Joint Final Environmental Impact Statement

Montanore Project

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Cabinet Mountains *Photo by M. Holdeman*

Volume 2

Chapter 3: Affected Environment and Environmental Consequences

Section 3.7, Cultural Resources through Section 3.24, Wilderness, Roadless Areas, and Wild and Scenic Rivers

United States Department of Agriculture
Forest Service
Northern Region
Kootenai National Forest

Montana Department of Environmental Quality

Contents

Volume 2

Tables—Volume 2

Charts—Volume 2

3.7 Cultural Resources

3.7.1 Regulatory Framework

3.7.1.1 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) of 1966 as amended and its implementing regulations under 36 CFR 800 require all federal agencies to consider effects of federal actions on cultural resources eligible for or listed in the National Register of Historic Places (NRHP). Both listed and potentially eligible properties must be considered during Section 106 review. In the Section 106 review, the Forest Service considers effects on cultural resource properties within the APE. The APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist" (36 CFR 800.16).

Traditional cultural properties (TCPs) are protected under Section 106 of the NHPA; the American Indian Religious Freedom Act; and the Native American Grave Protection and Repatriation Act. A TCP may be eligible for listing in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in the history of the community or tribe, and, (b) are important in maintaining the continuing cultural identity of the community or tribe. Effects on American Indians are discussed in section 3.5, *American Indian Consultation*.

Generally, any site of human activity older than 50 years is considered to be a potential cultural resource. The NHPA requires federal agencies to identify any cultural resource properties that might be affected by a federal undertaking. An undertaking refers to any federal action, such as approval of a Plan of Operations for the Montanore Project. If the cultural resource is affiliated with American Indian use, then consultation with any interested tribes begins. Once identified, a cultural resource property is formally evaluated by the KNF in consultation with the SHPO, to determine whether the property is eligible for listing on the NRHP.

After consultation, the SHPO provides a determination of eligibility for each cultural resource affected by the project. If the property is found to be eligible, the KNF will determine whether the property would be adversely affected by the undertaking. Cultural resources that are determined eligible for listing in the NRHP and that cannot be avoided during project implementation would be considered adversely affected. When adverse effects are anticipated, MMC may choose to redesign the project to avoid the property. If avoidance is not feasible, actions will be taken to mitigate any adverse effects on the property. A mitigation plan would be developed by MMC, reviewed by the KNF, reviewed by culturally affiliated tribes, and approved by the SHPO and the Advisory Council on Historic Preservation.

The location of cultural resource sites is exempt from public disclosure under Public Law 94-456. The purpose of this exemption is to protect a site from potential vandalism and to retain confidentiality of sites culturally significant to American Indian Tribes. Similar state laws governing cultural resources are found in 22-3, MCA.

3.7.1.2 Kootenai Forest Plan

The 2015 KFP direction considered in the analysis of cultural resources is:

> **FW-DC-CR-01.** Cultural resources are inventoried, evaluated for inclusion on the National Register of Historic Places, and managed according to their allocation category, including preservation, enhancement-public use, or scientific investigation. National Register ineligible cultural resources may be released from active management. Until evaluated, cultural resources are treated as National Register eligible. Historically and archaeologically important cultural resources and traditional cultural properties are nominated to the National Register.
>
> **FW-DC-CR-02.** Cultural resources are safeguarded from vandalism, looting, and environmental damage through monitoring, condition assessment, protection, and law enforcement measures. Interpretation and adaptive use of cultural resources provide public benefits and enhance understanding and appreciation of KNF prehistory and history. Cultural resource studies provide relevant knowledge and perspectives to KNF land management. Artifacts and records are stored in appropriate curation facilities and are available for academic research, interpretation, and public education.
>
> **FW-GDL-CR-01.** Cultural resource protection provisions should be included in applicable contracts, agreements, and special use permits for National Register-listed or eligible properties.
>
> **FW-GDL-CR-02.** Historic human remains should be left undisturbed unless there is an urgent reason (e.g., human health and safety, natural event, etc.) for their disturbance.

3.7.2 Analysis Area and Methods

3.7.2.1 Analysis Area

The APE includes all mine-related facilities and four transmission line alternatives, each with a 500-foot buffer. The buffer areas are included in the analysis of direct, indirect, and cumulative effects. Also included in the APE are locations where mitigation activities, such as culvert removals proposed as stream mitigation, would occur. No formal consultation has occurred between the KNF and the SHPO regarding definition of the APE, but consultation would take place before the KNF allowed MMC to proceed with ground-disturbing activities.

3.7.2.2 Cultural Resource Inventories

Cultural resources were identified within the APE using three methods:

- A Class I file and literature review with the SHPO and the KNF by Historical Resource Associates (Historical Research Associates 2006a, 2006b) to identify previous cultural resource inventories and archaeological sites within the APE
- A Class III intensive pedestrian cultural resource inventory was conducted within all mine facility footprints, including portions of the APE that are on private land (Historical Research Associates 1989a; 1989b; 1989c; 1990; 2006a; 2006b)

- Shovel testing areas identified by the KNF as medium to high probability areas for cultural resources, in addition to pedestrian survey (Historical Research Associates 2006a; 2006b)

Mine facility areas proposed in Alternative 2 (Little Cherry Creek Tailings Impoundment Site, LAD Areas 1 and 2, Ramsey Plant Site, and Libby Adit Site) were inventoried at an intensive level, including shovel testing in areas of low ground visibility (Historical Research Associates 2006a, 2006b). Previous inventory conducted for NMC included portions of alternative mine facility locations (Historical Research Associates 1990). Locations where ground disturbing mitigation activities would occur, such as the Swamp Creek wetland and stream mitigation site or fisheries mitigation sites, have not been inventoried. Locations used for mitigation of 404-permitted effects would be inventoried before the Corps issued a 404 permit.

Of the transmission line alternatives, only segments of the North Miller Creek, Modified North Miller Creek, and Miller Creek Alternatives were subject to intensive inventory (Historical Research Associates 1990, 2006b). The Sedlak Park Substation also was inventoried at an intensive level (Historical Research Associates 1990). It is not known if the substation loop line was included in the inventory of the substation. Effects on cultural resources were evaluated using GIS spatial analysis to compare the location of cultural resources in relation to proposed project facilities. Because not all of the proposed transmission line alternatives were inventoried for cultural resources, only those cultural resources identified through the file and literature review were considered in the effects analysis.

After the agencies selected a transmission line alignment in a ROD, any remaining pedestrian inventory and/or exploratory shovel testing would be conducted to comply with Section 106 of the NHPA. If previously unknown cultural or historical resources were discovered during any remaining inventory, MMC would either avoid disturbing the sites and their setting as recommended after formal evaluation and consultation with SHPO and as allowed by the landowner, or develop appropriate mitigation for all unavoidable impacts. The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on cultural resources in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.7.2.3 Site Evaluation Criteria

Cultural resources are evaluated for their eligibility to be listed on the National Register of Historic Places (NRHP). NRHP significance criteria are codified under 36 CFR 60.4 and are specified below (National Register Bulletin No. 15, revised 1998):

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and—

> a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> b) that are associated with the lives of persons significant in the past; or
>
> c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic

value, or that represent a significant or distinguishable entity whose components may lack individual distinction; or

d) that have yielded, or are likely to yield, information important in prehistory or history.

Ordinarily, cemeteries, birthplaces, or graves of historical figures; property owned by religious institutions or used for religious purposes; structures that have been removed from their original location; reconstructed historic buildings; properties that are primarily commemorative in nature; and properties that have achieved significance within the last 50 years shall not be considered eligible for the National Register. Such properties will qualify if they are integral parts of districts that do meet the criteria, or if they fall within the following categories:

a) a religious property deriving primary significance from architectural or artistic distinction or historical importance; or

b) a building or structure removed from its original location but which is significant primarily for its architecture, or which is the surviving structure most importantly associated with an historic person or event; or

c) a birthplace or grave of an historical figure of outstanding importance if there is no other appropriate site or building directly associated with his or her productive life; or

d) a cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

e) a reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan and when no building or structure with the same association has survived; or

f) a property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own historical significance; or

g) a property achieving significance within the past 50 years if it is of exceptional importance.

In addition, sites evaluated as eligible must retain physical integrity. Eroded or otherwise heavily disturbed sites are generally not considered eligible under Criterion d, although intact portions of an otherwise degraded site may still qualify the site as eligible. Unevaluated sites are those that may conform to the eligibility criteria, but require further work to determine NRHP significance. In most cases, these sites are prehistoric or historic sites with suspected buried cultural material or historic sites where additional archival research is necessary to determine historical context and overall significance. Sites that are evaluated as not eligible do not meet any of the eligibility criteria and/or have lost physical integrity. For purposes of the EIS, any unevaluated site is considered potentially eligible for the NRHP.

If the project involves a ground disturbing action, all documented cultural resources must be evaluated for potential adverse effects as codified under 36 CFR 800.5. Effects may be “no effect," "no adverse effect," or "adverse effect," depending on the type of anticipated disturbance. Determinations of effect must take into account the action involved and may be "beneficial" if the action has the potential to further preserve the cultural resource.

3.7.3 Affected Environment

3.7.3.1 Cultural Resource Overview

The following cultural overview is summarized from a synthesis provided by Historical Research Associates (1989a; 1989b; 1990; 2006a; 2006b). At the time of Euro-American contact, two major ethnic groups occupied and used areas that include the current analysis area. The Kalispell or Lower Pend d'Oreille occupied the Clark Fork River drainage from the area around Lake Pend Oreille in Idaho to the vicinity of Plains, Montana. The Kootenai (also spelled Kutenai) occupied the area drained by the Kootenai River in Montana and the Kootenay and upper Columbia rivers in British Columbia. They occupied semi-permanent winter encampments and seasonally exploited other sites. The Kootenai, who subsisted on a hunting-gathering economy based primarily on fish, big game and camas, have used the analysis area for the last three to five centuries.

