^3/d	Volume of water: **winter snowmaking** (hydraulic evaporation applied) days 1-120, **V_{W1}**
Volume of water: **summer percolation** (no evaporation or treatment credit) days 1-120, **V_p**	39,850	ft^3/d	56,791	ft^3/d	Volume of water: **winter percolation** (no evaporation or treatment credit) days 1-120, **V_{W2}**
Volume of water that is percolated after the LAD season days 121-370	96,257	ft^3/d	28,877	ft^3/d	Volume of adit water percolated for remainder of closure period days 371-548
Summer salt concentration in ground water near SP-11, **Days 1-120**	490	mg/L	**764**	µmhos/cm	days 1-120 projected concentration of salts in ground water near SP-11, summer closure
Summer salt concentration in ground water near SP-11, Days 121-185	602	mg/L	**939**	µmhos/cm	days 121-370 projected concentration of salts in ground water near SP-11, summer closure
Summer salt concentration in in ground water near SP-11, Days 186-548	553	mg/L	**862**	µmhos/cm	days 371-548 projected concentration of salts in ground water near SP-11, summer closure
Winter salt concentration in ground water near SP-11, **Days 1-120**	477	mg/L	**744**	µmhos/cm	days 1-120 projected concentration of salts in ground water near SP-11, winter closure
Winter salt concentration in ground water near SP-11, Days 121-185	600	mg/L	**936**	µmhos/cm	days 121-370 projected concentration of salts in ground water near SP-11, winter closure
Winter salt concentration in in ground water near SP-11, Days 186-548	317	mg/L	**494**	µmhos/cm	days 371-548 projected concentration of salts in ground water near SP-11, winter closure

Disposal of 150 gpm adit and 350 gpm tailings waters using land application at LAD Area 6 and percolation of excess waters meets the Class I beneficial use criterion of 1,000 µmhos/cm.

East Boulder River Concentration below LAD area					**LAD of 150 gpm treated adit water with 350 gpm treated tailings waters at the East Boulder LAD Area 6; the excess volume of water would be percolated; calculations were only made for the highest seaasonal projected ground water EC**
receiving streamflow, $\mathbf{Q_s}$	432,000	ft^3/d	5	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis p. 4
receiving stream ambient concentration, $\mathbf{C_{EBR}}$	49	mg/L	76	μmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
discharge volume of ground water at lowest summer salts concentration days 186-548, $\mathbf{Q_{DSL}}$	133,797	ft^3/d	1.5	cfs; corresponds to lowest projected ground water TDS concentration, summer closure	
discharge volume of ground water at **highest summer** salts concentration days **1-120**, $\mathbf{Q_{DSH}}$	184,255	ft^3/d	2.1	cfs; corresponds to highest projected ground water TDS concentration, summer closure	
discharge volume of ground water at lowest winter salts concentration days 186-548, $\mathbf{Q_{DWL}}$	133,797	ft^3/d	1.5	cfs; corresponds to lowest projected ground water TDS concentration, winter closure	
discharge volume of ground water at **highest winter** salts concentration days **1-120**, $\mathbf{Q_{DWH}}$	189,337	ft^3/d	2.2	cfs; corresponds to highest projected ground water TDS concentration, winter closure	
lowest summer projected discharge concentration of salts to East Boulder River, $\mathbf{C_{DSL}}$	553	mg/L		days 186-548 projected concentration of salts in ground water near SP-11, summer closure	
highest summer projected discharge concentration of salts to East Boulder River, $\mathbf{C_{DSH}}$	490	mg/L		days 1-120 projected concentration of salts in ground water near SP-11, summer closure	
lowest winter projected discharge concentration of salts to East Boulder River, $\mathbf{C_{DWL}}$	317	mg/L		days 186-548 projected concentration of salts in ground water near SP-11, winter closure	
highest winter projected discharge concentration of salts to East Boulder River, $\mathbf{C_{DWH}}$	477	mg/L		days 1-120 projected concentration of salts in ground water near SP-11, winter closure	
lowest summer projected concentration of salts in the East Boulder River at EBR-004/4A **(5.0 cfs)**	**168**	mg/L	176	mg/L	**lowest summer** projected concentration of salts in the East Boulder River at EBR-004/4A **(4.6 cfs)**
highest summer projected concentration of salts in the East Boulder River at EBR-004/4A **(5.0 cfs)**	**181**	mg/L	188	mg/L	**highest summer** projected concentration of salts in the East Boulder River at EBR-004/4A **(4.6 cfs)**
lowest winter projected concentration of salts in the East Boulder River at EBR-004/4A **(5.0 cfs)**	**112**	mg/L	116	mg/L	**lowest winter** projected concentration of salts in the East Boulder River at EBR-004/4A **(4.6 cfs)**
highest winter projected concentration of salts in the East Boulder River at EBR-004/4A **(5.0 cfs)**	**179**	mg/L	187	mg/L	**highest winter** projected concentration of salts in the East Boulder River at EBR-004/4A **(4.6 cfs)**

Spreadsheet 3C Nitrogen--*Revised* Agency-Mitigated Alternative 3C Boe Ranch LAD System Operations and Closure Nitrogen Analyses

If the Boe Ranch LAD was constructed it would be the agencies' preferred disposal option for treated adit water during operations and for treated adit plus tailings waters during the first eighteen months of closure. The East Boulder Mine LAD facilities would first be used for contingency disposal of treated adit water during operations, then the percolation pond. Monitoring well RMW-3A is located at Boe Ranch downgradient of the proposed LAD area and is considered to represent ambient total inorganic nitrogen (TIN) values. Baseline concentrations of TIN in the East Boulder River average 0.1 mg/L. At closure, all adit and East Boulder tailings waters would be treated through the BTS/Anox system then routed to the Boe Ranch LAD storage pond all year and disposed of through LAD pivots during the summer LAD season. For the Boe Ranch LAD, calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the Boe Ranch LAD area any water that percolates below the root zone is assumed to immediately enter the ground water.

The Boe Ranch LAD area would not have an MPDES permit. The BTS/Anox would be the same as Alternative 2B, with treated water routed to Boe Ranch LAD during operations and 18 months of closure. For this analysis, 20% of the applied TIN concentrations are expected to flush through the soil column/unsaturated zone to ground water at some point during the year. Ground water beneath the LAD area and LAD storage pond flows down-gradient where it is recharged by the Mason Ditch, then discharges to the East Boulder River. These calculations assume that during operations treated adit waters are routed to the Boe Ranch LAD storage pond. During summer LAD, PoleCat evaporators accomplish 30% evaporation and the center pivots accomplish 30% evaporation. In the winter, PoleCat snowmaking accomplishes 30% evaporation up slope of the lined LAD storage pond. At closure, treated adit and tailings waters would be routed to the Boe Ranch LAD storage pond which would hold 100 **MG of adit water, and mixing of these waters would occur prior to disposal at the LAD pivots. A weighted average was used to determine the concentration of TIN in the mixed LAD storage pond water. The East Boulder Mine MPDES permit has a**

monthly average TIN limit of 30 lbs/day. Historical maximum TIN load after BTS/Anox system treatment of 20 lbs/day was used in this analysis. These calculations assume that there will be a leak in the Boe Ranch LAD storage pond, and the liner leakage, land-applied water, and Mason Ditch waters contribute to ground water quality prior to discharge into the East Boulder River. It is assumed that only nine of the proposed Boe Ranch LAD center pivots on 166 of the proposed 194 acres in Section 17 will be developed for use during operations and closure. Fifty percent of proposed pivots 4 and 9 would be used, and none of pivot 10 would be used to prevent potential mass wasting/ stability problems. The TIN concentration of treated discharge will vary with total flow rate. The spreadsheet has been edited to account for updated volumes, concentrations, and timeframes. All edited cells are highlighted in mauve; all changed text is highlighted in blue; all anchor cells that carry through the spreadsheet are highlighted in green.

OPERATIONS CALCULATIONS

Alternative 3C Nitrogen Operations Option 1, 737 gpm: SMC would route 284 gpm treated adit water to the Boe Ranch LAD storage pond during the entire year. Treated adit water stored in the Boe Ranch LAD storage pond over fall, winter, and early spring, would be disposed of during the Boe Ranch LAD season. During the 120-day LAD season the 284 gpm treated adit water would be disposed of with up to 579 gpm stored treated adit water on the 166-acre Boe Ranch LAD area at greater than agronomic rates (10.4 gpm/acre). The excess 453 gpm of treated adit water would be disposed of at the East Boulder Mine during the entire year. During the LAD season at the mine, 293 gpm would be land applied at the existing East Boulder Mine LAD Area 6 and 160 gpm routed to the East Boulder Mine percolation pond. During snowmaking season, 205 gpm could be disposed of at the East Boulder Mine LAD Area 6 and 248 gpm at the percolation pond. The rest of the year, 453 gpm treated adit water would be disposed of at the East Boulder Mine percolation pond.

treated total inorganic nitrogen concentration of adit waters based on BTS/Anox system treatment (2009-2011)	0.4	mg/L			Demonstation has been made by SMC that tailings waters can be adequately treated to the same concentrations as adit water in the BTS/Anox (2009-2011)
OPERATIONS Hydraulic Loading Calculations *Boe Ranch LAD*	**assume 120 day LAD season and that Boe Ranch LAD storage pond contains 105 MG from previous winter**				
length of LAD season	120	days	863	gpm (24 h)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days on 166 acres, in Section 17
area available for LAD in section 17, **9 pivots** included (prevent mass wasting issues)	166	ac	**1,726**	gpm (12 h)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days, using 9 pivots in Section 17
greater than agronomic land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4	gpm/ac	569	gpm (12 h)	**LAD capacity available** at Boe Ranch LAD **for adit water** after dewatering Boe Ranch LAD storage pond
assumed volume in Boe Ranch LAD storage pond (2011 105 MG)	**100**	MG	**1,157**	gpm (12 h)	rate to dewater Boe Ranch LAD storage pond in one 120-day LAD season
adit flow rate during operations	**737**	gpm (24 hr)	1,474	gpm (12 h)	adit flow rate during operations
adit flow rate that must be **managed at East Boulder Mine**	**453**	gpm (24 hr)	905	gpm (12 h)	**adit** flow rate that must be **managed at East Boulder Mine**
summer hydraulic capacity available at East Boulder Mine at **LAD Area 6**	293	gpm (24 hr)	115	days	time to fill Boe Ranch LAD storage pond with adit water after 120 day LAD season

winter hydraulic capacity available at East Boulder Mine at **LAD Area 6**	205	gpm (24 hr)	1,105	gpm (24 h)	capacity of East Boulder Mine percolation pond (MPDES permit Statement of Basis)
summer excess adit flow rate that must be **percolated** at East Boulder Mine	**160**	gpm (24 hr)	**248**	gpm (24 h)	**winter** excess adit flow rate that must be **percolated** at East Boulder Mine

volume of water routed to **Boe Ranch LAD year round**	284	gpm (24 hr)	569	gpm (12 h)	volume of water routed to **Boe Ranch LAD year round**

During the 120 day LAD season, the hydraulic load of 284 gpm treated adit water plus 579 gpm treated stored water can be managed at Boe Ranch LAD area if seven pivots are operating at greater than agronomic rates as is done at the Hertzler Ranch LAD area. The excess water 453 gpm would be disposed at the East Boulder Mine LAD Area 6 and percolation pond.

OPERATIONS *East Boulder Mine* Nitrogen Loading Calculations					**Nitrogen load from disposal of 453 gpm at the East Boulder Mine Area 6 LAD and the mine percolation pond, both winter and summer.**
OPERATIONS *East Boulder Mine* Summer nitrogen **percolated load**	**0.8**	lbs/day	160	gpm (24 hr)	adit water volume percolated at East Boulder Mine percolation pond in **summer**
OPERATIONS *East Boulder Mine* Winter nitrogen **percolated load**	**1.2**	lbs/day	248	gpm (24 hr)	adit water volume percolated at East Boulder Mine percolation pond in **winter**
OPERATIONS *East Boulder Mine* Summer LAD Area 6 nitrogen **load**	0.3	lbs/day	**1.0**	lbs/day	**OPERATIONS *East Boulder Mine* total percolation plus LAD load**
OPERATIONS *East Boulder Mine* Winter LAD Area 6 nitrogen **load**	0.2	lbs/day	**1.4**	lbs/day	**OPERATIONS *East Boulder Mine* total percolation plus snowmaking load**
OPERATIONS *East Boulder Mine* adit percolated volume	453	gpm (24 hr)	**2.2**	lbs/day	**OPERATIONS *East Boulder Mine* percolation only load**

3C OPERATIONS The total inorganic nitrogen load produced at the East Boulder Mine in summer by LAD of 293 gpm (24 hr) and percolation of 160 gpm (24 hr) treated adit water does not exceed the MPDES limit of 30 lbs/day at the East Boulder Mine. The total inorganic nitrogen load produced at the East Boulder Mine in winter by LAD of 205 gpm (24 hr) and percolation of 248 gpm (24 hr) does not exceed the 30 lbs/day total inorganic nitrogen limit at the East Boulder Mine. The total inorganic nitrogen load produced at the East Boulder Mine from percolation of 453 gpm (24 hr) does not exceed the 30 lbs/day total inorganic nitrogen limit.

