Executive Summary

This Final Feasibility Study (FS) Report (report) documents the development and evaluation of remedial alternatives for the active Questa Mine (site) located near the Village of Questa in northern New Mexico. The site is owned and operated by Chevron Mining Inc. (CMI), formerly Molycorp. The site includes the underground mine, a mill, a tailing pipeline with a segment located adjacent to State Highway 38 and a segment that traverses the valley west toward the tailing facility, and a tailing facility.

The Remedial Investigation (RI)/Feasibility Study (FS) process includes three components: the remedial investigation, the risk assessment, and the feasibility study.

A RI was initiated in September 2001 as part of the RI/FS agreed to as part of the Administrative Order on Consent (AOC) with the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Docket No. 6-09-01. The objectives of the RI/FS are:

- By conducting a RI, determine the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants (hereinafter "contaminants") at or from the site.
- By conducting a FS, determine and evaluate alternatives for remedial action to prevent, mitigate, or otherwise respond to or remedy release or threatened release of contaminants at or from the site or facility.

The RI report describes the results of the investigation and the nature and extent of contamination at the site and summarizes the sources and potentially affected media. Data collected during the investigation was used in the risk assessment and this feasibility study. The risk assessment addresses the threat to the public health, welfare, or the environment.

The FS Report evaluates alternatives for remedial action based on the risk assessment, and encompasses a two-stage process. The first stage of the FS included the identification and screening of remedial technologies and the development and evaluation of alternatives to address areas identified in the EPA's human health and ecological risk assessments that pose a potential risk. The second stage includes the detailed evaluation of alternatives.

This FS takes into consideration current and reasonably anticipated future land uses, including current and reasonably anticipated future mining operations; closure and reclamation requirements under state water quality and mining programs; and water management activities for state and federal programs.

The Final FS Report activities included:

- Identification of applicable or relevant and appropriate requirements (ARARs)
- Evaluation of exposure areas that potentially pose a risk for which remedial technologies need to be identified

- Development of remedial action objectives (RAOs), which are criteria that address the area, media, chemicals, and potential receptors (based on identified risks and current and future reasonably anticipated land and water use)
- Identification and screening of potential process options (remedial technologies) to address media and exposure risks of concern
- Development and preliminary screening of remedial alternatives
- Recommendation of alternatives for detailed analysis
- Detailed analysis of remedial alternatives
  - Individual analysis
  - Comparative analysis

ES1.1 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Preliminary ARARs presented in the RI/FS Work Plan were updated and refined during the FS based on additional information obtained during the RI and were provided by the agencies. Requirements that were identified as ARARs are: 1) Chemical-Specific ARARs, 2) Location-Specific ARARs, and 3) Action-Specific ARARs. ARARs are identified on a site-specific basis using a two-part analysis: 1) determination of whether or not a given requirement is applicable and 2) determination of whether or not a requirement is relevant and appropriate if it is not applicable (EPA 1988a). “Applicable” and “relevant and appropriate” requirements refer to cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations under federal or state law. The difference between the two is that “applicable” requirements *specifically* address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance, whereas “relevant and appropriate” requirements address problems or situations *sufficiently similar* to those at a particular site but are not legally applicable to that site. As noted, several of the ARARs are classified as such because they describe an applicable process but do not describe a remediation standard (see Table 2-1 in the FS). There is more discretion in the determination of relevant and appropriate; it is possible for only part of a requirement to be considered relevant and appropriate in a given case. When a determination is made by EPA that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

Additionally, non-publicized advisories, proposed rules, criteria, or guidance documents issued by federal or state government that are not legally binding and do not have the status of potential ARARs, in many circumstances, are to be considered (i.e., To Be Considered [TBC]) material along with ARARs and may be used in determining the necessary level of cleanup for protection of health or the environment.

ARARs will define cleanup goals when they set an acceptable level with respect to site-specific factors. However, cleanup goals for some substances may have to be based on non-promulgated criteria and advisories rather than on ARARs because ARARs do not exist for those substances or because an ARAR alone would not be sufficiently protective in the given circumstances. In these situations, the cleanup requirements, in order to meet the cleanup goals, will not be based on ARARs alone but also TBCs.

In accordance with EPA policy and guidance, ARARs (and TBCs necessary for protection) must be attained for contaminants remaining on-site at the completion of the remedial action (unless a waiver is justified). EPA also intends that the implementation of remedial actions should also comply with ARARs (and TBCs as appropriate).

ES1.2 EXPOSURE AREAS THAT POTENTIALLY POSE A RISK

The RI/FS Work Plan (URS 2007b) defined exposure areas to be characterized for use in the risk assessment, in order to define whether or not each exposure area potentially posed an unacceptable risk. Media in exposure areas included soils, riparian soils, surface water, groundwater, sediment, tailing, waste rock, air, aquatic biota, terrestrial biota, and garden produce.

EPA subsequently provided revised exposure areas based on an analysis of concentration ranges and spatial distributions of chemicals of potential concern (COPCs) using the RI data. The EPA Final Risk Assessments (CDM 2009a, CDM 2009b) provide detailed descriptions of these revised exposure areas. A “lines of evidence” approach was then employed to evaluate whether a given area needed to be evaluated in the FS based on the risk calculated in the risk assessments, comparisons to background risk documented in the risk assessments, statistical comparison of site to reference area data, comparison to site-specific PRGs calculated in the risk assessment, the uncertainty in the calculated risk values, comparison to ARARs, toxicity data, plant and animal population and community structure characterization, habitat characterization, and tissue chemistry. Chemicals of concern (COCs) identified in the risk assessment process are to be carried forward for remedial consideration in the FS. COCs were further evaluated for ecological significance and whether concentrations exceed background or reference concentrations. This evaluation is reported in the *Technical Memorandum – Ecological Chemicals of Concern (COCs) to be Addressed by the Chevron Mining Inc. (CMI) Feasibility Study* (Ecological Significance Technical Memorandum). Tables ES-1 and ES-2 present a summary of the areas and media evaluated in the FS.

ES1.3 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives generally consist of medium-specific or area-specific goals for protecting human health and the environment. Preliminary RAOs were developed by EPA Region 6 to address the protection of human health and ecological receptors for each environmental medium at the site. These RAOs were refined by EPA to address each of the risk assessment exposure areas. Five areas were identified for which remedial alternatives were to be developed:

- Mill Area
- Mine Site Area
- Tailing Facility Area
- Red River and Riparian and South of Tailing Facility Area
- Eagle Rock Lake Area

The EPA RAOs are associated with each of the five alternative areas to address COCs, media of concern, applicable receptors for each area, and current and future land and water uses are presented in Table ES-3.

ES1.4 IDENTIFICATION AND SCREENING OF PROCESS OPTIONS

A primary component of the FS is the identification and screening of available remedial technologies, or process options, that are anticipated to address the RAOs. Remedial technologies are identified and evaluated to select technologies to be considered in the development of alternatives.

The four media of concern for the site include soil, sediment, surface water, and groundwater. Other media of concern are the source materials: tailing and waste rock. The primary source materials for the site are the tailing placed at the tailing facility and in historic tailing spills and the waste rock located in piles surrounding the open pit at the mine site (also known as waste rock dumps under the state water quality permitting programs). The exposure areas identified for inclusion in this FS were combined into 14 associated exposure areas based on commonalities such as location, medium of concern, and COC. Using existing site data and the associated COCs, general response actions were identified for the 14 combined associated exposure areas/media. General response actions are broad classes of actions (e.g., no action, containment, treatment, and removal) that might be implemented alone, or in combination, to address the RAOs. For each general response action, technology types (e.g., horizontal barriers, physical/chemical treatment, and excavation/disposal) and process options (e.g., soil cover, lime neutralization, and excavation and off-site disposal) were identified to address each medium and COC.

The preliminary phase of screening, or the technology screening, was completed by first evaluating those technologies that are technically implementable/feasible. The technologies were then evaluated with respect to three criteria:

- **Effectiveness –** Considers how well a technology or process option handles the estimated areas or volumes of media, how well it addresses the identified RAOs, potential impacts to human health and the environment during construction and implementation of the remedial action, how proven and reliable it is with respect to addressing contaminants and conditions at the site.
- **Implementability –** Includes things such as the ability to obtain necessary permits for off-site actions; the availability of treatment, storage, and disposal services (including capacity);

and the availability of needed equipment and workers in order to implement the technology/process option.

- **Relative Cost –** Includes initial construction and continued operation and maintenance (O&M) costs, based on engineering judgment, and whether or not costs are high, low, or medium, relative to other process options in the same technology type.

Table ES-4 summarizes the technologies and process options for each medium to be used in the development of alternatives.

ES1.5 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Alternatives were developed and screened for the five alternative areas to address potential risks and RAOs for each media of concern. Using the retained technologies and process options, together with ongoing or planned remedial actions, alternatives as a whole (i.e., combined remedial technologies) were developed for each of these alternative areas and screened with respect to effectiveness, implementability, and cost. The outcome of the alternatives evaluation was an identification of alternatives recommended for detailed analysis.

Each alternative was rated as low, medium, or high, or between two of these (e.g., low to medium), for each of the criteria. These ratings were based on available information, experience with the technologies and process options that comprise each alternative, and professional judgment. Recommendations were made as to which alternatives in each of the five alternative areas should be in the detailed analysis. Any alternative with low effectiveness and/or low implementability in combination with high cost was not recommended for detailed analysis. The No Action/No Further Action alternative is required to be evaluated in the detailed analysis in all cases.

For the five alternative areas, 21 alternatives were developed some with subalternatives. Table ES-5 provides a summary of the alternatives for each area and identifies the major components included in each alternative. Descriptions of the alternatives carried forward from preliminary screening are provided in ES 1.6. Following preliminary screening of the 21 alternatives (total of 29 alternatives/subalternatives), 19 alternatives (total of 27 alternatives/subalternatives) were recommended for detailed analysis. Two alternatives were screened out. The two alternatives that were not recommended for the detailed analysis included: Mine Site Area Alternative 4 (Source Removal and On-Site Placement; Groundwater Extraction and Treatment) and Eagle Rock Lake Area Alternative 4 (Remove Lake).

The Mine Site Alternative 4, which includes complete removal of the rock piles is not recommended for detailed analysis, because it has a low to medium effectiveness due to the exposure of residual scars. This alternative also has a low implementability because it will require an extended duration to complete, involves difficult construction activities, impairs local traffic for potentially long periods, and increases worker hazards. The Eagle Rock Lake Alternative 4, which includes removing the lake, is not recommended for detailed analysis, primarily because the benthic macroinvertebrates ecosystem is not protected and will actually be destroyed in both the short and long-term, and the existing fishery and recreational uses are lost.

In addition to the two alternatives, the Mine Site Area component for disposal of waste rock at an off-site repository was not recommended for detailed analysis, because of its low implementability, impacts to the local community potential human health impacts, and high potential to adversely impact and the environment.

ES1.6 DETAILED ANALYSIS OF ALTERNATIVES

For each of the five alternative areas, alternatives were further developed and an assessment of each alternative against the evaluation criteria was conducted.

- First, an individual analysis was conducted for each alternative using seven of the nine NCP criteria. The two modifying criteria, state and community acceptance, are evaluated by the EPA after the FS undergoes public comment and are not included in the FS.
- Secondly, a comparative analysis was conducted for each of the alternatives within a single alternative area.

The following seven NCP criteria were used in the analysis:

Threshold Criteria:

(1) Overall protection of human health and the environment
(2) Compliance with ARARs

Balancing Criteria:

(3) Long-term effectiveness and permanence
(4) Reduction of toxicity, mobility, and volume through treatment
(5) Short-term effectiveness
(6) Implementability
(7) Cost

The following is a summary of the alternatives developed for each of the five areas followed by a summary of how alternatives compare to each other with respect to each of the criteria. A summary of costs for each alternative and alternative area is provided in Table ES-6.

ES1.6.1 Mill Area

ES1.6.1.1 Description of Alternatives

Alternative 1 – No Further Action

The major components of Alternative 1 include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.

- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.

The Mill Area is currently surrounded by a fence with restricted access through a central gate with a badge identification system. Signs are posted at the gate and on fences to control access. The existing fence, restricted access through the gate, and signage will be maintained as part of this alternative. CMI currently provides a health and safety program and hazard communication for workers at the mill and the program would continue. Other maintenance and monitoring for the Mill Area is included in the alternative, which includes grading of roads; maintenance of structures; water quality monitoring for all wells, seeps, and springs in and along the Mill Area; and storm water management.

Institutional controls include:

- Deed restrictions and advisories applied to alert potential buyers and users of information about the property and the existence of soil containing PCBs and molybdenum and associated risks
- Groundwater use restrictions (i.e., well drilling, current well use, capping/closing of current wells) to be imposed by the State Engineer to prohibit the use of groundwater from current wells at the Mill Area
- Conservation easements[1] are to be applied to protect potential future receptors from contact with soil containing PCBs and molybdenum.

As part of mill decommissioning, the Mill Area will be regraded, a visual horizontal indicator placed and covered with amended Spring Gulch material, and revegetated.

Alternative 2 – Limited Action (Institutional Controls; Health and Safety Program and Hazard Communication; Cover at Mill Decommissioning)

The major components of Alternative 2 include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.
- BMP Plan development and implementation for in-place polychlorinated biphenyls (PCB) management, including, but not limited to, signage and targeted excavation and gravel placement.
- Regrade, cover, and vegetate Mill Area as part of mill decommissioning.

[1] CMI has granted conservation easement to the Village of Questa as "Grantee" and third party beneficiaries (EPA, NMED, EMNRD).

- Visual horizontal indicator placed under the cover as part of mill decommissioning.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Alternative 2 contains many of the same components as Alternative 1, such as recorded institutional controls, controlled access and worker health and safety program. BMPs will be implemented to manage the PCB currently in-place prior to placement of a final cover, in order to prevent the highest concentration PCBs from being spread by grading, wind dispersion, and traffic (i.e., pedestrian or vehicle traffic) through of the Mill Area. Per the TSCA definition for low occupancy use areas, bulk PCB remediation wastes may remain at a cleanup site at concentrations >25 ppm and ≤50 ppm if the site is secured by a fence and marked with a sign including the M_L mark. Therefore, BMPs for the Mill Area include installation of signs indicating the presence of PCBs above cleanup levels and the application of 4 inches of gravel over areas of soil containing concentrations of PCBs greater than 50 mg/kg.

Alternative 3 – Soil Removal (High Concentrations of PCBs >25 mg/kg) and Off-Site Treatment and Disposal (Low Occupancy/Commercial/Industrial)

The major components of Alternative 3 include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.
- Excavate soil greater than the TSCA cleanup level for total PCBs for low occupancy/commercial/industrial use areas (25 mg/kg).
- Confirmation sampling.
- Import clean fill and grade.
- Transport PCB soils and treat and/or dispose at appropriate EPA approved off-site facilities.
- Regrade, cover, and vegetate Mill Area as part of mill decommissioning.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management

Alternative 3 includes excavation of soil with concentrations of PCBs greater than the TSCA cleanup level for total PCBs in low occupancy/commercial/industrial use areas. As specified in 40 CFR § 271.61 (a)(4)(i)(B) for low-occupancy areas, the cleanup level for PCB-affected soil is 25 mg/kg. High concentrations of PCBs in soil are located primarily between the mill building and decline shop.

The estimated area exceeding the TSCA low occupancy cleanup level for total PCBs (Aroclor 1248, 1254, and 1260) is approximately 0.6 acre. Affected soil will be removed initially to a depth of 2.5 feet. Confirmation soil sampling will be conducted to determine if cleanup levels have been attained. If not, additional soil will be excavated until cleanup levels are met or an EPA acceptable depth has been reached. Assuming a 2.5-foot depth of excavation for the purposes of this FS report, the estimated volume of PCB-affected soil requiring removal is approximately 2,400 cubic yards. The excavated soil will be separated into soils containing PCBs >50 ppm and those with PCBs ≤50 ppm. The >50 ppm PCB-soils will be transported by truck-mounted roll-offs to the nearest off-site treatment, storage, and disposal (TSD) facility, approximately 400 miles away, that accepts and treats PCB-affected soil. The ≤50 ppm PCB-soils will be transported to the nearest off-site facility, approximately 300 miles away that accepts but does not treat the PCB-affected soil. Soil samples will be collected and analyzed to identify constituent concentrations prior to transport.

Approximately 2,400 cubic yards of clean fill material will be placed into the excavation. Sources of fill material include Spring Gulch Rock Pile which may require screening to achieve a suitable gradation for the backfill.

As part of mill decommissioning, the Mill Area will be regraded, covered with amended Spring Gulch material, and revegetated.

Alternative 4 – Soil Removal (High Concentrations of PCBs >10 mg/kg) and Treatment and Disposal and Source Containment (High Occupancy/Residential)

Subalternative 4A: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Soil Cap

The major components of Subalternative 4A include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.
- Excavate soil greater than the TSCA cleanup level for total PCBs for high-occupancy/residential use with a cap (10 mg/kg).
- Confirmation sampling.
- Import clean fill and grade.
- Transport PCB soils and treat and/or dispose at appropriate EPA approved off-site facilities.
- Apply a soil cap over soil areas exceeding the TSCA cleanup level for PCBs for high-occupancy/residential use (1 mg/kg) and/or the residential PRG for molybdenum (503 mg/kg).
- Regrade, cover, and vegetate appropriate portions of the Mill Area as part of mill decommissioning.

- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Subalternative 4A includes continuation of controlled access to the Mill Area, health and safety programs, and institutional controls to protect future receptors from contact or ingestion of soil below the cap.

Subalternative 4A includes targeted removal of PCB-affected soils, off-site disposal, and installation of a cap. In order for the cap to be compliant with PCB cleanup provisions in 40 CFR § 271.61 (a)(4)(i)(a) (TSCA 2007) for high occupancy areas, total PCB concentrations must be below 10 mg/kg if PCBs remain in place with no plans for removal or treatment of the soil. The total area includes approximately 0.8 acre. Assuming a 2.5-foot depth of excavation for this FS report, the estimated volume of PCB-affected soil requiring removal is approximately 3,300 cubic yards. Depth of excavation will be determined in a manner consistent with that described in Alternative 3.

The PCB-affected soil will be separated, transported, and disposed in a manner consistent with that described in Alternative 3.

Approximately 3,300 cubic yards of clean fill material will be placed into the excavation. Sources of fill material include the Spring Gulch Rock Pile which may require screening to achieve a suitable gradation for the backfill.

Areas not excavated that contain soil with concentrations exceeding either the TSCA cleanup level for high occupancy/residential use areas for total PCBs (1 mg/kg) or the residential PRG for molybdenum will be capped. The deed restrictions in place prohibit future residential or commercial uses of this area. This area is approximately 28 acres. The cap material will be soil. Soil material needed to meet the requirements of 40 CFR § 761.61 (a)(7) (TSCA 2007) will be obtained from an off-site borrow source, which is several hundred miles away (100 to 250 miles).

A soil cap over 28 acres requires approximately 45,000 cubic yards of off-site clay material, assuming a 1-foot-thick cap. A 6-inch thickness placed on top of the compacted clay cap requires approximately 23,000 cubic yards of Spring Gulch material.

Upon decommissioning, areas of the mill outside the remediated footprint area will be regraded, covered with amended Spring Gulch material, and revegetated. Areas required for water management will be excluded from reclamation activities until no longer used for this purpose. The compacted clay soil cap will also be covered with amended Spring Gulch material and revegetated upon closure.

Subalternative 4B: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Asphalt Cap

The major components of Subalternative 4B include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.
- Excavate soil greater than the TSCA cleanup level for total PCBs for high occupancy/residential use with a cap (10 mg/kg).
- Confirmation sampling.
- Import clean fill and grade.
- Transport PCB soils and treat and/or dispose at appropriate EPA approved off-site facilities.
- Apply an asphalt cap over soil areas exceeding the TSCA cleanup level for PCBs for high occupancy/residential use (1 mg/kg) and/or the residential PRG for molybdenum (503 mg/kg).
- Regrade, cover, and vegetate appropriate portions of the Mill Area as part of mill decommissioning.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Removal and disposal activities will be similar to those described for Subalternative 4A.