The most salient prehistoric data come from the work conducted at the Libby Dam and Reservoir area. Work from this area established clear continuity between prehistoric use of the area and the historic Kutenai. The spatial extent of the Kutenai, and by extension most other groups in the region, was considerable due to seasonal mobility between the mountains and plains as a means of successful adaptation. It is likely that the Kutenai split into smaller groups early in the Common Era, each relying more heavily on either plains or mountain-based resources, depending on their location, while using extensive trade networks.

The first contact between Native Americans and Euro-Americans in the area was initiated by explorers and fur traders. The first Euro-Americans to enter the analysis area were LeGasse and LeBlanc, employees of the Northwest Company sent into the region in 1801. Jaco Finley crossed the Rocky Mountains via Howse Pass in 1806 and David Thompson arrived in the Libby area in May, 1808; his travels are described in journals dated 1808-1812. Several trading posts were established in the region and travel routes such as the "Kootenai Road" became important links to connect the Kootenai River region with the trading posts.

More permanent Euro-American settlements resulted from the influx of people during the gold strikes of the 1860s and the construction of the transcontinental railroads through the Clark Fork Valley in 1883 and the Kootenai Valley in 1892. There was placer mining and an established mining camp along Libby Creek by 1867-1868. The initial rush to Libby Creek included 500 to 600 men, but the number quickly diminished to a handful by early 1868. The camp was referred to as Libbysville. Little to no placer mining took place during 1876 to 1885 when a small rush resumed after gold was once again discovered. Settlement along the Kootenai River was limited to the town of Tobacco Plains until the late 1880s, when Old Town or Lake City was established near with the mouth of Ramsey Creek on upper Libby Creek. The Thompson Falls to Libby Creek Trail was extended to Old Town and a general store existed to supply goods. Old Town was abandoned in 1889 with the establishment of Old Libby, which in turn was abandoned in 1891 when the Howards, among others, established ranches near the mouth of Libby Creek in anticipation of the Great Northern Railroad route to be established closer to the Kootenai. Placer mining in the Libby Creek drainage peaked in the early 1900s. Both railroads and mining contributed to the development of the timber industry, which became the economic base in both Lincoln and Sanders counties.

A major change in the region resulted from the establishment of the Forest Reserves, later known as National Forests. Lands within the reserves came under the administration and protection of the Federal Government, and timber cutting became regulated. Portions of the land within the analysis area were included in the Cabinet Forest Reserve, now part of the Libby and Cabinet Districts of the KNF.

3.7.3.2 Archaeological Resource Potential

Based on sites recorded in the region, and a synthesis of expected cultural resources provided in the KNF Heritage Guidelines (KNF 2002a), the following cultural resource types were considered most likely to occur in the analysis area: prehistoric campsites, scarred trees, historic cabins, trading posts, mining and logging sites, homesteads, bridges, and trash dumps. Cultural resources in upland areas are expected to be fewer than in lower elevation areas and along major water courses. Upland areas were used seasonally by hunter-gatherer groups for specific economic procurement tasks and, as such, the cultural imprints from these activities are expected to be less visible than long-term habitation sites located at lower elevations (KNF 2002a). Identification of specialized economic activity sites expected in upland areas is difficult because of the limited material assemblage associated with this type of site and the extensive vegetation cover of the analysis area. Subsurface testing was used in high probability areas to locate cultural resources.

3.7.3.3 Recorded Cultural Resources

3.7.3.3.1 Mine Facilities

The file and literature review and inventory of mine related facilities determined that 11 cultural resources have been previously recorded within the APE (Table 81). Two potential resources are known but have not been formally recorded (site leads FS D5-241SL and D5-363).

Known cultural resources in mine facility areas (Table 81) are six eligible sites, two recommended not eligible sites, one recommended eligible site, and two sites that have not been evaluated. The Libby Mining District (District) encompasses most of the mine facility areas and the northwest terminus of the transmission line alternatives. This site is a NRHP eligible historic district that embodies the physical features of mining from 1867 to the 1950s and a visual aspect that conveys both setting and location criteria. Six of the sites are related to the District and are considered contributing elements of the District. Sites 24LN320, known as the Comet Placer, 24LN1677 (Beager Cabin), and 24LN1678 (unnamed cabin) are eligible for the NRHP as contributing elements to the District. Sites 24LN943 and 24LN980 are recommended not eligible as contributing elements of the District, and site 24LN1209, the Old Libby Wagon Road, is considered a contributing element to the District. Sites 24LN320 and 24LN1209 are located within the Little Cherry Creek Tailings Impoundment Site (Alternatives 2 and 4) and are eligible for the NRHP. Site 24LN943 is a historic logging camp originally recommended as not eligible that has since been destroyed by previous construction associated with the Libby Adit (private property). Site 24LN1680 is believed to be a portion of a placer mine that extends about 100 feet into the Libby Adit facility. It is currently unknown if any elements of this resource actually extend into the APE.

Table 81. Known Cultural Resources within Mine Facility Areas.

Smithsonian Site #	Site Type	NRHP Eligibility	Area of Potential Effect
24LN320†	Historic Mining features - Comet Placer	Eligible	Little Cherry Creek Tailings Impoundment Alternatives 2 and 4
24LN943†	Logging Camp	Recommended Not Eligible (destroyed)	Libby Adit (All Alternatives)
24LN980†	Dam	Recommended Not Eligible	Alternative 2 – Proposed Mitigation Area
24LN1209†	Historic road/trail – Libby Wagon Road	Eligible	Little Cherry Creek Tailings Impoundment Alternatives 2 and 4
24LN1323	Libby Mining District	Eligible	All project components except Libby Adit
24LN1677†	Beager Cabin	Eligible	Alternative 2 – Proposed Mitigation Area
24LN1678†	Cabin	Eligible	Alternative 2 – Proposed Mitigation Area
24LN1680	Placer Mine Ditch	Eligible	Libby Adit (100 feet according to GIS) All Alternatives
24LN2203	Prehistoric	Recommended Eligible	Alternative 2 – Proposed Mitigation Area
FS D5-241SL	Mining features and cabin	Not Evaluated	Alternative 2 – Proposed Mitigation Area
FS D5-363	Mining Camp	Not Evaluated	Alternative 2 – Proposed Mitigation Area

†Contributing cultural resources to the Libby Mining District (24LN1323).

The KNF has identified an additional four cultural resources and two unrecorded sites that may be affected by proposed fishery mitigation work associated with Alternative 2. These include sites 24LN1677 and 24LN1678, which are contributing elements to the Libby Mining District (24LN1323); site 24LN2203, a prehistoric site with an unknown eligibility status; an unrecorded feature of 24LN980 (historic dam) recommended not eligible; and site leads D5-241SL and D5-363 that require documentation and evaluation before project implementation.

3.7.3.3.2 Transmission Line Alignments

Known cultural resources located within the four transmission line corridor alternatives are listed in Table 82. Cultural resources common to all transmission line alternatives include 24LN208, 24LN722, 24LN963, 24LN977, 24LN1323 (Libby Mining District), 24LN1679, and the Libby Divide and Miller Creek Trails. Site 24LN208 (Trail #6) would be crossed by all alternatives north of the Sedlak Substation where the alignment parallels US 2. Site 24LN722 was recorded within the area proposed for the Sedlak Substation, but could not be relocated by Historical Research Associates during its inventory efforts. Historical Research Associates assumed the scarred tree that comprised this resource had been logged and no longer exists. Site 24LN963 and the Libby Divide and North Fork of the Miller Creek Trail are a system of trails crossed by all transmission line alternatives except the West Fisher Alternative (Historical Research Associates 2006a, 2006b). Site 24LN977 is a historic school crossed by all alternatives. Sites crossed by all alternatives are eligible except for sites 24LN208 and 24LN722 (undetermined eligibility). Site 24LN1679 is the Libby Placer Mining Camp listed as officially eligible and a contributing resource to the Libby Mining District (24LN1323).

Cultural resources solely located within the transmission line corridor of Alternative E-R include 24LN165, 24LN718, 24LN719, and 24LN720. Site 24LN165 is a historic dump that requires SHPO concurrence to be determined as not eligible and 24LN719 is a large historic townsite eligible for the NRHP. Site 24LN718 is a historic log structure likely related to the mining activity in the area and is eligible for the NRHP. Site 24LN720 is a multi-component historic mining and prehistoric campsite and is eligible for the NRHP.

Site 24LN962 is the Teeter Peak Trail that would be crossed by Alternatives D-R and E-R and is recommended not eligible. Sites 24LN1584 and 24LN1585 include two and four culturally modified trees, respectively, located within the buffer area of Alternative B. Both sites are recommended eligible. Site 24LN1818 is a portion of US 2 that would be crossed by Alternatives B, C-R, and D-R. Because of the ongoing modification that the highway receives, the resource has not been evaluated for the NRHP.

Table 82. Cultural Resource Sites Located within the Transmission Line Alternatives.

Smithsonian Site #	Site Type	NRHP Eligibility	Area of Potential Effect
24LN165	Unknown	Unknown	Alternative E-R
24LN208	Trail #6	Recommended Not Eligible	All Alternatives
24LN718†	Historic Log Structure	Eligible	Alternative E-R
24LN719	Historic Townsite	Eligible	Alternative E-R
24LN720†	Historic Mining and Prehistoric campsite	Eligible	Alternative E-R
24LN722	Scarred Tree	Undetermined (destroyed)	All Alternatives (Sedlak Park Substation area)
24LN756	Fisher River Bridge	Undetermined (bridge removed)	Alternative B
24LN962	Teeter Peak Trail	Recommended Not Eligible	Alternatives D-R and E-R
24LN963	Historic road/trail	Recommended Not Eligible	All Alternatives
24LN977	Historic School	Eligible	All Alternatives
24LN1323	Libby Mining District	Eligible	All Alternatives (no contributing elements affected)
24LN1584	Two scarred trees	Recommended Eligible	Alternative B
24LN1585	Four scarred trees	Recommended Eligible	Alternative B
24LN1677†	Historic Mining	Eligible	Alternatives D-R and E-R
24LN1679†	Libby Placer Mining Camp	Eligible	All Alternatives
24LN1818	Portions of US 2	Not Evaluated	All Alternatives
FS D5-122	North Fork Miller Creek Trail #505	Avoidance per 1997 PMOA	All Alternatives
FS D5-126	Libby Divide Trail #716	Avoidance per 1997 PMOA	All Alternatives

†Contributing cultural resources to the Libby Mining District (24LN1323).