OPERATIONS *Boe Ranch LAD* Nitrogen Loading Calculations					**Disposal of 1,726 gpm (12 hr) at higher than agronomic rates at the Boe Ranch LAD area over a 120-day LAD season**
length of LAD season	120	days	737	gpm (24 h)	adit flow rate at closure
historical maximum post BTS/Anox system total inorganic nitrogen load	0	lbs/day	0.4	mg/L	treated total inorganic nitrogen concentration of adit waters
land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4	gpm/ac	1,726	gpm (12 h)	daily hydraulic load that can be applied on 166 acres, all Section 17 pivots
depth of aquifer, **D**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	0.283	ft/d			mid-range estimate, used by Hydrometrics (KP 2000c)
gradient, **i**	0.1				estimate, used by Hydrometrics (KP 2000c)
width of LAD storage pond liner leakage source	10	ft			assume point leakage from LAD pond exists for foreseeable impact to ground water
width of mixing zone for the LAD storage pond liner leakage, $\mathbf{W_2}$	229	ft			width of source + (tan 5 * length) allowed by statute 17.30.517(d)
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
length of LAD storage pond liner leakage, $\mathbf{L_2}$	2,500	feet			KP 2000c Apdx K, Tables
cross sectional area of aquifer at LAD storage pond liner leakage, $\mathbf{A_2}$	3,428	ft^2			D * W, allowed by 17.30.517(d)
volume of LAD storage pond **liner leakage**, $\mathbf{V_2}$	27	ft^3/d	**4.1**	lbs/day	**OPERATIONS *Boe Ranch LAD* total nitrogen load**
$\mathbf{Q_2}$=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d	**3.0**	lbs/ac/year	**OPERATIONS *Boe Ranch LAD* total nitrogen load per acre**
concentration of **total inorganic nitrogen in ambient ground water**; median value from RMW-3a, $\mathbf{C_A}$	0.1	mg/L			median ambient total inorganic nitrogen concentration derived from SMC monitoring data
width of LAD application	3,200	ft			KP 2000c Apdx K, Tables
length of LAD application, $\mathbf{L_1}$	4,500	ft			KP 2000c Apdx K, Tables
width of LAD application ground water mixing area, $\mathbf{W_1}$	3,593	ft			allowed by 17.30.517(d)
cross sectional area of ground water at LAD application, $\mathbf{A_1}$	53,901	ft^2			D * W, allowed by 17.30.517(d)

Appendix E
DEQ 2012

Q_1=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d			allowed by 17.30.517(d)
volume of LAD applied; evaporation factor taken, V_1	116,324	ft^3/d	1,208	gpm (12 hr)	adit water applied; evaporation credit taken
total inorganic nitrogen concentration in applied LAD adit water; assume 80% post plant TIN uptake, C_1	0.1	mg/L	0.14	gpm (24 hr)	estimate of LAD storage pond liner leakage, used by Hydrometrics (KP 2000c)
total inorganic nitrogen in LAD storage **pond liner leakage** discharge, C_2	0.4	mg/L			treated total inorganic nitrogen concentration of adit waters
width of aquifer below LAD, includes area of Mason Ditch to East Boulder River	3,593	ft			KP 2000c Apdx K, Tables
length between end of pivots to East Boulder River, L_3	4,000	ft			KP 2000c Apdx K, Tables
width of mixing zone between end of pivots to East Boulder River, W_3	3,943	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
cross sectional area of aquifer between pivots to East Boulder River, A_3	59,146	ft^2			D * W, allowed by 17.30.517(d)
Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**	1,674	ft^3/d			allowed by 17.30.517(d)
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), V_3	43,123	ft^3/d	224	gpm (24 hr)	KP 2000c Apdx K, Tables
assumed **total inorganic nitrogen concentration of Mason Ditch**, C_3	0.1	mg/L			assumed equivalent to the average of EBR-007and EBR-008
total inorganic nitrogen concentration in ground water resulting from applied LAD	**0.4**	mg/L	**737**	gpm (24 hr)	projected total inorganic nitrogen concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational total inorganic nitrogen concentration** in ground water for Q_1
total inorganic nitrogen concentration in ground water resulting from liner leakage plus applied LAD	**0.4**	mg/L			projected cumulative total inorganic nitrogen concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational total inorganic nitrogen concentration** in ground water for Q_2
total inorganic nitrogen concentration in ground water at Mason Ditch resultingfrom liner leakage, applied LAD, and Mason Ditch	**0.3**	mg/L			projected cumulative total inorganic nitrogen concentration in ground water beneath the Mason Ditch; this value will be **assumed to equal the operational concentration** of total inorganic nitrogen in **ground water below the Mason Ditch to the East Boulder River**
OPERATIONS total inorganic nitrogen concentration in ground water down-gradient of Mason Ditch, C_d	**0.3**	mg/L			compliance point in ground water; projected cumulative total inorganic nitrogen concentration prior to discharge to the East Boulder River

OPERATIONS The concentration of nitrogen in ground water below the Boe Ranch LAD area from the disposal of 1,726 gpm treated adit water at greater than agronomic rates is projected to be less than the DEQ-7 ground water standard of 10 mg/L total inorganic nitrogen.

receiving streamflow at $7Q_{10}$, Q_s	432,000	ft^3/d	**5.0**	cfs	7Q10 value for East Boulder Mine streamflow, non-irrigation season
receiving streamflow at full irrigation withdrawal, Q_s	172,800	ft^3/d	**2.0**	cfs	7Q10 value for East Boulder Mine streamflow, irrigation season
receiving stream ambient concentration, C_s	0.1	mg/L			KP 2000c, SMC Monitoring Data
ground water discharge volume, Q_d	162,771	ft^3/d	1.9	cfs	ground water discharge volume in cubic feet per second
ground water concentration below Mason Ditch, C_d	0.3	mg/L			projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River
OPERATIONS East Boulder River total inorganic nitrogen concentration **below Boe Ranch LAD at 5 cfs**	**0.1**	mg/L			projected total inorganic nitrogen concentration in East Boulder River at non-irrigation flow
OPERATIONS East Boulder River total inorganic nitrogen concentration **below Boe Ranch LAD at 2 cfs**	**0.2**	mg/L			projected total inorganic nitrogen concentration in East Boulder River during irrigation withdrawals

OPERATIONS The total inorganic nitrogen concentration in the East Boulder River below the Boe Ranch LAD Area at EBR-008 from the disposal of 1,726 gpm treated adit water is projected to be less than 1.0 mg/L.

Alternative 3C total inorganic nitrogen OPERATIONS Option 1, 150 gpm: SMC would route 150 gpm (24 hr) treated adit water to the Boe Ranch LAD storage pond all year. The 150 gpm (24 hr) of treated adit water and 301 gpm (24 hr) of stored treated adit water would be disposed at Boe Ranch LAD at greater than agronomic rates during the 120-day LAD season. No treated adit water disposal would occur at the East Boulder Mine.

Assume the BTS/Anox capacity is 1,000 gpm for 24 hours

Boe Ranch LAD design capacity is 1,486 gpm for 12 hr rate (743 gpm for 24 hr rate)

OPERATIONS *Boe Ranch LAD* Hydraulic Loading

volume in Boe Ranch LAD storage pond; assume 8 months storage of adit water	52	MG
area available for LAD in section 17, all pivots included	166	ac
greater than agronomic land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4	gpm/ac
adit flow rate at closure	**150**	gpm (24 hr)

assume 120 day LAD season and that Boe Ranch LAD storage pond contains 52 MG from previous winter

30	lbs/day	MPDES permit total inorganic nitrogen limit
100	MG	capacity of Boe Ranch LAD storage pond
120	days	time to dewater Boe Ranch LAD storage pond in one season
602	gpm (12 h)	rate to dewater Boe Ranch LAD storage pond in one season
1,726	gpm (12 h)	hydraulic load that can be applied on 166 acres, 9 pivots in Section 17
902	gpm (12 h)	rate of LAD to dispose of adit plus stored water

OPERATIONS *Boe Ranch LAD* During the 120 day LAD season, the (24 hr) hydraulic load of 150 gpm adit water plus 602 gpm (12 hr) rate to dewater stored water in the Boe Ranch LAD storage pond (52 MG) can be managed at Boe Ranch LAD area if 9 pivots are operating on 166 acres at greater than agronomic rates, as is done at Hertzler Ranch LAD.

OPERATIONS *Boe Ranch LAD* Nitrogen Loading Calculations

to minimize redundancy, the aquifer parameters link back to, and are the same as, the above values for Boe Ranch in the spreadsheet

volume of LAD storage pond **liner leakage**, V_2	27	ft^3/d
Q_2=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d
concentration of **total inorganic nitrogen in ambient ground water**; median value from RMW-3a, C_A	0.1	mg/L
Q_1=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d
volume of LAD applied; evaporation factor taken, V_1	121,533	ft^3/d

150	gpm (24 hr)	adit flow rate
0.4	mg/L	treated concentration of adit waters based BTS/Anox average total inorganic nitrogen concentration post treatment (SMC Database 2011)
902	gpm (12 hr)	hydraulic load to be applied on 166 acres, 9 Section 17 pivots
0.14	gpm (24 h)	KP 2000c Apdx K, Tables
		median total inorganic nitrogen concentration at RMW-3a derived from SMC monitoring data
631	gpm (24 h)	evaporation factor applied to hydraulic load to be applied on 166 acres, 9 Section 17 pivots
1,674	ft^3/d	Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**

total inorganic nitrogen concentration in applied LAD adit water; assume 80% post plant total inorganic nitrogen uptake, $\mathbf{C_1}$	0.1	mg/L	43,123	ft^3/d	**volume** of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), $\mathbf{V_3}$
total inorganic nitrogen in LAD storage **pond liner leakage** discharge, $\mathbf{C_2}$	0.4	mg/L	0.1	mg/L	assumed **total inorganic nitrogen concentration of Mason Ditch**, $\mathbf{C_3}$
total inorganic nitrogen concentration in ground water resulting from applied LAD	**0.1**	mg/L			projected total inorganic nitrogen concentration in ground water below the Boe Ranch LAD storage pond; this value will be assumed to equal the operational concentration of total inorganic nitrogen in ground water below the Boe Ranch LAD storage pond
total inorganic nitrogen concentration in ground water resulting from liner leakage plus applied LAD	**0.1**	mg/L			projected total inorganic nitrogen concentration in ground water below the Boe Ranch LAD area; assumed to equal the operational total inorganic nitrogen concentration in ground water for $\mathbf{Q_1}$
total inorganic nitrogen concentration in ground water at Mason Ditch resulting from liner leakage, applied LAD, and Mason Ditch	**0.1**	mg/L			projected cumulative total inorganic nitrogen concentration in ground water beneath the Mason Ditch; this value will be assumed to equal the operational concentration of total inorganic nitrogen in ground water at the Mason Ditch
OPERATIONS total inorganic nitrogen concentration in ground water down-gradient of Mason Ditch, $\mathbf{C_d}$	**0.1**	mg/L			compliance point in ground water; projected cumulative total inorganic nitrogen concentration prior to discharge to the East Boulder River; this value will be assumed to equal the operational concentration of total inorganic nitrogen in ground water below the Mason Ditch to the East Boulder River

OPERATIONS The concentration of nitrogen in ground water below the Boe Ranch LAD area from the disposal of 902 gpm treated adit water at greater than agronomic rates is projected to be less than the DEQ-7 ground water standard of 10 mg/L total inorganic nitrogen.

receiving streamflow at $7Q_{10}$, $\mathbf{Q_s}$	432,000	ft^3/d	5.0	cfs	7Q10 value for East Boulder Mine streamflow, non-irrigation season
receiving streamflow at full irrigation withdrawal, $\mathbf{Q_s}$	172,800	ft^3/d	2.0	cfs	7Q10 value for East Boulder Mine streamflow, irrigation season
receiving stream ambient concentration, $\mathbf{C_s}$	0.1	mg/L			KP 2000 Appx K
ground water discharge volume, $\mathbf{Q_d}$	167,979	ft^3/d	1.9	cfs	ground water discharge volume in cubic feet per second
ground water concentration below Mason Ditch, $\mathbf{C_d}$	0.1	mg/L			projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River
East Boulder River below Boe Ranch total inorganic nitrogen concentration 5.0 cfs, non-irrigation season	**0.1**	mg/L			projected total inorganic nitrogen concentration in East Boulder River at non-irrigation flow
East Boulder River below Boe Ranch total inorganic nitrogen concentration 2.0 cfs, irrigation season	**0.1**	mg/L			projected total inorganic nitrogen concentration in East Boulder River during irrigation withdrawals

OPERATIONS The nitrogen concentration in the East Boulder River below the Boe Ranch LAD Area at EBR-008 from the disposal of 902 gpm treated adit water is projected to be less than 1.0 mg/L.