The area to be capped is approximately 28 acres. The cap material will be asphalt. Asphalt will be obtained from an off-site contractor approximately 30 miles away. The asphalt will be placed over the affected soil areas and compacted using an asphalt paver. Approximately 23,000 cubic yards of asphalt will be required for a 6-inch thick layer of asphalt to cap the 28 acres. Confirmation sampling described for Subalternative 4A would also be included.

Alternative 5 – Soil Removal and Treatment and Disposal (High Occupancy/Residential)

Subalternative 5A: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Off-Site Disposal of Molybdenum Soil

The major components of Subalternative 5A include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.
- Excavate soil where concentrations are greater than the residential PRG for molybdenum and/or the TSCA cleanup level for total PCBs for high occupancy/residential use (1 mg/kg).

- Transport molybdenum-affected soil and dispose at an appropriate off-site facility.
- Transport PCB-affected soils and treat and/or dispose at appropriate EPA approved off-site facilities.
- Confirmation sampling.
- Import clean fill and grade.
- Regrade, cover, and vegetate Mill Area as part of mill decommissioning.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Subalternative 5A includes continuation of controlled access to the Mill Area, health and safety programs, and institutional controls to protect future receptors from contact or ingestion of soil.

Alternative 5A adds removal of soil with concentrations of molybdenum greater than the residential PRG and total PCBs greater than the TSCA cleanup level for high occupancy/residential use areas.

The high occupancy/residential cleanup level for total PCBs (Aroclor 1248, 1254, and 1260) is 1 mg/kg and the residential PRG for molybdenum (non-cancer) is 503 mg/kg. Areas with soil concentrations greater than these cleanup levels will be excavated to eliminate direct exposure to soil. The area with concentrations in soil exceeding the high occupancy/residential cleanup level for total PCBs is approximately 28 acres. The area with concentrations in soil exceeding the residential non-cancer PRG for molybdenum is approximately 12 acres. Assuming a 2.5-foot depth for this FS report, approximately 113,000 cubic yards of PCB-affected soil and 49,000 cubic yards of molybdenum-affected soil will be excavated over the full 40 acres. Depth of excavation will be determined in a manner consistent with that described in Alternative 3.

The excavated soil will be separated, transported, and disposed in a manner consistent with that described in Alternative 3.

The molybdenum-affected soil will be disposed off-site at a solid waste landfill, approximately 30 miles away.

The excavation will be backfilled with approximately 162,000 cubic yards of clean fill material. The clean fill will be obtained from the Spring Gulch Rock Pile and may require amending prior to placement and revegetation.

Subalternative 5B: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil

The major components of Subalternative 5B include:

- Continue controlled access (fencing, signage, etc.) to the site.

- Continue current worker health and safety program and hazard communication.
- Excavate soil where concentrations are greater than the residential PRG for molybdenum and/or the TSCA cleanup level for total PCBs for high occupancy/residential use (1 mg/kg).
- Transport molybdenum-affected soil and dispose at an appropriate on-site location.
- Transport PCB-affected soils and treat and/or dispose at appropriate EPA approved off-site facilities.
- Confirmation sampling.
- Import clean fill and grade.
- Regrade, cover, and vegetate Mill Area as part of mill decommissioning.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Removal and disposal activities will be similar to those described for Subalternative 5A except that the molybdenum-affected soils (approximately 49,000 cubic yards) will be excavated and disposed on-site. On-site disposal includes either placement in an impoundment at the tailing facility or at an appropriate location on-site, possibly the pit repository. If the pit repository is not available due to the potential future mining of the molybdenum ore bodies there, new cells will be constructed. The cells will be lined and of similar construction to the cells designed to contain the sludge or filter cake from the water treatment plant and otherwise comply with applicable disposal regulations.

Subalternative 5C: Soil Removal; On-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil

The major components of Subalternative 5C include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue current worker health and safety program and hazard communication.
- Excavate soil where concentrations are greater than the residential PRG for molybdenum and/or the TSCA cleanup level for total PCBs for high occupancy/residential use (1 mg/kg).
- Transport molybdenum-affected soil and dispose at an appropriate on-site location.
- On-site treatment (i.e., thermal desorption) of PCB-affected soil and on-site disposal of treated soil and molybdenum-affected soil.
- Manage on-site air emissions from thermal desorption process.
- Confirmation sampling.

- Import clean fill and grade.
- Regrade, cover, and vegetate Mill Area as part of mill decommissioning.
- Recorded institutional controls (deed restrictions): restrictive covenant, conservation easement, groundwater use and well drilling restrictions.
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Removal activities will be similar to those described for Subalternative 5B. However, all PCB-affected soils will be treated on-site. On-site treatment consists of the use of a thermal desorption unit. The direct-fired system ultimately heats the soil to temperatures ranging from 1,200 degrees Fahrenheit (°F) to 2,000°F, thereby destroying organics to levels below cleanup standards. The thermal treatment process likely consists of using a front-end loader to load soil into the feed hopper, screening the soil to the appropriate grain size, weighing and conveying the soil to the thermal desorber rotary drum/heat exchanger, where air emissions are routed to a filter baghouse and then a thermal oxidizer. The treated soil exits the thermal desorber, is rehydrated, and conveyed for stockpiling. The thermal desorption unit requires collection and treatment of air emissions generated from the thermal desorption process. Although the soil will be treated for PCBs, molybdenum still remains in the soil at concentrations greater than the residential cleanup level for molybdenum (503 mg/kg). Therefore, the PCB-treated soils containing molybdenum above cleanup standards requires disposal on-site, and will be combined with the molybdenum-only soil initially separated out prior to treatment. Testing of soils and other residuals will be performed to characterize constituent concentrations prior to treatment and/or disposal. As in Subalternative 5B, on-site disposal includes placement of soils either in an impoundment at the tailing facility or at an appropriate location on site, possibly the pit repository.

ES1.6.1.2 Mill Area Analysis of Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 (No Further Action) is the least protective of human health as impacted by direct contact/ingestion of PCB- and molybdenum-affected soil. Alternative 1 will be protective of human health because of restricted access, and the need to comply with worker health and safety, and hazard communications program requirements. An increased level of protection occurs under Alternative 2 (Limited Action) by limited excavation of soils containing PCBs greater than 50 ppm, gravel placement on soils with PCBs greater than 25 ppm, and institutional controls. Recorded institutional controls such as a conservation easement and deed restrictions for the Mill Area will restrict future uses. Deed restrictions will be layered with other institutional controls such as well drilling prohibitions imposed by the State Engineer. These layered controls will restrict future human receptor exposure to soil and groundwater.

Subalternatives 5A, 5B, and 5C are the most protective of potential future residents because soil is removed and treated. Deed restrictions prohibit residential/commercial use of the area.

Subalternatives 4A and 4B are also protective of potential future residents. However, residual contamination remains and requires long-term management. Alternative 3 is protective of potential future commercial/industrial uses, which is the anticipated future land use for the mill area.

Overall, Alternative 3 and Subalternatives 4A, 4B, 5A, 5B, and 5C are more protective of human health than Alternative 2 and Alternative 1.

Protection of the environment is not evaluated because ecological risks for the Mill Area were not estimated in the Final Baseline Ecological Risk Assessment.

Compliance with ARARs

Implementation of Alternatives 2 and 3 and Subalternatives 4A, 4B, 5A, 5B, and 5C comply with the applicable and relevant and appropriate ARARs. Implementation of Alternative 1 complies with applicable ARARs, except that the 40 CFR Part 761, Subpart D PCB soil cleanup levels would not be met, because no soil is removed.

Long-Term Effectiveness and Permanence

Alternative 1 is the least effective in the long-term because there will not be a reduction in toxicity, mobility, or volume of soil contaminants and PCB- and molybdenum affected soils remain in place. Alternative 2 includes recorded institutional controls and deed restrictions to restrict future human exposure to affected soil and soil containing PCBs greater than 50 ppm are removed. However, under Alternative 2 (Limited Action), molybdenum-affected soil and PCB-affected soil (less than or equal to 50 ppm) remain.

Alternative 3 and Subalternatives 5A, 5B, and 5C provide a permanent remedy through removal of soils. Alternative 3 and Subalternative 5A include off-site disposal of soil. This is more effective in the long term than Subalternatives 5B and 5C that include long-term management of an on-site facility. Off-site facilities have established reliable controls for long-term management of soils. Subalternatives 4A and 4B provide a long-term remedy that requires long-term maintenance of the cap, but molybdenum- and PCB-affected soil remain under the cap. Subalternative 4B requires less frequent maintenance of the asphalt cap versus the clay soil cap in Subalternative 4A. Institutional controls are included in each alternative to restrict future human receptor exposure to affected soil.

Overall, the alternatives that have the highest long-term effectiveness and permanence in order of most effective to least effective are as follows: Alternative 3 is equal to Subalternative 5A, which is more effective than Subalternatives 5B and 5C, which are more effective than Subalternatives 4A and 4B, which are more effective than Alternative 2, and then Alternative 1.

Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction of toxicity, mobility, or volume through treatment under Alternative 1 (No Further Action) or Alternative 2 (Limited Action). Molybdenum and PCBs in soil remain in place and untreated.

Subalternatives 4A, 4B, 5A, and 5B provide reduction in toxicity, mobility, and volume through treatment of high concentration PCB soil (i.e., incineration) at a TSD facility. However, soil containing PCBs less than or equal to 50 ppm will be disposed at a facility that does not treat the soil. In Subalternative 5C, PCB-affected soil will be treated (i.e., thermal desorption) on-site prior to disposal, which also reduces the toxicity, mobility, and volume through treatment of soil but does not treat the molybdenum in soil. The quantity of soil removed and treated in Alternative 3 and Subalternatives 4A and 4B are similar in volume, but less than the volume removed and treated in Subalternatives 5A, 5B, and 5C. The molybdenum-affected soils in Subalternatives 5A, 5B, and 5C will either be disposed of on site or transported to an off-site solid waste landfill. There is no reduction of toxicity, mobility or volume by treatment of molybdenum in soil.

Overall, Subalternatives 5A, 5B, and 5C provide greater reduction in toxicity, mobility, and volume than Alternative 3 and Subalternatives 4A and 4B. Alternative 1 and Alternative 2 do not reduce toxicity, mobility or volume of the affected contaminated soil.

Short-Term Effectiveness

Alternative 1 (No Further Action) provides no increased short-term risks because no construction-related actions will be implemented that would create additional risks to workers or the community. Alternative 2 (Limited Action) involves a small potential for increased risks from limited excavation/hauling of approximately 200 cubic yards (bulked) PCB soil, and hauling/placement of approximately 2,400 cubic yards of gravel.

Potential additional risks to workers and the community may occur during the implementation of the targeted removal actions in Alternative 3 and Subalternatives 4A and 4B, and the large scale removal in Alternatives 5A, 5B, and 5C. Risks to workers may occur during excavation around buildings with buried utilities. Risks associated with truck haulage on local roads will increase the potential for traffic hazards in the community. Subalternatives 5A and 5B include increased truck traffic due to the increased volume of soil being handled. There will be increased risks to workers during the operation of the thermal treatment system and management of byproducts in Subalternative 5C. Subalternatives 4A and 4B include the import of cap material from off-site sources. This will increase truck traffic and thereby potential risks to the community. The haul distance for clay materials are more than double the distance for asphalt materials.

Overall, the alternatives from the most effective (least short-term impacts) to least effective (greatest short-term impacts) for remedy implementation are as follows: Alternative 1 greater than Alternative 2, greater than Alternative 3, greater than Subalternative 4A, then 4B, then Subalternative 5C, and then Subalternative 5A equal to Subalternative 5B.

Implementability

Alternative 1 (No Further Action) does not include construction activities, and Alternative 2 (Limited Action) includes limited construction activities, and are the easiest to implement.

Alternative 3 and Subalternatives 4A, 4B, 5A, 5B, and 5C include excavation, transport, and disposal of larger volumes of soil, which is a common practice. Excavation and backfill of approximately 2,000 to 3,000 cubic yards of soil in Alternative 3 and Subalternatives 4A and 4B results in a shorter construction period and uses less construction equipment to complete than the 160,000 cubic yards of soil in Subalternatives 5A, 5B, and 5C. Subalternative 5A includes transport of the largest quantity of soil and the longest haul distances for disposal. Subalternative 5A includes disposal of soils at three off-site locations (i.e., local solid waste landfill, RCRA Subtitle C treatment facility, and RCRA Subtitle C non-treatment facility). Subalternative 5B includes transport of PCB soils to off-site locations (TSD facility and non-treatment facility). Subalternatives 5B and 5C include transport of molybdenum soils a shorter distance to an on-site location. Alternative 3 and Subalternatives 4A and 4B include transport of the 2,000 to 3,000 cubic yards of soils to the TSD and non-treatment facilities.

Subalternatives 4A and 4B include import of materials from off-site locations (clay soil, 100 miles and asphalt, 30 miles). Subalternative 4A includes compacting the clay soil to achieve the requirements specified by TSCA resulting in a longer construction period than the asphalt paving in Subalternative 4B.

Subalternative 5C includes on-site thermal treatment of soil. Thermal desorption subcontractors are limited and the technology requires multiple treatment trains (i.e., soil preprocessing, soil treatment, air treatment, and PCB recovery), resulting in the on-site transport of complex equipment and use of by specially trained operators. Collection/management of treatment byproducts (i.e., air emissions) results in additional sampling and monitoring activities. Thermal treatment of 113,000 cubic yards of PCB-affected soils will take approximately 3 to 4 years to complete.

Overall, Alternative 1 is the easiest to implement followed by Alternative 2. Alternative 3 is the next easiest alternative to implement and notably easier than Subalternatives 4A and 4B, which include soil removal and transport and clay soil/asphalt transport and placement for the cap. Subalternatives 5A, 5B, and 5C involve the greatest construction activities, which include excavation and backfill of large volumes of soil and transport of soil (Subalternatives 5A and 5B) over large distances or on-site treatment and disposal of soil (Subalternatives 5C).

Cost

Alternative 1 (No Further Action) does not include construction activities and has the lowest cost. For an additional cost of approximately $2.1 million (present value), limited excavation of high concentration PCB soils and gravel placement are included (Alternative 2). An approximate increase of $100,000 (present value) includes targeted soil removal (Alternative 3) for the commercial/industrial receptor scenario. An increase of approximately $11 million (present value) over Alternative 3 includes limited soil removal and cap installation (Subalternatives 4A and 4B). Installation of an asphalt cap (Subalternative 4B) costs approximately $2 million (present value) less than the clay soil cap (Subalternative 4A). An approximate $30 to $36 million (present value) increase in cost over Subalternatives 4A and 4B adds removal of a larger volume of soil (Subalternatives 5A, 5B, and 5C). On-site treatment and disposal of PCB soils (Subalternative 5C) costs approximately the same as off-site treatment and disposal (Subalternatives 5A and 5B).

ES1.6.2 Mine Site Area

ES1.6.2.1 Description of Alternatives

Alternative 1 – No Further Action

The major components of this alternative include:

- Continue controlled access (e.g., fencing, gate, signage).
- Continue operating 3 existing withdrawal wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjustment using lime and placement at the tailing facility (for tailing slurry/pipeline maintenance).
- Continue current storm water controls and conveyance of storm water to the open pit.
- Continue to maintain existing 8,720- and 8,920-foot storm water diversions at the roadside rock piles that convey run-off to the open pit.
- Continue collection and conveyance of Capulin and Goathill North rock pile seepage to the subsidence zone.
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence zone, old underground workings, and decline.
- Water in the underground mine will be maintained at an elevation below the Red River, and water withdrawn from the underground mine will be pH adjusted with lime.
- Continue groundwater and geotechnical monitoring and general site maintenance of storm water diversions.
- Recorded institutional controls (deed restrictions): restrictive covenant (Administrative Area), conservation easement, groundwater use and well drilling restrictions.

Deed restrictions will be layered with other institutional controls such as a conservation easement. The recorded institutional controls identify specific requirements and restrictions on future use. Controlled access to the mine site will continue. Controls such as fencing, placement of signage, and guarded entry points are used to restrict access to the site.

CMI has constructed storm water run-on and run-off diversions at rock piles and the diversions are maintained in this alternative. Storm water for the roadside rock piles and pit rock piles is diverted to the open pit directly or via the North Detention Pond where it is temporarily collected and pumped to the open pit.

Continuation of water management for use in operations is a component of Alternative 1. This includes: 1) operation of the withdrawal well system within the Red River alluvial aquifer located downgradient of the roadside rock pile drainages, 2) operation of the Spring 13 and

Spring 39 collection systems, 3) operation of the Capulin seepage collection and pumpback system and the Goathill North toe drain, and 4) capture and management of water in the underground mine. The total amount of water collected in these systems is approximately 770 gpm. Water from the groundwater collection systems (e.g., withdrawal wells, interceptor drains, spring collection systems) is pumped to the mill, pH adjusted with lime, and is used as makeup water for pipeline maintenance and to transport slurry. Water is maintained at a pH of between 6.0 and 9.0 as required in DP-933. During periods when the mill is not operating, this pH-adjusted water is conveyed through the tailing pipeline as necessary for maintenance purposes and for dust control at the tailing facility.

The withdrawal well system extracts groundwater from the alluvial aquifer along the base of the roadside rock piles. The system includes three extractions wells, GWW-1, GWW-2, and GWW-3. The total extraction rate from the withdrawal wells is approximately 420 gpm and the water is pumped to the mill for use in operations as per the NPDES permit. The original objective of the system was to construct and pump a groundwater withdrawal well to capture potential discharges from point source mine operations through a hydrologic connection in the vicinity of the old mill site. CMI installed two additional withdrawal wells to collect potential mine-related discharges that may occur from other side drainages.

The Spring 13 and Spring 39 collection systems collect shallow alluvial seepage that forms aluminum hydroxide precipitate along the bank of Red River. The systems are French drains that are 1.5 feet below the low water level of the river. The collected water flows by gravity to a concrete vault where it is pumped through a pipeline to the mill. The Spring 13 collection system is located near the mouth of Capulin Canyon and collects approximately 20 gpm of water. Spring 39 is located at the base of the Goathill debris fan and collects approximately 80 gpm of water.

Seepage from Capulin and Goathill North rock piles is currently being collected and managed. The Capulin seepage collection and pumpback system collects an average of approximately 20 gpm of water derived from seepage from Capulin Rock Pile and storm water. The collected water is pumped through a horizontal borehole to the Goathill drainage, then is directed overland in an unlined channel to the subsidence zone. The Goathill North Rock Pile toe drain collects seepage at a rate of approximately 10 gpm; this seepage also is directed to the subsidence zone.

The underground mine collects the natural flow of colluvial and bedrock water from the open pit, the subsidence zone, old underground workings, and the decline, as well as surface water run-off directed to the open pit and subsidence zone and seepage from Capulin and Goathill North rock piles. The underground mine is currently dewatered at an average rate of approximately 250 gpm and the water level is maintained below the Red River, maintaining a hydraulic gradient in bedrock toward the mine in the areas of the open pit, the subsidence zone, old underground workings, and the decline.

Numerical and analytical analyses were performed to evaluate whether or not preliminary cleanup levels could be achieved under Alternative 1. For Alternative 1, it could not be demonstrated that the existing groundwater extraction systems in front of the roadside waste rock piles will achieve cleanup in the alluvial aquifer at all locations for all constituents, although the concentrations in some alluvial aquifer wells have decreased due to extraction. Also, it could not be demonstrated that colluvial and bedrock groundwater at the mine site can meet some cleanup levels at all locations for all constituents. Groundwater in colluvium and bedrock already meets some cleanup levels in a number of locations, such as in the debris fans in Capulin, Goathill, and Slickline drainages and in portions of the debris fans in the roadside rock pile drainages. Some of the wells used to monitor water quality in these debris fans may represent a mixing of colluvial and alluvial groundwater.