3.7.4 Environmental Consequences

3.7.4.1 Alternative 1 – No Mine

No direct, indirect, or cumulative effects would occur to cultural resources in Alternative 1. Natural weathering, deterioration, and vandalism of cultural resources would continue. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ's approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands.

3.7.4.2 Alternative 2 – MMC's Proposed Mine

All eleven cultural resources identified within mine facilities would be affected by Alternative 2 (Table 81) and remain potentially eligible for listing in the NRHP. Six of these resources may be affected by proposed fishery mitigation areas and are discussed separately below. Site 24LN1323, the Libby Mining District, would be affected by all Alternative 2 facility components except construction of the Libby Adit site. The District includes an extensive area where placer mining took place, including locations along drainages of Libby, Big Cherry, Midas, Bear, Poorman, Ramsey, Little Cherry, and Howard creeks. Mitigation would be necessary for those areas of the District that would be adversely affected by facility construction. A determination as to whether individual contributing sites (such as mines and mine-related sites) should be included in the mitigation plan for the Historic District would be the decision of the Forest Service. Mitigation for the District could include formal documentation under the USDI National Park Service's Cultural Landscapes Program or updating the existing site form for the District, or could be limited to mitigation for individually contributing historic properties. The type of data recovery necessary for a mining historic district and contributing properties would be determined from a data recovery plan developed in consultation with the KNF and the SHPO.

Site 24LN320 is located on private land within the Little Cherry Creek Tailings Impoundment Site and is individually eligible for the NRHP and a contributing element to the Historic District. The KNF recommends that additional recording is necessary in addition to potential data recovery efforts of known site components. Mitigation plans for sites 24LN320 and 24LN1209, also located within the Little Cherry Creek Tailings Impoundment Site, would need to be developed in consultation with the SHPO and could include Level II HAER documentation for 24LN1209 and/or HABS documentation for site 24LN320 depending on the type of mining features present. Review and consultation with SHPO is required for site 24LN943 in order to receive a consensus determination of not eligible based on the loss of physical integrity of the site. Assuming concurrence from the SHPO, no additional work would be required. GIS analysis indicates that about 100 feet of an eligible mining ditch (site 24LN1680) extends into the disturbance area of the Libby Adit Site; any portion of the eligible mining ditch that may have once extended into the Libby Adit disturbance area would have been destroyed by previous ground disturbing activity. Monitoring should be conducted in this area should any new disturbance occur.

Alternative 2 also includes proposed fishery mitigation work around Howard Lake and Libby Creek, which may have the potential to adversely affect six cultural resources. Trail paving associated with mitigation activities around Howard Lake has the potential to adversely affect site 24LN2203. The Forest Service has recommended that mitigation be implemented before ground disturbance, which could include either protective covering or data recovery. Rehabilitation efforts associated with Libby Creek have the potential to adversely affect three cultural resource sites (24LN980, 24LN1677, and 24LN1678) and two unrecorded sites (D5-241SL and D5-363). An unrecorded feature of 24LN980 would require documentation and evaluation as a potential contributing element of the District (24LN1323). The eligible historic cabins (24LN1677 and 24LN1678) would require HABS documentation if adversely affected by fishery mitigation activities. Review and consultation also would be required for site 24LN980 in order to receive a consensus determination of not eligible. This site also would need to be evaluated as to whether it contributes to the District. If the site were not eligible either individually or as a contributing element to the District, no additional work would be required. If the site were a contributing element to the District a data recovery plan would need to be developed and could include HAER documentation. The two unrecorded sites (D5-241SL and D5-363) would need to be formally documented and evaluated for effects from the proposed mitigation activities. The KNF has recommended that the sites 24LN980, 24LN1677, 24LN1678, and the two unrecorded sites be considered for interpretation to benefit the public.

For those sites with unresolved eligibility status (24LN943, 24LN980, 24LN2203, D5-363, and D5-241SL), review and consultation with SHPO would be necessary before ground disturbing activities. For those cultural resources found to be eligible for listing in the NRHP following consultation, the project proponent would develop a data recovery plan that would require approval by the Forest Service, SHPO, and the Tribes, if necessary. Finally, for those sites with consensus eligible determinations (24LN320, 24LN1209, 24LN1323, 24LN1677, and 24LN1678), data recovery plans would need to be developed in consultation between the Forest Service and the SHPO, and the Tribes, if necessary.

3.7.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Effects on cultural resource sites 24LN943, 24LN1323, and 24LN1680 are the same as described under Alternative 2. Alternative 3 would not directly affect any other cultural resources. Cultural resources in the analysis area may see increased vandalism, artifact collecting, and inadvertent physical disturbance as a result of increased human activity and accessibility to the sites over the life of the mine.

3.7.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Effects on cultural resource sites 24LN320, 24LN943, 24LN1209, 24LN1323, and 24LN1680 are the same as described under Alternative 2. Alternative 4 would not directly affect any other cultural resources. Cultural resources in the analysis area may see increased vandalism, artifact collecting, and inadvertent physical disturbance as a result of increased human activity and accessibility to the sites over the life of the mine.

3.7.4.5 Alternative A – No Transmission Line

No direct, indirect, or cumulative effects in the transmission line corridors would occur to cultural resources in Alternative A. Natural weathering, deterioration, and vandalism of cultural resources would continue.

3.7.4.6 Alternative B – MMC’s Proposed Transmission Line (North Miller Creek Alternative)

Twelve cultural resources are located within the North Miller Creek Transmission Line (Alternative B) alignment and 500-foot buffer area (Table 82). Affected sites would be 24LN208, 24LN722, 24LN756, 24LN963, 24LN977, 24LN1323, 24LN1584, 24LN1585, 24LN1679, 24LN1818, and Forest Trails 505 and 716. Effects on site 24LN1323 and potential mitigation efforts are discussed under Alternative 2.

Site 24LN722 was once located within the proposed Sedlak Substation facility. Fieldwork determined that logging operations have removed the tree (Historical Research Associates 2006a). Site 24LN756 is the former location of the Fisher River Bridge. Since the bridge was removed from this location, no further work is necessary except for a formal eligibility review by SHPO. The North Miller Creek Alternative would cross site 24LN208 north of the Sedlak Substation location and an unnamed historic road/trail (24LN963). Both of these sites require SHPO consultation in order to receive consensus determinations of not eligible for the NRHP. Sites 24LN977 and 24LN1679 are both eligible for the NRHP. Site 24LN977 is located south of the Sedlak Substation and site 24LN1679 is a contributing resource to the Libby Mining District. Both sites would not be directly affected by this alternative.

Sites 24LN1584 and 24LN1585 are both culturally scarred tree locations within the 500-foot buffer area of the alignment; both have an eligibility status of recommended eligible. If the sites were determined eligible, they would be either avoided or a data recovery plan would be developed. Preliminary field review indicates they could be avoided by flagging and appropriate pole placement. Other trees would be preserved in the general location, if possible, to maintain integrity of setting and location. Site 24LN1818 remains unevaluated for the NRHP due to the ongoing modifications that the highway receives.

Although considered significant under the 1997 PMOA, Forest Trails 505 and 716 (the North Fork of the Miller Creek Trail and Libby Divide Trail, respectively) would be formally recorded and evaluated for the NRHP. If determined eligible, a plan would be necessary to mitigate adverse effects. If feasible, vegetation clearing for the transmission line would be conducted in a manner that maintains integrity of setting and location. Pole placement would also be designed to avoid or minimize visual effects on the trails.

Review and consultation with the SHPO would be necessary for sites 24LN208, 24LN722, 24LN756, 24LN963, 24LN1584, and 24LN1585 in order to receive consensus determinations and to develop a plan of action for site 24LN1818. Additional fieldwork may be necessary to complete evaluation before SHPO consultation. Because effects would entail crossing of an overhead transmission line with no direct effects, a determination of no adverse effect may be achieved through consultation for eligible sites 24LN977 and 24LN1679. For those cultural resources determined to be ineligible for the NRHP, no additional work would be necessary.

3.7.4.7 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

Effects on cultural resource sites 24LN208, 24LN722, 24LN963, 24LN977, 24LN1323, 24LN1677, 24LN1679, 24LN1818, and Forest Trails 505 and 716 and proposed mitigation would be the same as described in Alternative B.

3.7.4.8 Alternative D-R – Miller Creek Transmission Line Alternative

Effects on cultural resource sites 24LN208, 24LN722, 24LN963, 24LN977, 24LN1323, 24LN1677, 24LN1679, 24LN1818, and Forest Trails 505 and 716 and proposed mitigation would be the same as described in Alternative B. Alternative D-R would cross the Teeter Peak Trail (24LN962), which has an unresolved eligibility status of not eligible. Review and consultation with the SHPO to receive a consensus determination for 24LN962 and an effects determination for 24LN1677 would be necessary before project implementation.

3.7.4.9 Alternative E-R – West Fisher Creek Transmission Line Alternative

Effects on cultural resource sites 24LN208, 24LN722, 24LN963, 24LN977, and 24LN1323, 24LN1677, 24LN1679, 24LN1818, and Forest Trails 505 and 716 and proposed mitigation would be the same as described in Alternative B. Alternative E-R would cross the Teeter Peak Trail (24LN962) described in Alternative D-R. Sites 24LN718 is also located within the buffer zone for

Alternative E-R. 24LN718 is officially eligible and requires a determination of effect from SHPO. Site 24LN720 is multi-component historic mining and prehistoric campsite that is officially eligible for the NRHP. It was not included in Historical Research Associates' file and literature review because it was not under consideration as an alternative at the time of Historical Research Associates' review. Direct effects on this site may be avoided by proper pole placement and a protective cover of vegetation to maintain integrity of setting. Site 24LN719 is a historic townsite that is largely buried. The site covers an extensive area (about 2 acres). It remains unknown as to whether Alternative E-R could avoid this site given the site's spatial area.