CLOSURE CALCULATIONS

Agency-Mitigated Alternative 3C CLOSURE Option 1, 737 gpm: At closure, SMC would treat 737 gpm adit water and 263 gpm tailings waters in the BTS. The closure time frame would be 18 months. *Days 1-120:* SMC would maximize disposal of 284 gpm treated adit and tailings waters at the Boe Ranch LAD area at greater than agronomic rates. SMC would dispose of the remaining 716 gpm at the East Boulder Mine. LAD Area 6 would receive 293 gpm and the excess 423 gpm would be routed to the East Boulder Mine percolation pond during the first 120 day summer LAD season in the 18 month closure period.
***Days 121-365:* After day 120, the tailings impoundment would be closed and only 737 gpm of treated adit water would need disposal during the rest of the 18-month closure period. From days 121-365, up to 284 gpm would be routed to the Boe Ranch LAD storage pond, and 453 gpm would be disposed at the East Boulder MIne percolation pond.**
***Days 366-548:* During the second year 120 day LAD season, 284 gpm would be routed and disposed at greater than agronomic rates with 579 gpm stored waters in the Boe Ranch LAD storage pond. After the second year LAD season, all 737 gpm of treated adit water would be disposed at the East Boulder Mine percolation pond.**

CLOSURE *Boe Ranch LAD* hydraulic loading *Days 1-120*

***Days 1-120:* Disposal of 284 gpm treated adit and tailings waters with 579 gpm stored treated adit water at the Boe Ranch LAD; disposal of 293 gpm at the East Boulder Mine LAD Area 6, and 423 gpm at the percolation pond; no winter LAD disposal would occur at East Boulder Mine.**

greater than agronomic land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4	gpm/ac	1,726	gpm (12 h)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days on 166 acres, using 9 pivots in Section 17
assumed Boe Ranch **LAD storage pond volume Day 1 of closure**	100	MG	**93**	MG	East Boulder **tailings waters volume** (KP 87; SMC 93)
rate to dewater Boe Ranch LAD storage pond in one LAD season	**579**	gpm (24 hr)	1,157	gpm (12 h)	rate to **dewater Boe Ranch LAD storage pond** in one season
adit flow rate during closure	**737**	gpm (24 hr)	569	gpm (12 h)	**LAD capacity available** at Boe Ranch LAD **for adit plus tailings water** after dewatering Boe Ranch LAD storage pond
East Boulder tailings pumping rate at closure; fixed by nitrogen load in MPDES permit with disposal by percolation and LAD	**263**	gpm (24 hr)	47.8	mg/L	untreated total inorganic nitrogen concentration of tailings waters (SMC 2011)
nitrogen concentration of treated adit waters	0.4	mg/L	3.8	mg/L	Current BTS/Anox end of pipe treatment efficiency of **92%** for tailings water
time to dewater the East Boulder tailings impoundment	**246**	days	1.3	mg/L	total inorganic nitrogen concentration of mixed treated adit plus tailings waters (weighted average)
hydraulic capacity available at East Boulder Mine at **LAD Area 6**	293	gpm (24 hr)	1,105	gpm (24 h)	capacity of East Boulder Mine percolation pond (MPDES permit Statement of Basis)
excess adit and tailings waters that must be **percolated** at East Boulder Mine	423	gpm (24 hr)	**716**	gpm (24 h)	**excess** water that must be **managed at East Boulder Mine** using percolation and LAD

CLOSURE *Boe Ranch LAD* hydraulic loading *Days 121-365*

***Days 121-246:* Of the 737 gpm treated adit water, 284 gpm would be routed to the Boe Ranch LAD storage pond and 716 gpm would be routed to the East Boulder Mine percolation pond; Days 247 - 365: 284 gpm would be routed to the Boe Ranch LAD storage pond and 453 gpm would be routed to the East Boulder Mine percolation pond.**

volume of water routed to **Boe Ranch LAD year round**	284	gpm (24 hr)	48	MG	assumed East Boulder **tailings waters volume Day 121**
volume of adit and tailings waters that must be **percolated at East Boulder Mine until tailings impoundment is dewatered Day 246**	311	gpm (24 hr)	0	MG	assumed East Boulder **tailings waters volume Day 246**
volume of **adit** waters that must be **percolated at East Boulder Mine after** East Boulder tailings impoundment is dewatered from **Day 247**	453	gpm (24 hr)	0	MG	assumed **Boe Ranch LAD storage pond** volume **Day 121**

CLOSURE *Boe Ranch LAD* hydraulic loading *Days 366-486*

***Days 366-486:* Second 120-day LAD season, 284 gpm would be routed and disposed of at greater than agronomic rates with 579 gpm stored waters at the Boe Ranch LAD Area. Excess treated adit waters would be percolated at the East Boulder Mine percolation pond.**

Boe Ranch **LAD storage pond volume day 366 assumed full at start of second LAD season Day 366**	100	MG	863	gpm (24 h)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days on 166 acres, using 9 pivots in Section 17
rate to **dewater Boe Ranch LAD storage pond** in one 120-day season	579	gpm (24 hr)	284	gpm (24 hr)	volume of **treated adit** water routed to **Boe Ranch LAD year round**
excess treated adit water that must be **percolated** at East Boulder Mine	453	gpm (24 hr)	0	MG	assumed **Boe Ranch LAD storage pond** volume **Day 487**

CLOSURE *Boe Ranch LAD* hydraulic loading *Days 487-548*

***Days 487-548:* After the second LAD season, Boe Ranch would be closed and all 737 gpm treated adit water would be routed to the East Boulder Mine percolation pond.**

treated adit water that must be **percolated** at East Boulder Mine	**737**	gpm (24 hr)	0	MG	East Boulder **tailings waters volume**

The hydraulic load of 737 gpm plus 174 gpm tailings waters can be managed at the East Boulder Mine and the Boe Ranch LAD area under Option 1, 737 gpm.

CLOSURE *East Boulder Mine* nitrogen loading Days 1-120			***Days 1-120:* Disposal of 293 gpm treated adit and tailings waters at the East Boulder Mine LAD Area 6, and 423 gpm treated adit and tailings waters at the percolation pond; no winter LAD disposal would occur at East Boulder Mine.**		
Days 1-120 total inorganic nitrogen load at LAD Area 6	**0.9**	lbs/day	0.4	mg/L	total inorganic nitrogen concentration of **treated adit** water based on BTS/Anox system capabilities
Days 1-120 percolation total inorganic nitrogen load at East Boulder Mine	**6.6**	lbs/day	3.8	mg/L	total inorganic nitrogen concentration of **treated tailings** waters based on 92% nitrogen removal by BTS/Anox system
Days 1-120 LAD Area 6 plus percolation total inorganic nitrogen load at East Boulder Mine	**7.5**	lbs/day	1.3	mg/L	total inorganic nitrogen concentration of **mixed treated adit plus tailings** waters (weighted average)
CLOSURE Days 1-120 *East Boulder Mine:* The nitrogen load from disposal of 293 gpm treated adit and tailings waters at the LAD Area 6 and percolation of 334 gpm treated adit and tailings waters at the percolation pond are less than the 30 lbs/day MPDES permit limit.					
CLOSURE *Boe Ranch LAD* nitrogen loading Days 1-120			***Days 1-120:* Disposal of 284 gpm treated adit and tailings waters with 579 gpm stored treated adit water at the Boe Ranch LAD so storage pond would be emptied by the end of the 120-day LAD season; excess waters would be disposed at the East Boulder Mine. (All aquifer and hydraulic parameters from above).**		
volume of water applied at **Boe Ranch LAD**	**863**	gpm (24 hr)	**737**	gpm (24 hr)	adit flow rate at closure
volume of LAD storage pond **liner leakage**, $\mathbf{V_2}$	27	ft^3/d	**0.4**	mg/L	**737 gpm** adit flow **assumed OPERATIONS total inorganic nitrogen concentration** for ground water in $\mathbf{Q_2}$
$\mathbf{Q_2}$=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d	**0.4**	mg/L	**737 gpm** adit flow **assumed OPERATIONS total inorganic nitrogen concentration** for ground water in $\mathbf{Q_1}$
upgradient concentration of **total inorganic nitrogen in ambient ground water**; median value from RMW-3a, $\mathbf{C_A}$	0.1	mg/L	**0.4**	mg/L	**total inorganic nitrogen concentration in applied LAD**; assume 80% post plant total inorganic nitrogen uptake, $\mathbf{C_1}$
$\mathbf{Q_1}$=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d	**0.4**	mg/L	concentration of total inorganic nitrogen in Boe Ranch LAD storage pond at beginning of closure, $\mathbf{C_2}$
volume of LAD applied; evaporation factor applied to hydraulic load to be applied on 166 acres, 9 Section 17 pivots, $\mathbf{V_1}$	116,324	ft^3/d	**1.0**	mg/L	**weighted average** concentration of total inorganic nitrogen in Boe Ranch LAD storage pond after mixing with tailings waters
$\mathbf{Q_3}$=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**	1,674	ft^3/d	0.3	mg/L	**assumed operational total inorganic nitrogen concentration** for ground water in Q_3
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), $\mathbf{V_3}$	43,123	ft^3/d	0.1	mg/L	assumed **total inorganic nitrogen concentration of Mason Ditch**, $\mathbf{C_3}$
total inorganic nitrogen concentration in ground water resulting from **applied LAD**	0.4	mg/L	**9.7**	lbs/ac/year	**CLOSURE *Boe Ranch LAD* nitrogen load days 1-120**
total inorganic nitrogen concentration in ground water resulting from **liner leakage plus applied LAD**	0.4	mg/L	**1,617**	lbs/yr	**CLOSURE *Boe Ranch LAD* total nitrogen load days 1-120**
total inorganic nitrogen concentration in ground water at Mason Ditch resulting from **liner leakage, applied LAD, and Mason Ditch**	0.3	mg/L			projected cumulative nitrogen ground water concentration using operational ground water values
CLOSURE total inorganic nitrogen concentration in ground water **downgradient of Mason Ditch**, $\mathbf{C_d}$	**0.3**	mg/L			projected cumulative nitrogen ground water concentration using operational ground water values
CLOSURE Days 1-120 ground water at the Boe Ranch LAD: The nitrogen concentration in ground water at the Boe Ranch LAD from the disposal of 1,726 gpm (12 hr) treated adit and tailings waters is projected to be less than the DEQ-7 ground water standard of 10 mg/L.					
receiving streamflow, $\mathbf{Q_s}$	432,000	ft^3/d	5.0	cfs	7Q10 value for East Boulder Mine streamflow, non-irrigation season
receiving streamflow, $\mathbf{Q_s}$	172,800	ft^3/d	2.0	cfs	7Q10 value for East Boulder Mine streamflow, irrigation season
receiving stream ambient concentration, $\mathbf{C_s}$	0.1	mg/L			KP 2000 Appx K
ground water discharge volume, $\mathbf{Q_d}$	129,450	ft^3/d	1.5	cfs	ground water discharge volume in cubic feet per second

ground water concentration below Mason Ditch, $\mathbf{C_d}$	0.3 mg/L	projected total inorganic nitrogen concentration in ground water just prior to discharge to East Boulder River
CLOSURE East Boulder River total inorganic nitrogen concentration at **5 cfs flow**	**0.1** mg/L	projected total inorganic nitrogen concentration in East Boulder River at non-irrigation flow
CLOSURE East Boulder River total inorganic nitrogen concentration at **2 cfs flow (irrigation season)**	**0.2** mg/L	projected total inorganic nitrogen concentration in East Boulder River during irrigation withdrawals

CLOSURE *Boe Ranch LAD* days 1-120*:* The nitrogen concentration in surface water downstream of the Boe Ranch LAD from the disposal of 1,726 gpm (12 hr) treated adit and tailings waters in the East Boulder River is projected to be less than 1.0 mg/L.

CLOSURE *East Boulder Mine* nitrogen loading calculations Days 121-246		**CLOSURE *East Boulder Mine* nitrogen loading calculations Days 247 - 365**	
CLOSURE Days 121-365 **percolation** total inorganic nitrogen load at East Boulder Mine	**4.8** lbs/day	**2.2** lbs/day	CLOSURE Days 247-365 **percolation** total inorganic nitrogen load at East Boulder Mine
CLOSURE *East Boulder Mine* nitrogen loading calculations Days 366-486		***Days 121-246:* Percolation of 311 gpm treated adit plus tailings waters at the Mine. *Days 247 - 365:* The tailings impoundment would be empty. Percolation of 453 gpm treated adit waters. *Days 366-486:* Second 120-day LAD season, treated adit water would be routed to and disposed of at greater than agronomic rates with 579 gpm stored waters at the Boe Ranch LAD Area. The 453 gpm of excess treated adit waters would be percolated at the East Boulder Mine percolation pond.**	
CLOSURE Days 366-486 **percolation** total inorganic nitrogen load at East Boulder Mine	**2.2** lbs/day		

CLOSURE *East Boulder Mine* Days 121 -365, and 366 - 486: The nitrogen load from percolation of 453 gpm treated adit and tailings waters at the percolation pond are less than the 30 lbs/day MPDES permit limit.

CLOSURE *Boe Ranch LAD* nitrogen loading calculations Days 366-486			***Days 366-486:*** **Second 120-day LAD season, 284 gpm would be routed and disposed at greater than agronomic rates with 579 gpm stored waters at the Boe Ranch LAD Area. The 453 gpm of excess treated adit waters would be percolated at the East Boulder Mine percolation pond. *(above values***		
total inorganic nitrogen concentration **in ground water** resulting from **applied LAD**	0.1	mg/L	**0.1**	mg/L	**total inorganic nitrogen concentration in applied LAD** adit water; assume 80% post plant total inorganic nitrogen uptake, $\mathbf{C_1}$
total inorganic nitrogen concentration in **ground water** resulting from **liner leakage plus applied LAD**	0.1	mg/L	162,771	ft^3/d	ground water discharge volume in cubic feet per day
total inorganic nitrogen concentration in **ground water at Mason Ditch** resulting from liner leakage, applied LAD, and Mason Ditch	0.1	mg/L	1.9	cfs	ground water discharge volume in cubic feet per second
CLOSURE total inorganic nitrogen concentration in **ground water downgradient of Mason Ditch,** $\mathbf{C_d}$	**0.1**	mg/L	**9.7**	lbs/ac/year	**CLOSURE *Boe Ranch LAD* per acre nitrogen load days 366-486**
CLOSURE East Boulder River total inorganic nitrogen concentration **below Boe Ranch LAD at 5 cfs flow (non-irrigation)**	**0.1**	mg/L	**1,617**	lbs/yr	**CLOSURE *Boe Ranch LAD* nitrogen load days 366-486**
CLOSURE East Boulder River total inorganic nitrogen concentration below Boe Ranch LAD at **2 cfs flow (irrigation season)**	**0.1**	mg/L	**3,233**	lbs/yr	**CLOSURE *Boe Ranch LAD* Total nitrogen load days 1-486**
CLOSURE *Boe Ranch LAD* Total nitrogen load to ground water during closure, Days 1-486	**604**	lbs/18-mos	Projected total inorganic nitrogen load for two LAD seasons		
CLOSURE *Boe Ranch LAD* Days 366-486: The nitrogen concentration in ground water from the disposal of 863 gpm (24 hr) treated stored adit water is projected to be less than the DEQ-7 ground water standard					
CLOSURE *East Boulder Mine* nitrogen loading calculations Days 487-548			***Days 487-548:*** **After the second LAD season, all 737 gpm treated adit water would be routed to the East Boulder Mine percolation pond**		
CLOSURE daily nitrogen load from **percolation** Days 487-548	**3.5**	lbs/day	**0.4**	mg/L	total inorganic nitrogen concentration of treated adit water
CLOSURE East Boulder Mine Total nitrogen load to ground water from percolation Days 1-548	**2,994**	lbs/18-mos	**110**	lbs/18-mos	**CLOSURE *East Boulder Mine* Total nitrogen load from LAD Days 1 - 548**
CLOSURE *East Boulder Mine* Days 487-548: The nitrogen load from percolation of 737 gpm treated adit waters at the percolation pond are less than the 30 lbs/day MPDES permit limit.					