Alternative 2 – Limited Action (Institutional Controls; Storm Water, Surface Water, and Groundwater Management and Treatment)

The major components of this alternative include:

- Continue controlled access (e.g., fencing, gate, signage).
- Continue operating 3 existing withdrawal wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjust water.
- Pipe seepage to and install a fence around the Capulin seepage collection and pumpback ponds to prevent exposure by a visitor/trespasser to the seepage.
- Continue current storm water controls and conveyance of storm water to the open pit.
- Continue to maintain existing 8,720- and 8,920-foot storm water diversions at the roadside rock piles that convey run-off to the open pit.
- Continue collection and conveyance of Capulin and Goathill North rock pile seepage to the subsidence zone.
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence zone, old underground workings, and decline.
- Water in the underground mine will be maintained at an elevation below the Red River and water withdrawn from the underground mine will be pH adjusted with lime.
- Continue groundwater and geotechnical monitoring and general site maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event, or an alternative design approved by the EPA during the remedial design phase).
- Recorded institutional controls (deed restrictions): restrictive covenant (Administrative Area), conservation easement, groundwater use and well drilling restrictions.

Controlled access limits human access to the mine site. In addition, piping of seepage and a fence installed around the Capulin seepage collection catchments and the pumpback pond addresses potential exposure to the seepage by a visitor/trespasser.

Alternative 2 includes the same storm water, surface water, and groundwater management components as Alternative 1. In addition, Alternative 2 includes installation of pipe at the toe of Capulin Rock Pile, to direct seepage to the upper sump and subsequently fenced pumpback pond. Seepage will also be piped from the toe of Goathill North Rock Pile to the subsidence zone.

General maintenance of the Mine Site Area with monitoring continues during operation and after closure.

Water from the groundwater collection systems (e.g., withdrawal wells, interceptor drains, spring collection systems) is pumped to the mill, pH adjusted with lime, and is used as makeup water for pipeline maintenance to transport slurry. Water is maintained at a pH of between 6.0 and 9.0 as required in DP-933. During periods when the mill is not operating, this pH adjusted water is conveyed through the tailing pipeline as necessary for maintenance purposes and for dust control at the tailing facility.

A new water treatment plant will be constructed and online approximately 6 months prior to mill decommissioning. Other options under the CERCLA process for timing of the new water treatment plant include early implementation at years 0, 10, 20, and 30 of the remedial action. It is also noted that early implementation may also be required under state permitting requirements.

Numerical and analytical analyses were performed to evaluate whether or not preliminary cleanup levels could be achieved under Alternative 2. For Alternative 2, it could not be demonstrated that the existing groundwater extraction systems in front of the roadside waste rock piles will achieve cleanup in the alluvial aquifer at all locations for all constituents, although the concentrations in some alluvial aquifer wells have decreased due to extraction. Also, it could not be demonstrated that colluvial and bedrock groundwater at the mine site can meet some cleanup levels at all locations for all constituents. Groundwater in colluvium and bedrock already meets some cleanup levels in a number of locations, such as in the debris fans in Capulin, Goathill, and Slickline drainages, and portions of the debris fans in the roadside rock pile drainages. Some of the wells used to monitor water quality in these debris fans may represent a mixing of colluvial and alluvial groundwater.

Alternative 3 – Source Containment; Storm Water, Surface Water, and Groundwater Management; Groundwater Extraction and Treatment

Subalternative 3A – Minimum 3H:1V: Balanced-Cut-Fill, Partial/Complete Removal, On-Site Repository, Regrade, and Cover at a Minimum of 3H:1V Interbench Slopes; Storm Water, Surface Water, and Groundwater Management; Groundwater Extraction and Treatment

The major components of this subalternative include:

- Balanced-cut-fill, partial/complete removal, and regrade of the rock piles using minimum 3H:1V interbench slopes; amended cover; and revegetation.
- Construct and utilize an on-site repository(ies) for waste rock. Locations are to be determined during the remedial design phase for each rock pile.
- Continue controlled access (e.g., fencing, gate, signage).
- Continue operating three existing alluvial groundwater extraction wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjust water.

- Continue collection and conveyance of Capulin and Goathill North rock pile seepage to the subsidence zone on an interim basis until remedial construction has been completed, at which time water will be piped to the Mill Area for treatment.
- Upgrade/install a seepage collection system near the base of Capulin Rock Pile to enhance seepage capture; pipe seepage to the Mill Area for treatment.
- Operate a new groundwater extraction well system in lower Capulin Canyon and pipe the water to the Mill Area for treatment.
- Operate a new seepage collection system near the base of Goathill North Rock Pile to enhance seepage capture; pipe water to the Mill Area for treatment.
- Operate a new groundwater extraction well system in lower Goathill Gulch near the head of the debris fan; pipe water to the Mill Area for treatment.
- Install a groundwater extraction well system in lower Slickline Gulch between wells MMW-21 and MMW-48A; pipe water to the Mill Area for treatment.
- Operate a new groundwater extraction well system in colluvium at the base of the roadside rock pile drainages. Phase out operation of three existing alluvial groundwater extraction wells as alluvial groundwater cleanup levels are achieved.
- Decommission the Capulin pumpback system to prevent exposure by a visitor/trespasser to the seepage.
- Continue or modify current storm water controls and conveyance of storm water to the open pit.
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence zone, old underground workings, and decline.
- Water in the underground mine will be maintained at an elevation below the Red River and water withdrawn from the underground mine will be pH adjusted with lime.
- Continue groundwater and geotechnical monitoring and general site maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event, or an alternative design approved by the EPA during the remedial design phase).
- Recorded institutional controls (deed restrictions): restrictive covenant (Administrative Area), conservation easement, groundwater use and well drilling restrictions.

As part of this subalternative, the waste rock piles were evaluated to identify possible and practical balanced-cut-fill, partial/complete removals, and regrade. The rock pile with a balanced-cut-fill within the regraded rock pile is Goathill South. The rock piles that were selected for partial/complete removal because the interbench 3H:IV grades are not achievable with an in-place regrade include: Capulin, Goathill North, Sugar Shack West, Sugar Shack South, Middle, Sulphur Gulch South, and Sulphur Gulch North/Blind Gulch. Each of these waste rock piles is unique. Consequently, during the remedial design phase, each waste rock pile will be evaluated independently to balance the relative value of a number of factors including: attainable slope stability, safety – both worker and public, sustainable vegetation, water management, environmental protection, minimizing construction related environmental impacts such as exposure of hydrothermal scars, and consistency with NCP criteria. This evaluation may include further study or pilot studies before a final design can be fully developed for an individual waste rock pile. The information obtained from such studies and pilots will be used in the detailed evaluation and design of individual waste rock piles. The balanced-cut-fill, partial/complete removal, and regrade and cover plan for each rock pile is summarized in Table ES-7.

The total surface area for grading and revegetation is approximately 420 acres. A total of 123 million cubic yards of material is removed as part of this 3H:1V removal/partial removal/balanced-cut-fill alternative. The total volume of material to cover the rock piles is estimated to be approximately 2.4 million cubic yards based on a 36-inch cover thickness.

Groundwater Management, Extraction, and Treatment

Subalternative 3A includes the same groundwater management components as Alternative 2 except that extraction and treatment components added to Subalternative 3A include: 1) two new seepage interceptor drains near the toe of Capulin Rock Pile, 2) a new interceptor drain near the toe of Goathill North Rock Pile, 3) a new groundwater extraction well system at the base of the roadside rock pile drainages, 4) a new groundwater extraction well system in lower Goathill Gulch near the head of the debris fan, 5) a new groundwater extraction well system in lower Slickline Gulch between existing monitoring wells MMW-21 and MMW-48A, 6) a new groundwater extraction well system in lower Capulin Canyon, and 7) decommissioning of the Capulin seepage collection and pumpback system. Water collected from the new groundwater collection system components listed above will be piped to a water treatment facility.

Two new interceptor drains will be installed in two drainages below the toe of the Capulin Rock Pile during the rock pile regrade, and one new interceptor drain will be installed approximately 100 feet downstream of the existing toe drain at Goathill North Rock Pile.

For the conceptual design, two Capulin Rock Pile interceptor drains will collect an estimated combined seepage rate of 50 gpm. The collected seepage will drain by gravity through an HDPE pipe 8,000 feet in length routed down Capulin Canyon to the Spring 13 collection vault, then pumped to the water treatment facility (other routes for piping will be evaluated in the remedial design). The new Goathill North interceptor drain will collect an estimated rate of 30 gpm for both the new drain and existing toe drain. The collected seepage will be drained by gravity through an HDPE pipe 12,000 feet in length and routed down Goathill Gulch to the Columbine pump station, then pumped to the water treatment facility (other routes for piping will be evaluated in the remedial design).

A new groundwater extraction well system will be installed at the base of the roadside rock piles in pre-mine drainages to capture seepage from the rock piles before it enters the Red River alluvial aquifer. The wells will be designed to capture the estimated groundwater flow in the colluvium and the upper 10 feet of the weathered portion of bedrock in the drainages. When constituent concentrations in the alluvial aquifer are reduced to cleanup levels, the three existing GWW extraction wells may be phased out of operation. The extracted water will be pumped to a water treatment facility.

A new extraction well system will be installed in lower Goathill/Slickline Gulch, located in lower Goathill Gulch near the head of the debris fan and in Slickline Gulch between monitoring wells MMW-21 and MMW-48A. The purpose of the extraction wells is to capture mine related constituents that potentially bypass the bedrock capture zone created by dewatering of the underground mine. Also the wells will collect constituents in groundwater resulting from leaching of natural scar material. The extracted water will be pumped to a water treatment facility.

A new groundwater extraction well system will be installed in lower Capulin Canyon to capture potential residual impacts from rock pile seepage that occurred before seepage collection was implemented in 1992. Also, constituents dissolved from natural scar material in the lower portion of the drainage will be collected. The extracted water will be pumped to a water treatment facility.

The additional water collected and managed in Subalternative 3A is approximately 200 gpm. The total amount of water collected and managed under Subalternative 3A is estimated to be 970 gpm.

Currently, water from the groundwater collection systems (e.g., withdrawal wells, interceptor drains, spring collection systems) is pumped to the mill, pH adjusted using lime, and is used as makeup water for pipeline maintenance and to transport slurry. All water is maintained at a pH of between 6.0 and 9.0 as required in DP-933. During periods when the mill is not operating, this pH adjusted water is conveyed through the tailing pipeline as necessary for maintenance purposes and for dust control at the tailing facility. A new water treatment plant will be constructed and online approximately 6 months prior to mill decommissioning. Other options under the CERCLA process for timing of the new water treatment plant include early implementation at years 0, 10, 20, and 30 of the remedial action. It is also noted that early implementation may also be required under state permitting requirements.

For Subalternative 3A, the estimated time for groundwater to restore to preliminary cleanup levels in the alluvial aquifer along the mine site is less than 10 years. This time is based on the estimated time for the alluvial aquifer to be replaced with background water upgradient of the mine, because for Subalternative 3A, source control of the waste rock seepage in the mine site drainages is achieved through extraction wells, cover, and/or waste rock removal. The alluvial aquifer in the area of Spring 13 and well MMW-45A, near Capulin Canyon, is believed to be impacted from natural sources as discussed in the Final RI Report (URS 2009). If constituent concentrations in these areas are elevated above background due to natural sources, cleanup levels will likely not be achieved in these areas as a result of operating Subalternative 3A. However, if the Spring 13 and well MMW-45A area is impacted by waste rock seepage, then cleanup of these areas should also occur in less than 10 years, because the majority of waste rock seepage in the mine site drainages will be captured under Subalternative 3A. Based on the results of the analysis, some of the extraction wells and the underground mine dewatering will need to continue to operate to maintain the water level below the Red River.

It could not be demonstrated for Subalternative 3A that cleanup levels will be achieved for colluvial and bedrock groundwater on the mine site at certain locations, in particular under the remaining rock piles (even if covered) and adjacent portions of the drainages. However, the quantity of waste rock seepage will be reduced where a vegetated cover is added and no seepage will be produced where the rock pile has been removed to the native ground. During remedial design phase, treatability or pilot scale testing of cover design parameters, physical properties of borrow such as grain size, are necessary to determine optimal cover design specifications for reducing infiltration to the maximum extent practicable and ensuring that performance criteria are met. Groundwater in colluvium and bedrock already meets some preliminary cleanup levels in a number of locations, such as in the debris fans in Capulin, Goathill, and Slickline drainages and in portions of the roadside rock pile debris fans. Some of the wells used to monitor water quality in these debris fans may represent a mixing of colluvial and alluvial groundwater.

Water Treatment

Mine site water treatment includes a new water treatment plant that would be constructed at the mine site.

The primary treatment technology includes lime neutralization/chemical precipitation/HDS with secondary treatment (i.e., reverse osmosis/ultrafiltration or other membrane/filtration technology) to achieve more stringent discharge limits, if required. Conveyance of water (i.e., pipelines, ditches, pumps, etc.) is included with the water treatment and uses existing infrastructure. If the existing infrastructure is not adequate at the time water treatment begins, new or additional infrastructure would be required. A discharge point for the treated water has not been determined and will be evaluated during the remedial design phase. The preliminary location for the treatment plant is at the mill.

Existing buildings and equipment may be used depending on the condition of the equipment at the time the treatment plant is constructed. Sludge from the clarifier/thickener bottoms will be pumped to a filter press for dewatering. A portion of the sludge will be recycled to the beginning of the treatment system, mixed with lime, and fed to the first reactor to assist in the chemical precipitation and formation of a high density sludge. The filter cake is expected to be nonhazardous and will be analyzed to ensure proper disposal.

An engineered repository will be constructed at the mine site for placement of water treatment residuals (sludge/filter cake). Maximum height of the downstream impoundment berms will be limited to less than 10 feet so that the cells are not considered jurisdictional dams under New Mexico Office of the State Engineer Rules and Regulations.

Subalternative 3B – Minimum 2H:1V: Balanced-Cut-Fill, On-Site Repository, Regrade, and Cover at a Minimum of 2H:1V Interbench Slopes; Storm Water, Surface Water, and Groundwater Management; Groundwater Extraction and Treatment

The major components of this subalternative include:

- Balanced-cut-fill and regrade of the rock piles using minimum 2H:1V interbench slopes, amended cover, and revegetation.
- Construct and utilize an on-site repository(ies) for waste rock if necessary. Locations are to be determined during the remedial design phase for each rock pile.
- Continue controlled access (e.g., fencing, gate, signage).
- Continue operating three existing alluvial groundwater extraction wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjust water.
- Continue collection and conveyance of Capulin and Goathill North rock pile seepage to the subsidence zone, on an interim basis until remedial construction has been completed, at which time water will be piped to the Mill Area for treatment.
- Upgrade/install a seepage collection system near the base of Capulin Rock Pile to enhance seepage capture; pipe seepage to the Mill Area for treatment.
- Operate a new groundwater extraction well system in lower Capulin Canyon and pipe the water to the Mill Area for treatment.
- Operate a new seepage collection system near the base of Goathill North Rock Pile to enhance seepage capture; pipe water to the Mill Area for treatment.
- Operate a new groundwater extraction system in lower Goathill Gulch near the head of the debris fan; pipe water to the Mill Area for treatment.
- Install a groundwater extraction system in lower Slickline Gulch between wells MMW-21 and MMW-48A; pipe water to the Mill Area for treatment.
- Operate a new groundwater extraction well system in the colluvium at the base of the roadside rock pile drainages. Phase out operation of three existing alluvial groundwater extraction wells as alluvial groundwater cleanup levels are achieved.
- Decommission the Capulin pumpback system to prevent exposure by a visitor/trespasser to the seepage.
- Continue current storm water controls and conveyance of storm water to the open pit.
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence zone, old underground workings, and decline.
- Water in the underground mine will be maintained at an elevation below the Red River and water withdrawn from the underground mine will be pH adjusted with lime.

- Continue groundwater and geotechnical monitoring and general site maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event, or an alternative design approved by the EPA during the remedial design phase).
- Recorded institutional controls (deed restrictions): restrictive covenant (Administrative Area), conservation easement, groundwater use and well drilling restrictions.

As part of this subalternative, the waste rock piles were evaluated to achieve a minimum interbench slope of 2H:1V to the underlying slope to the maximum extent practicable. Regrading activities included a balanced-cut-fill within or between rock piles. The waste rock piles that have an in-place regrade are Capulin, Goathill North, and Sugar Shack West. The waste rock piles with a balanced-cut-fill achieved by moving waste rock material to other rock piles include: Goathill South, Sugar Shack South, Middle, and Sulphur Gulch South. The rock piles that receive waste rock material include Sulphur Gulch North/Blind Gulch and Spring Gulch. Each of these waste rock piles is unique. Consequently, during the remedial design phase, each waste rock pile will be evaluated independently to balance the relative value of a number of factors including: attainable slope stability, safety – both worker and public, sustainable vegetation, water management, environmental protection, minimizing construction related environmental impacts such as exposure of hydrothermal scars, and consistency with NCP criteria. This evaluation may include further study or pilot studies before a final design can be fully developed for an individual waste rock pile. The information obtained from such studies and pilots will be used in the detailed evaluation and design of individual waste rock piles. The regrade, and cover approach for each rock pile is summarized in Table ES-7.

The total surface area for grading and revegetation is approximately 660 acres. A total of 37 million cubic yards of material is removed as part of this 2H:1V partial removal/balanced-cut-fill alternative. The total volume of material to cover the rock piles is estimated to be approximately 3.8 million cubic yards based on a 36-inch cover thickness.

Groundwater Management, Extraction, and Treatment

Groundwater management, extraction, and treatment under Subalternative 3B is the same as described for Subalternative 3A. Differences in rock pile configurations between Subalternatives 3A and 3B result in different restoration timeframes and waste rock seepage production; however, the groundwater management, extraction, and treatment methods are the same.

The ability for Subalternative 3B to restore groundwater to preliminary cleanup levels and the restoration timeframe is similar to that estimated for Subalternative 3A. The alluvial aquifer is expected to meet cleanup levels in less than 10 years. It could not be demonstrated for Subalternative 3B that cleanup levels will be achieved for colluvial and bedrock groundwater on the mine site at certain locations, in particular under the footprint of remaining rock piles (even if covered) and adjacent portions of the drainages. However, the quantity of waste rock seepage will be reduced where a vegetated cover is added. During remedial design phase, treatability or pilot scale testing of cover design parameters, physical properties of borrow such as grain size, are necessary to determine optimal cover design specifications for reducing infiltration to the maximum extent practicable and ensuring that performance criteria are met. Groundwater in colluvium and bedrock already meets some preliminary cleanup levels in a number of locations, such as in the debris fans in Capulin, Goathill, and Slickline drainages and in portions of the roadside rock pile debris fans. Some of the wells used to monitor water quality in these debris fans may represent a mixing of colluvial and alluvial groundwater.

Water Treatment

Mine Site water treatment under Subalternative 3B is the same as described for Subalternative 3A.

Alternative 4 – Source Removal, Storm Water, Surface Water, and Groundwater Management, Groundwater Extraction and Treatment

Alternative 4 was removed during preliminary screening and not carried forward to the detailed analysis.

ES1.6.2.2 Mine Site Area Analysis of Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 (No Further Action) is the least protective of human health and the environment. Current health and safety programs and restricted access limit human receptor exposure to surface water and groundwater. Recorded institutional controls including conservation easement and deed restrictions for the Mine Site Area restrict future uses. These will be layered with other institutional controls, such as well-drilling prohibitions to be imposed by the State Engineer. These layered controls will restrict future human receptor exposure to soil, surface water, and groundwater. An increased level of protection occurs under Alternative 2 (Limited Action) through piping of seepage to and fencing of the Capulin seepage collection and pumpback ponds, which protect human receptors from exposure to seepage.