3.7.4.10 Summary of Effects

Table 83 and Table 84 provide a summary of cultural resource effects for the mine and transmission line alternatives. The Sedlak Park Substation and loop line are included in the transmission line alternatives. The number of cultural resources affected under each alternative is:

- Alternative 2—11 cultural resources
- Alternative 3—3 cultural resources
- Alternative 4—5 cultural resources
- Alternative B—12 cultural resources
- Alternative C-R—9 cultural resources
- Alternative D-R—11 cultural resources
- Alternative E-R—15 cultural resources

3.7.4.11 Indirect Effects Common to All Alternatives

Indirect effects on cultural resources are possible from the increased access to the KNF that would result from the improvement and new construction of access roads. Effects would be more pronounced to visible historic properties such as mining or homesteading related cultural resources. Access would increase during mine operation and potential effects on cultural resources may result from recreational activities. Access to cultural resources would be similar to pre-mine levels following mine closure and decommissioning of all mine-related access roads. Specific effects on cultural resources could include the illegal collection of artifacts and vandalism to standing structures or features.

3.7.4.12 Mitigation

All mine and transmission line alternatives, including the loop line at the Sedlak Park Substation site, would require additional cultural resource inventory and SHPO consultation to satisfy requirements of Section 106 under the NHPA. The number of cultural resources that would require mitigation may increase pending the results of these additional inventory efforts. The appropriate type of mitigation would depend on the nature of the cultural resource involved and would be determined during consultation among MMC, the KNF, and the SHPO.

Mitigation could include data recovery (excavation) of prehistoric archaeological sites, a HABS for standing structures, or HAER for engineered resources such as mines, roads, and trails. For landscape-level resources such as the Libby Mining District, the USDI National Park Service's (NPS) Cultural Landscapes Program may be implemented as an appropriate mitigation tool (see below). Mitigation would also include monitoring during ground disturbing activities when the subsurface spatial extent of the resource is unknown or because of the fragility of the resource and its proximity to the activity.

Any mitigation plan would be developed by MMC and approved by both the KNF and the SHPO under a Programmatic Agreement, and would include consulting American Indian Tribes if affected cultural resources were of cultural significance. A Programmatic Agreement been developed that addresses remaining Section 106 compliance, the mitigation of unavoidable historic properties, and inadvertent cultural resource discoveries.

Mitigation effectiveness is evaluated by assessing whether unavoidable impacts on historic properties would be mitigated appropriately and whether all available data contained within those properties would be fully captured. All historic properties except the Libby Mining District would be avoided through proper pole placement and minor shifts in the overall alignment. Effects on properties within mine disturbance areas would be unavoidable, but would be fully mitigated using four different approaches: HABS/HAER, archaeological excavation, and completion of a cultural landscapes report or site form update. Any of the four approaches would capture all available data contained within the affected properties. The KNF and the SHPO would review and approve MMC's final mitigation plan. The agencies anticipate that the cultural resources mitigation would have high effectiveness.

Table 83. Summary of Effects of Mine Alternatives on Cultural Resources within the APE and Potential Mitigation Efforts.

Site	Type	NRHP Status	SHPO Consultation Necessary	Potential Mitigation
		Alternative 2		
24LN320†	Historic Mining features - Comet Placer	Eligible	No	HABS/HAER
24LN943†	Logging Camp	Recommended Not Eligible (destroyed)	Yes – eligibility	No Further Work
24LN980†	Dam	Recommended Not Eligible	Yes – eligibility	Pending Consultation HAER
24LN1209	Historic road/trail –Libby Wagon Road	Eligible	No	HAER
24LN1323	Libby Mining District	Eligible	No	NPS Cultural Landscapes Program
24LN1677†	Beager Cabin	Eligible	No	HABS
24LN1678†	Cabin	Eligible	No	HABS
24LN1680	Placer Mine Ditch	Eligible	No	HAER (if necessary)
24LN2203	Prehistoric	Recommended Eligible	Yes	Protective Covering or Data Recovery (excavation)
FS D5-241SL	Mining features and cabin	Not Evaluated	Yes– eligibility following evaluation	Pending Consultation HABS/HAER
FS D5-363	Mining Camp	Not Evaluated	Yes– eligibility following evaluation	Pending Consultation HABS/HAER
		Alternative 3		
24LN943†	Logging Camp	Recommended Not Eligible (destroyed)	Yes – eligibility	No Further Work
24LN1323	Libby Mining District	Eligible	No	NPS Cultural Landscapes Program
24LN1680	Placer Mine Ditch	Eligible	No	HAER (if necessary)

Site	Type	NRHP Status	SHPO Consultation Necessary	Potential Mitigation
Alternative 4				
24LN320†	Historic Mining features - Comet Placer	Eligible	No	HABS/HAER
24LN943†	Logging Camp	Recommended Not Eligible (destroyed)	Yes – eligibility	No Further Work
24LN1209	Historic road/trail –Libby Wagon Road	Eligible	No	HAER
24LN1323	Libby Mining District	Eligible	No	NPS Cultural Landscapes Program
24LN1680	Placer Mine Ditch	Eligible	No	HAER (if necessary)
All Mine Action Alternatives				
24LN943†	Logging Camp	Recommended Not Eligible (destroyed)	Yes – eligibility	No Further Work
24LN1323	Libby Mining District	Eligible	No	NPS Cultural Landscapes Program
24LN1680	Placer Mine Ditch	Eligible	No	HAER (if necessary)

†Associated with the Libby Mining District.

Table 84. Summary of Effects of Transmission Line Alternatives on Cultural Resources within the APE and Potential Mitigation Efforts.

Site	Type	NRHP Status	SHPO Consultation Necessary	Potential Mitigation
		Alternative B		
24LN756	Fisher River Bridge (removed)	Undetermined	Yes – eligibility	No Further Work (Pending Consultation)
24LN1584	Two scarred trees	Recommended Eligible	Yes – eligibility and effects	Avoidance and monitoring
24LN1585	Four scarred trees	Recommended Eligible	Yes – eligibility and effects	Avoidance and monitoring
		Alternative C-R		
24LN208	Trail #6	Recommended Not Eligible	Yes – eligibility	No Further Work
24LN722	Scarred Tree (destroyed)	Undetermined	Yes – eligibility	No Further Work (Pending Consultation)
24LN963	Historic road/trail	Recommended Not Eligible	Yes – eligibility	No Further Work (Pending Consultation)
24LN977	Historic School	Eligible	Yes – effects	Avoidance
24LN1323	Libby Mining District	Eligible	No – eligibility Yes – mitigation plan	NPS Cultural Landscapes Program
24LN1679	Libby Placer Mining Camp	Eligible	Yes – effects	Avoidance
FS D5-122	North Fork Miller Creek Trail #505	Avoidance per 1997 PMOA	Yes – eligibility and effect	Pending Consultation
FS D5-126	Libby Divide Trail #716	Avoidance per 1997 PMOA	Yes – eligibility and effect	Pending Consultation
24LN1818	Portions of US 2	Not Evaluated	Yes – eligibility and effects	Pending Consultation
		Alternative D-R		
24LN962	Teeter Peak Trail	Recommended Not Eligible	Yes – eligibility	No Further Work (Pending Consultation)
24LN1677	Historic Mining	Eligible	Yes – effects	Avoidance

Site	Type	NRHP Status	SHPO Consultation Necessary	Potential Mitigation
		Alternative E-R		
24LN165	Historic Dump	Recommended Not Eligible	Yes – eligibility	No further work
24LN718	Historic Log Structure	Eligible	No – eligibility Yes – effects	Avoidance
24LN719	Historic Townsite	Eligible	Yes – effects	Avoidance or Data Recovery
24LN720	Historic Mining and Prehistoric campsite	Eligible	No – eligibility Yes – effects	Avoidance
24LN962	Teeter Peak Trail	Recommended Not Eligible	Yes – eligibility	No Further Work (Pending Consultation)
24LN1677[†]	Historic Mining	Eligible	Yes – effects	Avoidance
		All Alternatives		
24LN208	Trail #6	Recommended Not Eligible	Yes – eligibility	No Further Work
24LN722	Scarred Tree (destroyed)	Undetermined	Yes – eligibility	No Further Work (Pending Consultation)
24LN963	Historic road/trail	Recommended Not Eligible	Yes – eligibility	No Further Work (Pending Consultation)
24LN977	Historic school	Eligible	Yes – effects	Avoidance
24LN1323	Libby Mining District	Eligible	No – eligibility Yes – mitigation plan	NPS Cultural Landscapes Program
24LN1679	Libby Placer Mining Camp	Eligible	Yes – effects	Avoidance
FS D5-122	North Fork Miller Creek Trail #505	Avoidance per 1997 PMOA	Yes – eligibility and effect	Pending Consultation
FS D5-126	Libby Divide Trail #716	Avoidance per 1997 PMOA	Yes – eligibility and effect	Pending Consultation
24LN1818	Portions of US 2	Not Evaluated	Yes – eligibility and effects	Pending Consultation

3.7.4.12.1 Mine Alternatives

Alternative 2 – MMC's Proposed Mine

In Alternative 2, nine cultural resources would require mitigation. The largest of these is the Libby Mining District (24LN1323), a historic vernacular landscape that encompasses a large geographic area. Six other cultural resources contribute to the District. These include the Comet Placer (24LN320), an unnamed logging camp (24LN943), a dam (24LN980), the Libby Wagon Road (24LN1209), the Beager Cabin (24LN1677), an unnamed cabin (24LN1678), and a prehistoric archaeological site (5LN2203). Although site 24LN980 is recommended not eligible, the site may contribute to the overall significance of the District.