Agency-Mitigated Alternative 3C CLOSURE Option 1, 150 gpm: SMC would treat 562 gpm (150 gpm adit water and 412 gpm of tailings waters) at closure to reserve hydraulic capacity to empty the East Boulder Mine tailings impoundment in 157 days. The Boe Ranch LAD storage pond would contain 52 MG of treated adit waters on the first day of the 120-day LAD season. To empty the Boe Ranch LAD storage pond during the 120-day LAD season, SMC would maximize treated adit and tailings waters disposal at greater than agronomic rates. After the 120-day LAD season, 150 gpm of treated adit water (plus 412 gpm of treated tailings waters through day 157) would be routed to the Boe Ranch LAD storage pond for disposal during the second LAD season in the 18-month closure period. Up to 150 gpm treated adit water would be disposed at East Boulder Mine days 487 to 548.

CLOSURE *Boe Ranch LAD* Hydraulic Loading Days 1-486			**CLOSURE: First LAD Season: Days 1-120, disposal of 412 gpm treated adit and tailings waters with 301 gpm stored treated adit waters would occur at the Boe Ranch LAD. Days 158-365, storage of 150 gpm (24 hr) would occur at the Boe Ranch LAD storage pond until the second LAD season. The second LAD season would occur Days 366-486, and treated adit and stored waters would be disposed at Boe Ranch LAD. Beginning on day 487, the Boe Ranch LAD would be decommissioned and all remaining treated adit water would be disposed at the East Boulder Mine percolation pond.**		
volume in LAD storage pond, assume 8 months stored at 150 gpm	**52**	MG	**120**	days	time to dewater the **LAD storage pond**
Days 1-120 rate to empty **LAD storage pond**	**301**	gpm (24 hr)	602	gpm (12 hr)	**LAD storage pond** dewatering rate
Days 1-157 rate to dewater **East Boulder tailings impoundment** to maximize hydraulic load at the Boe Ranch LAD	**412**	gpm (24 hr)	825	gpm (12 hr)	East Boulder **tailings impoundment** dewatering rate
Days 1-548 adit flow rate at closure	**150**	gpm (24 hr)	300	gpm (12 hr)	**adit** flow rate
total pumping rate to dispose of all treated mine waters during 120 day LAD season	863	gpm (24 hr)	**1,726**	gpm (12 hr)	**total rate** of all treated mine waters needing disposal during 120 day LAD season
volume of the East Boulder Tailings impoundment waters needing disposal	**93**	MG	863	gpm (24 hr)	**total rate** of all treated mine waters needing disposal during 120 day LAD season

area available for LAD in section 17, all pivots included	166	ac	157	days	number of days to dewater **East Boulder tailings impoundment** at above rate
greater than agronomic land application rate	10.4	gpm/ac	**1,726**	gpm (12 hr)	hydraulic load that can be applied
rate that **adit** water is routed to the **Boe Ranch LAD storage pond** days 1-486	150	gpm (24 hr)	150	gpm (24 hr)	rate of disposal at East Boulder Mine during **days 487-548** of closure

Days 1-120: The hydraulic load of 150 gpm (24 hr) treated adit water plus 286 gpm (24 hr) treated tailings waters and 301 gpm (24 hr) Boe Ranch LAD stored waters can be managed at Boe Ranch LAD in one 120 day LAD season without managing any waters at the East Boulder Mine. Days 121-365: The hydraulic load of 150 gpm (24 hr) treated adit water can be stored at the Boe Ranch LAD over the first fall, winter, and spring for disposal during days 366-486. After day 486, the 150 gpm (24 hr) would be percolated at the East Boulder Mine.

CLOSURE *Boe Ranch LAD* nitrogen loading calculations Days 1-120

First LAD Season: Days 1-120, disposal of 562 gpm (24 hr) treated adit and tailings waters with 301 gpm stored treated adit water would occur at the Boe Ranch LAD.

adit flow rate at closure (24 hr rate)	**150**	gpm	0.4	mg/L	treated concentration of **adit waters** based on historical maximum nitrogen load; Days 1-548
weighted average concentration of **treated adit, storage pond, and tailings waters** days 1-120	2.2	mg/L	**3.8**	mg/L	concentration of treated tailings waters based on 92% total inorganic nitrogen removal by BTS/Anox
Days 1-157 rate to dewater **East Boulder tailings impoundment**	**412**	gpm (24 hr)	**2.9**	mg/L	weighted average of **treated adit plus tailings waters** days 1-97
volume in Boe Ranch LAD storage pond on day **120** if water is applied at greater than agronomic rate listed above	0.0	MG			Boe Ranch LAD pond is dewatered at the end of the first LAD season
volume of LAD storage pond **liner leakage**, $\mathbf{V_2}$	27	ft^3/d			
$\mathbf{Q_2}$=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d	0.1	mg/L	**assumed operational total inorganic nitrogen concentration** for ground water in $\mathbf{Q_2}$
concentration of **total inorganic nitrogen in ambient ground water**; median value from RMW-3a, $\mathbf{C_A}$	0.1	mg/L			at closure, this concentration is assumed to be present only in ground water entering the LAD
$\mathbf{Q_1}$=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d	0.1	mg/L	**assumed operational total inorganic nitrogen concentration** for ground water in $\mathbf{Q_1}$
volume of LAD applied; evaporation factor taken, $\mathbf{V_1}$	116,324	ft^3/d	604	gpm (24 hr)	evaporation factor applied; hydraulic load to be applied on 166 acres, 9 Section
total inorganic nitrogen concentration in applied LAD adit water; assume 80% post plant total inorganic nitrogen uptake, $\mathbf{C_1}$	**0.6**	ft^3/d			concentration of total inorganic nitrogen in Boe Ranch LAD storage pond at beginning of closure

Appendix E
DEQ 2012

weighted average total inorganic nitrogen in LAD storage **pond liner leakage** discharge days 1-120, C_2	**2.2**	mg/L			weighted average concentration of total inorganic nitrogen in Boe Ranch LAD storage pond after mixing with tailings waters for the 120-day season
Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East**	1,674	ft^3/d	0.1	mg/L	**assumed operational total inorganic nitrogen concentration** for ground water
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), V_3	43,123	ft^3/d			
assumed **total inorganic nitrogen concentration of Mason Ditch**, C_3	0.1	mg/L			assumed equivalent to the average of EBR-007and EBR-008
total inorganic nitrogen concentration in ground water resulting from **applied LAD**	0.6	mg/L			projected nitrogen concentration using operational ground water values
total inorganic nitrogen concentration in ground water resulting from **liner leakage plus applied LAD**	0.6	mg/L			projected cumulative nitrogen ground water concentration using operational ground water values
total inorganic nitrogen concentration in ground water at Mason Ditch resulting from **liner leakage, applied LAD, and Mason Ditch**	0.5	mg/L			projected cumulative nitrogen ground water concentration using operational ground water values
CLOSURE total inorganic nitrogen concentration in ground water **downgradient of Mason Ditch, C_d**	**0.5**	mg/L			projected cumulative nitrogen ground water concentration using operational ground water values

CLOSURE Days 1-120 ground water at the *Boe Ranch LAD* : The nitrogen concentration in ground water downstream of the Boe Ranch LAD from the disposal of 1,726 gpm (12 hr) treated adit and tailings waters is projected to be less than the DEQ-7 standard of 10 mg/L.

receiving streamflow non-irrigation season, Q_s	432,000	ft^3/d	5.0	cfs	7Q10 value for East Boulder Mine streamflow non-irrigation season
receiving streamflow irrigation season, Q_s	172,800	ft^3/d	2.0	cfs	7Q10 value for East Boulder Mine streamflow irrigation season
receiving stream ambient concentration, C_s	0.1	mg/L			KP 2000 Appx K
aquifer discharge volume, Q_d	162,771	ft^3/d	1.9	cfs	ground water discharge in cubic feet per second
aquifer concentration below Mason Ditch, C_d	0.5	mg/L			total inorganic nitrogen concentration in aquifer just prior to discharge to East Boulder River
East Boulder River total inorganic nitrogen concentration non-irrigation season (5.0 cfs)	**0.2**	mg/L			projected total inorganic nitrogen concentration in East Boulder River at non-irrigation flow
East Boulder River total inorganic nitrogen concentration irrigation season (2.0 cfs)	**0.3**	mg/L			projected total inorganic nitrogen concentration in East Boulder River during irrigation withdrawals

CLOSURE Days 1-120 surface water at the Boe Ranch LAD: The nitrogen concentration in surface water downstream of the Boe Ranch LAD from the disposal of 1,726 gpm (12 hr) treated adit and tailings waters in the East Boulder River is projected to be less than 1.0 mg/L.

CLOSURE *Boe Ranch LAD* nitrogen loading calculations Days 121-365					**During days 121-365 no disposal of treated adit water would occur; it would be stored at the Boe Ranch LAD storage pond.**
CLOSURE *Boe Ranch LAD* nitrogen loading calculations Days 366-486					**During the second LAD season, days 366-486, 150 gpm of treated adit water plus 301 gpm of treated stored water would be disposed at Boe Ranch LAD at greater than agronomic rates. No treated adit water disposal would occur at the East Boulder Mine.**
weighted average total inorganic nitrogen in LAD storage **pond liner leakage** discharge, C_2	**0.4**	mg/L	**0.1**	mg/L	**total inorganic nitrogen concentration in applied LAD** adit water; assume 80% post plant total inorganic nitrogen uptake, C_1
CLOSURE total inorganic nitrogen concentration in ground water down-gradient of Mason Ditch, C_d	**0.1**	mg/L	86,809	ft^3/d	volume of ground water discharged in cubic feet per day from 451 gpm LAD
East Boulder River below Boe Ranch total inorganic nitrogen concentration 5.0 cfs, non-irrigation season	**0.1**	mg/L			projected total inorganic nitrogen concentration in East Boulder River at non-irrigation flow
East Boulder River below Boe Ranch total inorganic nitrogen concentration 2.0 cfs, irrigation season	**0.1**	mg/L			projected total inorganic nitrogen concentration in East Boulder River during irrigation withdrawals
CLOSURE *Boe Ranch LAD* Total nitrogen load to ground water during closure Days 1-486	**642**	lbs/18-mos			
CLOSURE *Boe Ranch LAD* nitrogen load Days 487-548					**During days 487 - 548, no water would be disposed at the Boe Ranch LAD.**
CLOSURE *East Boulder Mine* nitrogen load to ground water Days 487-548					**Days 487 - 548: Up to 150 gpm treated adit water would be percolated at the East Boulder Mine.**
CLOSURE Days 487-548 percolation total inorganic nitrogen load at East Boulder Mine	**0.7**	lbs/day	**0.4**	mg/L	total inorganic nitrogen concentration of treated adit water
CLOSURE Total total inorganic nitrogen load to ground water disposed at East Boulder Mine during closure days 486-548	**45**	lbs/18-mos			

CLOSURE Days 487-548 at the *East Boulder Mine*: The nitrogen load from percolation of 150 gpm treated adit and tailings waters at the percolation pond are less than the 30 lbs/day East Bouler Mine MPDES permit limit.

Spreadsheet 3C Salts: *Revised* Agency-Mitigated Alternative 3C Boe Ranch LAD System Operations and Closure Salinity Analyses

Per KP 2000c, if the Boe Ranch LAD were constructed it would be the agencies' preferred disposal option for treated adit water during operations and for treated adit plus tailings waters during the first eighteen months of closure. The East Boulder Mine percolation pond would be used for contingency disposal of treated adit water during operations. Monitoring well RMW-3A is located at the Boe Ranch downgradient of the proposed LAD and is considered to represent ambient electrical conductivity (EC) values. Based on EC measurements at RMW-3A, the average EC of ground water at Boe Ranch is 1,025 µmhos/cm having a Class II Beneficial Use with an electrical conductivity criteria between 1,000 to 2,500 µSiemens/cm (equivalent to µmhos/cm). The measured median total dissolved salts (TDS) concentration of the ground water is 721 mg/L. For this analysis, the agencies calculated the TDS concentration from the EC of ground water. Ambient median salts concentrations in the East Boulder River up- and downstream of the Boe Ranch are 186 mg/L TDS at EBR-007 and 290

mg/L at EBR-008, respectively. At closure, adit and East Boulder tailings waters would be treated for nitrogen through the BTS/Anox system then preferentially routed to Boe Ranch LAD storage pond and disposed of through LAD pivots during the summer LAD season. For the Boe Ranch LAD calculations have been made according to the regulatory requirements of the Montana Water Quality Act and Rules and Federal Clean Water Act regarding surface and ground water mixing zones. No dilution from precipitation (recharge) was assumed. For the Boe Ranch LAD any water that percolates below the root zone is assumed to immediately enter the aquifer. The Boe Ranch LAD area would not have an MPDES permit. Salts are not treated in the BTS/Anox system or during LAD, so all concentrations of salt are expected to flush through the soil column/unsaturated zone to ground water. Ground water flows beneath the LAD area and LAD storage pond, flows downgradient where it is recharged by the Mason Ditch, then discharges to the East Boulder River. These calculations assume that during operations, treated adit waters are routed to the Boe Ranch LAD storage pond. PoleCat evaporators accomplish summer 30% evaporation, center pivots 30%; PoleCat winter snowmaking 30% evap-

oration up slope of the lined LAD storage pond. At closure, treated adit and tailings waters would be routed to the Boe Ranch LAD storage pond which would hold up to 100 MG of adit waters, and mixing of these waters occurs prior to disposal at the LAD pivots. A weighted average was used to determine the concentration of salts in the mixed LAD storage pond water. The East Boulder Mine MPDES permit sets no total dissolved solids (TDS) or electrical conductivity (EC) limits. Median adit and tailings TDS concentrations were used in these calculations. Salts loading is calculated using TDS concentrations. These calculations assume that there will be a leak in the Boe Ranch LAD storage pond, and the liner leakage, applied LAD, and Mason Ditch waters contribute to ground water quality prior to discharge into the East Boulder River. It is assumed that 9 of the 10 proposed Boe Ranch LAD center pivots on 166 acres will be developed for use during operations and closure. Only 50 percent of pivots 4 and 9 were used to address concerns regarding mass wasting. The spreadsheet has been edited to account for updated volumes, concentrations, and timeframes. All edited cells are highlighted in mauve; changed text is highlighted in blue; all anchor cells that carry through the spreadsheet are highlighted in green.