Subalternatives 3A and 3B provide protection of human health and the environment as a result of cover placement, which reduces infiltration and potential leachate production. However, Subalternative 3A is less protective because removal activities result in significantly increased exposure of hydrothermal scar material under multiple rock piles (i.e., 35 to 500 percent increase). Subalternative 3B may also expose some underlying scar. This measure will increase the potential for run-off/sediment that could impact surface water. Removal of waste rock will also leave steep, altered native material exposed, which are virtually impossible to reclaim, cover, or construct structures for the management of storm water. The actual location for waste rock disposal would be selected during the remedial design phase. Depending on the location(s) selected, there are differing levels of potential environmental impacts. The use of any repository for waste rock placement would result in increased emissions and safety concerns associated with haul truck traffic. If the pit repository or Spring Gulch pile are not utilized, other on-site locations may impact greenfields. If an off-site repository is selected, such concerns are more significant in terms of emissions and safety, and a potentially distant undisturbed greenfield would be impacted. Subalternative 3A results in less steep slopes than Subalternative 3B. A greater area of steep underlying natural slopes is exposed under Subalternative 3A (approximately 374 acres) than for Subalternative 3B (158 acres).

Alternative 1 and Alternative 2 include essentially current measures and are generally protective of human health and the environment. Current measures include: storm water controls at the rock piles; groundwater extraction within the Red River alluvial aquifer located downgradient of the roadside rock pile drainages; and groundwater collection at Spring 13 and 39 under the BMPs in CMI's EPA NPDES permit NM002306 (EPA 2006). Subalternatives 3A and 3B include collection and treatment of seepage from Capulin and Goathill North rock piles and groundwater extraction from the base of the roadside rock pile drainages, in Goathill and Slickline gulches, and in lower Capulin Canyon, which results in a greater level of protection than the current collection and management in the underground mine (Alternatives 1 and 2).

Overall, Subalternatives 3B is the most protective of human health and the environment. Subalternative 3A is more protective than Alternative 2 and Alternative 1, but less protective than Subalternative 3B.

Compliance with ARARs

The alternatives/subalternatives comply with applicable and relevant and appropriate requirements, except that the standards of 40 CFR Part 141, Subparts B and G (MCLs) and Subpart F (MCLGs), NM Water Supply Regulations 20.7.10.100 NMAC (MCLs and MCLGs), and NM WQCC 20.6.2.3103 NMAC (standards for groundwater) will not be met for certain constituents in groundwater. Such standards will not be met because they are below site-specific naturally-occurring background concentrations and it is EPA policy not to remediate to levels below background. Background water quality is based on the preliminary baseline water quality study performed by the U.S. Geological Survey (USGS) and the reference background assessment conducted by CMI's consultant, URS Corporation, as part of the RI. It is also not required by New Mexico regulations to achieve numeric criteria for a specific constituent if that constituent is present in natural background concentrations above the numeric criteria. New Mexico is in the process of establishing site-specific groundwater standards for some constituents based on the USGS and URS work on background water quality.

Furthermore, based on groundwater modeling and other analyses, and using an estimated 60 percent reduction of infiltration through the waste rock, it could not be demonstrated that the background levels being considered as site-specific groundwater standards by New Mexico would be achieved in colluvium and bedrock for all constituents beneath, and in the vicinity of, the waste left in place within a reasonable time frame.

Long-Term Effectiveness and Permanence

Subalternative 3A more closely achieves slopes that favor cover placement. However, Subalternative 3A also includes the most removal of rock, exposing steep underlying natural grades that cannot be reclaimed/covered (greater than 1.9H:1V). The erodible nature of the underlying material and exposure of hydrothermal scars may result in increased potential long-term impacts from run-off/sediment. Subalternative 3A also involves the removal of waste rock pile material to an on-site repository. This increases the collateral impact of the remediation through increased truck haulage and other direct and indirect environmental impacts and requires long-term management. The location of the on-site repository(ies) would be determined during the remedial design phase. The pit repository is one option. However, it may not be available for waste rock placement should it be utilized for mining or accessing ore (see also Mine Plans, Appendix L). In this case, the pit repository may be a more suitable location for waste rock only after such utilization for ore mining is completed. Other potential on-site repository locations for waste rock placement probably have insufficient capacity for the total volume of waste rock to be relocated under Subalternative 3A, but could be utilized for some volume of waste rock. Off-site locations will require the disturbance of a greenfield and may not be available. Also, there will be substantial collateral environmental impacts (e.g., emissions from haul trucks and safety concerns) resulting from the actions necessary to move the waste rock to a potentially distant location.

The additional water extraction and collection in Subalternatives 3A and 3B results in additional water treatment, production of treatment-related waste, and long-term management.

Overall, the alternatives that have the highest long-term effectiveness and permanence in order of most effective to least effective are as follows: Subalternative 3B, which is more effective than Subalternative 3A, which is more effective than Alternative 2, and then Alternative 1.

Reduction of Toxicity, Mobility, or Volume through Treatment

Because soil/waste rock is not treated in these alternatives, there is no reduction of toxicity, mobility, or volume for the affected materials. There is a reduction in the migration of mine-related inorganic COCs in groundwater to the Red River; however, exposing hydrothermal scars at rock piles as a result of Subalternative 3A (and to a lesser extent in Subalternative 3B) creates the potential for increased run-off/sediment impacts and increased consequential contamination.

The current water treatment system, pH adjustment with lime, which was designed to provide for reuse, results in some metals being removed and precipitated and thus limited reduction in toxicity, mobility, or volume through treatment. Water from the current treatment system is reused and not discharged as a point source at the mine site. If it were discharged to surface water it would not achieve the state water quality standards.

The new water treatment plant at the mine site will be a more robust system using a chemical precipitation, high density sludge process, following by a polishing step, possibly reverse osmosis, that will be designed to meet the appropriate discharge standards. This new system will remove metals of concern and reduce toxicity, mobility, and volume through treatment. Subalternatives 3A and 3B include increased extraction and collection, and will thereby increase treatment of collected groundwater. Alternative 1 has no reduction through additional collection or treatment.

Overall, Subalternatives 3A and 3B provide greater reduction in toxicity, mobility, and volume of contaminants than Alternatives 1 and 2.

Short-Term Effectiveness

Alternative 1 provides no increased short-term risk because no construction-related actions are proposed that create additional risk to workers, community, or the environment. Alternative 2 and Subalternatives 3A and 3B include actions that increase potential risks to workers and the environment if additional water treatment is required, because it will require construction of a water treatment plant and conveyance structures. Additional risks to workers and the environment beyond those already described are most likely to occur during implementation of the activities in Subalternatives 3A and 3B. These activities will require extensive earthmoving activities, over large areas in multiple years (sometimes decades) and in steep terrain. The actual risk of injury posed by remediation activities can be orders of magnitude higher than the hypothetical risk posed to future site users by leaving the site undisturbed. In addition, the long construction periods required for Subalternatives 3A and 3B result in greater risks. The movement of rock below the first bench of the roadside rock piles (Subalternatives 3A and 3B) includes greater risks and interruptions to vehicles on Highway 38. Therefore, the road may be required to be temporarily shut down either partially or completely for multiple hours/days throughout this period of time. This would create traffic delays and could have a negative impact on tourism in the town of Red River and other nearby recreational areas. In addition, the volume of waste rock requiring removal to an on-site repository in Subalternative 3A could result in potentially three times as many accidents as in Subalternative 3B.

Overall, the short-term effectiveness of the alternatives from more effective (least short-term impacts) to least effective (greatest short-term impacts) is as follows: Alternative 1 greater than Alternative 2, greater than Subalternative 3B, and then Subalternative 3A.

Implementability

Alternative 1 (No Further Action) and Alternative 2 (Limited Action) do not include construction activities and are the easiest to implement. The potential addition of water treatment to Alternative 2 includes construction work to build a water treatment plant, sludge repository, and conveyance structures, and require large quantities of chemicals to be transported and stored on-site.

Partial/complete removal or balanced-cut-fill of the roadside rock piles in Subalternatives 3A and 3B requires additional equipment, longer durations, and increased potential construction hazards due to steep underlying slopes. Exposed steep, altered native materials, especially those containing scar, are difficult if not impossible to reclaim. Subalternative 3A results in significantly greater areas of exposure, which may make it more difficult to implement. Placement of rock in an on-site repository (Subalternative 3A) requires a longer haul distance compared to regrade within rock piles or balanced-cut-fill within and between another rock pile and therefore, increased impacts and risk. It would also negate mining of the remaining molybdenum ore bodies.

Overall, Alternative 1 does not require construction and is the easiest to implement followed by Alternative 2. Subalternative 3B is the next easiest to implement. Subalternative 3A involves the largest scale construction activities, including almost complete removal of the roadside rock piles and partial removal of all other rock piles except Goathill South.

Cost

Alternative 1 (No Further Action) does not include construction activities and has the lowest cost. An increase in approximately $250,000 (present value) over Alternative 1 includes piping of seepage to, and fencing around, Capulin pumpback ponds (Alternative 2). For approximately an additional $167 million (present value) over Alternative 2, balanced-cut-fill, partial/complete removal, and/or regrade and cover of rock piles to minimum 3H:1V interbench slope is achieved (Subalternative 3A). A decrease in cost of approximately $112 million (present value) below Subalternative 3A includes balanced-cut-fill and/or regrade and cover of rock piles to minimum 2H:1V interbench slopes (Subalternative 3B), with a significant decrease in exposed scar and steep, altered native materials. Additional water collection and extraction from the toe of Capulin Rock Pile, below the toe of Goathill North Rock Pile, new wells in the roadside rock pile drainages, in lower Capulin Canyon, and lower Goathill/Slickline Gulch (Subalternatives 3A and 3B) add a cost of approximately $600,000 (present value). If additional water treatment is added to the alternatives, overall costs increase approximately $5 to $35 million (present value) depending on whether the year of implementation is Year 0 or Year 30.

ES1.6.3 Tailing Facility Area

ES1.6.3.1 Description of Alternatives

Alternative 1 – No Further Action

Alternative 1 includes continuation of current actions at the tailing facility with no additional actions.

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue operation of the existing seepage interception systems and pumpback system.
- Discharge of collected water under existing NPDES permit.
- Continue tailing dust control measures.
- Continue groundwater monitoring, general site maintenance, and storm water management.
- Continue air monitoring of PM_{10} at air monitoring stations.
- Recorded institutional controls (deed restrictions): restrictive covenant, groundwater use and well drilling restrictions.

Institutional controls (a restrictive covenant, deed restrictions, and well drilling restrictions) limit certain land uses and use of groundwater. The deed restriction will apply to groundwater south of the tailing facility, south of the Change House, and south of Dam No. 4 on CMI property.

Continuation of the current water collection management at the tailing facility is included in Alternative 1. CMI currently operates seepage interception systems that collect tailing water seepage south of Dam No. 1 and on the eastern abutment of Dam No. 4; and continued operation of these systems is included in Alternative 1. The seepage interception system includes rock drains, seepage barriers, and extraction wells. The system currently collects approximately 550 gpm of water. The flow from seepage barriers and rock drains accounts for nearly 80 percent of the total water collected, whereas 20 percent of the total water collected is from the extraction wells.

The 002 seepage interception system is located south of Dam No. 1 and consists of a combination of shallow rock-filled drains, seepage barriers, and extraction wells. The estimated seepage collection rate from the upper 002 barrier is 200 gpm (Vail Engineering 2003). The lower 002 seepage barrier is located farther south near Embargo Road. The lower seepage barrier is recently reported to be dry, which may be due to dewatering of the shallow groundwater in the area by the upper seepage barrier. The Outfall 002 system also includes extraction wells that are located along the base of Dam No. 1 and within the drainage to the south (EW-2, -3, -4, -5A, -5B, -5C, -5D, -5E, and -6).

The 003 seepage interception system includes seepage barriers across a drainage on the eastern slope of Dam No. 4 and an extraction well, EW-1 and collects seepage originating from the Dam No. 4 impoundment. The seepage collection rate is estimated to be 60 gpm (Vail Engineering 2003). The lower 003 seepage barrier is located a few hundred feet farther to the east (downgradient) of the upper barrier. The lower 003 barrier has been dry.

CMI installed a pumpback system to reduce the load of metals and other inorganic constituents discharged at Outfall 002. The pumpback system consists of a new manhole located approximately 750 feet north of the existing Outfall 002 manhole. Seepage-impacted groundwater is pumped back northward over Dam No. 1 through a 4-inch-diameter HDPE pipeline approximately 6,200 feet in length and discharged at the Dam No. 5A impoundment. A portion of the seepage-impacted groundwater collected from the 002 seepage interception system is discharged untreated to the Red River via the National Pollutant Discharge Elimination System (NPDES) permitted 002 Outfall Pipe, while the balance of the seepage-impacted groundwater is pumped back to Dam No. 5A to meet the NPDES surface water discharge requirements for manganese. DP-933 (NMED 2008b) regulates discharges from the facility that have the potential to impact the underlying aquifer. Of the 550 gpm collected from the seepage interception systems at the tailing facility, approximately 150 gpm is pumped back to the Dam No. 5A impoundment and approximately 400 gpm is discharged to Red River through Outfall 002.

Approximately 280 gpm of tailing seepage and 270 gpm of native groundwater is being collected by the existing systems and 2,510 gpm of tailing seepage is uncollected. Uncontrolled seepage primarily is documented infiltrating downward from the portion of the tailing facility in the vicinity of Dam No. 4 (est. 770 gpm) and Dam No. 5A (est. 1,700 gpm) to the basal bedrock (volcanic) aquifer. Seepage-impacted bedrock groundwater (with elevated molybdenum and sulfate) has been detected/measured in monitoring wells south of Dam No. 4 (MW-11 and

MW-13), as well as in springs along the Red River between the tailing facility and the state fish hatchery (one mile south of the tailing facility). Mine constituents also exist in groundwater downgradient of the seepage interception system south of Dam No. 1. Groundwater also appears to be affected by an area of historic buried tailing located northwest of the Change House.

Fencing and restrictive entry to the tailing facility are in place and controlled access will be kept in place under Alternative 1. Groundwater monitoring is currently performed at the tailing facility and is a component of this alternative as is continued site maintenance, tailing dust control measures (e.g., straw placement), and storm water management. Air monitoring is also included for PM_{10} at downwind air monitoring stations.

Under Alternative 1, molybdenum concentrations in groundwater will not decrease to below the PRG of 0.05 mg/L after 30 years of closure, based on the numerical modeling analysis. After the tailing impoundments are no longer receiving tailing slurry, infiltration of tailing seepage will continue due to the addition of pumpback water, draining of impounded tailing, and precipitation that collects and infiltrates the tailing impoundment surface. Alternative 1 assumes continued pumpback of approximately 150 gpm of tailing seepage and groundwater collected at the seepage interception systems to the Dam No. 4/5A impoundment, with no cover.

Alternative 2 – Limited Action (Institutional Controls; Source Containment; Continued Groundwater Withdrawal Operations; Piping of Water in Eastern Diversion Channel)

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue operation of the seepage interception and pumpback system.
- Discharge of collected water under existing NPDES permit.
- Continue tailing dust control measures.
- Continue groundwater monitoring, general site maintenance, and storm water management.
- Continue air monitoring program (e.g., PM_{10} monitoring, $PM_{2.5}$ monitoring during earthmoving remediation activities, risk management) at air monitoring stations.
- Recorded institutional controls (deed restrictions): restrictive covenant, groundwater use and well drilling restrictions.
- Cover and revegetate tailing facility (and limited removal of soil areas at the dry/maintenance and south of Dam No. 1) at the cessation of tailing deposition.
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through the historic buried tailing.
- Performance monitoring downgradient (southeast) of Dam No. 1 (in the area of wells MW-4 and MW-17) to assess the effects on groundwater quality from piping irrigation water in the

eastern diversion channel; and allow leading edge of plume near the change house to recede by advection and dispersion.

- Performance monitoring downgradient (south and west) of Dam No. 4 and (south) Dam No. 1, including basal alluvial and bedrock aquifers, to assess the effects of existing seepage collection on groundwater quality.

In addition to the components in Alternative 1 (i.e., controlled access, continued operation of the seepage interception systems, discharge of water under the existing NPDES permit, dust controls, and monitoring), Alternative 2 includes recorded institutional controls.

Alternative 2 reduces infiltration and water contact with the historic buried tailing northwest of the Change House by piping constructed in the eastern diversion channel. The final design of the piping remedy will be evaluated during the remedial design phase. For the purposes of this FS, it was assumed that water in the diversion channel will be directed into the pipe and discharged south near Dam No. 1, thereby by-passing the area of historic buried tailing. A concrete dam will be constructed in the bottom the diversion channel to prevent unused irrigation water from continuing to flow in the channel. The dam will extend across the channel and will be keyed into the bottom of the channel. The leading edge of the plume associated with the historic buried tailing northwest of the Change House will be allowed to recede by advection and dispersion. Groundwater southeast of Dam No. 1 will be monitored to assess the effectiveness of piping the irrigation water on reducing constituents in groundwater in this area.

Although soil in the area outside the tailing impoundments (EA-7) do not require remediation based on protection of terrestrial ecological receptors, one location outside of the impoundment footprints with elevated molybdenum will be excavated and placed at the tailing facility prior to cover placement. This soil sample (TSS11-4) is located at the dry/maintenance area south of the Change House.

Alternative 2 also includes placement of a store and release/ET cover after tailing deposition ceases. Process water in the tailing will drain out, over time, regardless of the type of cover installed. The cover will be designed to protect water quality, by reducing infiltration to the maximum extent practicable, and ecological receptors by preventing exposure. A store and release/ET soil cover is not affected by drying and cracking or frost effects, which increases its long-term integrity (RGC 1998). A 3-foot thickness consistent with DP-933 conditions is assumed for final cover. The estimated area requiring cover is approximately 1,050 acres and generally includes the footprint of the two impoundments. As part of the 1,050 acres, historic surface tailing adjacent to the impoundments will also be covered. Based on engineering estimates, the volume of cover material is approximately 5.4 million cubic yards. The source of cover material is the alluvial soils in the northern portion of the tailing facility.

The alluvial borrow material provides an effective control for both dust and water erosion. As vegetative growth is established, the erosion resistance of the cover is further increased. The plant roots will also create upward hydraulic gradients drawing soil moisture back up into the root zone. The final cover will be revegetated with grasses and forbs and possibly woody shrubs. Revegetation will be designed to optimize the effectiveness of the cover to reduce infiltration into underlying materials, promote evapotranspiration from the cover system, and provide cover stability and protection from wind and water erosion.

Under Alternative 2, the estimated time for molybdenum concentrations in groundwater to decrease below the PRG of 0.05 mg/L is 20 to 30 years following closure, based on numerical modeling. After the tailing impoundments are no longer receiving tailing slurry and are covered, infiltration of tailing seepage will continue due to draining of impounded tailing. Approximately 150 gpm of tailing seepage and groundwater collected at the seepage interception system will be pumped back to the Dam No. 4/5A impoundment until cleanup is achieved in the Dam No. 1 arroyo (20 to 30 years). Following drainage and cessation of pumpback, only small amounts of water from precipitation will infiltrate through the cover into the tailing and underlying groundwater. The area downgradient of Dam No. 4 will take less time (less than 15 years) to reach PRGs due to the high hydraulic conductivity and rapid flushing rate of the volcanic aquifer. For the purpose of the conceptual design in the FS, it was assumed that cleanup of groundwater at the entire tailing facility would take 15 years even though some areas (below Dam No. 1) may achieve the PRG sooner.

Alternative 3 – Source Containment; Continued Groundwater Withdrawal Operations with Upgraded Seepage Collection; Piping of Water in Eastern Diversion Channel

Subalternative 3A: Continued Groundwater Withdrawal Operations with Upgraded Seepage Collection

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Discharge of collected water.
- Continue tailing dust control measures.
- Continue groundwater monitoring, general site maintenance, and storm water management.
- Continue air monitoring program (e.g., PM_{10} monitoring, $PM_{2.5}$ monitoring during earthmoving remediation activities, risk management) at air monitoring stations.
- Recorded institutional controls (deed restrictions): restrictive covenant, groundwater use and well drilling restrictions.
- Cover and revegetate tailing facility (and limited soil areas at the dry/maintenance and south of Dam No. 1) at the cessation of tailing deposition.
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing.
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier to intercept tailing seepage in deeper strata.