The most appropriate mitigation would be to complete a Cultural Landscape Report developed by the USDI National Park Service for the treatment of landscape-level cultural resources. This report would document the history, significance, and treatment of the Libby Mining District, including any changes to its geographical context, features, and use (NPS Preservation Brief 36). Specific topics addressed under a Cultural Landscape Report include detailed history, existing conditions, analysis and evaluation, a visual history that documents its past and current setting, and management recommendations. Although developed by the NPS, a Cultural Landscape Report is not restricted to NPS lands and the documentation method can be applied to any landscape that reflects the cultural character of a people – specifically in this case, the mining character of the mid to late 1800s gold rush within the Libby Mining District. Individually, the remaining historic sites would require either HABS or HAER documentation (24LN320, 24LN1209, 24LN1677, and 24LN1678), including one site that has not been related to the District (24LN1680), but would probably be found to be contributing through additional archival research. Two known but unrecorded sites require formal documentation and evaluation (D5-241 and D5-363). If either site is found to be eligible for the NRHP, mitigation would require HAER documentation and may be included within the Libby Mining District and the Cultural Landscape Report.

Site 24LN2203 would require either protective covering or data recovery (excavation) if covering is not found to be an appropriate mitigation tool. An excavation plan would be developed by the project proponent in consultation with the KNF, SHPO, and any interested Tribes.

Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

In Alternative 3, two cultural resources would require mitigation. These sites are the Libby Mining District (24LN1323) and the Placer Mine (24LN1680). Mitigation efforts are described in Alternative 2.

Alternative 3 would require the KNF to contact the Confederated Salish and Kootenai Tribes and Kootenai Tribe of Idaho. The Tribes would be afforded the opportunity to monitor construction activities associated with the mine. Section C.3, *Cultural Resources* of Appendix C discusses monitoring requirements.

Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

In Alternative 4, four cultural resources would require mitigation. All four of the sites, are discussed above in Alternative 2.

Tribal monitoring requirements would be the same as described under Alternative 3.

3.7.4.12.2 Transmission Line Alternatives

Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

In Alternative B, 10 cultural resources may require mitigation depending on the outcome of eligibility determinations between the KNF and SHPO. Segments of US 2 (24LN1818) affected by the alternative have not been evaluated for the NRHP. If found to be eligible for the NRHP, mitigation for US 2 would entail HAER documentation. It is unlikely that mitigation would be required given the on-going use and maintenance of the road and the no effect, other than visual, for the resource. Mitigation for the Libby Mining District (24LN1323) is discussed above in Alternative 2. Two of the sites, 24LN1584 and 24LN1585, can be avoided during pole placement and vegetation clearing and would not require mitigation. In the event that they could not be avoided, mitigation would include extensive photographic documentation. The two trails located within this alternative (D5-122 and D5-126) could also be avoided during pole placement. Visual effects on the trails could not be avoided under this alternative and therefore Level I HAER documentation would be necessary. The historic school (24LN977), located south of the Sedlak Substation and within the 500-foot corridor, is avoidable and no further work should be necessary. The Libby Placer Mining Camp (24LN1679) is also avoidable during pole placement and vegetation clearing. In the event that the sites are unavoidable, mitigation would include a combination of HABS/HAER and data recovery (excavation). Consultation is required with both the KNF and the SHPO to determine potential effects and mitigation efforts for significant cultural resources and to provide consensus determinations for 24LN208, 24LN722, 24LN756, 24LN963 (all recommended not eligible), and 24LN1818. Should any of the recommended not eligible or unevaluated sites become eligible, a mitigation plan would be developed. Two sites, 24LN722 and 24LN756, no longer exist and no mitigation is recommended, pending SHPO consultation.

Alternative C-R – Modified North Miller Creek Transmission Line Alternative

In Alternative C-R eight cultural resources may require mitigation depending on the outcome of eligibility determinations between the KNF and SHPO. All nine sites under Alternative C-R are discussed above under Alternative B.

All agency-mitigated transmission line alternatives (C-R, D-R, and E-R) would require the KNF to contact the Confederated Salish and Kootenai Tribes and Kootenai Tribe of Idaho. The Tribes would be afforded the opportunity to monitor any ground disturbing activities (construction and reclamation) associated with the transmission line on state and federal lands. Section C.3, *Cultural Resources* of Appendix C discusses monitoring requirements.

Alternative D-R – Miller Creek Transmission Line Alternative

In Alternative D-R, six to seven cultural resources may require mitigation depending on the outcome of eligibility determination. All sites except for 24LN962 and 24LN1677 are discussed under Alternative B. Site 24LN962 requires an eligibility consensus from the SHPO; should the site become eligible following review, the resource would require pole placement avoidance and mitigation of adverse visual effects through Level 1 HAER documentation. If site 24LN1677 is unavoidable, mitigation would include HABS/HAER documentation.

Tribal monitoring requirements would be the same as described under Alternative C-R.

Alternative E-R – West Fisher Creek Transmission Line Alternative

In Alternative E-R, 16 cultural resources may require mitigation depending on the outcome of eligibility determinations between the KNF and SHPO. Sites common to all alternatives are discussed above in Alternative B. Potential mitigation for sites 24LN962 and 24LN1677 is discussed above in Alternative D-R.

The alternative would affect a multi-component historic mining and prehistoric site (24LN720). If unavoidable, the mining portion of the site would require either HAER and/or HABS treatment (depending on the type of features present) and the prehistoric component would require data recovery (excavation). Site 24LN718 is a historic log structure that would require HABS documentation if found to be adversely effected by this alternative. Site 24LN719 is a very large (2-acre) buried historic townsite that, if unavoidable, would require extensive data recovery (excavation). Finally, site 24LN165 is a historic dump recommended not eligible and would require a consensus determination from the SHPO.

Tribal monitoring requirements would be the same as described under Alternative C-R.

3.7.4.13 Cumulative Effects

Past action, such as road building and timber harvest, may have affected cultural resources. Cultural resources affected by past actions after the passage of the NHPA in 1966 were mitigated in accordance with approved mitigation plans. The Miller-West Fisher Vegetation Management Project would avoid or protect eligible cultural resources and there would be no cumulative effect with the Montanore Project. No other reasonably foreseeable actions would have a cumulative effect with the Montanore Project.

3.7.4.14 Regulatory/Forest Plan Consistency

Following the identification of cultural resources, mitigation, and consultation, all alternatives would make progress toward the cultural resources desired conditions **(FW-DC-CR-01 and 02)**, would be designed and implemented in accordance with cultural resource guidelines (**FW-GDL-CR-01 and 02), and** would comply with all applicable federal regulations concerning cultural resources.

3.7.4.15 Irreversible and Irretrievable Commitments

Regardless of mine facility alternative or transmission line alternative, project implementation would require the irreversible commitment of portions of the Libby Mining District (24LN1323) and possibly a portion of 24LN1680. Additionally, five and possibly seven potentially NRHP eligible cultural resources would require irreversible commitments in Alternative 2: 24LN320, 24LN1209, 24LN1677, 24LN1678, 24LN2203, and possibly unrecorded sites D5-241SL and FS D5-363. Evaluation of potential irreversible effect was determined using GIS analysis. Each of these sites would be destroyed following mitigation by the construction of mining related facilities. Their loss would be irreversible. Mitigation would serve to preserve these cultural resources in perpetuity through documentation. Pending consultation, an additional non-significant cultural resource would require irreversible commitments (24LN980). Aside from 24LN1323 and 24LN1680, no additional cultural resources would require an irreversible commitment. Alternative 4 would require irreversible commitments to sites 24LN320 and 24LN1209, in addition to sites 24LN1323 and 24LN1680. All transmission line alternatives could avoid significant cultural resources except for the Libby Mining District (24LN1323).

3.7.4.16 Short-term Uses and Long-term Productivity

Since cultural resources are non-renewable, the short-term use of the area for project implementation has the potential for permanent impacts as discussed above in Alternative 2.

3.7.4.17 Unavoidable Adverse Environmental Effects

Unavoidable effects on cultural resources would be mitigated through the development of mitigation plans approved by KNF, in consultation with the SHPO. When Tribally-affiliated sites were affected, consultation with Native American Tribes would also be initiated.

3.8 Hydrologic and Geochemical Approach to Water Quality Assessment

3.8.1 Generalized Approach to Water Resources Impact Analysis

The agencies revised the approach to the water resources impact analysis in response to comments on the Draft EIS. In their comments on the Draft EIS analysis, the EPA requested more information on water management and the project water balance, better integration of geology and geochemistry with the water quality assessment, and a discussion of mitigation measures or contingency plans for potential water quality impacts.

The lead agencies met with the EPA and other interested agencies in 2009 to discuss EPA's comments. Following the 2009 interagency meeting, the agencies formed interagency workgroups to address EPA's concerns with the water resources impact analysis. The five workgroups addressed geochemistry, groundwater hydrology, water quality and quantity, monitoring and compliance, and regulatory issues. Most workgroups held a series of conference calls to discuss possible resolution of EPA's comments. To ensure integration between workgroups, a meeting was held in 2010 to discuss workgroup progress and the interrelationship between the workgroups. The outcome of the workgroups was twofold: a more integrated approach to the water resources impact analysis, and a revised monitoring section that better defines monitoring objectives and implementation (Appendix C), both of which were presented in the Supplemental Draft EIS.

The results of the agencies' 2-dimensional (2D) model were provided in the Draft EIS (USDA Forest Service and DEQ 2009). Subsequently, MMC prepared a more complex and comprehensive 3D model of the same analysis area. The results of the 2D and the 3D models were used to evaluate the site hydrogeology and analyze potential impacts due to mining. Although the results of the two models were similar, the 3D model provides a more detailed analysis by incorporating the influence of known or suspected faults on groundwater hydrology, recent underground hydraulic testing results from the Libby Adit, a more comprehensive calibration process, and better simulation of vertical hydraulic characteristics of the geologic formations that would be encountered during the mining process.

A more thorough integration of geochemistry with groundwater hydrology and surface water hydrology recognizes the interdependent nature of effects on water quality. For example, the relative saturation or rate of water flow through mined rock influences drainage quality, and the inflow of groundwater into mine workings potentially affects streamflow.