OPERATIONS CALCULATIONS

Alternative 3C Operations Option 1, 737 gpm: SMC would route 284 gpm treated adit water to the Boe Ranch LAD storage pond during the entire year. Treated adit water stored in the Boe Ranch LAD storage pond over fall, winter, and early spring, would be disposed during the Boe Ranch LAD season. During the 120-day LAD season the 284 gpm treated adit water would be disposed with up to 579 gpm stored treated adit water on the 166-acre Boe Ranch LAD area at greater than agronomic rates (10.4 gpm/acre) to prevent salts build-up in the soil. The excess 453 gpm of treated adit water would be disposed at the East Boulder Mine during the entire year. During the LAD season at the mine, 293 gpm would be disposed at the East Boulder Mine LAD Area 6 and 160 gpm at the East Boulder Mine percolation pond. During snowmaking season, 205 gpm could be disposed at the East Boulder Mine LAD Area 6 and 248 gpm at the percolation pond. The rest of the year, 453 gpm treated adit water would be disposed at the East Boulder Mine percolation pond.

1 ppm TDS = 1.56 µmhos/cm — 120 days length of LAD season

OPERATIONS *Boe Ranch LAD* Hydraulic Loading Calculations			OPERATIONS: assume Boe Ranch LAD storage pond is full on the first day of the LAD season		
area available for LAD in section 17, **not all pivots** included (prevent mass wasting issues)	166	ac	**1,726**	gpm (12 hr)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days on 166 acres
greater than agronomic land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4	gpm/ac	569	gpm (12 hr)	**LAD capacity available** at Boe Ranch LAD **for adit water** after dewatering Boe Ranch LAD storage pond
assumed volume in Boe Ranch LAD storage pond	**100**	MG	**1,157**	gpm (12 hr)	rate to dewater Boe Ranch LAD storage pond in one 120-day season
adit flow rate during operations	**737**	gpm (24 hr)	1,474	gpm (12 hr)	adit flow rate during operations
adit flow rate that must be managed at **East Boulder Mine**	**453**	gpm (24 hr)	905	gpm (12 hr)	**adit** flow rate that must be **managed at East Boulder Mine**
summer hydraulic capacity available at East Boulder Mine at **LAD Area 6**	293	gpm (24 hr)	115	days	time to fill Boe Ranch LAD storage pond with adit water after 120 day LAD season
winter hydraulic capacity available at East Boulder Mine at **LAD Area 6**	205	gpm (24 hr)	1,105	gpm (24 hr)	capacity of East Boulder Mine percolation pond (MPDES permit Statement of Basis)
summer excess adit flow rate that must be **percolated** at East Boulder Mine	**160**	gpm (24 hr)	**248**	gpm (24 hr)	**winter** excess adit flow rate that must be **percolated** at East Boulder Mine

volume of water routed to **Boe Ranch LAD year round**	**284**	gpm (24 hr)	569	gpm (12 hr)	volume of water routed to **Boe Ranch LAD year round**

OPERATIONS During the 120 day LAD season, the hydraulic load of 284 gpm treated adit water plus 579 gpm treated stored water can be managed at Boe Ranch LAD area if seven pivots are operating at greater than agronomic rates as is done at the Hertzler Ranch LAD area. The excess water 453 gpm would be disposed at the East Boulder Mine LAD Area 6 and percolation pond.

OPERATIONS *East Boulder Mine* Mixing Zone Salinity Calculations

OPERATIONS The aquifer at the East Boulder Mine has a Class I Beneficial Use.

East Boulder Source-Specific percolation pond mixing zone imputs

These data inputs are carried through below, but not repeated to reduce redundancy

			160	gpm (24 hr)	adit water percolated at East Boulder Mine percolation pond in **summer**
			248	gpm (24 hr)	adit water percolated at East Boulder Mine percolation pond in **winter**
depth of aquifer, **D**	80	ft			MPDES Statement of Basis, p. 25-26; not used in calculations
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft			MPDES Statement of Basis, p. 25-26
width of source	385	ft			MPDES Statement of Basis, p. 25-26
length from percolation pond to wells, $\mathbf{L_1}$	3600	ft			MPDES Statement of Basis, p. 25-26
porosity, ϕ	0.3				MPDES Statement of Basis, p. 25-26
ground water velocity, **v**	6.5	ft/d			MPDES Statement of Basis, p. 25-26
volume of ground water flux available for mixing from MODFLOW	77,005	ft^3/d	400	gpm	MPDES Statement of Basis, p. 25-26
ambient concentration of TDS in ground water (median at WW-1 is 106; EBMW-6 operational concentration is 515), $\mathbf{C_A}$	515	mg/L	803	µmhos/cm	CES 2008 Apdx D, EBoulder Mine TDS Table p 2, central value
angle of dispersion	0.087421693	tan 5°	10.2	ac	area of East Boulder Mine LAD Area 6
width of mixing zone, $\mathbf{W_1}$	700	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_1}$	55,977	ft^2			D * W, allowed by 17.30.517(d)
70% volume of ground water available for mixing $\mathbf{Q_1}$=kiA_1	76,409	ft^3/d			MPDES Statement of Basis, p.25-26
Volume of adit water percolated in summer, $\mathbf{V_{pS}}$	30,707	ft^3/d	**2.0**	cfs	Projected flowrate of the East Boulder River below Boe Ranch after irrigation withdrawals
Volume of adit water percolated in winter, $\mathbf{V_{pW}}$	47,648	ft^3/d	172,800	ft^3/d	Projected flowrate of the East Boulder River below Boe Ranch after irrigation withdrawals
depth of aquifer, $\mathbf{D_2}$	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	75	ft/d			MPDES Statement of Basis, p. 25-26
gradient, **i**	0.026	ft/ft	**85,070**	lbs/ac/yr	**OPERATIONS *East Boulder Mine* LAD Area 6 Salts Load**
width of source	700	ft	**138,960**	lbs/yr	**OPERATIONS *East Boulder Mine* Percolation Pond Summer Salts Load**
length from perc pond to river, $\mathbf{L_2}$	2,900	ft	**215,625**	lbs/yr	**OPERATIONS *East Boulder Mine* Percolation Pond Winter Salts Load**
angle of dispersion	0.08742169	tan 5°	**394,221**	lbs/yr	**OPERATIONS *East Boulder Mine* Percolation Pond Non-LAD Season Salts Load**
width of zone, $\mathbf{W_2}$	954	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
area of mixing zone, $\mathbf{A_2}$	14,303	ft^2			D * W, allowed by 17.30.517(d)
Volume of ground water available for mixing $\mathbf{Q_2}$=kiA	27,891	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d)
volume of adit water land applied in summer, $\mathbf{V_{2S}}$	39,484	ft^3/d	205	gpm (12 hr)	capacity of East Boulder LAD Area 6 in summer, evaporation credit taken
volume of adit water land applied in winter, $\mathbf{V_{2W}}$	27,626	ft^3/d	144	gpm (12 hr)	capacity of East Boulder LAD Area 6 in winter, evaporation credit taken
median concentration of salt in adit water (SMC database 2011), $\mathbf{C_1}$	**605**	mg/L	**864**	mg/L	effective concentration of salt in land applied waters
receiving stream ambient concentration at EBR-001, $\mathbf{Q_c}$	**49**	mg/L	76	µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)

receiving streamflow, Q_s	423,000	ft^3/d	5.0	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis page 4
OPERATIONS ***East Boulder Mine*** **Summer Salinity Calculations**			**OPERATIONS Summer: Percolation of 160 gpm (24 hr) at East Boulder Mine and 293 gpm (24 hr) at LAD at Area 6**		
salts concentration in ground water *East Boulder Mine*	610	mg/L	**951**	µmhos/cm	projected summer salts concentration in ground water near SP-11
salts concentration in East Boulder River *below East Boulder Mine*	**205**	mg/L	319	µmhos/cm	projected summer salts concentration in surface water near EBR-004/EBR-004A
OPERATIONS: Summer disposal of 293 gpm (24 hr) treated adit water at LAD Area 6 and 160 gpm (24 hr) at the percolation pond would not exceed the 1,000 µmhos/cm EC Class I beneficial use criterion or 500 mg/L TDS in the East Boulder River at the East Boulder Mine.					
OPERATIONS ***East Boulder Mine*** **Winter Salinity Calculations**			**OPERATIONS Winter: Percolation of 248 gpm (24 hr) at East Boulder Mine and 205 gpm (24 hr) at LAD at Area 6**		
salts concentration in ground water *East Boulder Mine*	579	mg/L	**904**	µmhos/cm	projected winter salts concentration in ground water near SP-11
salts concentration in East Boulder River below *East Boulder Mine*	**210**	mg/L	328	µmhos/cm	projected winter salts concentration in surface water near EBR-004/EBR-004A
OPERATIONS: Winter disposal of 205 gpm (24 hr) treated adit water at LAD Area 6 and 248 gpm (24 hr) at the percolation pond would not exceed the 1,000 µmhos/cm EC Class I beneficial use criterion or 500 mg/L TDS in the East Boulder River at the East Boulder Mine.					
OPERATIONS: *East Boulder Mine* Percolation Salinity Calculations			**OPERATIONS: Percolation of up to 453 gpm (24 hr) at the East Boulder Mine when LAD cannot occur**		
salts concentration in ground water *East Boulder Mine*	556	mg/L	**917**	µmhos/cm	projected salts concentration in ground water near EBMW-006 or EBMW-007
salts concentration in East Boulder River *below East Boulder Mine*	**149**	mg/L	233	µmhos/cm	projected salts concentration in surface water near EBR-004/EBR-004A
OPERATIONS: Percolation of 453 gpm (24 hr) at the East Boulder Mine percolation pond would not exceed the 1,000 µmhos/cm EC Class I beneficial use criterion or 500 mg/L TDS in the East Boulder River at the East Boulder Mine.					
OPERATIONS ***Boe Ranch LAD*** **Mixing Zone Salinity Calculation Input Values** These data inputs are carried through below, but not repeated to reduce redundancy			**OPERATIONS: LAD of 284 gpm treated adit water plus up to 579 gpm (24 hr) stored treated adit water at greater than agronomic rates on 166 acres; the aquifer at the Boe Ranch has a Class II Beneficial Use.**		
2000-2008 median East Boulder adit EC concentration, calculated from TDS	**944**	µmhos/cm	**605**	mg/L	2000-2008 median East Boulder adit TDS concentration; CES 2008 page 13
depth of aquifer, **D**	15	ft			allowed by 17.30.517(d)
hydraulic conductivity, **k**	0.283	ft/d			mid-range estimate, used by Hydrometrics (KP 2000c)
gradient, **i**	0.1				estimate, used by Hydrometrics (KP 2000c)
width of LAD storage pond liner leakage source	10	ft			assume point leakage from LAD pond exists for foreseeable impact to aquifer
width of mixing zone for the LAD storage pond liner leakage, $\mathbf{W_2}$	229	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
angle of dispersion	0.087421693	tan 5°			allowed by 17.30.517(d)
length of LAD storage pond liner leakage, $\mathbf{L_2}$	2,500	feet			KP 2000c Apdx K, Tables
cross sectional area of aquifer at LAD storage pond liner leakage, $\mathbf{A_2}$	3,428	ft^2			D * W, allowed by 17.30.517(d)
volume of LAD storage pond **liner leakage**, $\mathbf{V_2}$	27	ft^3/d	0.14	gpm (24 hr)	KP 2000c Apdx K, Tables
$\mathbf{Q_2}$=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d			KP 2000c Apdx K, Tables
concentration of **salts in ambient ground water**; median value from RMW-3a, $\mathbf{C_A}$	**1,025**	µmhos/cm	**657**	mg/L	median ambient TDS concentration derived from SMC monitoring data
width of LAD application	3,200	ft			KP 2000c Apdx K, Tables
length of LAD application, $\mathbf{L_1}$	4,500	ft			KP 2000c Apdx K, Tables