- Performance monitoring downgradient (southeast) of Dam No. 1 (in the area of wells MW-4 and MW-17) to assess the effects on groundwater quality from piping irrigation water in the eastern diversion channel; and allow leading edge of plume near the change house to recede by advection and dispersion.
- Groundwater characterization in the basal bedrock aquifer downgradient (south) of Dam No. 1 to evaluate the need for further groundwater remediation (includes installing a well(s) to replace former well TPZ-5B).
- Performance monitoring downgradient (south) of Dam No. 4 and Dam No. 1, including basal alluvial and bedrock aquifers, to assess the effects of remedial actions (e.g., upgraded seepage barriers, extraction well systems, cover) on groundwater quality.
- Continue operation of existing seepage interception system and pumpback system.

Similar to Alternative 2, Subalternative 3A reduces infiltration and water contact with the historic buried tailing northwest of the Change House by constructing piping in the eastern diversion channel.

In addition to installing pipe in the diversion channel, Subalternative 3A includes an upgrade to the existing seepage interception systems to limit tailing seepage bypass of the 002 system in the Dam No. 1 arroyo and the 003 system off the southeast flank of Dam No. 4. The upgrade to the Outfall 002 system includes installation of new groundwater extraction wells across the Dam No. 1 arroyo just downgradient of the location of the existing lower 002 seepage barrier which is dry. The upgrade to the Outfall 003 system includes the replacement of the upper 003 seepage barrier with a new seepage barrier that extends approximately 30 feet below the existing barrier.

The new extraction wells will be located at CMI's downgradient property boundary in the Dam No. 1 arroyo to limit off-site and downward migration of tailing seepage constituents (primarily sulfate and molybdenum). There will be four wells, placed along a 250-foot wide transect across the Dam No. 1 arroyo, with each well pumping at 30 gpm.

The new upper 003 seepage barrier will be 50-feet in length, and will be excavated to a depth of approximately 50 feet to collect seepage that may be migrating beneath the existing barrier. The upgraded seepage barrier is estimated to produce 180 gpm, an increase of 120 gpm compared to the existing 003 barrier.

The estimated additional seepage and groundwater collected by the upgraded system is approximately 250 gpm compared to Alternative 2. The total water collected by the existing and upgraded system is 790 gpm.

Subalternative 3A includes additional groundwater characterization in the bedrock aquifer south of Dam No. 1 in the former well TPZ-5B area. The purpose of a monitoring well to replace former well TPZ-5B is to verify whether elevated molybdenum and manganese concentrations observed during two historical sampling events at TPZ-5B are representative of current aquifer conditions.

Subalternative 3A also includes groundwater monitoring downgradient (south) of Dam No. 1 and Dam No. 4 to assess the performance of remedial actions in reducing groundwater concentrations to below the PRGs in these areas. Cover and regrading of the tailing impoundments at closure will result in decreased groundwater concentrations. Cover placement and limited excavation near the dry/maintenance area will be performed consistent with Alternative 2.

For Subalternative 3A, the time for molybdenum concentrations in groundwater to decrease below the PRG of 0.05 mg/L is assumed to be 20 years following closure, similar to Alternative 2 based on numerical modeling. After the tailing impoundments are no longer receiving tailing and are covered, infiltration of the tailing seepage will continue due to draining of impounded tailing. Approximately 300 gpm of tailing seepage and groundwater collected at the seepage interception system will be pumped back to the Dam No. 4/5A impoundment until cleanup is achieved in the Dam No. 1 arroyo (10 to 20 years). Following drainage and cessation of pumpback, only small amounts of water from precipitation will infiltrate through the cover into the tailing and underlying groundwater.

Subalternative 3B: Continued Groundwater Withdrawal Operations with Upgraded Seepage Collection and Treatment

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Discharge of collected water.
- Continue tailing dust control measures.
- Continue groundwater monitoring, general site maintenance, and storm water management.
- Continue air monitoring program (e.g., PM_{10} monitoring, $PM_{2.5}$ monitoring during earthmoving remediation activities, risk management) at air monitoring stations.
- Recorded institutional controls (deed restrictions): restrictive covenant, groundwater use and well drilling restrictions.
- Cover and revegetate tailing facility (and limited areas at the dry/maintenance and south of Dam No. 1) at the cessation of tailing deposition.
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing.
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier to intercept tailing seepage in deeper strata.
- Performance monitoring downgradient (southeast) of Dam No. 1 (in the area of wells MW-4 and MW-17) to assess the effects on groundwater quality from piping irrigation water in the eastern diversion channel; and allow leading edge of plume near the change house to recede by advection and dispersion.

- Groundwater characterization in the basal bedrock aquifer downgradient (south) of Dam No. 1 to evaluate the need for further groundwater remediation (includes installing a well(s) to replace former well TPZ-5B).
- Performance monitoring downgradient (south) of Dam No. 4 and Dam No. 1, including basal alluvial and bedrock aquifers, to assess the effects of remedial actions (e.g., upgraded seepage barriers, extraction well systems, cover) on groundwater quality.
- Water treatment of pumpback seepage

In addition to replacing the selected existing seepage barriers, Subalternative 3B includes a water treatment component. The total water collection rate for Subalternative 3B is 790 gpm, 400 gpm of which is discharged through Outfall 002. Following collection, the remaining water will be treated at the existing ion exchange treatment plant and/or new treatment plant located south of Dam No. 4. Piping associated with conveyance of water from the various collection/extraction systems at the tailing facility is included in Subalternative 3B. Influent water to the treatment plant includes water collected from the existing/upgraded Outfall 002 and Outfall 003 seepage barrier/extraction wells, which is currently pumped back to Dam No. 5, to capture tailing seepage from Dam No. 1 and Dam No. 4 impoundments.

The existing ion exchange treatment plant is located south of Dam No. 4 and will be used for treatment of extracted groundwater and/or a new treatment facility will be constructed. Modifications may be necessary if constituents in groundwater, in addition to molybdenum, require removal. Reverse osmosis may be included for additional treatment.

Either an evaporator will be installed in conjunction with the water treatment system or an evaporation pond constructed at the tailing facility for treatment of the reverse osmosis reject, if required. For the purposes of this FS, it was assumed that an evaporator will be used.

Limited excavation near the dry/maintenance area will be performed consistent with Alternative 2.

For Subalternative 3B, the estimated time for molybdenum concentrations in groundwater to decrease below the PRG of 0.05 mg/L is 15 years following closure, based on numerical modeling. After the tailing impoundments are no longer receiving tailing and are covered, infiltration of the tailing seepage will continue due to draining of the impounded tailing. For Subalternative 3B, it is assumed that the pumpback water will be treated. Following drainage of the tailing, only small amounts of water from precipitation will infiltrate through the cover into the tailing and underlying groundwater.

Alternative 4 – Source Containment; Groundwater Extraction and Treatment; Piping of Water in Eastern Diversion Channel

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site.
- Continue discharge of collected water.

- Continue tailing dust control measures.
- Continue groundwater monitoring, general site maintenance, and storm water management.
- Continue air monitoring program (e.g., PM_{10} monitoring, $PM_{2.5}$ monitoring during earthmoving remediation activities, risk management) at air monitoring stations.
- Recorded institutional controls (deed restrictions): restrictive covenant, groundwater use and well drilling restrictions.
- Cover and revegetate tailing facility (and limited soil areas at the dry/maintenance and south of Dam No. 1) at the cessation of tailing deposition.
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing.
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier to intercept tailing seepage in deeper strata.
- Groundwater characterization in the basal bedrock aquifer downgradient (south) of Dam No. 1 to evaluate the need for further groundwater remediation (includes installing a well(s) to replace former well TPZ-5B).
- Groundwater extraction in the upper alluvial aquifer southeast of Dam No. 1 in the area downgradient of the historic buried tailing.
- Groundwater extraction downgradient (south) of Dam No. 4.
- Water treatment.
- Performance monitoring downgradient (south and west) of Dam No. 4 and (south) Dam No. 1, including basal alluvial and bedrock aquifers, to assess the effects of remedial actions (e.g., upgraded seepage barriers, extraction well systems, cover) on groundwater quality.

In addition to the Subalternative 3B components, Alternative 4 includes groundwater extraction southeast of Dam No. 1 (in the area of wells MW-4 and MW-17) to capture contamination in the alluvial aquifer. As in Subalternative 3B, source containment is included through the use of piping to bypass the unused irrigation water in the diversion channel, which addresses the source of infiltration that reaches the historic buried tailing. It is assumed that five extraction wells will be installed along an east-west line, approximately 240 feet apart, to create a continuous zone of groundwater capture over the 1,200 feet of potentially affected aquifer. For conceptual-level design, each well is assumed to be pumped at 10 gpm for a total extraction rate of 50 gpm.

Like in Subalternative 3B, Alternative 4 includes additional groundwater characterization in the basal bedrock aquifer south of Dam No. 1, in the area of former well TPZ-5B. If the characterization results in COC concentrations above the PRG for molybdenum, groundwater extraction will be included to address this area.

In addition, Alternative 4 includes groundwater extraction in the basal bedrock (volcanic) aquifer south of Dam No. 4 (in the area of wells MW-11 and MW-13). The objective of the extraction is to create a zone of groundwater capture across the former arroyo to prevent further downgradient migration of seepage from the Dam No. 4 impoundment (including the Dam No. 5A impoundment and decant pond). A water balance conducted based on CMI's water usage for calendar year 2006 found that the total estimated seepage that is available to migrate from the tailing facility south of Dam No. 4 is 2,510 gpm. This seepage rate was used to develop a preliminary conceptual design for groundwater extraction in this area. Based on hydraulic analysis, it was determined that hydraulic capture could be achieved by installing three wells with a total extraction rate of 3,500 gpm. The extraction wells will be placed in the area of MW-11, MW-13, and to the west of MW-11.

As in Subalternative 3B, Alternative 4 includes a water treatment component. Piping associated with conveyance of water from the various collection/extraction systems at the tailing facility are included in Alternative 4. The total water collection rate for Alternative 4 is assumed to be 4,300 gpm. Influent water to the treatment plant may include the following:

- Water collected from the existing/upgraded Outfall 002 and Outfall 003 seepage barrier/extraction wells to capture tailing seepage from Dam No. 1 and Dam No. 4 impoundments.
- Water extracted/collected southeast of Dam No. 1 (in area of wells MW-4 and MW-17) to capture the leading edge of the plume associated with the historic buried tailing.
- Water extracted/collected south of Dam No. 4 (in area of wells MW-11 and MW-13) to capture seepage from the Dam No. 4 impoundment.

Cover placement and limited excavation near the dry/maintenance area will be performed consistent with Alternative 2.

For Subalternative 4, the estimated time for molybdenum concentrations in groundwater to decrease below the PRG of 0.05 mg/L is 8 years following closure, based on numerical modeling. After the tailing impoundments are no longer receiving tailing and are covered, infiltration of the tailing seepage will continue due to draining of the impounded tailing. For Subalternative 4, it is assumed that all water collected from extraction wells and seepage barriers will be treated. Following drainage of the tailing, only small amounts of water from precipitation will infiltrate through the cover into the tailing and underlying groundwater.

ES1.6.3.2 Tailing Facility Analysis of Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 (No Further Action) is the least protective of human health and the environment. Current health and safety programs and restricted access limit human receptor exposure to tailing and groundwater. An increased level of protection occurs through the use of recorded institutional controls including restrictive covenants. Deed restrictions are layered with other institutional controls including well drilling prohibitions to be imposed by the State Engineer. These layered controls will restrict future human receptor exposure to soil/tailing and groundwater. All of these alternatives are conditioned upon post-tailing facility area closure being used for something other than wildlife habitat, such as for nonresidential, light industrial use, for example for renewable energy production. Installation of piping in the diversion channel under Alternative 2 adds to the overall protection of human health and the environment.

Cover placement after tailing deposition ceases in Alternative 2, Subalternatives 3A and 3B, and Alternative 4 protects future receptors from direct contact/ingestion of tailing and reduce infiltration and migration to groundwater. In addition, cover placement results in natural dewatering of the tailing and decreased seepage, further protecting human health and the environment and ultimately eliminating the impact of tailing on groundwater.

Current seepage collection in Alternatives 1 and 2 reduces human receptor exposure to groundwater. The upgraded seepage barriers in Subalternatives 3A and 3B and Alternative 4 increase protection through additional seepage collection. Extraction and collection of water from wells southeast of Dam No. 1 in Alternative 4 further protects human receptors from potential impacts from groundwater. Extraction of groundwater south of Dam No. 4 (Alternative 4) does not currently increase protection of human health; however, the volcanic aquifer downgradient of the tailing facility has potential use as a future source of domestic water supply. Water treatment in Subalternative 3B and Alternative 4 increase protection of human health and the environment through removal of metals and inorganics from groundwater.

Overall, Alternative 4 is more protective of human health than Subalternative 3B, which is more protective than Subalternative 3A, then Alternative 2, and then Alternative 1.

Compliance with ARARs

The alternatives/subalternatives comply with the applicable ARARs except that following cover placement, the standards of 40 CFR Part 141 Subparts B and G (MCLs) and Subpart F (MCLGs), WQCC 20.6.2.3103 NMAC (standards for groundwater), and NM Water Supply Regulations 20.7.10 NMAC (MCLs and MCLGs) will not be met for Alternative 1, for a limited number of constituents in the upper alluvial aquifer (south and southeast of Dam No. 1).

Long-Term Effectiveness and Permanence

Cover placement in Alternative 2, Subalternatives 3A and 3B, and Alternative 4 provides a permanent and effective long-term barrier for reducing infiltration and preventing exposure of tailing to ecological receptors. Alternative 1 is the least effective because cover is not included.

Alternative 2 and Subalternatives 3A and 3B are effective at reducing the seepage and migration of metals and inorganics from tailing to downgradient groundwater. Subalternative 3B and Alternative 4 provide increased long-term effectiveness through water treatment.

Overall, the alternatives that have the highest long-term effectiveness and permanence in order of most effective to least effective are as follows: Subalternative 3B and Alternative 4 are more effective than Subalternative 3A, which is more effective than Alternative 2, and then Alternative 1.

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume of the affected contaminants is not achieved through treatment of the impacted tailing or soil. However, there is reduction of toxicity, mobility, and volume through treatment for Subalternative 3B and Alternative 4 through water treatment.

Overall, Subalternative 3B and Alternative 4 provide greater reduction in toxicity, mobility, and volume of the affected contaminants than Subalternative 3A, Alternative 1, and Alternative 2, which have no reduction through treatment.

Short-Term Effectiveness

Alternative 1 provides no short-term impacts because no construction-related actions are included that may pose a risk to workers, community, or the environment. Potential risks to workers and the environment are likely to occur during placement of the cover in Alternative 2, Subalternatives 3A and 3B, and Alternative 4 associated with earthmoving activities over large areas. Installation of piping in the diversion channel (Alternative 2, Subalternatives 3A and 3B, and Alternative 4) and upgraded seepage barriers and groundwater extraction wells (Subalternatives 3A and 3B and Alternative 4) also include risks to workers associated with construction activities. Subalternative 3B and Alternative 4 likely include potential risks to workers, community, and the environment, with the addition of water treatment, due to construction associated with modifying the existing water treatment plant and installation of conveyance structures. Since Alternative 4 includes larger treatment requirements, additional construction, and concomitant risks.

Overall, the alternatives from the most effective (least short-term impacts) to least effective (greatest short-term impacts) for remedy implementation are as follows: Alternative 1 greater than Alternative 2, greater than Subalternatives 3A and 3B, and then Alternative 4.

Implementability

Alternative 1 (No Further Action) does not include construction activities and is the easiest to implement. Alternative 1 also includes institutional controls that are in place for the property. Alternative 2, Subalternatives 3A and 3B, and Alternative 4 all include installation of piping in the diversion channels, which is easily installed; however, piping may require a long lead time for procurement. Alternative 2, Subalternatives 3A and 3B, and Alternative 4 all also include placement of cover, which requires additional equipment and longer durations (approximately six years).

Alternative 4 includes groundwater extraction from the basal bedrock aquifer south of Dam No. 4, which is highly transmissive and requires pumping of several thousand gallons per minute to hydraulically contain the groundwater. In addition, water treatment in Subalternative 3B and Alternative 4 requires modifications to the existing equipment and long-term operations and maintenance of the system; however, Subalternative 3B requires less treatment and would be easier to implement.

Overall, Alternative 1 does not require construction and is the easiest to implement. Alternative 2 and Subalternative 3A is the next easiest to implement followed by Subalternative 3B. Alternative 4 involves the greatest construction activities.

Cost

Alternative 1 (No Further Action) does not include construction activities and has the lowest cost. An approximate $20 million (present value) increase over Alternative 1 provides a greater level of human health and environmental protection through covering the tailing facility, which reduces infiltration and migration to groundwater and piping water in the eastern diversion channel, which decreases the potential for off-site migration of tailing seepage (Alternative 2). An increase in cost of approximately $690,000 (present value) over Alternative 2 includes upgrading the seepage interception system, which provides a greater level of human health and environmental protection by further reducing the migration of seepage (Subalternative 3A). An increase in cost of approximately $7.6 to $52.7 million (present value) over Subalternative 3A includes water treatment of the pumpback seepage (present value) depending on whether the year of implementation is year zero or year 30 (Subalternative 3B). The installation and additional collection and treatment of groundwater from extraction wells (Alternative 4) increase the cost over Subalternative 3B by approximately $13.1 to $85.2 million (present value).

ES1.6.4 Red River Riparian and South of Tailing Facility Area

ES1.6.4.1 Description of Alternatives

Alternative 1 – No Further Action

This alternative includes no additional actions to address potential ecological risks from contact with tailing/soil in the Red River riparian area. CMI has previously removed a large portion of the historical tailing spill deposits in the riparian area (approximately 55 percent), and no additional removal is proposed for this alternative.

In addition, this alternative proposes that copper blocks continue to be used in the area south of the tailing facility to reduce the potential risk to livestock—primarily cattle. CMI has provided copper blocks to landowners for this purpose. Copper blocks are commonly used to supplement the diet of animals that graze in areas with a high molybdenum concentration in soil since molybdenum interferes with copper uptake in some animals. Soil posing an ecological risk remains in place.

Alternative 2 – Cap Soil and Tailing Spill Deposits

The major components of this alternative include:

- Cap and apply erosion mats and/or armoring over tailing spill deposits along the Red River riparian corridor.
- Dewatering area south of tailing facility.

- Stabilize soil in area south of tailing facility.
- Cap and revegetate affected soil south of tailing facility.

Tailing spill deposits located along the Red River riparian corridor will be capped with a layer of soil, erosion mats and/or armoring applied to provide protection for the cap, and revegetated as appropriate. Suitable alluvial cap material is available at the tailing facility. The estimated area containing tailing spill deposits in the Red River riparian area is approximately 3 acres. Capping of the tailing deposits requires approximately 4,400 cubic yards of soil material assuming a 6-inch (i.e., smaller deposits 5 cubic yards or less) to 12-inch (i.e., larger deposits greater than 5 cubic yards) depth. In addition, approximately 1,600 square yards of erosion control mats and 1,600 cubic yards of armoring will be placed on top of the cap material to provide protection against erosion.

Approximately 8 acres were identified south of the tailing facility in exposure area EA-9 where molybdenum concentrations in soil exceed the PRG of 11 mg/kg. The area will be capped with a 1-foot layer of soil. A cap thickness of 1 foot should be adequate to limit contact with the affected soil. Suitable alluvial cap material is available at the tailing facility. The alluvial material will be appropriately screened prior to transport to the area south of the tailing facility where it will be placed and revegetated. The approximate volume of cap material is estimated to be approximately 13,000 cubic yards. Due to the wet nature of the soil in this area, portions of the area may have to be dewatered using shallow trenches. Soil stabilizers may need to be added to access areas to provide a firm foundation for equipment.