3.8.2 Project Water Balance, Potential Discharges, and Impact Assessment Locations

The project water balances presented in the *Water Use and Management* section of each mine alternative in Chapter 2 are estimates of inflows and outflows for various project components that are used for the analysis of alternatives. Actual volumes for water balance variables (*e.g.*, mine and adit inflows, precipitation and evaporation, dust suppression) would vary seasonally and annually from the volumes estimated. The agencies developed graphical representations of the estimated water balance for Alternative 3 throughout the Evaluation, Construction, Operations, Closure, and Post-Closure phases (Figure 56 through Figure 60). The water balance for Alternatives 2 and 4 is very similar and varies only slightly from those shown for Alternative 3.

Alternative 2 would include discharge of some water during all phases except Operations to the LAD Areas. The following sections briefly discuss the water balance for each phase, locations where discharges during each phase may occur, and the location where the agencies are assessing effects, or "impact assessment locations." The subsequent sections on *Groundwater Hydrology* (section 3.10), *Surface Water Hydrology* (section 3.11), and *Water Quality* (section 3.13) provide a more detailed discussion of impact analysis methods and an analysis of effects.

3.8.2.1 Evaluation Phase

During the Evaluation Phase, MMC would dewater the full extent of the existing Libby Adit, extend the adit 3,300 feet to beneath the ore zones, and develop an additional 7,100 feet of drifts and 16 drill stations. Groundwater in the vicinity of the adit and drifts would flow toward the adit and drift void. An estimated 256,000 tons (174,000 cubic yards) of waste rock would be generated and stored on private land at the Libby Adit site. The waste rock storage areas would be lined to collect runoff from the area and seepage through the waste rock. Based on the 3D model results (Geomatrix 2011a), the agencies estimate average mine and adit inflows over the 2-year phase would be 230 gpm of water flowing into the adit and drifts, and 30 gpm of water from mineralized zones, or mine water (Figure 56). A small amount of water (3 gpm) from precipitation is expected to be collected from the waste rock stockpiles.

Adit, mine, and waste rock water would be collected and piped to a Water Treatment Plant at the Libby Adit Site. Following treatment, treated water would be discharged to a percolation pond or drainfield at the Libby Adit Site or to Libby Creek. Water discharged to the pond would percolate to groundwater, which would then flow to Libby Creek adjacent to the adit site (Figure 56).

In the impact analysis in the subsequent sections, the agencies assess the effects of mine inflows on groundwater levels and streamflow. The streams to be assessed are those potentially affected by dewatering in the Libby Creek, East Fork Rock Creek, and East Fork Bull River watersheds. The impact assessment locations for the effects of discharged water on streamflow and surface water quality are streams downstream of any discharge location. Groundwater quality is assessed adjacent to any discharge location. Impact assessment locations are shown on Figure 76.

Certain monitoring and mitigation would be required before MMC started the Evaluation Phase. Such activities are described as occurring in the Pre-Evaluation Phase.

3.8.2.2 Construction Phase

The Construction Phase would begin after MMC analyzed the data from the Evaluation Phase, collected the necessary data for final design, submitted final design plans to the agencies, and received agency approval to implement the Construction Phase. Two new adits would be constructed in the Ramsey Creek drainage in Alternative 2 and in the Libby Creek drainage in Alternatives 3 and 4. In addition to the new adits, limited development would occur in the ore zones. Waste rock generated during the Construction Phase would be sampled to address uncertainty about spatial geochemical variation within the deposit identified at the end of the Evaluation Phase (see Appendix C). Rock would be stockpiled on a liner, either at the LAD Areas in Alternative 2, or at the impoundment area in Alternatives 3 and 4. Waste rock that met suitability criteria established following the Evaluation Phase would be used in the construction of impoundment dams in all alternatives. Groundwater would flow toward the mine and adits. In MMC's model, the Construction Phase was combined with the first two years of mining. The modeled period had estimated average inflows of 450 gpm of adit water and 30 gpm of mine water (Figure 57).

In Alternative 2, mine and adit inflows would be piped to the LAD Areas for discharge to groundwater. The Water Treatment Plant would be used, if necessary, to meet BHES Order limits or applicable nondegradation criteria. Groundwater from the LAD Areas would flow to Ramsey, Poorman, and Libby creeks. The agencies assumed 130 gpm would be sent to the LAD Areas for discharge and 370 gpm to the Water Treatment Plant for discharge in the Construction, Closure and Post-Closure phases in Alternative 2. MMC did not propose in Alternative 2 to discharge water to Libby Creek from the Water Treatment Plant to prevent adverse effects on senior water rights.

Water management in Alternatives 3 and 4 would be substantially different from Alternative 2 in the Construction, Operations, Closure, and Post-closure Phases to accommodate the Forest Service's instream flow water right of 40 cfs in Libby Creek at the confluence of Bear Creek with a 2007 priority date. Mine and adit water would not be used beneficially in any phase, and would be treated and discharged from the Water Treatment Plant during all phases. MMC would divert groundwater from Libby Creek during high flows (April through July) and store it in the tailings impoundment, Seepage Collection Pond, or mine water pond at the Libby Plant Site. No appropriation would be made whenever flow at LB-2000 was less than 40 cfs. Storage of diverted water would occur during the late Construction Phase after the Starter Dam was lined and MMC began storing water for mill startup, during the Operations Phase, and during the Closure Phase until the impoundment was dewatered for reclamation. In Alternatives 3 and 4, MMC would increase the Water Treatment Plant capacity before mill startup. The impact assessment locations are the same as for the Evaluation Phase.

Certain monitoring and mitigation would be required before MMC started the Construction Phase. Such activities are described as occurring in the Pre-Construction Phase.

3.8.2.3 Operations Phase

The Operations Phase would begin with mill operations. Waste rock generated during the Operations Phase that met the suitability criteria would be used in the construction of impoundment dams for all alternatives or returned underground. Annual average inflows are estimate to be 370 to 380 gpm throughout operations. The amount of mine water is anticipated to be the greatest in the last years of operations, reaching 200 gpm of adit water and 170 gpm of mine water in Operations Phase Years 11-19 (Figure 58). Groundwater over the mine area would continue to flow toward the mine and adits.

Sometime after the first 5 years of mill operations in Alternative 2, additional water, or make-up water, would be needed at the mill. Make-up water requirements are expected to average 159 gpm over Project Years 16 to 24 (Table 14). MMC would not withdraw any surface water for operational use whenever flow at the point of withdrawal was less than the average annual low flow. MMC did not propose in Alternative 2 to discharge water to Libby Creek from the Water Treatment Plant to prevent adverse effects on senior water rights.

In Alternative 3, groundwater tributary to Libby Creek would be appropriated from Libby Creek alluvium between April 1 and July 31 at an average flow rate of 765 gpm and a maximum flow rate of 1,125 gpm (410 acre-feet/year maximum volume) in an average precipitation year. Water would be diverted using a subsurface infiltration gallery installed in the gravels along the west side of the Libby Creek channel at the proposed point-of-diversion (Figure 25). The gallery would be connected to a pumping station that would pump water in a single pipe to the Poorman tailings impoundment. Groundwater tributary to Libby Creek also would be appropriated year-round at an average and maximum flow rate of 250 gpm (403 acre-feet/year maximum volume) from the pumpback wells. Precipitation captured by the impoundment would be appropriated year-round at an average flow rate of 625 gpm and a maximum flow rate of 1,950 gpm (1,038 acre-feet/year maximum volume). (The values shown in Table 25 are what MMC requested and may be different from those in any beneficial water use permit issued.) Diverted water would be stored in the impoundment water pond and would be pumped to the plant/mill for ore-processing make-up water. Whenever flow in Libby Creek at LB-2000 was less than 40 cfs, stored water would be treated at the Libby Adit Water Treatment Plant, and discharged at a rate equal to all Libby Creek appropriations. The rates would vary, depending on actual precipitation and the total pumping rate of the pumpback wells. Similar appropriations and discharges would occur in Alternative 4.

In all alternatives, an estimated 25 gpm of tailings seepage not intercepted by the seepage collection system beneath the impoundment would flow to groundwater beneath the gravel drains of the Seepage Collection System. A pumpback well system in the impoundment area would intercept groundwater containing tailings seepage that was not collected by the gravel drains. Water intercepted by the pumpback wells would be routed to the tailings impoundment and then to the mill for re-use (Figure 58).

In the subsequent effects analysis, the agencies assess effects on groundwater quality beneath the tailings impoundment. Effects of inflows and appropriations on streamflow are assessed in Libby Creek, Ramsey Creek, Poorman Creek, Little Cherry Creek, East Fork Rock Creek, and East Fork Bull River. Impact assessment locations are shown on Figure 76.

3.8.2.4 Closure Phase

The Closure Phase would begin when mill operations ceased. Closure activities would include the removal of surface facilities, decommissioning of the underground workings, adit plugging, and reclamation of surface disturbances in accordance with the approved closure plan. The tailings impoundment would be dewatered to facilitate capping. The agencies estimate that the dewatering of the tailings impoundment may last from 5 to 20 years. The seepage collection system would continue to operate until BHES Order limits or applicable nondegradation criteria were met in receiving waters. Water would be pumped from the impoundment to the LAD Areas or Water Treatment Plant, if necessary, in Alternative 2, and to the Water Treatment Plant in Alternatives 3 and 4.

In Alternative 2, MMC would plug the adits near the adit portal after the workings are decommissioned. Mine and adit inflows would flow toward the mine void and would begin filling it. In Alternatives 3 and 4, MMC would place two or more plugs in each adit. The plugs would be located to isolate the adits hydraulically from the mine void and to ensure any groundwater tributary to Libby and Ramsey creeks would flow into the adits, and remain within the Libby Creek watershed. Following adit plugging, water flowing into the adits would begin to refill the adits. As long as MMC appropriated or diverted water from Libby Creek whenever flow at LB-2000 was less than 40 cfs, MMC would treat stored and adit water, if necessary to meet MPDES permitted effluent limits, and discharge it to Libby Creek at a rate equal to all of MMC's Libby Creek appropriations or diversions occurring at that time. Discharges of water to Ramsey Creek also may be required to avoid adversely affecting senior water rights. After facilities were reclaimed, appropriations or diversions from the Libby Creek watershed would be limited to adit inflows and pumping from the pumpback well system.