Appendix E
DEQ 2012

width of LAD application ground water mixing area, W_1	3,593	ft			allowed by 17.30.517(d)
cross sectional area of ground water at LAD application, A_1	53,901	ft^2			D * W, allowed by 17.30.517(d)
Q_1=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d			allowed by 17.30.517(d)
volume of LAD applied; evaporation factor taken, V_1	116,324	ft^3/d	**1,208**	gpm (12 hr)	treated adit water stored in Boe Ranch LAD storage pond; evaporation credit taken
salts concentration in applied LAD adit water; assume pivots 30% evaporation, no post plant salt uptake credit, C_1	**1,348**	μmhos/cm	**864**	mg/L	effective applied LAD TDS concentration
salts in LAD storage **pond liner leakage** discharge, C_2	**944**	μmhos/cm	**4,530**	lbs/ac/yr	**OPERATIONS Salts load at the Boe Ranch**
width of aquifer below LAD, includes area of Mason Ditch to East Boulder River	3,593	ft			KP 2000c Apdx K, Tables
length between end of pivots to East Boulder River, L_3	4,000	ft			KP 2000c Apdx K, Tables
width of mixing zone between end of pivots to East Boulder River, W_3	3,943	ft			width of source + (tan 5 * length) allowed by 17.30.517(d)
cross sectional area of aquifer between pivots to East Boulder River, A_3	59,146	ft^2			D * W, allowed by 17.30.517(d)
Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**	1,674	ft^3/d			allowed by 17.30.517(d)
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), V_3	43,123	ft^3/d	224	gpm	KP 2000c Apdx K, Tables
assumed **salts concentration of Mason Ditch** , C_3	**290**	μmhos/cm	**186**	mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008

OPERATIONS Ground water calculations down-gradient of Boe Ranch LAD			**OPERATIONS: LAD of 284 gpm treated adit water plus up to 579 gpm (24 hr) stored treated adit water at greater than agronomic rates on 166 acres; the aquifer at the Boe Ranch has a Class II beneficial use.**		
salts concentration in ground water resulting **from applied LAD**	**1,344**	μmhos/cm	862	mg/L	projected salts concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational salts concentration** in ground water for Q_1
salts concentration in ground water resulting **from liner leakage plus applied LAD**	**1,344**	μmhos/cm	861	mg/L	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational salts concentration** in ground water for Q_2
salts concentration in ground water at Mason Ditch resulting **from liner leakage, applied LAD, and Mason Ditch**	**1,062**	μmhos/cm	681	mg/L	projected cumulative salts concentration in ground water beneath the Mason Ditch; this value will be **assumed to equal the operational concentration of salts** in ground water below the Mason Ditch to the East Boulder River, Q_3
OPERATIONS salts concentration in ground water below Mason Ditch, C_d	**1,061**	μmhos/cm	680	mg/L	compliance point in ground water; projected cumulative salts concentration prior to discharge to the East Boulder River

OPERATIONS: Summer disposal of 863 gpm (24 hr) treated adit water at the Boe Ranch LAD would result in a ground water concentration less than the Class II Beneficial Use criterion of 2,500 μmhos/cm EC.

OPERATIONS East Boulder River calculations down-gradient of Boe Ranch LAD			**OPERATIONS: LAD of 284 gpm treated adit water plus up to 579 gpm (24 hr) stored treated adit water at greater than agronomic rates on 166 acres; the aquifer at the Boe Ranch has a Class II beneficial use.**		
receiving streamflow non-irrigation season, Q_s	423,000	ft^3/d	5.0	cfs	7Q10 value for East Boulder Mine streamflow non-irrigation season
receiving streamflow irrigation season, Q_s	172,800	ft^3/d	2.0	cfs	7Q10 value for East Boulder Mine streamflow irrigation season
receiving stream ambient concentration, C_s	290	μmhos/cm	186	mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008; period of record
ground water discharge volume, Q_d	162,771	ft^3/d	1.9	cfs	ground water discharge volume in cubic feet per second
aquifer concentration below Mason Ditch, C_d	1,061	μmhos/cm	680	mg/L	salt concentration in aquifer just prior to discharge to East Boulder River

East Boulder River salt concentration down-gradient of LAD at **5.0 cfs**	504 µmhos/cm	**323 mg/L**	TDS value calculated from EC at 5 cfs
East Boulder River salt concentration down-gradient of LAD at **2.0 cfs**	664 µmhos/cm	**426 mg/L**	TDS value calculated from EC at 2 cfs

Alternative 3C OPERATIONS Option 1, 150 gpm: SMC would route 150 gpm (24 hr) treated adit water to the Boe Ranch LAD storage pond all year. The 150 gpm (24 hr) of treated adit water and 301 gpm (24 hr) of stored treated adit water would be disposed at Boe Ranch LAD at greater than agronomic rates during the 120-day LAD season. No treated adit water disposal would occur at the East Boulder Mine.

OPERATIONS Hydraulic Loading Calculations for Boe Ranch LAD		**OPERATIONS assume 120 day LAD season and that Boe Ranch LAD storage pond contains 52 MG from previous winter; LAD of 150 gpm treated adit water and 301 gpm stored water; the aquifer at the Boe Ranch has a Class II beneficial use**	
capacity of LAD Storage Pond	100 MG	120 days	time to dewater the LAD storage pond
assumed volume in LAD storage pond	**52** MG	301 gpm (24 hr)	pumping rate to empty **Boe Ranch LAD storage pond**
area available for LAD in section 17,not all pivots included	166 ac	602 gpm (12 hr)	Boe Ranch LAD storage pond dewatering rate
greater than agronomic land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4 gpm/ac	**1,726** gpm (12 hr)	**hydraulic load** that can be applied on 166 acres, in Section 17
adit flow rate	**150** gpm (24 hr)	**902** gpm (12 hr)	rate of LAD to dispose of adit plus stored water

OPERATIONS During the 120 day LAD season, the (24 hr) hydraulic load of 150 gpm adit water plus 602 gpm (12 hr) rate to dewater stored water in the Boe Ranch LAD storage pond (52 MG) can be managed at Boe Ranch LAD area if not all pivots are operating on 166 acres at greater than agronomic rates, as is done at Hertzler Ranch LAD.

OPERATIONS *Boe Ranch LAD* Salinity Calculations		**OPERATIONS assume 120 day LAD season and that Boe Ranch LAD storage pond contains 52 MG from previous winter; LAD of 150 gpm treated adit water and 301 gpm stored water; the aquifer at the Boe Ranch has a Class II beneficial use**	
volume of LAD storage pond **liner leakage**, V_2	27 ft^3/d	0.14 gpm (24 hr)	KP 2000c Apdx K, Tables
Q_2=kiA, **ground water** available for mixing below **liner leakage**	97 ft^3/d		KP 2000c Apdx K, Tables
concentration of **salts in ambient ground water**; median value from RMW-3a, C_A	**1,025** µmhos/cm	**657** mg/L	median ambient TDS concentration derived from SMC monitoring data
Q_1=kiA, **ground water** available for mixing below **LAD application area**	1,525 ft^3/d		allowed by 17.30.517(d)
volume of LAD applied; evaporation factor taken, V_1	121,533 ft^3/d	**631** gpm (12 hr)	treated adit water stored in Boe Ranch LAD storage pond; evaporation credit taken
salts concentration in applied LAD adit water; assume pivots 30% evaporation, no post plant salt uptake credit, C_1	**1,348** µmhos/cm	**864** mg/L	effective applied LAD TDS concentration
salts in LAD storage **pond liner leakage** discharge, C_2	**944** µmhos/cm	**605** mg/L	median adit TDS concentration derived from SMC monitoring data
Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**	1,674 ft^3/d	**150** gpm (24 hr)	adit flow rate
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), V_3	43,123 ft^3/d	**150** gpm (24 hr)	rate that adit water is routed to LAD Storage Pond year round
assumed **salts concentration of Mason Ditch** , C_3	290 µmhos/cm	**186** mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008; period of record
salts concentration in ground water resulting **from applied LAD, in Q_1**	**1,344** µmhos/cm	862 mg/L	projected salts concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational salts concentration** in ground water for Q_1
salts concentration in ground water resulting **from liner leakage plus applied LAD, in Q_2**	**1,344** µmhos/cm	861 mg/L	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational salts concentration** in ground water for Q_2

salts concentration in ground water at Mason Ditch resulting **from liner leakage, applied LAD, and Mason Ditch, in Q_3**	**1,071**	µmhos/cm	686	mg/L	projected cumulative salts concentration in ground water beneath the Mason Ditch; this value will be **assumed to equal the operational concentration of salts** in ground water below the Mason Ditch to the East Boulder River, Q_3
OPERATIONS salts concentration in ground water below Mason Ditch, C_d	**1,070**	µmhos/cm	686	mg/L	compliance point in ground water; projected cumulative salts concentration prior to discharge to the East Boulder River
OPERATIONS: Summer disposal of 902 gpm (24 hr) treated adit water at the Boe Ranch LAD would result in a salts concentration in ground water less than the Class II beneficial use criterion of 2,500 µmhos/cm.					
OPERATIONS East Boulder River calculations down-gradient of Boe Ranch LAD					**OPERATIONS assume 120 day LAD season and that Boe Ranch LAD storage pond contains 52 MG from previous winter; LAD of 150 gpm treated adit water and 301 gpm stored water; the aquifer at the Boe Ranch has a Class II beneficial use**
receiving streamflow non-irrigation season, Q_s	423,000	ft^3/d	5.0	cfs	7Q10 value for East Boulder Mine streamflow non-irrigation season
receiving streamflow irrigation season, Q_s	172,800	ft^3/d	2.0	cfs	7Q10 value for East Boulder Mine streamflow irrigation season
receiving stream ambient concentration, C_s	290	µmhos/cm	**186**	mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008; period of record
ground water discharge volume, Q_d	167,979	ft^3/d	2.0	cfs	ground water discharge volume in cubic feet per second
aquifer concentration below Mason Ditch, C_d	1,070	µmhos/cm	686	mg/L	compliance point in ground water; projected cumulative salts concentration prior to discharge to the East Boulder River
OPERATIONS East Boulder River salt concentration below Boe Ranch LAD area 5.0 cfs	512	µmhos/cm	**328**	**mg/L**	TDS value projected from EC at 5 cfs
OPERATIONS East Boulder River salt concentration below Boe Ranch LAD area 2.0 cfs	675	µmhos/cm	**432**	**mg/L**	TDS value projected from EC at 2 cfs

CLOSURE CALCULATIONS

Agency-Mitigated Alternative 3C CLOSURE Option 1, 737 gpm: At closure, SMC would treat 737 gpm adit water and 263 gpm tailings waters in the BTS. The closure time frame would be 18 months. *Days 1-120:* SMC would maximize disposal of 284 gpm treated adit and tailings waters at the Boe Ranch LAD area at greater than agronomic rates. SMC would dispose of the remaining 716 gpm at the East Boulder Mine. LAD Area 6 would receive 293 gpm and the excess 423 gpm would be routed to the East Boulder Mine percolation pond during the first 120-day summer LAD season in the 18 month closure period.
***Days 121-365:* After day 259, the tailings impoundment would be closed and only 737 gpm of treated adit water would need disposal during the rest of the 18-month closure period. From days 260-365, up to 284 gpm would be routed to the Boe Ranch LAD storage pond, and 453 gpm would be disposed at the East Boulder MIne percolation pond.**
***Days 366-548:* During the second year 120-day LAD season, 284 gpm would be routed and disposed at greater than agronomic rates with 579 gpm stored waters in the Boe Ranch LAD storage pond. After the second year LAD season, all 737 gpm of treated adit water would be disposed at the East Boulder Mine percolation pond.**

2000-2005 average field and laboratory EC at RMW-3A, SMC Monitoring Data	**1,025**	µmhos/cm	**657**	mg/L	calculated TDS concentration at RMW-3A, based on SMC Monitoring Data
2000-2008 calculated median adit EC	944	µmhos/cm	**605**	mg/L	median adit TDS concentration (SMC Database 2011)
2000-2008 calculated median tailings waters EC	1,164	µmhos/cm	**746**	mg/L	median tailings waters TDS concentration (SMC Database 2011)
weighted average calculated EC in mixed adit plus tailings waters	1,002	µmhos/cm	**642**	mg/L	weighted average TDS concentration of treated adit plus tailings waters
CLOSURE Hydraulic Routing for 737 gpm adit water *Days 1-120*					**CLOSURE: Days 1-120: Disposal of 284 gpm treated adit and tailings waters with 579 gpm stored treated adit water at the Boe Ranch LAD; disposal of 293 at the East Boulder Mine LAD Area 6, and 423 gpm at the percolation pond; no winter LAD disposal would occur at East Boulder Mine**
area available for LAD in section 17, to prevent potential mass wasting/stability issues	166	ac	**1,726**	gpm (12 hr)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days on 166 acres, in Section 17
assumed Boe Ranch **LAD storage pond volume**	100	MG	10.4	gpm/ac	**greater than agronomic land application rate** used at Hertzler Ranch LAD area (SMC Monitoring data)
adit flow rate at closure	**737**	gpm (24 hr)	**284**	gpm (24 hr)	volume of water sent to **Boe Ranch LAD storage pond** year round

rate to dewater **East Boulder tailings impoundment** fixed by nitrogen load in MPDES permit with disposal by percolation	**263**	gpm (24 hr)	**98**	MG	volume of the **East Boulder Tailings impoundment waters** needing disposal
time to dewater the East Boulder tailings impoundment	**259**	days	569	gpm (12 hr)	**LAD capacity available** at Boe Ranch LAD **for adit water** after dewatering Boe Ranch LAD storage pond
hydraulic capacity available at East Boulder Mine at **LAD Area 6**	**293**	gpm (24 hr)	**716**	gpm (24 hr)	**excess** water that must be **managed at East Boulder Mine**
excess adit and tailings waters that must be **percolated** at East Boulder Mine	**423**	gpm (24 hr)	579	gpm (24 hr)	rate to **dewater Boe Ranch LAD storage pond** in one season
rate to **dewater Boe Ranch LAD storage pond** in one season	**1,157**	gpm (12 hr)	1,105	gpm (24 hr)	capacity of East Boulder Mine percolation pond (MPDES permit Statement of Basis)