Alternative 3 – Removal of Soil and Tailing Spill Deposits and Disposal

Subalternative 3A: Removal of Soil and Tailing Spill Deposits and Off-Site Disposal

The major components of this subalternative include:

- Excavate soil south of tailing facility and tailing spill deposits along the Red River riparian corridor.
- Dewater soil in area south of tailing facility.
- Stabilize soils excavated from area south of tailing facility.
- Transport and dispose of the excavated soil/tailing at an appropriate off-site facility.
- Backfill excavations with alluvial soil.

In the Red River riparian area, the tailing spill deposits will be excavated to a depth where tailing is no longer visible. The estimated total area containing tailing spill deposits is approximately 3 acres. The volume of tailing spill deposits requiring excavation is estimated to be 3,800 cubic yards. The excavations will be backfilled with clean alluvial soil and revegetated, if needed.

For the area south of the tailing facility, approximately 8 acres will be excavated and backfilled with clean alluvial soil. Based on an excavation depth of 2 feet for the purposes of this FS report, the estimated volume of soil requiring excavation is approximately 26,000 cubic yards. Due to the wet nature of the excavated soil, portions of the area may need to be dewatered.

Excavated soil will be transported and disposed of at a solid waste landfill, which may be located approximately 30 miles away, one way.

Subalternative 3B: Removal of Soil and Tailing Spill Deposits and On-Site Disposal

The major components of this subalternative include:

- Excavate soil south of tailing facility and tailing spill deposits along the Red River corridor.
- Dewater soil in area south of tailing facility.
- Stabilize soils excavated from south of tailing facility.
- Transport and placement of the excavated soil/tailing at the tailing facility.
- Backfill excavations with alluvial soil.

The activities associated with Subalternative 3B are the same as those described for Subalternative 3A except the excavated soil/tailing will be transported and placed in an impoundment at the tailing facility.

ES1.6.4.2 Red River and Riparian and South of Tailing Facility Area Analysis of Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 (No Further Action) is the least protective of the environment (i.e., ecological receptors). Subalternatives 3A and 3B are the most protective of the environment because they include removal of tailing spill deposits and affected soil south of the tailing facility. Capping the tailing spill deposits and affected soil south of the tailing facility under Alternative 2 is protective; however, the cap requires maintenance and residuals remain in place.

Overall, Subalternatives 3A and 3B are equally protective of the environment, which are more protective than Alternative 2, which is more protective than Alternative 1.

Compliance with ARARs

The alternatives/subalternatives comply with the applicable and relevant and appropriate ARARs. Compliance of groundwater with ARARs south of the tailing facility is addressed through alternatives at the Tailing Facility Area.

Long-Term Effectiveness and Permanence

Subalternatives 3A and 3B are the most effective in the long-term because the soil/tailing spill deposit are removed. However, long-term management is required for soil/tailing spill deposit material disposed of on-site in Subalternative 3B. Alternative 2 is less effective because the cap and erosion controls (i.e., rock armoring and erosion matting) require maintenance in the long-term to continue its effectiveness and affected soil/tailing spill deposits remain in place.

Alternative 1 is least effective because no actions are proposed and affected soil/tailing spill deposits remain in place.

Overall, the alternatives that have the highest long-term effectiveness and permanence in order of most effective to least effective are as follows: Subalternative 3A is more effective than Subalternative 3B, which is more effective than Alternative 2, and then Alternative 1.

Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction in toxicity, mobility, or volume through treatment in each alternative.

Overall, Alternatives 1 and 2 and Subalternatives 3A and 3B are equal, because they have no reduction through treatment.

Short-Term Effectiveness

Alternative 1 provides no short-term impacts because no construction-related actions are included that may pose a risk to workers, community, or the environment. Potential risks to the riparian ecosystem are likely to occur during placement of the cap and erosion controls in Alternative 2 from the use of construction equipment. Subalternatives 3A and 3B result in the greatest impacts because additional earthmoving activities (excavation, hauling, and backfilling) are included within the riparian areas and south of the tailing facility.

Overall, the alternatives from the most effective (least short-term impacts) to least effective (greatest short-term impacts) for remedy implementation are as follows: Alternative 1 greater than Alternative 2 greater than Subalternatives 3A and 3B.

Implementability

Alternative 1 (No Further Action) does not include construction activities and is the easiest to implement. Alternative 2 and Subalternatives 3A and 3B for the Red River and Riparian area include construction activities in sensitive riparian areas and multiple mobilization/demobilization of equipment along the Red River. Placement of erosion controls requires additional construction time and long-term management. Construction activities south of the tailing facility in Alternative 2 and Subalternatives 3A and 3B will be performed in a boggy area with a shallow water table, which involves the use of additional equipment and complex site preparation.

Overall, Alternative 1 does not require construction and is the easiest to implement. Alternative 2 and Subalternatives 3A and 3B involve approximately the same level of construction activities.

Cost

Alternative 1 (No Further Action) does not include construction activities and has the lowest cost. An increase in cost of approximately $2.2 million (present value) over Alternative 1 includes capping of soil south of the tailing facility and tailing spill deposits along the Red River riparian corridor (Alternative 2). An additional approximately $1.3 to $3.8 million (present value) over Alternative 2 includes excavation and disposal of soil south of the tailing facility and tailing spill deposits along the Red River riparian corridor (Subalternative 3A and Subalternative 3B). On-site disposal of excavated soil/tailing (Subalternatives 3B) decreases costs by approximately $2.5 million (present value) over off-site disposal (Subalternatives 3A).

ES1.6.5 Eagle Rock Lake Area

ES1.6.5.1 Description of Alternatives

Alternative 1 – No Action

This alternative includes no remedial actions to reduce the ecological risk. Sediment that poses an ecological risk will be left in place.

Alternative 2 – Inlet Storm Water Controls; In-Lake Capping of Sediment

The major components of this alternative include:

- Inlet controls to manage storm water entering the lake
- In-lake capping of sediments

Controls on the inlet structure to the lake are proposed. The goal of the inlet control is to reduce the sediment load from entering the lake during storm events or other high flow conditions that entrain sediment in the river. Flows into Eagle Rock Lake range from approximately 100 to 400 gpm. Storm events generate a considerable sediment load in the river that originates from drainages upstream of the mine site, and controls on the inlet are designed to close the headgate if the sediment load increases. Closing the headgate will be accomplished through the use of specific conductance and turbidity probes that monitor the river water and close the headgate if prescribed values are exceeded.

The other component of Alternative 2 is in-lake capping of sediments. The objective of capping is to cover the existing sediments and to provide more suitable sediment for the macroinvertebrates. Capping includes placement of approximately 1 foot of suitable alluvial fill on the bottom of the 3-acre lake. This requires approximately 4,900 cubic yards of material. The alluvial fill will be excavated from the borrow area at the tailing facility and hauled to the lake.

Alternative 3 – Inlet Storm Water Controls; Dredge Sediments and Disposal

Subalternative 3A: Inlet Storm Water Controls; Dredge Sediments and Off-Site Disposal

The major components of this subalternative include:

- Inlet controls to manage storm water entering the lake.
- Dredge and dewater sediments.

- Transport and dispose of excavated sediments at an appropriate off-site facility.

As in Alternative 2, Subalternative 3A includes installation of a motor-driven headgate that is actuated by an increase in the specific conductance and turbidity of the river water. The headgate will close if prescribed values are exceeded to prevent the sediment load from entering the lake.

Dredging of sediments is also proposed as part of Subalternative 3A. Two types of dredging are available: hydraulic dredging from a barge; or drainage of the lake, allowing the sediments to dewater, and excavation of the sediments. Hydraulic dredging was selected as the removal technology because it will have less impact to the lake and recreational use of the lake. In addition, this type of dredging is quicker than draining and excavating the sediments because the sediments in the bottom of the drained lake may take several months to naturally dry to a point where they can be excavated and transported for disposal.

Hydraulic dredging removes the sediment by pumping sediments from a barge to a staging area near the lake. The staging area needs to be sufficient in size to temporarily impound the dredged sediments. A temporary berm will be constructed around the staging area to contain the sediments. The sediments will then be mechanically dewatered by a hopper in the staging area to facilitate drying. Excess water will temporarily be impounded then allowed to flow back into the lake. Sediments will be allowed to dry in the staging area until an appropriate moisture is reached that will allow for haulage and disposal.

Once dewatered, the dredged sediments will be transported and disposed of at an appropriate off-site facility. It is assumed that the sediments can be handled as a solid waste and will be hauled to a solid waste landfill, which may be located approximately 30 miles away, one way. The volume of dredged sediments is estimated to be approximately 15,000 cubic yards, based on a 3-foot depth of dredging over the 3-acre lake.

Subalternative 3B: Inlet Storm Water Controls; Dredge Sediments and On-Site Disposal

The major components of this subalternative include:

- Inlet controls to manage storm water entering the lake.
- Dredge and dewater sediments.
- Transport and place the excavated sediments at an appropriate on-site facility.

The activities conducted for Subalternative 3B are the same as those described for Subalternative 3A. The difference is that the dewatered sediments will be placed at an appropriate on-site facility. If placed on-site, the proposed cells constructed at the mine site for the water treatment filter cake or sludge could be used to contain these sediments. The volume of sediments is approximately 15,000 cubic yards. Multiple cells are estimated to be constructed to contain the filter cake/sludge from the water treatment plant. Each cell is estimated to contain approximately 7,500 cubic yards of material. Therefore, two cells will be needed for the sediments.

Alternative 4 – Remove Lake

Alternative 4 was removed during preliminary screening and not carried forward to the detailed analysis.

Alternative 5 – Inlet Storm Water Controls; Backfill Lake and Construct New Lake

The major components of this alternative include:

- Drain the existing lake.
- Excavate and construct new lake.
- Excavate current breach dam and remove existing headgate.
- Backfill the existing lake.
- Construct earthen dam and inlet/outlet structures at new lake.
- Inlet controls to manage storm water entering the new lake.
- Relocate or construct infrastructure.

In Alternative 5, the existing lake will be drained by breaching the earthen dam at the lake's outlet. The outlet of the lake consists of two 16-inch-diameter corrugated metal pipes that discharge water to Red River. The earthen dam at the outlet will be breached to drain water in the lake, which is estimated to be 23 ac-ft. Breaching will proceed slowly to minimize sediment from discharging into the river. A dead pool of water is expected to be present in the lake after the dam is breached, and the remaining water will be removed and contained or used at CMI facilities. The inlet from the river to the lake will be removed.

A new lake is proposed to be constructed. The new lake will cover the same approximate area (3 acres) as the existing lake and will have a comparable maximum water depth of approximately 8 feet and storage volume of approximately 23 ac-ft. The cross section shows the elevation of the river, existing land surface elevation, preliminary limits of excavation, and anticipated water level in the new lake once filled. Access will be provided at the western end during construction.

The volume of backfill is estimated to be approximately 37,000 cubic yards, based on an average depth of the lake of 7.5 feet. An earthen dam will be constructed on the west side of the lake and will be non-jurisdictional (i.e., <10 feet). Excavated material will be used to construct the dam. An outlet structure comparable to the exiting outlet will be constructed at the dam. Erosion controls (i.e., riprap) will be placed around the outlet. A channel from the outlet to Red River will be excavated and lined-with riprap. The outlet channel will convey water from the lake back to the river, similar to the existing lake. Water will be supplied to the new lake by a new headgate and concrete diversion at the river located on the eastern end of the lake. A channel will be excavated from the headgate to the new lake and lined with riprap. Once constructed, the new lake will be filled by diverting water from the river.

Excavated material from the new lake will be used to backfill the existing lake. A balance of cut/excavation of the new lake, and filling of the exiting lake is assumed. Excavated material will be transported to the existing lake by haul trucks, spread, graded and revegetated.

Alternative 5 also includes storm water controls at the inlet of the new lake, similar to Alternatives 2 and 3. A motor-driven headgate will be installed at the inlet that will automatically close the headgate with either the specific conductance or turbidity of the river water increases to values indicative of high sediment load in the river.

ES1.6.5.2 Eagle Rock Lake Area Analysis of Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 (No Action) is the least protective of the environment (i.e., BMI ecosystem) because residuals will be left in place; however, there is no impact to human health, and reduction of inputs to the river along the mine site should improve over time. Alternative 2, Subalternatives 3A and 3B, and Alternative 5 are all protective of the environment after remedial actions are complete and the ecosystem recovers. However, in Alternative 2, which includes in-lake capping of affected sediment, residuals remain in place. Alternative 2, Subalternatives 3A and 3B, and Alternative 5 are not protective of the benthic ecosystem in the short-term because the remedial actions proposed in each alternative (capping, dredging, and backfilling, respectively) destroy the benthic ecosystem and a degradation of water quality during implementation.

Protection of human health is not addressed by the alternatives for Eagle Rock Lake because the Final Baseline Human Health Risk Assessment (BHHRA) (CDM 2009a) identified no risk to human health.

Overall, Subalternatives 3A and 3B and Alternative 5 are equally protective of the benthic ecosystem, which are more protective than Alternative 2, which is more protective than Alternative 1.

Compliance with ARARs

The alternatives/subalternatives comply with the applicable and relevant and appropriate ARARs.

Long-Term Effectiveness and Permanence

Each of the alternatives is effective and permanent in the long-term except for Alternative 1 (No Action). Accumulation of sediment from drainages upstream of the mine site continue under Alternative 1 and this will continue to affect the benthic ecosystem. Remedial actions in Alternative 2, Subalternatives 3A and 3B, and Alternative 5 provide a new substrate for the macroinvertebrate ecosystem and controls at the inlet (i.e., headgate) minimize sedimentation in the lake. Alternative 2 may require long-term maintenance of the in-lake cap in the future. A headgate is an adequate and reliable control; however uncertainties exist with regard to maintenance of the headgate, which could impact the long-term effectiveness of the alternatives. Long-term management is required for sediments disposed of on-site in Subalternative 3B.

Overall, the alternatives that have the highest long-term effectiveness and permanence in order of most effective to least effective are as follows: Subalternatives 3A and 3B and Alternative 5, are more effective than Alternative 2, which is more effective than Alternative 1.

Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction of toxicity, mobility, or volume through treatment. Overall, the inlet controls in Alternative 2, Subalternatives 3A and 3B, and Alternative 5 provide greater reduction in mobility and volume than Alternative 1; however, they have no reduction through treatment.

Short-Term Effectiveness

Alternative 2, Subalternatives 3A and 3B, and Alternative 5 have low short-term effectiveness. While risks to workers and the community will be minimal under these alternatives, the existing macroinvertebrate ecosystem in the lake sediments will be destroyed and water quality will be degraded in the short-term. A period of time will be required before an ecosystem is re-established in the existing or new lake. Alternative 1 has the highest short-term effectiveness because no remedial actions are proposed that pose risks to workers, the community, or the environment. There are increased short-term impacts to the community from the limited recreational use of the lake during the implementation of Alternative 2 and Subalternatives 3A and 3B.

Overall, the alternatives from the most effective (least short-term impacts) to least effective (greatest short-term impacts) for remedy implementation are as follows: Alternative 1 greater than Alternative 5 greater than Alternative 2 and Subalternatives 3A and 3B.

Implementability

Alternative 1 does not include construction activities and is the easiest to implement. Alternative 2 is the next easiest to implement. Capping involves hauling alluvial material from a local source to the lake and placing the material on the sediments. Subalternatives 3A and 3B involve more complicated construction from the dredging activities and subsequent drying and disposal of the dredged material. Construction of a new lake in Alternative 5 requires a change in the point of diversion from the river and may require the addition of water rights. Off-site disposal in Subalternative 3A is more implementable because off-site disposal facilities are readily available, whereas Subalternative 3B requires construction and management of a new on-site disposal cell.

Overall, Alternative 1 does not require construction and is the easiest to implement. Capping in Alternative 2 involves less construction activities then Subalternatives 3A and 3B and Alternative 5.

Cost

Alternative 1 (No Action) does not include construction activities and has the lowest cost. In-lake capping and storm water inlet controls (Alternative 2) increases cost by approximately $400,000 (present value). An increase of approximately $1 to $2 million (present value) over Alternative 2 includes dredging and disposal of the sediments. On-site disposal of excavated soil/tailing (Subalternatives 3B) decreases costs by approximately $900,000 (present value) below off-site disposal (Subalternatives 3A). For approximately $1 million (present value) over Alternative 2, the existing lake will be backfilled and a new lake constructed (Alternative 5). Constructing a new lake and backfilling the existing lake is approximately the same as or lower than the cost of Subalternatives 3A and 3B.

Table ES-1
EXPOSURE AREAS/MEDIA THAT WARRANT REMEDIAL CONSIDERATION TO BE EVALUATED IN FEASIBILITY STUDY

MINE SITE			
Media	Exposure Area	Decision to Evaluate in FS	
		HH	Eco
Soil	EA-1 (Administration Area)	No	NA
	EA-2 (Mill Area)	Yes	NA
	EA-3 (Rock Piles excluding Capulin, Goathill North, and Goathill South)	No	No
	EA-4 (Other Mine Site Areas including Capulin, Goathill North, and Goathill South rock piles)	No	No
	EA-5 (Mine Site Riparian)	No	No[1]
Sediment	Eagle Rock Lake	No	Yes[2]
	Red River	No	No
Surface Water	Red River	No	Yes
	Eagle Rock Lake	No	No
	Mine Site Storm Water Catchments	No	No
	Mine Site Seepage Catchments	Yes	No
	Mine Site Rock Pile Seepage	Yes	No
	Mine Site Springs and Seeps along Red River	No	Yes[3]
Groundwater	Alluvium-1 Rock Pile Reach (similar to Surface Water EA-3)	Yes	NA
	Alluvium-2 Columbine Park (similar to Surface Water EA-4)	Yes	NA
	Alluvium-3 Goathill Reach (similar to Surface Water EA-5)	Yes	NA
	Alluvium-4 Downstream Boundary (similar to Portions of Surface Water EA-4)	Yes	NA
	Alluvium-9 Western Mill Area	No	NA
	Colluvium-5 Rock Piles (similar to Rock Pile Soil EA-3)	Yes	NA
	Colluvium-6 Goathill/Slickline Gulch (Incorporates Admin Soil EA-1)	Yes	NA
	Colluvium-7 Capulin Canyon	Yes	NA
	Bedrock-5 Rock Piles (similar to Rock Pile Soil EA-3)	Yes	NA
	Bedrock-6 Goathill/Slickline Gulch (Incorporates Admin Soil EA-1)	Yes	NA
	Bedrock-7 Capulin Canyon	No	NA
	Bedrock-8A Subsidence Zone	Yes	NA
	Bedrock-8B Open Pit	Yes	NA
	Bedrock-9 Western Mill Area	No	NA
	Bedrock-10 Western Mine Boundary	Yes	NA

Table ES-1
EXPOSURE AREAS/MEDIA THAT WARRANT REMEDIAL CONSIDERATION TO BE EVALUATED IN FEASIBILITY STUDY

TAILING FACILITY			
Media	Exposure Area	Decision to Evaluate in FS	
		HH	Eco
Soil	EA-6 (Tailing Facility Riparian)	No	No[1]
	EA-7 (Tailing Facility)	No	No
	EA-8 (South of Tailing Facility - Human Health)	No[4]	NA
	EA-9 (South of Tailing Facility - Ecological)	NA	Yes
Sediment	Tailing Impoundments	Yes	Yes
	Red River	No	No
	Hunt's Pond	No	No
Surface Water	Tailing Impoundments	No	No
	Tailing Facility Seeps and Springs	No	No
	Red River	No	Yes
	Hunt's Pond	No	No
Groundwater	Upper Alluvial Aquifer-1 (South of Dam 1)	Yes	NA
	Upper Alluvial Aquifer-2 (East of Tailing Facility) (MW-17 Area Only)	Yes	NA
	Upper Alluvial Aquifer-2 (East of Tailing Facility) (Excluding MW-17 Area)	No	NA
	Upper Alluvial Aquifer-3 (Lower Sump)	No	NA
	Basal Alluvial Aquifer-1 (South of Dam 1)	No	NA
	Basal Alluvial Aquifer-2 (East of Tailing Facility)	No	NA
	Basal Bedrock Aquifer-1 (South of Dam 1) (TPZ-5B Area)	Yes	NA
	Basal Bedrock Aquifer-4 (Dam 4 Impoundment)	Yes	NA