The agencies estimate the adits would take one to two decades to fill after the initial plugs in each adit were in place. Filling would be reduced to a few years if MMC used groundwater diverted from Libby Creek alluvium using the infiltration gallery during high flows to fill the adits during the Closure Phase. Before the water level in the adits reached the bedrock-colluvium interface (about 800 feet from the adit portal), MMC would place an additional plug in bedrock at the bedrock-colluvium interface and allow the adits to reach steady state hydrologic conditions. A third plug would be placed at the opening of each adit. The third plug to be placed at the adit opening would be coarse rock fill intended to prevent access to the tunnel and also to prevent subsidence in the near-surface portion of the tunnel. The adit portals then would be reclaimed. Treatment and discharge of water would cease after the portal plug in each adit was installed.

Water appropriated by the pumpback well system during the Closure and Post-Closure Phases would be treated and discharged at the Water Treatment Plant. After the second plug was placed in each adit in Alternatives 3 and 4, no further discharges to Libby Creek other than from the pumpback well system would be required to avoid adversely affecting senior water rights.

The impact assessment locations for effects on groundwater quality are beneath the tailings impoundment and LAD Areas in Alternative 2, and beneath the tailings impoundment and adjacent to the Libby Adit Site in Alternatives 3 and 4. The effect of mine void flooding on streamflow are assessed in areas potentially affected by dewatering in Libby Creek, Ramsey Creek, Poorman Creek, East Fork Rock Creek, East Fork Bull River, and downstream of any discharge location. Impact assessment locations are shown on Figure 76.

3.8.2.5 Post-Closure Phase

The Post-Closure Phase would consist of long-term operations, maintenance, and associated monitoring of the Water Treatment Plant and the seepage pumpback well facilities at the tailings impoundment. MMC would maintain, operate, and monitor these facilities until BHES Order limits or applicable nondegradation criteria were met in all receiving waters. After BHES Order limits or nonsignificance criteria were met, seepage from the impoundment would flow to Libby Creek. The length of time that treatment would be required is unknown. Hydrologic and geochemical data would be collected throughout Post-Closure in the same locations as the Closure Phase.

In Alternative 2, mine and adit water would continue to fill the mine void and discharge of water from the Seepage Collection System after treatment at the Water Treatment Plant as discussed in the Closure Phase would continue in the Post-Closure Phase. In Alternatives 3 and 4, the adits and the mine void would be isolated hydrologically. In all mine alternatives, the Water Treatment Plant would continue to operate until all water that came from project facilities could flow to area streams without treatment. MMC also would continue water monitoring as long as the MPDES permit was in effect. As long as post-closure water treatment operated, the agencies would require a bond for the operation and maintenance of the Water Treatment Plant. The length of time that these closure activities would occur is not known, but may be decades or more.

The 3D groundwater model developed for the project (see section 3.10, *Groundwater Hydrology*) predicts that the mine void would fill in about 490 years and water levels overlying the mine void would reach steady state conditions in 1,150 to 1,300 years. The actual time to recover to steady state may be shorter or longer and would be re-evaluated using the 3D model after additional data were collected during the Evaluation Phase. At steady state conditions, groundwater levels would not reach pre-mining levels, but flow paths would be similar to pre-mining conditions (Figure 60).

3.8.3 Streamflow, Baseflow, and $7Q_2$ and $7Q_{10}$ Flow Definitions and Uses in EIS Analyses

The agencies used the Region 1 Water Yield and Sediment Model (WATSED) and ECAC model to predict streamflow changes and used estimated 3D model-derived streamflow to analyze the effects of the mine alternatives on streamflow and water quality (see section 3.11.2, *Analysis Area and Methods* for a discussion of the models). Available streamflow data are presented in section 3.11.3. Because none of the analysis area streams have been continuously gaged and hydrographs have not been developed except at LB-200, baseflow, average low flow and peak values cannot be determined. Certain low flows, as defined in the next section, have been estimated or simulated for specific locations. The uncertainties associated with the use of these estimated low flows in the hydrology and water quality analyses are discussed in section 3.13.4.5, *Uncertainties Associated with the Water Quality Assessment.*

3.8.3.1 Definitions and Comparisons of Peak Flow, Annual Flow, Baseflow, and $7Q_2$ and $7Q_{10}$ Flows

Snowmelt, rainfall, and groundwater discharge are the main sources of water supplied to streams in the analysis area. Precipitation ranges from 100 inches per year at higher elevations in the Cabinet Mountains to about 30 inches per year at the proposed tailings impoundment site (Geomatrix 2006b). The period of highest precipitation generally occurs in November through February and the lowest in July through October.

Peak flow is that portion of the annual water cycle that contains the highest 30 continuous days of streamflow in the watershed. It is during this time period when the greatest potential impacts on stream channels usually occur. Peak flows are affected by weather events and management activities in the watershed. Changes in peak flows were estimated using the WATSED and ECAC models.

Annual flow is the total output of the watershed on a yearly basis. Changes in annual flow occur due to climatic variability, such as drought, which can decrease the total amount of streamflow over a yearly cycle. Natural and management activities such as forest fires, timber harvest, and road building can also impact the amount of water leaving the watershed. The removal of vegetation allows more of the natural precipitation to leave the watershed because it is not used by the plants for transpiration. About 15 percent of the annual flow occurs during the time period when streams are in the baseflow condition. Changes in annual flows were estimated using the WATSED and ECAC models.

Baseflow is the contribution of near-channel alluvial groundwater and deeper bedrock groundwater to a stream channel. Baseflow does not include any direct runoff from rainfall or snowmelt into the stream. During the driest portions of the year, the only flow into the stream channel is baseflow. Streamflow may not reduce to baseflow in years when higher than normal precipitation occurs in later summer/early fall or when the residual snow pack continues to melt through late summer/early fall. In the analysis area, streamflow is generally reduced to only the baseflow component from mid-August to mid-October, and may occur during November through March. Baseflow was simulated using a 3D numerical groundwater model (Geomatrix 2011a). Above an elevation of between about 5,000 to 5,600 feet, the only source of water to drainages is surface water from snowmelt and storm runoff, so there is no baseflow and surface flow is ephemeral.

The $7Q_{10}$ flow is defined as the lowest streamflow averaged over 7 consecutive days that occurs, on average, once every 10 years. The $7Q_{10}$ flow has a 10 percent probability of occurring in any given year (10-year recurrence interval) and is commonly used when setting MPDES permit effluent limits and allowable pollutant loads for streams. The $7Q_2$ flow is the lowest streamflow averaged over 7 consecutive days that occurs, on average, once every 2 years. The $7Q_2$ flow has a 50 percent probability of being exceeded in any one year (2-year recurrence interval). Because streamflow in analysis area streams has not been continuously gaged for an extended period, $7Q_{10}$ and $7Q_2$ flows cannot be estimated directly. The agencies used an alternative method to estimate flow. The two most commonly used methods for estimating streamflow statistics at ungaged sites are the drainage-area ratio method and the regression equations method (Ries and Friesz 2000). The drainage-area ratio method is best used when the ungaged site is located near a gaging station on the same stream and the ratio between the drainage areas of the index site and the ungaged site is between 0.5 and 1.5 (Hortness 2006). Because no such index sites are available for the analysis area streams, the agencies estimated $7Q_{10}$ and $7Q_2$ flows for analysis area streams using a regression equations method developed by the USGS (Hortness 2006). The agencies considered the USGS method to be the best available information on $7Q_{10}$ and $7Q_2$ flows of analysis area streams. The USGS used multiple linear regression analyses to develop equations for estimating $7Q_{10}$ and $7Q_2$ flows at ungaged, unregulated streams in northeast Idaho and northwest Montana. Based on the regression analysis, the USGS developed specific equations using different variables for eight regions of the study area, one of which (Region 2) encompassed the Montanore Project analysis area (Hortness 2006). Data from 41 gaging stations within the region, with at least 10 years of flow records, were used to develop the equations. Streamflow data from gaging stations were statistically related to various watershed basin physical and climatic characteristics to develop the equations. The Montanore Project analysis area is similar to the USGS study area, which was composed mainly of rugged mountainous terrain where most precipitation results from storms moving inland from the Pacific Ocean. The most significant amounts of precipitation are a direct result of orographic effects (mountainous terrain-induced precipitation) and occur primarily in the winter months. The lowest streamflow typically occurs in August through March, but large rain-on-snow events may occur occasionally.

Drainage area and mean annual precipitation were the location-specific variables in the final equations for Region 2 developed by the USGS to estimate both $7Q_2$ and $7Q_{10}$ flows (Hortness 2006). The agencies calculated drainage area from KNF watershed mapping, with small adjustments at specific locations based on USGS topographic maps. Mean annual precipitation was estimated using a weighted area average within the drainage area.

There are many methods of interpolating precipitation from monitoring stations to specific areas, but few have been able to adequately explain the complex variations in precipitation that occur in mountainous regions. The PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate data have been developed to provide such information. PRISM is an analytical model that uses point data and a digital elevation model to generate gridded estimates of monthly and annual precipitation. PRISM is well suited to mountainous terrain because it incorporates a conceptual framework that addresses the spatial scale and pattern of orographic precipitation. The

PRISM gridded climate maps are considered the most detailed, highest-quality spatial climate datasets currently available (National Weather Service 2011). The agencies used the 1971-2000 in the analysis (Oregon State University 2006). The 1981-2010 dataset became available in July 2012. The agencies' comparison of precipitation values from the 1971-2000 and 1981-2010 datasets for a sample of four watersheds in the analysis area showed fairly small differences ranging from 7 percent lower to 3 percent higher using the 1981-2010 dataset (ERO Resources Corp. 2012a). Due to the small difference using the newer dataset, precipitation values from the 1971-2000 dataset were used, and assumed to be representative of precipitation occurring in the analysis area during recent decades.