CLOSURE *Boe Ranch LAD* Hydraulic Loading Calculations *Days 121-365*

CLOSURE: Days 121-259: Of the 737 gpm treated adit water, 284 gpm would be routed to the Boe Ranch LAD storage pond and 716 gpm would be routed to the East Boulder Mine percolation pond; Days 260 - 365: The impoundment would be dewatered and 284 gpm would be routed to the Boe Ranch LAD storage pond and 453 gpm would be routed to the East Boulder Mine percolation pond. Please see sheet 3C Nitrogen for volume calculations for the East Boulder Tailings Impoundment and Boe Ranch LAD Storage Pond.

volume of water routed to **Boe Ranch LAD year round**	**284**	gpm (24 hr)	**453**	gpm (24 hr)	excess adit waters that must be **percolated** at East Boulder Mine
volume of adit and tailings waters that must be **percolated at East Boulder Mine until tailings impoundment is dewatered Day 259**	**716**	gpm (24 hr)	365	days	length of year

CLOSURE *Boe Ranch LAD* Hydraulic Loading Calculations *Days 366-486*

CLOSURE: Days 366-486: Second 120-day LAD season, 284 gpm would be routed and disposed at greater than agronomic rates with 579 gpm stored waters at the Boe Ranch LAD Area. Excess waters would be percolated at the East Boulder Mine percolation pond.

greater than agronomic land application rate used at Hertzler Ranch LAD area (SMC Monitoring data)	10.4	gpm/ac	**1,726**	gpm (12 hr)	**hydraulic load** that can be land applied at greater than agronomic rates for 120 days on 166 acres, in Section 17
assumed Boe Ranch **LAD storage pond volume**	100	MG	0	MG	East Boulder **tailings waters volume**
rate to dewater Boe Ranch LAD storage pond in one season	579	gpm (24 hr)	1,157	gpm (12 hr)	rate to **dewater Boe Ranch LAD storage pond** in one season
volume of water routed to **Boe Ranch LAD year round**	**284**	gpm (24 hr)	**453**	gpm (24 hr)	excess treated adit water that must be **percolated** at East Boulder Mine

CLOSURE *East Boulder Mine* Hydraulic Loading Calculations *Days 487-548*

CLOSURE: Days 487-548: After the second LAD season, the Boe Ranch would be closed and all 737 gpm treated adit water would be routed to the East Boulder Mine percolation pond

treated adit water that must be **percolated** at East Boulder Mine	**737**	gpm (24 hr)	0	MG	East Boulder **tailings waters volume**

The hydraulic load of 737 gpm plus 263 gpm tailings waters can be managed at the East Boulder Mine and the Boe Ranch LAD area under Option 1, 737 gpm.

CLOSURE *East Boulder Mine* salinity calculations *Days 1-120*

CLOSURE: Days 1-120: Disposal of 293 gpm treated adit and tailings waters at the East Boulder Mine LAD Area 6, and 423 gpm treated adit and tailings waters at the percolation pond; no winter LAD disposal would occur at East Boulder Mine; the aquifer at the East Boulder Mine has a Class I beneficial use

70% Volume of aquifer available for mixing $\mathbf{Q_1}$=kiA$_1$	76,409	ft^3/d	**515**	mg/L	median ambient TDS concentration derived from SMC monitoring data
Volume of adit water percolated at East Boulder Mine, $\mathbf{V_p}$	81,338	ft^3/d	**423**	gpm (24 hr)	volume of treated adit and tailings waters percolated at East Boulder Mine
Volume of aquifer available for mixing beneath the LAD $\mathbf{Q_2}$=kiA	27,891	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d)
weighted average TDS concentration in mixed percolated waters, $\mathbf{C_P}$	**642**	mg/L	**1,002**	µmhos/cm	weighted average EC in mixed percolated waters, $\mathbf{C_P}$

effective weighted average TDS concentration in mixed land applied waters, C_{LAD}	**917**	mg/L	**1,431**	μmhos/cm	effective weighted average EC in mixed land applied waters, C_{LAD}
volume of land applied treated adit plus tailings waters (evaporation credit taken), V_{2LAD}	39,484	ft^3/d	**205**	gpm (24 hr)	Days 1-120 rate land application at East Boulder Mine LAD Area 6 (evaporation applied)
receiving stream baseline ambient concentration at EBR-001, Q_c	49	mg/L	76	μmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
receiving streamflow, Q_s	423,000	ft^3/d	5.0	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis page 4
CLOSURE *East Boulder Mine* Days 1-120: Salts concentration in ground water	681	mg/L	**1,063**	μmhos/cm	projected salts concentration near SP-11 from percolation and disposal at LAD Area 6
CLOSURE *East Boulder Mine* Days 1-120 Salts concentration in East Boulder River	**268**	mg/L	419	μmhos/cm	projected salts concentration at EBR-004/004A from percolation and disposal at LAD Area 6
CLOSURE *East Boulder Mine* Days 1-120 Total Salts load to LAD Area 6	**270,908**	lbs/18 mos	**2,461,929**	lbs/18 mos	**CLOSURE *East Boulder Mine* Days 1-548 Total Salts load percolated**

CLOSURE *East Boulder Mine* Days 1-120: Percolation of 423 gpm (24 hr) treated adit and tailings waters and land application of 293 gpm (24 hr) at LAD Area 6 at the East Boulder Mine would temporarily exceed the ground water Class I Beneficial Use criterion of 1,000 μmhos/cm EC during closure.

CLOSURE *East Boulder Mine* salinity calculations *Days 121-365*			**CLOSURE: Days 121-365: Of the 1,000 gpm mixed treated adit and tailings waters, 284 gpm would be routed to the Boe Ranch LAD storage pond and 716 gpm would be routed to the East Boulder Mine percolation pond**		
volume of water routed to **Boe Ranch LAD storage pond** days 121-365	**284**	gpm (24 hr)	**100**	MG	volume of water in **Boe Ranch LAD storage pond on day 365**
days 121-365: volume of adit water percolated at East Boulder Mine, V_p	137,744	ft^3/d	**716**	gpm (24 hr)	volume of treated adit and tailings waters percolated at East Boulder Mine percolation pond
weighted average TDS concentration in mixed adit and tailings percolated waters, C_P	642	mg/L	1,002	μmhos/cm	weighted average EC in mixed percolated waters, C_P
effective average TDS concentration in treated adit waters, C_P	**605**	mg/L	944	μmhos/cm	effective average EC of treated land applied adit waters
CLOSURE *East Boulder Mine* Days 121-365: Salts concentration in ground water	583	mg/L	**909**	μmhos/cm	projected salts concentration near SP-11 from percolation
CLOSURE *East Boulder Mine* Days 121-365: Salts concentration in East Boulder River below East Boulder Mine at $7Q_{10}$	**243**	mg/L	379	μmhos/cm	projected salts concentration at EBR-004/004A from percolation of treated adit water

CLOSURE *East Boulder Mine* Days 121-365: Percolation of 453 gpm (24 hr) treated adit water at the East Boulder Mine would meet the Class I Beneficial Use criterion of 1,000 μmhos/cm EC during closure.

CLOSURE *East Boulder Mine* salinity calculations Days 366-486			**CLOSURE: Days 366-486: Second 120-day LAD season, 284 gpm would be routed and disposed at greater than agronomic rates with 579 gpm stored waters at the Boe Ranch LAD Area. Excess waters would be percolated at the East Boulder Mine percolation pond.**		
volume of water routed to **Boe Ranch LAD** days 366-486	**284**	gpm (24 hr)	**579**	gpm (24 hr)	rate that Boe Ranch LAD stored waters are applied at Boe Ranch
2000-2008 median adit TDS concentration; CES 2008 page 13	**605**	mg/L	**944**	μmhos/cm	2000-2008 calculated median adit EC
days 366-486: volume of adit water percolated at East Boulder Mine, V_p	87,113	ft^3/d	**453**	gpm (24 hr)	volume of treated adit waters percolated at East Boulder Mine percolation pond
CLOSURE *East Boulder Mine* Days 366-486: Salts concentration in ground water	556	mg/L	**867**	μmhos/cm	projected salts concentration near SP-11 from percolation of treated adit water

CLOSURE *East Boulder Mine* Days 366-486 Salts concentration in East Boulder River below East Boulder Mine at $7Q_{10}$	**207**	mg/L	323	µmhos/cm	projected salts concentration at EBR-004/004A from percolation of treated adit water
CLOSURE *East Boulder Mine* salinity calculations Days 487-548					**CLOSURE: Days 487-548: After the second LAD season, all 737 gpm treated adit water would be routed to the East Boulder Mine percolation pond**
volume of water routed to **Boe Ranch LAD** days 487-548	**0**	gpm (24 hr)	0	MG	volume of water in **Boe Ranch LAD storage pond on day 487**
days 487-548: volume of adit water percolated at East Boulder Mine, V_p	141,882	ft^3/d	**737**	gpm (24 hr)	adit flow rate at closure
CLOSURE *East Boulder Mine D* ays 487-548: Salts concentration in ground water	567	mg/L	**884**	µmhos/cm	projected salts concentration near SP-11 from percolation
CLOSURE *East Boulder Mine* Days 487-548: Salts concentration in East Boulder River below East Boulder Mine	**239**	mg/L	373	µmhos/cm	projected salts concentration at EBR-004/004A from percolation of treated adit water
CLOSURE *East Boulder Mine* Days 366-548: Percolation of 453 to 737 gpm (24 hr) treated adit water at the East Boulder Mine would meet the ground water Class I Beneficial Use criterion of 1,000 µmhos/cm EC during closure.					
CLOSURE *Boe Ranch LAD* salt calculations Days 1-120					**CLOSURE: Days 1-120: Disposal of 284 gpm treated adit and tailings waters with 579 gpm stored treated adit water at the Boe Ranch LAD so storage pond would be emptied by the end of the 120-day LAD season; excess waters would be disposed at the East Boulder Mine**
volume of LAD storage pond **liner leakage**, V_2	27	ft^3/d	**737**	gpm (24 hr)	adit flow rate at closure
Q_2=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d	**861**	mg/L	projected salts concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational salts concentration** in ground water for Q_2
concentration of **salts in ambient ground water**; median value from RMW-3a, C_A	**1,025**	µmhos/cm	**657**	mg/L	median ambient TDS concentration derived from SMC monitoring data
Q_1=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d	**862**	mg/L	projected salts concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational salts concentration** in ground water for Q_1
volume of LAD applied; evaporation factor taken, V_1	116,324	ft^3/d	**604**	gpm (12 hr)	treated stored water plus adit and tailings waters in the Boe Ranch LAD storage pond; evaporation credit taken
salts concentration in applied LAD adit plus tailings water; assume pivots 30% evaporation, no post plant salt uptake credit, C_1	1,348	µmhos/cm	880	mg/L	effective applied LAD TDS concentration
salts in LAD storage **pond liner leakage** discharge, C_2	944	µmhos/cm	616	mg/L	weighted average adit and tailings TDS concentration in the Boe Ranch LAD storage pond
Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**	1,674	ft^3/d	**686**	mg/L	projected salts concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational salts concentration** in ground water for Q_3
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), V_3	43,123	ft^3/d	224	gpm	KP 2000c Apdx K, Tables
assumed **salts concentration of Mason Ditch** , C_3	290	µmhos/cm	**186**	mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008; period of record
salts concentration in ground water resulting **from applied LAD**	1,342	µmhos/cm	860	mg/L	projected salts concentration in ground water below the Boe Ranch LAD area; **assumed to equal the operational salts concentration** in ground water for Q_1
salts concentration in ground water resulting **from liner leakage plus applied LAD**	1,342	µmhos/cm	860	mg/L	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational salts concentration** in ground water for Q_2
salts concentration in ground water at Mason Ditch resulting **from liner leakage, applied LAD, and Mason Ditch**	1,060	µmhos/cm	680	mg/L	projected cumulative salts concentration in ground water beneath the Mason Ditch; this value will be **assumed to equal the operational concentration of salts** in ground water below the Mason Ditch to the East Boulder River, Q_3

CLOSURE Days 1-120 *Boe Ranch LAD* salts concentration in ground water below Mason Ditch, C_d	**1,083** µmhos/cm	694 mg/L	compliance point in ground water; projected cumulative salts concentration prior to discharge to the East Boulder River
CLOSURE Days 1-120 *Boe Ranch LAD* Salt concentration in East Boulder River below LAD area, non-irrigation season (5.0 cfs)	510 µmhos/cm	**327** mg/L	**This value is less than 500 mg/L TDS projected at 5 cfs.**
CLOSURE Days 1-120 *Boe Ranch LAD* Salt concentration in East Boulder River below LAD area, irrigation season (2.0 cfs)	675 µmhos/cm	**432** mg/L	**This value is less than 500 mg/L TDS projected at 2 cfs.**
CLOSURE *Boe Ranch LAD* salt calculations Days 366-486		**CLOSURE Days 366-486: Second 120-day LAD season, 284 gpm treated adit water would be routed and disposed at greater than agronomic rates with 579 gpm stored waters at the Boe Ranch LAD Area. Excess waters would be percolated at the East Boulder Mine percolation pond.**	
salts concentration in ground water resulting **from applied LAD**	1,344 µmhos/cm	862 mg/L	projected salts concentration in ground water below the Boe Ranch LAD area
salts concentration in ground water resulting **from liner leakage plus applied LAD**	1,344 µmhos/cm	862 mg/L	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond using the assumed operational salts concentration in ground water for $\mathbf{Q_2}$
salts concentration in ground water at Mason Ditch resulting **from liner leakage, applied LAD, and Mason Ditch**	1,062 µmhos/cm	681 mg/L	projected cumulative salts concentration in ground water beneath the Mason Ditch using the assumed operational concentration of salts in ground water below the Mason Ditch to the East Boulder River, $\mathbf{Q_3}$
CLOSURE *Boe Ranch LAD* salts concentration in ground water below Mason Ditch, C_d	**1,062** µmhos/cm	694 mg/L	compliance point in ground water; projected cumulative salts concentration prior to discharge to the East Boulder River
CLOSURE Days 366-486 *Boe Ranch LAD* Salt concentration in East Boulder River below LAD area, non-irrigation season (5.0 cfs)	505 µmhos/cm	**323** mg/L	**This value is less than 500 mg/L TDS projected at 5 cfs.**
CLOSURE Days 366-486 *Boe Ranch LAD* Salt concentration in East Boulder River below LAD area, irrigation season (2.0 cfs)	665 µmhos/cm	**426** mg/L	**This value is less than 500 mg/L TDS projected at 2 cfs.**
CLOSURE Days 1-486 *Boe Ranch LAD* Total Salt Load	1,940,462 lbs/18 mos	**11,690** lbs/ac/yr	

CLOSURE *Boe Ranch LAD* Days 120-486: Disposal of treated adit water with stored water produces a salts concentration in ground water less than the Class II beneficial use criterion of 2,500 µmhos/cm at the Boe Ranch.