Notes:
[1]Areas do not require remediation to address protection of terrestrial ecological receptors; however, alternatives have been developed in the FS.
[2]Controlling total aluminum in the Red River during and after storm events is considered likely to result in an analogous reduction in the effects of storms on Eagle Rock Lake water.
[3]Only for total aluminum during and after storm events for COCs in the Red River near Springs and Seeps along the Red River.
[4]Elevated Fe in small area will be addressed under EA-9 (ecological).
Eco = Evaluated based on ecological risks
EA = Exposure Area
FS = Feasibility Study
HH = Evaluated based on human health risks
MW = Monitoring well
NA = Not Applicable - Risk not evaluated for this area
TPZ = Temporary piezometer

(yellow)	Evaluated in FS
(white)	Not evaluated in FS

Table ES-2
KEY TO ALTERNATIVE AREAS AND EXPOSURE AREAS

Alternative Area	Media of Concern	Associated Exposure Areas
1 - Mill Area	Soil	EA-2 (Mill)
2 - Mine Site Area [1]	Waste Rock	EA-3 (Rock Piles excluding Capulin, Goathill North, and Goathill South)
	Surface Water	Mine Site Rock Pile Seepage[2]
	Surface Water	Mine Site Seepage Catchments[2]
	Surface Water	Mine Site Springs & Seeps along Red River
	Groundwater	Alluvium-1 (Rock Pile Reach)
	Groundwater	Alluvium-2 (Columbine Park)
	Groundwater	Alluvium-3 (Goathill Reach)
	Groundwater	Alluvium-4 (Downstream Boundary)
	Groundwater	Colluvium-5 (Rock Piles)
	Groundwater	Colluvium-6 (Goathill/Slickline Gulch)
	Groundwater	Colluvium-7 (Capulin Canyon)
	Groundwater	Bedrock-10 (Western Mine Boundary)
	Groundwater	Bedrock-5 (Rock Piles)
	Groundwater	Bedrock-6 (Goathill/Slickline Gulch)
3 - Tailing Facility Area	Soil	EA-7 (Tailing Facility)
	Tailing	Tailing Impoundments [3]
	Groundwater	Upper Alluvial Aquifer-1 (South of Dam 1)
	Groundwater	Upper Alluvial Aquifer-2 (East of Tailing Facility) (MW-17 Area Only)
	Groundwater	Basal Bedrock Aquifer-4 (Dam 4 Impoundment)
4 - Red River and Riparian and South of Tailing Facility Area	Soil; Tailing	EA-5 (Mine Site Riparian)
	Soil; Tailing	EA-6 (Tailing Facility Riparian)
	Soil	EA-9 (South of Tailing Facility)
	Sediment	Red River [4] Exposure Areas (HHEA1, HHEA2, EEA3-8)
	Surface Water	Red River [5] Exposure Areas (HHEA1, HHEA2, EEA3-8)
	Groundwater [6]	Upper Alluvial Aquifer-1 (South of Dam 1)
5 - Eagle Rock Lake Area	Sediment	Eagle Rock Lake
	Surface Water	Eagle Rock Lake [7]

Notes:

[1] The samples collected in EA-4 included some samples collected from the open pit. The BHHRA indicated there was a low level risk largely due to copper from EA-4 based on the EPC calculated from the data set including open pit samples. EPA, in discussion with CMI and NMED, decided the low level of risk and large amount of uncertainty in the copper TRV did not warrant response actions to reduce such risk at the open pit. No samples were collected from the Subsidence Zone due to safety concerns for the workers, so an assessment was not made on risk within the Subsidence Zone. The Truck Shop Slice is a natural area that has not been mined; risk for Bedrock - 8A (Subsidence Zone) and Bedrock - 8B (Open Pit) has not been evaluated and groundwater is managed in the underground. Rock piles in EA-4 (Capulin, Goathill North, and Goathill South) are included even though EA-4 was not carried forward for evaluation in the feasibility study.

[2] Mine Site Rock Pile Seepage and Mine Site Seepage Catchments are evaluated separately because the areas have different COCs.

[3] Alternatives or components of alternatives addressing RAOs will be initiated upon cessation of mining for the underground workings and cessation of tailing disposal for the tailing facility.

[4] Red River sediments are being addressed through reduction of inputs to the river from mine site affected groundwater.

[5] Red River water quality is being addressed through reduction of inputs to the river from mine site affected groundwater.

[6] Alternatives do not address groundwater, which is being addressed through reduction of mine site affected groundwater at the Tailing Facility.
[7] Eagle Rock Lake water quality controlled by Red River, which is being addressed through reduction of inputs to the river from mine site affected groundwater.

BHHRA = Baseline Human Health Risk Assessment
EA = Exposure Area
EEA = Ecological Exposure Area
EPA = U.S. Environmental Protection Agency
EPC = Exposure point concentration
HHEA = Human Health Exposure Area
NMED = New Mexico Environmental Department
RAO = Remedial action objective
TRV = Toxicity reference value

Table ES-3
REMEDIAL ACTION OBJECTIVES

Exposure Area/Location	Medium of Concern	Receptor	Remedial Action Objectives (RAOs)
Mill Area			
Mill Area (EA-2)	Soil	Human Health	Protect human receptors by preventing direct contact/ingestion of mine site soils that have concentrations of molybdenum and PCBs greater than federal ARARs and/or selected risk-based cleanup levels for soil.
Mine Site Area			
Mine Rock Piles (EA-3) (excluding Spring Gulch, Capulin, Goathill North and Goathill South)	Soil	Ecological	Prevent future transport of mine site soil containing inorganic COCs[1] to surface water entering the Red River to prevent future adverse impacts to habitat, physical toxicity, and exceedance of surface-water quality ARARs.
Mine Rock Pile Seepage and Seepage Catchments	Surface Water	Human Health	Protect recreational visitor/trespasser by reducing exposure (ingestion) to surface water containing beryllium, cadmium, and manganese exceeding federal drinking water standards or preliminary site-specific risk-based cleanup levels.
Mine Site Seeps and Springs Along Red River	Surface Water	Ecological	Protect Red River aquatic species from chronic exposure to inorganic[1] COCs and acidity at Springs 13 and 39 by eliminating or reducing discharge, to the maximum extent practicable, of Springs 13 and 39 water to the Red River at levels that result in total aluminum concentrations below the preliminary site-specific risk-based cleanup level of 1.0 mg/L in Red River surface water at Spring 13 and 0.8 mg/L in Red River surface water at Spring 39.[2]
	Groundwater to Surface Water	Ecological	Eliminate or reduce, to the maximum extent practicable, the migration of mine-related inorganic[1] COCs in groundwater to Red River surface water at concentrations that would result in surface water concentrations exceeding surface water ARARs or preliminary site-specific risk-based cleanup levels.
Mine Rock Piles (EA-3 and EA-4)	Source Material Waste Rock	Human Health	Eliminate or reduce, to the maximum extent practicable, leaching and migration of inorganic[1] COCs and acidity from waste rock (acid rock drainage) to groundwater at concentrations and quantities that have the potential to cause exceedances of the numerical ground-water ARARs[3] or preliminary site-specific risk-based cleanup levels.
		Ecological	Restore habitat to a condition which will allow for the establishment of a self-sustaining ecosystem.

Table ES-3
REMEDIAL ACTION OBJECTIVES

Exposure Area/Location	Medium of Concern	Receptor	Remedial Action Objectives (RAOs)
Mine Site Groundwater (excluding Capulin Canyon – Bedrock 7; Mill Area – Alluvium 9, Bedrock 9)	Groundwater	Human Health	Prevent ingestion by humans of groundwater containing mine-related inorganic[1] COCs exceeding state/federal ARARs or preliminary site-specific risk-based cleanup levels.
			Restore contaminated groundwater to meet state/federal ARARs or preliminary site-specific risk-based cleanup levels for inorganic[1] COCs.
Underground Mine Working	Groundwater	Human Health	Maintain underground mine water elevations below those of the Red River, prevent ingestion by humans and treat groundwater from the underground mine working containing mine-related inorganic[1] COCs exceeding state/federal ARARs or preliminary site-specific risk-based cleanup levels.
Tailing Facility Area			
Tailing Facility (EA-7)	Soil	Ecological	Restore habitat to a condition which will allow for the establishment of a self-sustaining ecosystem.
	Tailing	Human Health	Protect recreational visitor/trespasser by reducing or eliminating exposure (dermal contact/ingestion) to tailing in the ponded area that contains molybdenum at concentrations exceeding preliminary site-specific risk-based cleanup levels.
		Ecological	Protect aquatic and aquatic-dependent life by reducing or eliminating exposure to tailing in the ponded area that contains metals at concentrations exceeding site-specific risk-based cleanup levels.
		Human Health	Eliminate or reduce, to the maximum extent practicable, the seeping and migration of inorganic[1] COCs from tailing to groundwater at concentrations and quantities that have the potential to cause exceedances of the numerical groundwater ARARs[3] or preliminary site-specific risk-based cleanup levels for groundwater.
	Groundwater	Human Health	Eliminate or reduce ingestion by humans of groundwater withdrawn from private wells containing mine-related inorganic[1] COCs exceeding state/federal ARARs or preliminary site-specific risk-based cleanup levels.
			Restore contaminated groundwater at and off-site of the Tailing Facility to meet state/federal ARARs or preliminary site-specific risk-based cleanup levels for inorganic[1] COCs.

Table ES-3
REMEDIAL ACTION OBJECTIVES

Exposure Area/Location	Medium of Concern	Receptor	Remedial Action Objectives (RAOs)
Red River, Riparian, and Area South of Tailing Facility[4]			
South of Tailing Facility (EA-9)	Soil[4]	Ecological	Eliminate or reduce direct exposure and exposure via accumulation in plants to mining-affected soil and tailing spills that contains molybdenum at concentrations exceeding the preliminary site-specific risk-based cleanup level of 11 mg/kg for protection of livestock (cattle, sheep).
Red River (EA-4, EA-5, EA-6, EA-7, EA-8)	Surface Water[5]	Ecological	Eliminate or reduce direct exposure of fish to Red River surface water along the Mine Site and Tailing Facility during and following storm events that exceeds surface-water ARARs or preliminary site-specific risk-based cleanup levels for aluminum (direct toxicity).
Eagle Rock Lake Area			
Eagle Rock Lake Area	Sediment	Ecological	Eliminate or reduce direct exposure of benthic macroinvertebrates to Mine Site-affected sediment in Eagle Rock Lake that exceeds preliminary site-specific risk-based cleanup levels for aluminum, arsenic, nickel, selenium and zinc.
			Eliminate or reduce the deposition of Mine Site-affected sediment in Eagle Rock Lake that exceeds preliminary site-specific risk-based cleanup levels for the Red River sediment COCs (nickel and zinc) for benthic macroinvertebrates.

Notes:

[1] Inorganics include metals.

[2] The following provides a basis for this RAO:

> *The EPCs for total aluminum in Red River surface water, based on four sampling events over two years (and not including any storm events or snow melt conditions) are 0.91 mg/L upstream of Spring 39 (EA-4), 0.67 mg/L adjacent to Spring 39 (EA-5) and 1.41 mg/L adjacent to Spring 13 (EA-6). The corresponding chronic TRVs for trout, based on trout-specific toxicity data and the mean hardness of each EA are 0.77mg/L (EA-4), 0.95 mg/L (EA-5), and 0.97 mg/L (EA-6).*

The methodology for evaluating the achievement of the 1.0 mg/L (i.e., 0.95 mg/L and 0.97 mg/L trout chronic TRVs rounded to 1.0 mg/L for Spring 13 and 0.77 rounded to 0.8 mg/L for Spring 39) risk-based cleanup level for total aluminum will be based on monthly monitoring of total aluminum concentrations in the Red River. Sample collection will take place within a period of 2 hours or less of each other at an upstream and downstream location of each of these two springs in the Red River, approximately equidistant from the north bank and mid-channel, at approximately mid-depth. Sampling locations will be just upstream of all known Spring 13 and Spring 39 discharges to the Red River and approximately mid way between the most downstream Spring 13 and Spring 39 discharges to the river and the next RR sampling station.

Executive Summary

Monitoring will not take place, nor will this RAO and its requirements be applicable during precipitation events and for a period of a minimum of 2 days after stream flow returns to pre-precipitation flow rates. To verify a return to baseline water quality following a storm event, monitoring of select indicator parameter(s) (e.g., turbidity or conductivity[1]) will also be part of the monthly monitoring program, as well as monitoring baseline gauge height after the storm event.

The concentration limit for further action is the exceedance in the downstream sample of the preliminary cleanup level of 1.0 mg/L total aluminum for Spring 13 and 0.8 mg/L total aluminum for Spring 39. This limit does not apply when the upstream total aluminum concentration exceeds 1.0 mg/L for Spring 13 and 0.8 mg/L total aluminum for Spring 39. In cases where the upstream sample concentration exceeds the 1 mg/L limit for Spring 13 and 0.8 mg/L total aluminum for Spring 39, the temporary limit for further action to be applied to the downstream sample is 1.3 times the total aluminum concentration measured in the upstream sample. The factor of 30% is designed to minimize false positives. The analytical variability was assessed through the analysis of field duplicate samples. The standard deviation due to sampling/analysis variability is about 16% for each of the two measurements at a spring. The uncertainty in measurement is estimated from this standard deviation for both the upstream and downstream concentrations as approximately 30%.

Therefore, total aluminum concentrations below Spring 13 and Spring 39 are not allowed to increase beyond 1.3 times the concentration in water collected just upstream of Spring 13 and Spring 39.

[3] Numeric criteria, existing concentrations or background concentrations whichever is higher.

[4] Groundwater contamination south of Tailing Facility is being addressed through remediation of affected groundwater at the Tailing Facility and source control.

[5] Red River water quality is being addressed through reduction of COCs entering the river from groundwater, including source control measures.

ARAR = Applicable or Relevant and Appropriate Requirement
COC = Chemical of Concern
EA = Exposure area
EPC = Exposure point concentration
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
PCB = Polychlorinated biphenyl
RAO = Remedial action objective
RR = Red River
TRV = Toxicity reference value

Table ES-4
SUMMARY OF PROCESS OPTIONS CARRIED FORWARD FOR ALTERNATIVE DEVELOPMENT

<table>
<tr><th>Media</th><th>General Response Action</th><th>Technology Type</th><th colspan="2">Screened Process Options Retained [1]</th></tr>
<tr><td rowspan="14">Soil/Waste Rock</td><td rowspan="2">No Action</td><td>No Action</td><td colspan="2">No remedial actions</td></tr>
<tr><td>No Further Action</td><td colspan="2">No further remedial actions</td></tr>
<tr><td rowspan="4">Institutional/Engineering Actions/Controls</td><td rowspan="2">Restrictions</td><td colspan="2">Controlled Access</td></tr>
<tr><td colspan="2">Notices to deed and advisories/permitting/restrictive covenant/conservation easement/restrictive zoning/groundwater use and well drilling restriction</td></tr>
<tr><td rowspan="2">General Operating Procedures</td><td colspan="2">General Operating Procedures</td></tr>
<tr><td colspan="2">Best Management Practices</td></tr>
<tr><td rowspan="5">Containment</td><td rowspan="5">Horizontal Barrier</td><td colspan="2">Grading of Existing Surface</td></tr>
<tr><td colspan="2">Vegetation</td></tr>
<tr><td rowspan="3">Monolithic Cover</td><td>Simple Soil Cover/Cap</td></tr>
<tr><td>Store and Release/ET</td></tr>
<tr><td>Asphalt Concrete</td></tr>
<tr><td>Treatment</td><td>Thermal Treatment</td><td colspan="2">Thermal Desorption</td></tr>
<tr><td rowspan="2">Removal</td><td rowspan="2">Excavation/Disposal</td><td colspan="2">Excavation and Off-Site Disposal</td></tr>
<tr><td colspan="2">Excavation and On-Site Disposal</td></tr>
<tr><td rowspan="9">Sediment/ Tailing</td><td rowspan="2">No Action</td><td>No Action</td><td colspan="2">No remedial actions</td></tr>
<tr><td>No Further Action</td><td colspan="2">No further remedial actions</td></tr>
<tr><td rowspan="4">Containment</td><td rowspan="2">Horizontal Barriers</td><td colspan="2">Simple Soil Cover/Cap</td></tr>
<tr><td colspan="2">Store and Release/ET</td></tr>
<tr><td rowspan="2">Vertical Barriers</td><td colspan="2">Inlet/Outlet Controls</td></tr>
<tr><td colspan="2">Soil Cover</td></tr>
<tr><td>Treatment</td><td>Physical/Chemical Treatment</td><td colspan="2">Constructed Wetlands</td></tr>
<tr><td rowspan="2">Removal</td><td rowspan="2">Excavation/Disposal</td><td colspan="2">Backfill</td></tr>
<tr><td colspan="2">Dredge and Dispose Off-Site</td></tr>
<tr><td rowspan="7">Surface Water</td><td>No Action</td><td>No Further Action</td><td colspan="2">No further remedial actions</td></tr>
<tr><td rowspan="2">Institutional/Engineering Actions/Controls</td><td rowspan="2">Restrictions</td><td colspan="2">Controlled Access</td></tr>
<tr><td colspan="2">Notices to deed and advisories/permitting/restrictive covenant/conservation easement/restrictive zoning/groundwater use and well drilling restriction</td></tr>
<tr><td rowspan="4">Collection/Containment</td><td>Horizontal Barriers</td><td colspan="2">Subsurface Drains</td></tr>
<tr><td rowspan="3">Vertical Barriers</td><td colspan="2">Extraction Wells</td></tr>
<tr><td colspan="2">Interceptor Trench/Cut-Off Wall/Grout Curtain</td></tr>
<tr><td colspan="2">Pipe Conveyance</td></tr>
</table>

Table ES-4
SUMMARY OF PROCESS OPTIONS CARRIED FORWARD FOR ALTERNATIVE DEVELOPMENT

Media	General Response Action	Technology Type	Screened Process Options Retained[1]
	Treatment	Physical/Chemical Treatment	Ion Exchange
			Lime Neutralization/Chemical Precipitation
			Reverse Osmosis
			Ultrafiltration
	Source Removal	Excavation/Disposal	Excavation of road fill and disposal on-site
Groundwater	No Action	No Further Action	No further remedial actions
	Institutional/Engineering Actions/Controls	Restrictions	Notices to deed and advisories/permitting/restrictive covenant/conservation easement/restrictive zoning/groundwater use and well drilling restriction
	Collection/Containment	Horizontal Barriers	Line/Pipe Diversion Ditch
			Storm Water Controls
		Vertical Barriers	Extraction Wells
			Interceptor Trench/Cut-Off Wall/Grout Curtain/Slurry Wall
			Pipe Conveyance
	Treatment	Physical/Chemical Treatment	Ion Exchange
			Lime Neutralization/Chemical Precipitation
			Reverse Osmosis
			Ultrafiltration
	Source Removal	Excavation/Disposal	Excavation and On-Site Disposal of Historic Tailing

Notes:
[1] Process Options, from Appendix B, that were not ranked Low for Effectiveness or Implementability (Relative Cost was evaluated on a case-by-case basis); "No Action"/"No Further Action" alternatives are required to be carried forward for alternative development.