Agency-Mitigated Alternative 3C CLOSURE Option 1, 150 gpm: SMC would treat 562 gpm (150 gpm adit water and 412 gpm of tailings waters) at closure to empty the East Boulder Mine tailings impoundment in 157 days. The Boe Ranch LAD storage pond would contain 52 MG of treated adit waters on the first day of the 120-day LAD season. To empty the Boe Ranch LAD storage pond during the 120-day LAD season, SMC would maximize disposal of treated adit and tailings waters at the Boe Ranch LAD area at greater than agronomic rates. After the 120-day LAD season, 150 gpm of treated adit water (plus 412 gpm of treated tailings waters through Day 157) would be routed to the Boe Ranch LAD storage pond for disposal during the second LAD season in the 18-month closure period. Up to 150 gpm treated adit water would be disposed at the East Boulder Mine Days 487 to 548 of the the 18-month closure period.

CLOSURE *Boe Ranch LAD* Hydraulic Loading Calculations Days 1-486		**CLOSURE: First LAD Season: Days 1-120, disposal of 412 gpm treated adit and tailings waters with 301 gpm stored treated adit waters would occur at the Boe Ranch LAD. Days 121-365, storage of 150 gpm (24 hr) would occur at the Boe Ranch LAD storage pond until the second LAD season. The second LAD season would occur Days 366-486, and treated adit and stored waters would be disposed at Boe Ranch LAD. Beginning on day 487, the Boe Ranch LAD would be decommissioned and all remaining treated adit water would be disposed at the East Boulder Mine percolation pond.**	
initial volume in LAD storage pond, assume 8 months stored at 150 gpm	52 MG	**120** days	time to dewater the **LAD storage pond**
Days 1-120 and Days 366-486 rate to empty **LAD storage pond**	**301** gpm (24 hr)	602 gpm (12 hr)	**LAD storage pond** dewatering rate
Days 1-165 rate to dewater **East Boulder tailings impoundment**	**412** gpm (24 hr)	824 gpm (12 hr)	East Boulder **tailings impoundment** dewatering rate

Days 1-548 adit flow rate at closure	**150**	gpm (24 hr)	300	gpm (12 hr)	**adit** flow rate
volume in LAD storage pond Day 120	**0**	MG	**80**	MG	**volume in LAD storage pond Day 365**
volume in LAD storage pond Day 165	**37**	MG	**20**	MG	**capacity remaining in pond Days 165-365**
total pumping rate to dispose of all treated mine waters during 120 day LAD season	863	gpm (24 hr)	**1,726**	gpm (12 hr)	**total rate** of all treated mine waters needing disposal during 120 day LAD season
volume of the East Boulder Tailings impoundment waters needing disposal	**98**	MG	863	gpm (24 hr)	**total rate** of all treated mine waters needing disposal during 120 day LAD season
area available for LAD in section 17, all pivots included	166	ac	**165**	days	number of days to dewater **East Boulder tailings impoundment** at above rate
land application rate that would empty the LAD storage pond in 97 days	10.4	gpm/ac	**1,726**	gpm (12 hr)	hydraulic load that can be applied at a greater than agronomic rate
rate that adit water is routed to the **Boe Ranch LAD storage pond** days 1-486	150	gpm (24 hr)	150	gpm (24 hr)	rate of disposal at East Boulder Mine during days 487-548 of closure

CLOSURE *Boe Ranch LAD* Days 1-120: Mixing Zone Salinity Calculations

CLOSURE: First LAD Season: Days 1-120, disposal of 562 gpm treated adit and tailings waters with 301 gpm stored treated adit water would occur at the Boe Ranch LAD. The aquifer at Boe Ranch has a Class II Beneficial Use.

2000-2008 calculated median adit EC	943.8	μmhos/cm	**605**	mg/L	2000-2008 median **adit** TDS concentration; CES 2008 page 13
2000-2008 calculated median tailings waters EC	1,164	μmhos/cm	**746**	mg/L	2002-2006 median **tailings waters** TDS concentration (CES 2008 p 13)
weighted average calculated EC in mixed adit plus tailings waters	1,066	μmhos/cm	**684**	mg/L	weighted average TDS concentration of **treated mixed adit, tailings, and stored waters**
volume of LAD storage pond **liner leakage**, V_2	27	ft^3/d	365	days	start of the second LAD season
Q_2=kiA, **ground water** available for mixing below **liner leakage**	97	ft^3/d	**1,344**	μmhos/cm	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational salts concentration in ground water** for Q_2
concentration of **salts in ambient ground water**; median value from RMW-3a, C_A	1,025	μmhos/cm	**657**	mg/L	KP 2000c Apdx K, Tables
Q_1=kiA, **ground water** available for mixing below **LAD application area**	1,525	ft^3/d	**1,344**	μmhos/cm	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational salts concentration in ground water** for Q_1
volume of LAD applied; evaporation factor taken, V_1	116,324	ft^3/d	**604**	gpm (24 hr)	the rate of adit, tailings, and stored waters that would be LAD at the Boe Ranch, evaporation factor applied
salts concentration in applied LAD adit plus tailings water; assume pivots 30% evaporation, no post plant salt uptake credit, C_1	1,523	μmhos/cm	976	mg/L	EC calculated from TDS ;
salts in LAD storage **pond liner leakage** discharge, C_2	1,066	μmhos/cm	684	mg/L	EC calculated from TDS ;
Q_3=kiA, **ground water** available for mixing **below Mason Ditch to East Boulder River**	1,674	ft^3/d	**1,071**	μmhos/cm	projected cumulative salts concentration in ground water below the Boe Ranch LAD storage pond; **assumed to equal the operational salts concentration in ground water** for Q_3
volume of flow from **Mason Ditch** that is assumed to infiltrate (25 % of total), V_3	43,123	ft^3/d	224	gpm (24 hr)	KP 2000c Apdx K, Tables
assumed **salts concentration of Mason Ditch** , C_3	290	μmhos/cm	**186**	mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008; period of record

salts concentration in ground water resulting **from applied LAD**	1,521 µmhos/cm	975 mg/L	projected TDS concentration in ground water for Q_1
salts concentration in ground water resulting **from liner leakage plus applied LAD**	1,521 µmhos/cm	975 mg/L	projected TDS concentration in ground water for Q_2
salts concentration in ground water at Mason Ditch resulting **from liner leakage, applied LAD, and Mason Ditch**	1,191 µmhos/cm	764 mg/L	projected cumulative salts concentration in ground water beneath the Mason Ditch; this value will be **assumed to equal the operational concentration of salts** in ground water below the Mason Ditch to the East Boulder River, Q_3
CLOSURE *Boe Ranch LAD* Days 1-120 EC concentration at in ground water below Mason Ditch, C_d	**1,190** µmhos/cm	763 mg/L	compliance point in ground water; projected cumulative salts concentration prior to discharge to the East Boulder River
receiving streamflow non-irrigation season, Q_s	432,000 ft³/d	5.0 cfs	7Q10 value for East Boulder Mine streamflow, non-irrigation season
receiving streamflow irrigation season, Q_s	172,800 ft³/d	2.0 cfs	7Q10 value for East Boulder Mine streamflow, irrigation season
receiving stream ambient concentration, C_s	290 µmhos/cm	186 mg/L	SMC Monitoring Data, assumed equal to median of all values from EBR-007 and EBR-008; period of record
discharge volume, Q_d	162,771 ft³/d	1.9 cfs	
EC concentration at in ground water below Mason Ditch, C_d	1,190 µmhos/cm	764 mg/L	
CLOSURE *Boe Ranch LAD* Days 1-120 East Boulder River TDS concentration during non-irrigation season (5 cfs)	536 µmhos/cm	**344 mg/L**	**This value is less than 500 mg/L TDS projected at 5 cfs.**
CLOSURE *Boe Ranch LAD* Days 1-120 East Boulder River TDS concentration during irrigation season (2 cfs)	727 µmhos/cm	**466 mg/L**	**This value is less than 500 mg/L TDS projected at 2 cfs.**

CLOSURE Boe Ranch LAD Days 1-120: Disposal of treated mixed adit, tailings, and stored waters produces a salts concentration in ground water less than the Class II beneficial use criterion of 2,500 µmhos/cm EC at the Boe Ranch.

CLOSURE *Boe Ranch LAD* Days 121-365: Salinity Calculations	**CLOSURE: Days 121-165, storage of 150 gpm treated adit water with 412 gpm treated tailings waters would occur at the Boe Ranch LAD. Days 166-365, storage of 150 gpm treated adit water in the Boe Ranch LAD storage pond. No disposal of water would occur at the Boe Ranch.**
CLOSURE *East Boulder Mine* Days 121-365 Salinity Calculations	**CLOSURE: Days 121-365 No disposal of water would occur at the East Boulder Mine**
CLOSURE *Boe Ranch LAD* Days 366-486: Salinity Calculations	**CLOSURE: Second LAD season Days 366-486, 150 gpm of treated adit water and 433 gpm treated stored waters would be disposed at Boe Ranch LAD. Beginning on Day 487, the Boe Ranch would be decommissioned.**

Day 365 volume in LAD storage pond; days 121-157 mixed treated tailings plus adit water; days 158-365 treated adit water	**80** MG	**461** gpm (24 hr)	rate to dewater LAD storage pond, second LAD season in 120 days
volume of LAD applied; evaporation factor taken, V_1	82,389 ft³/d	**428** gpm (24 hr)	the rate of adit, tailings, and stored waters that would be LAD at the Boe Ranch, evaporation factor applied
salts concentration in applied LAD adit water; assume pivots 30% evaporation, no post plant salt uptake credit, C_1	976 mg/L	1,523 µmhos/cm	calculated EC in applied LAD waters
salts concentration in ground water resulting **from applied LAD**	977 µmhos/cm	977 µmhos/cm	**salts concentration** in ground water resulting **from liner leakage plus applied LAD**
salts concentration in ground water at Mason Ditch resulting **from liner leakage, applied LAD, and Mason Ditch**	793 µmhos/cm	**796** µmhos/cm	**CLOSURE *Boe Ranch LAD* EC concentration at in ground water below Mason Ditch, C_d**
CLOSURE *Boe Ranch LAD* East Boulder River TDS concentration during non-irrigation season (5 cfs)	**238 mg/L**	371 µmhos/cm	TDS value projected from EC at 5 cfs
CLOSURE *Boe Ranch LAD* East Boulder River TDS concentration during irrigation season (2 cfs)	**291 mg/L**	454 µmhos/cm	TDS value projected from EC at 2 cfs

CLOSURE Boe Ranch LAD Days 366-486: Disposal of treated adit water with stored water produces a salts concentration in ground water less than the Class II beneficial use criterion on 2,500 µmhos/cm EC.

CLOSURE *Boe Ranch LAD* Days 487-548: Salinity Calculations			**CLOSURE: Days 487-548, no disposal would occur at the Boe Ranch LAD**		
CLOSURE *East Boulder Mine* Days 487-548 Salinity Calculations			**CLOSURE: Days 487-548, 150 gpm adit water would be disposed at the mine percolation pond.**		
upgradient concentration of TDS in aquifer (average of WW-1 and EBMW-6/EBMW-7), C_A	311	mg/L	484	µmhos/cm	EC calculated from TDS; Stillwater Monitoring Data
70% Volume of aquifer available for mixing Q_1=kiA$_1$	76,409	ft^3/d	**150**	gpm (24 hr)	treated adit water percolated at East Boulder Mine percolation pond
Volume of adit water percolated at East Boulder Mine, V_p	28,877	ft^3/d	145	gpm (24 hr)	calculation per 17.30.517(d)
Volume of aquifer available for mixing Q_2=kiA	27,891	ft^3/d	**605**	mg/L	projected TDS calculated from EC
based on Stillwater east side adit water salts concentration decline data after cessation of blasting and mining, C_2	944	µmhos/cm	76	µmhos/cm	1996-1999 median baseline EC concentration from SMC monitoring data (Hydrometrics 2001)
receiving stream baseline ambient concentration at EBR-001, Q_c	49	mg/L	5.0	cfs	7Q10 at Boulder River USGS gaging station; MPDES Statement of Basis page 4
receiving streamflow, Q_s	423,000	ft^3/d			
CLOSURE *East Boulder Mine* Days 487-548: Salt concentration in ground water below East Boulder Mine	591	mg/L	**922**	µmhos/cm	projected ground water EC in aquifer at SP-11
CLOSURE *East Boulder Mine* Days 487-548 Salt concentration in East Boulder River below East Boulder Mine at 7Q$_{10}$	**378**	mg/L	589	µmhos/cm	projected TDS in East Boulder River at EBR-004/4A

CLOSURE *East Boulder Mine* Days 487-548: Percolation of 150 gpm (24 hr) at the East Boulder Mine would produce an EC less than the ground water Class I Beneficial Use criterion of 1,000 µmhos/cm EC at the East Boulder Mine.