ET = Evapotranspiration

Table ES-5
SUMMARY OF MAJOR COMPONENTS OF ALTERNATIVES

Alternative Area (Media)	1 - Mill Area (Soil)								2 - Mine Site Area (Soil, Waste Rock, Surface, and Groundwater)					3 - Tailing Facility Area (Soil, Tailing, and Groundwater) [1]					4 - Red River and Riparian and South of Tailing Facility Area (Soil and Tailing) [2, 3]				5 - Eagle Rock Lake Area (Sediment) [4]					
Alternative Number	**1**	**2**	**3**	**4A**	**4B**	**5A**	**5B**	**5C**	**1**	**2**	**3A**	**3B**	**4**	**1**	**2**	**3A**	**3B**	**4**	**1**	**2**	**3A**	**3B**	**1**	**2**	**3A**	**3B**	**4**	**5**
Major Component																													
Monitoring/Maintenance	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Controlled Access	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Institutional Controls (e.g., notices to deed, restrictive covenants or conservation easements, well drilling restrictions)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
BMPs for In-Place PCB Management		x																										
Evaluate BMPs for Water Management														x	x	x	x	x										
Copper Blocks																			x									
Dust Control Measures														x	x	x	x	x										
Storm Water Controls	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Water Extraction/Collection									x	x	x	x	x	x	x	x	x	x										
Install Monitoring Wells																x	x	x										
Install Extraction Wells											x	x	x			x	x	x										
Upgrade Seepage Barriers																x	x	x										
Install Seepage Collection System											x	x	x					x										
Increased Water Extraction/Collection											x	x	x			x	x	x										
Pipe Seepage to and Fence Pumpback Pond										x	x	x	x															
Pipe Capulin/Goathill North Seepage																												
Water Management (piping, pumping, collection in underground)									x	x	x	x	x	x	x	x	x	x										
Water Discharge (under NPDES)														x	x	x	x	x										
Water Management (piping, conveyance, pumping)									x	x	x	x	x	x	x	x	x	x										
Pipe Water in Eastern Diversion Channel at Tailing Facility															x	x	x	x										
Water Treatment [5]									x	x	x	x	x				x	x										
Soil Cap				x																x				x				
Asphalt Cap					x																							

Executive Summary

Table ES-5
SUMMARY OF MAJOR COMPONENTS OF ALTERNATIVES

Alternative Area	1 - Mill Area								2 - Mine Site Area					3 - Tailing Facility Area					4 - Red River and Riparian and South of Tailing Facility Area				5 - Eagle Rock Lake Area					
(Media)	(Soil)								(Soil, Waste Rock, Surface, and Groundwater)					(Soil, Tailing, and Groundwater) [1]					(Soil and Tailing) [2, 3]				(Sediment) [4]					
Alternative Number	1	2	3	4A	4B	5A	5B	5C	1	2	3A	3B	4	1	2	3A	3B	4	1	2	3A	3B	1	2	3A	3B	4	5
Erosion Matting/Armoring																				x								
Regrade/Cover/Revegetate		x	x	x	x	x	x	x																				
Regrade/Cover/Revegetate (Rock Piles)											x	x	x															
Grade/Cover/Revegetate (Tailing Ponds)															x	x	x	x										
Excavate/Backfill			x	x	x	x	x	x							x	x	x	x			x	x						
Balanced-Cut-Fill (Rock Piles)											x	x																
Partially/Completely Remove (Rock Piles)											x																	
Excavate (All Rock Piles)													x															
Off-Site Soil Treatment			x	x	x	x	x																					
On-Site Soil Treatment								x																				
Inlet Controls/Water Management																								x	x	x		x
Dredge																									x	x		
Drain Lake and Backfill																											x	x
Construct New Lake																												x
Off-Site Disposal			x	x	x	x	x				x		x								x				x			
On-Site Disposal							x	x			x		x		x	x	x	x				x				x		

Notes:
[1] Alternatives or components of alternatives addressing RAOs will be initiated upon cessation of mining for the underground workings and cessation of tailing disposal for the tailing facility.
[2] Red River sediments are being addressed through reduction of inputs to the river from mine site affected Groundwater.
[3] Red River water quality is being addressed through reduction of inputs to the river from mine site affected Groundwater.
[4] Eagle Rock Lake water quality controlled by Red River, which is being addressed through reduction of inputs to the river from mine site affected Groundwater.
[5] Water treatment for the Mine Site Area includes either current lime neutralization for pH adjustment for use in mining operations or lime neutralization/chemical precipitation/HDS (with reverse osmosis, ultrafiltration, or other membrane/filtration technology as secondary treatment, if necessary).

BMP = best management practice
PCB = polychlorinated biphenyl
RAO = remedial action objective
NPDES = National Pollutant Discharge Elimination System
HDS = high-density sludge

Table ES-6
SUMMARY OF COSTS BY ALTERNATIVE FOR EACH ALTERNATIVE AREA

Alternative Area	Alternative - Description	Costs in Current Dollars (K$)			Total Present Value (K$)[1]
		Construction	O&M	Total	
Mill	1 – No Further Action	0	802	802	327
	2 – Limited Action (Institutional Controls; Health and Safety Program and Hazard Communication)	2,078	923	3,001	2,451
	3 – Soil Removal (High PCBs) and Off-Site Treatment and Disposal	2,176	923	3,099	2,549
	4A – Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Soil Cap	13,064	946	14,010	13,446
	4B – Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Asphalt Cap	10,444	2,847	13,291	11,502
	5A – Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Off-Site Disposal of Molybdenum Soil	47,269	1,206	48,475	47,746
	5B – Soil Removal; Off-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil	43,190	1,206	44,396	43,667
	5C – Soil Removal; On-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil	43,337	1,206	44,543	43,814
Mine Site	1 – No Further Action	0	20,198	20,198	8,265
	2 – Limited Action (Institutional Controls; Storm Water, Surface Water, and Groundwater Management and Treatment)	150	20,455	20,605	8,524
	3A – Minimum 3H:1V - Balanced-Cut-Fill, Partial/Complete Removal, On-Site Repository, Regrade, and Cover at a Minimum of 3H:1V Interbench Slopes; Storm Water, Surface Water and Groundwater Management, Groundwater Extraction and Treatment	601,457	104,139	705,596	175,225
	3B – Minimum 2H:1V - Balanced-Cut-Fill, On-Site Repository, Regrade, and Cover at a Minimum of 2H:1V Interbench Slopes; Storm Water, Surface Water and Groundwater Management, Groundwater Extraction and Treatment	232,595	115,539	348,134	61,690
	Mine Site Water Treatment[2]				
	Year 0 Construction, 30 year period of analysis	20,263	41,063	61,326	34,541
	Year 10 Construction, 40 year period of analysis	20,263	41,063	61,326	17,559
	Year 20 Construction, 50 year period of analysis	20,263	41,063	61,326	9,147
	Year 30 Construction, 60 year period of analysis	20,263	41,063	61,326	4,538

Table ES-6
SUMMARY OF COSTS BY ALTERNATIVE FOR EACH ALTERNATIVE AREA

Alternative Area	Alternative - Description	Costs in Current Dollars (K$)			Total Present Value (K$)[1]
		Construction	O&M	Total	
Tailing Facility	1 – No Further Action	0	30,151	30,151	12,425
	2 – Limited Action (Institutional Controls; Source Containment; Continued Groundwater Withdrawal Operations; Piping of Water in Eastern Diversion Channel)	28,472	16,443	44,915	32,332
	3A – Source Containment; Continued Groundwater Withdrawal Operations with Upgraded Seepage Collection; Piping of Water in Eastern Diversion Channel	28,878	17,592	46,470	33,018
	3B – Source Containment; Continued Groundwater Withdrawal Operations with Upgraded Seepage Collection; Piping of Water in Eastern Diversion Channel; Water Treatment	29,043	18,547	47,590	33,758
	Tailing Facility Water Treatment - 400 gpm[3]				
	Year 0 Construction, 30 year period of analysis	22,076	73,027	95,103	51,989
	Year 10 Construction, 40 year period of analysis	22,076	73,027	95,103	26,428
	Year 20 Construction, 50 year period of analysis	22,076	73,027	95,103	13,435
	Year 30 Construction, 60 year period of analysis	22,076	73,027	95,103	6,830
	4. Source Containment; Groundwater Extraction and Treatment; Piping of Water in Eastern Diversion Channel	30,442	20,876	51,318	35,939
	Tailing Facility Water Treatment - 4500 gpm[3]				
	Year 0 Construction, 30 year period of analysis	54,533	197,162	251,695	135,051
	Year 10 Construction, 40 year period of analysis	54,533	197,162	251,695	68,653
	Year 20 Construction, 50 year period of analysis	54,533	197,162	251,695	34,899
	Year 30 Construction, 60 year period of analysis	54,533	197,162	251,695	17,741
Red River Riparian and South of Tailing Facility	1 – No Further Action	0	177	177	65
	2 – Cap Soil and Tailing Spill Deposits	2,080	558	2,638	2,281
	3A – Removal of Soil and Tailing Spill Deposits and Off-Site Disposal	5,947	412	6,359	6,096
	3B – Removal of Soil and Tailing Spill Deposits and On-Site Disposal	3,442	412	3,854	3,591

Table ES-6
SUMMARY OF COSTS BY ALTERNATIVE FOR EACH ALTERNATIVE AREA

Alternative Area	Alternative - Description	Costs in Current Dollars (K$)			Total Present Value (K$)[1]
		Construction	O&M	Total	
Eagle Rock Lake Area	1 – No Further Action	0	149	149	54
	2 – Inlet Storm Water Controls; In-Lake Capping of Sediment	286	495	781	469
	3A – Inlet Storm Water Controls; Dredge Sediments and Off-Site Disposal	2,274	495	2,769	2,457
	3B – Inlet Storm Water Controls; Dredge Sediments and On-Site Disposal	1,352	504	1,856	1,538
	4 – *Not Carried Forward*	NA	NA	NA	NA
	5 – Inlet Storm Water Controls; Backfill Lake and Construct New Lake	1,299	527	1,826	1,495

Notes:
[1]Discounted at a 7% rate for a period of analysis ranging from 30 to 96 years
[2]Mine Site Water Treatment applies to Subalternatives 3A, 3B, and 3C
[3]Tailing Facility Water Treatment applies to Subalternatives 3B and Alternative 4 with flow rates of 400 gpm and 4,500 gpm, respectively

gpm = gallons per minute
O&M = operations and maintenance

Table ES-7
ALTERNATIVES FOR MINE SITE AREA
DESCRIPTION OF ALTERNATIVES BY ROCK PILE

Alternative	Rock Pile			
	Capulin	Goathill North	Goathill South	Sugar Shack West
3 - Source Containment; Storm Water, Surface Water, and Groundwater Management; Extraction and Treatment				
3A – Minimum 3H:1V: Alternative 3A includes balance-cut-fill, partial/complete removal, on-site repository, and regrade of rock piles to a minimum of 3H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Partial Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 1.5 M CY Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.8H:1V to 2.8H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.2 M CY	Partial Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 2.8 M CY Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.9H:1V to 2.9H:1V Max slope length 200 feet Estimated Scar Area Exposed 5.3 acres Cover thickness of 3 feet Approx. volume of cover: 0.1 M CY	Balance-Cut-Fill, Regrade, and Cover Balanced-Cut-Fill within Rock Pile Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.8H:1V to 2.0H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.01 M CY	Partial Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 3.9 M CY Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.6H:1V to 2.4H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.1 M CY
3B – Minimum 2H:1V: Alternative 3B includes balance-cut-fill, on-site repository, and regrade of rock piles to a minimum of 2H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Balanced-Cut-Fill, Regrade, and Cover Balanced-Cut-Fill within Rock Pile Interbench Slopes: targeted average 2H:1V Underlying Natural Slope: 1.8H:1V to 2.8H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.2 M CY	Balanced-Cut-Fill, Regrade, and Cover Balanced-Cut-Fill within Rock Pile Interbench Slopes: targeted average 2H:1V Overall Rock Pile Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.9H:1V to 2.9H:1V Max slope length 200 feet Estimated Scar Area Exposed 3.9 acres Cover thickness of 3 feet Approx. volume of cover: 0.2 M CY	Balanced-Cut-Fill, Regrade, and Cover Material removed to Spring Gulch or Sulphur Gulch North/ Blind Gulch Balanced-Cut-Fill Volume: 0.3 M CY Interbench Slopes: targeted average 2H:1V Overall Rock Pile Regrade Slope: targeted average 2.3H:1V Estimated Scar Area Exposed 0 acres Underlying Natural Slope: 1.8H:1V to 2.0H:1V Max slope length 200 feet Cover thickness of 3 feet Approx. volume of cover: 0.02 M CY	Balanced-Cut-Fill, Regrade, and Cover Balanced-Cut-Fill within Rock Pile Interbench Slopes: targeted average 2H:1V Overall Rock Pile Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.6H:1V to 2.4H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.2 M CY

Notes:
- Regrade - material is moved to achieve the proposed grade within the same rock pile.
- Balanced-Cut-Fill - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or at another location within the same rock pile.
- Partial/Complete Removal - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or within the pit repository.
- Slopes and volumetric quantities provided are approximate.

M CY = million cubic yards

Table ES-7
ALTERNATIVES FOR MINE SITE AREA
DESCRIPTION OF ALTERNATIVES BY ROCK PILE

Alternative	Rock Pile		
	Sugar Shack South	Middle	Sulphur Gulch South
3 - Source Containment; Storm Water, Surface Water, and Groundwater Management; Extraction and Treatment			
3A – Minimum 3H:1V: Alternative 3A includes balance-cut-fill, partial/complete removal, on-site repository, and regrade of rock piles to a minimum of 3H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Partial/Complete Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 25.7 M CY Interbench Slopes: 3H:1V Overall Waste Rock Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.2H:1V to 3H:1V Max. slope length 200 vertical feet Estimated Scar Area Exposed 33.4 acres Cover thickness of 3 feet Approx. volume of cover: 0.2 M CY	Partial/Complete Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 34.7 M CY Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.9H:1V to 3.7H:1V Max slope length 200 feet Estimated Scar Area Exposed Minimal Cover thickness of 3 feet Approx. volume of cover: 0.06 M CY	Partial/Complete Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 34.7 M CY Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.2H:1V to 1.4H:1V Max slope length 200 feet Estimated Scar Area Exposed 32.3 acres Cover thickness of 3 feet Approx. volume of cover: 0.4 M CY
3B – Minimum 2H:1V: Alternative 3B includes balance-cut-fill, on-site repository, and regrade of rock piles to a minimum of 2H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Balanced-Cut-Fill, Regrade, and Cover Material removed to Spring Gulch or Sulphur Gulch North/ Blind Gulch Balanced-Cut-Fill Volume: 7.3 M CY Interbench Slopes: targeted average 2H:1V Overall Waste Rock Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.2H:1V to 3H:1V Max slope length 200 feet Estimated Scar Area Exposed 5.6 acres Cover thickness of 3 feet Approx. volume of cover: 0.5 M CY	Balanced-Cut-Fill, Regrade, and Cover Material removed to Spring Gulch or Sulphur Gulch North/ Blind Gulch Balanced-Cut-Fill Volume: 12.1 M CY Interbench Slopes: targeted average 2H:1V Overall Rock Pile Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.9H:1V to 3.7H:1V Max slope length 200 feet Estimated Scar Area Exposed Minimal Cover thickness of 3 feet Approx. volume of cover: 0.5 M CY	Balanced-Cut-Fill, Regrade, and Cover Material removed to Spring Gulch or Sulphur Gulch North/ Blind Gulch Balanced-Cut-Fill Volume: 9.1 M CY Interbench Slopes: targeted average 2H:1V Overall Rock Pile Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.2H:1V to 1.4H:1V Max slope length 200 feet Estimated Scar Area Exposed 7.4 acres Cover thickness of 3 feet Approx. volume of cover: 0.8 M CY

Notes:
- Regrade - material is moved to achieve the proposed grade within the same rock pile.
- Balanced-Cut-Fill - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or at another location within the same rock pile.
- Partial/Complete Removal - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or within the pit repository.
- Slopes and volumetric quantities provided are approximate.

M CY = million cubic yards

Table ES-7
ALTERNATIVES FOR MINE SITE AREA
DESCRIPTION OF ALTERNATIVES BY ROCK PILE

Alternative	Rock Pile	
	Sulphur Gulch North / Blind Gulch	**Spring Gulch**
3 - Source Containment; Storm Water, Surface Water, and Groundwater Management; Extraction and Treatment		
3A – Minimum 3H:1V: Alternative 3A includes balance-cut-fill, partial/complete removal, on-site repository, and regrade of rock piles to a minimum of 3H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Partial Removal, Regrade, and Cover Material removed to On-site Repository or Off-site Repository Removal Volume: 12.7 M CY Interbench Slopes: 3H:1V Overall Waste Rock Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.4H:1V to 1.9H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.9 M CY	Partial Removal, Regrade, and Cover Material Removed to be used for Cover: 5.7 M CY (with Off-site Repository) Material Removed to be used for Cover: 3.9 M CY (with Open Pit) Removal Volume: 6.5 M CY Interbench Slopes: 3H:1V Overall Rock Pile Regrade Slope: 3.2H:1V Underlying Natural Slope: 1.5H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.5 M CY
3B – Minimum 2H:1V: Alternative 3B includes balance-cut-fill, on-site repository, and regrade of rock piles to a minimum of 2H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Balanced-Cut-Fill, Regrade, and Cover Balanced-Cut-Fill within Rock Pile Backfill from Goathill South, Sulphur Gulch South, Middle, Sugar Shack South, and Sugar Shack West Backfill Volume: 30.1 M CY Interbench Slopes: targeted average 2H:1V Overall Waste Rock Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.4H:1V to 1.9H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.9 M CY Approx. volume of cover with fill: 1.0 M CY	Balanced-Cut-Fill, Regrade, and Cover Material removed to Spring Gulch or Sulphur Gulch North/ Blind Gulch Balanced-Cut-Fill Volume: 6.7 M CY Material Removed to be used for Cover: 5.4 M CY (with additional cover for Sulphur Gulch North/Blind Gulch and Spring Gulch as Repositories) Could receive backfill from Goathill South, Sulphur Gulch South, Middle, Sugar Shack South, and Sugar Shack West Backfill Volume: 0 M CY Interbench Slopes: targeted average 2H:1V Overall Rock Pile Regrade Slope: targeted average 2.3H:1V Underlying Natural Slope: 1.5H:1V Max slope length 200 feet Estimated Scar Area Exposed 0 acres Cover thickness of 3 feet Approx. volume of cover: 0.6 M CY

Notes:
- · Regrade - material is moved to achieve the proposed grade within the same rock pile.
- · Balanced-Cut-Fill - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or at another location within the same rock pile.
- · Partial/Complete Removal - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or within the pit repository.
- · Slopes and volumetric quantities provided are approximate.

M CY = million cubic yards

Table ES-7
ALTERNATIVES FOR MINE SITE AREA
DESCRIPTION OF ALTERNATIVES BY ROCK PILE

Alternative	Rock Pile	
	Pit Repository	**Offsite Repository**
3 - Source Containment; Storm Water, Surface Water, and Groundwater Management; Extraction and Treatment		
3A – Minimum 3H:1V: Alternative 3A includes balance-cut-fill, partial/complete removal, on-site repository, and regrade of rock piles to a minimum of 3H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	Backfill, Grade, and Cover Backfill from Capulin, Goathill North, Sugar Shack West Sugar Shack South, Middle, Sulphur Gulch South, and Sulphur Gulch North Backfill Volume: 119 M CY Interbench Slopes: N/A Cover thickness of 3 feet Approx. volume of cover: 1.5 M CY	Backfill, Grade, and Cover Backfill from Capulin, Goathill North, Sugar Shack West Sugar Shack South, Middle, Sulphur Gulch South, and Sulphur Gulch North Backfill Volume: 117 M CY Interbench Slopes: 3H:1V Overall Slope: Max. slope length 200 vertical feet Cover thickness of 3 feet Approx. volume of cover: 3.3 M CY
3B – Minimum 2H:1V: Alternative 3B includes balance-cut-fill, on-site repository, and regrade of rock piles to a minimum of 2H:1V interbench slope to the existing underlying slope, above which, waste rock will be removed to the underlying slope and grade.	N/A	N/A

Notes:
- Regrade - material is moved to achieve the proposed grade within the same rock pile.
- Balanced-Cut-Fill - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or at another location within the same rock pile.
- Partial/Complete Removal - material removed from a rock pile to achieve the proposed grade will be placed on another rock pile or within the pit repository.
- Slopes and volumetric quantities provided are approximate.
- The Pit Repository was used as an example of an on-site repository for FS purposes, but the actual location of the on-site repository(ies), and the timing of the use of such repository(ies), will be determined during the remedial design phase.

M CY = million cubic yards
N/A = Not Applicable