The drainage area of the USGS study Region 2 ranged from 3 to 2,443 square miles, and the mean annual precipitation ranged from 24.8 to 69.4 inches. The mean annual precipitation for the monitoring sites in the analysis area is greater than 69 inches at higher elevations, such as within the CMW and in the upper half of the Poorman Creek watershed. Three of the drainage areas at the CMW boundary (Ramsey Creek, Poorman Creek, and East Fork Rock Creek) are less than 3 square miles and one is near the minimum of 3 square miles (Table 85). All of the drainage areas listed in Table 85 have estimated annual precipitation that exceeds 69 inches.

At the highest elevations, the source of water is only surface water runoff, and flow is ephemeral. In the upper perennial reaches of the analysis area streams (below about 5,000 to 5,600 feet), the estimated $7Q_{10}$ and $7Q_2$ flows may not be reliable and are higher than the modeled baseflows (Table 85). The upper reaches of each drainage (mostly within the CMW) are characteristically steep, with exposed bedrock and little, if any, surficial deposits. Runoff from precipitation generally is rapid and there is little porous material for seasonal groundwater storage. In these areas, below about 5,000 to 5,600 feet, baseflow is maintained primarily by discharge from fractured bedrock. The lower reaches of each stream, including the East Fork Bull River at the CMW boundary, contain thick deposits of alluvium and glacial deposits sufficiently porous to store large volumes of groundwater that continue to provide water to streams even during dry years (although in some years, sections of lower reaches appear dry because the baseflow is below the channel surface within the alluvium).

Table 86 provides the modeled baseflow and estimated $7Q_{10}$ and $7Q_2$ flows for the lower reaches of the nine analysis area streams. At six of the nine locations listed in Table 86, the estimated $7Q_{10}$ values are less than the modeled baseflow values. The drainage areas of the watersheds in Table 86 are between 5.9 and 28.2 square miles, and the average annual precipitation values range from 47.8 to 64.1 inches, well within the ranges to provide reliable $7Q_2$ and $7Q_{10}$ values. The exception is EFBR-500, which has an estimated annual average precipitation of 69.5 inches, above the maximum precipitation range for the equations. Therefore, the estimated $7Q_2$ and $7Q_{10}$ values for this location may not be reliable.

The USGS developed standard error of prediction ranges for each $7Q_2$ and $7Q_{10}$ equation. The standard error of prediction includes the model error as well as an estimate of the sample error and is a better indicator of the model's overall predictive ability (Hortness 2006). In Region 2, the standard error of prediction for the $7Q_{10}$ equation was +113 percent to -53.1 percent. For the $7Q_2$ equation, the standard error of prediction was +78.9 percent to -44.1 percent (Hortness 2006). The estimated range of $7Q_2$ values and $7Q_{10}$ values for locations in the analysis area are provided in Table 87; the locations are shown on Figure 76. The equations may not yield reliable results for sites with characteristics outside the range of or near the minimums and maximums of the equation variables.

Table 85. Simulated Baseflow and Estimated $7Q_2$ and $7Q_{10}$ Flow in Upper Analysis Area Streams.

Monitoring Site	Drainage Area (square miles)	Average Watershed Area Precipitation (inches)§	Modeled Baseflow (cfs)[1]	Estimated $7Q_2$ Flow (cfs)	Estimated $7Q_{10}$ Flow (cfs)
Libby Creek at CMW boundary (~LB-100)†	3.3	79.4	0.54	2.35	1.49
Libby Creek LB-300	7.8	71.7	1.22	4.73	3.03
Poorman Creek at CMW boundary†	1.0	84.7	0.12	0.76	0.47
Ramsey Creek at CMW boundary†	2.3	83.3	0.38	1.76	1.11
East Fork Bull River at Isabella Creek (EFBR-2)	7.1	74.3	2.92	4.57	2.93
East Fork Rock Creek at CMW boundary (EFRC-200)†	1.4	77.6	0.29	0.92	0.57

§Estimated using 1971-2000 PRISM data (Oregon State University 2006); all values exceed the maximum value of 69 inches for the USGS equation variable.
†Watershed area is near or less than 3 square miles.
[1]Modeled baseflows are the best currently available estimates that can be obtained using the 3D groundwater models. The baseflow estimates would be refined after baseflow measurements were collected during the Evaluation Phase and incorporated into the model.
Source: Geomatrix 2011a; Appendix G.

3.8.3.2 Uses of Baseflow, and $7Q_2$ and $7Q_{10}$ Flows in EIS Analyses

The adits and mine workings would intercept and drain groundwater from water-bearing fractures in bedrock during all mining phases. This would reduce the amount of groundwater available to discharge to streams, springs, and lakes. The 3D numerical groundwater model simulated the changes in baseflow for each mine phase. Discharges of treated mine water would meet effluent limitations prescribed by an MPDES permit. The effluent limitations would normally be calculated using the estimated $7Q_{10}$ flow of the receiving water. The agencies used the estimated $7Q_{10}$ flows to analyze the effects of the project on streamflow, with the exception of LB-100, LB-300 and EFRC-200. Although the drainage area at LB-100 and LB-300 is greater than 3 square miles, the location fits the characteristics of upper drainages, where the estimated $7Q_{10}$ values are greater than the modeled baseflow values. The Libby Creek channel is narrow and contains limited surficial deposits above LB-300. Some avalanche chutes in the upper Libby Creek watershed contain surficial deposits that may store and transmit shallow groundwater through much of the summer depending on remaining snow pack at the head of each chute. In addition, the average annual precipitation at LB-100 and LB-300 is outside the range of the values used to develop the USGS equation. Flow rates measured during late summer/early fall in upper Libby Creek are similar to the 3D model predicted baseflows, indicating that there may be little if any contribution from surficial deposits during late summer/early fall during years with little or no late season snow pack or precipitation. The primary source of baseflow to streams in the upper reaches of the analysis area is fractured bedrock up to an elevation of between 5,000 and 5,600 feet. The drainage area and the average annual precipitation at EFRC-200 are outside the range of the values used to develop the USGS equation. The discussion and summary tables in section 3.11.4.4 use modeled baseflow at LB-100, LB-300, and EFRC-200, and estimated $7Q_{10}$ flow at other locations, to provide the total estimated streamflow change as a result of project activities during a an especially dry year.

Table 86. Modeled Baseflow and Estimated $7Q_2$ and $7Q_{10}$ Flow in Lower Analysis Area Streams.

Monitoring Site	Drainage Area (square miles)	Average Watershed Area Precipitation (inches)§	Modeled Baseflow (cfs)‡	Estimated $7Q_2$ Flow (cfs)	Estimated $7Q_{10}$ Flow (cfs)
Libby Creek					
LB-800	21.2	59.2	5.90	9.27	5.99
LB-1000	34.9	54.4	9.80	13.23	8.59
LB-2	35.7	53.8	10.55	13.27	8.62
LB-2000	40.8	51.2	12.20	13.85	8.99
At US 2	67.4	47.8	19.83	20.46	13.36
Ramsey Creek					
RA-600	6.7	64.1	1.50	3.26	2.07
Poorman Creek					
PM-1200	6.5	56.3	1.80	2.46	1.55
Rock Creek					
RC-3	14.9	69.7	3.08	8.80	5.70
RC-2000	32.4	57.3	7.70	13.53	8.80
East Fork Bull River					
EFBR-500†	10.0	69.5	4.36	5.77	3.71
At mouth (Lower East Fork Bull River)	28.2	58.7	11.34	12.27	7.97

§Estimated using 1971-2000 PRISM data (Oregon State University 2006); all values exceed the maximum value of 69 inches for the USGS equation variable.
†Average annual precipitation for EFBR-500 watershed is 69.5 inches, and at RC-3 is 69.7 inches, just above the maximum range for the $7Q_2$ and $7Q_{10}$ equations; therefore, $7Q_2$ and $7Q_{10}$ values shown in table may not be reliable.
‡Modeled baseflows are the best currently available estimates that can be obtained using the 3D groundwater models The baseflow estimates would be refined after baseflow measurements were collected during the Evaluation Phase and incorporated into the model.
Monitoring sites are shown on Figure 76.
Source: Geomatrix 2011a; Appendix G.

Table 87. Estimated $7Q_2$ and $7Q_{10}$ Ranges for Streams in the Analysis Area.

Stream Location	Low Estimate $7Q_{10}$ (cfs)	Estimated $7Q_{10}$ (cfs)	High Estimate $7Q_{10}$ (cfs)	Low Estimate $7Q_2$ (cfs)	Estimated $7Q_2$ (cfs)	High Estimate $7Q_2$ (cfs)
Libby Creek						
LB-50†	0.41	0.86	1.84	0.77	1.38	2.47
LB at CMW boundary (~LB-100)†	0.70	1.49	3.18	1.32	2.35	4.21
LB-300†	1.42	3.03	6.46	2.65	4.73	8.47
LB-800	2.81	5.99	12.75	5.18	9.27	16.58
LB-1000	4.03	8.59	18.30	7.40	13.23	23.67
LB-2	4.04	8.62	18.36	7.42	13.27	23.75
LB-2000	4.22	8.99	19.15	7.74	13.85	24.78
Libby Creek at US 2	6.27	13.36	28.45	11.44	20.46	36.61
Poorman Creek						
Poorman Creek at CMW boundary†	0.22	0.48	1.02	0.43	0.77	1.38
PM-1000	0.71	1.51	3.23	1.34	2.40	4.30
PM-1200	0.73	1.55	3.30	1.38	2.46	4.40
Ramsey Creek						
Ramsey Creek at CMW boundary†	0.52	1.12	2.38	0.99	1.77	3.17
RA-400	0.97	2.06	4.39	1.81	3.24	5.80
RA-600	0.97	2.07	4.40	1.82	3.26	5.83
Little Cherry Creek						
LC-800†	0.11	0.22	0.48	0.21	0.37	0.67
East Fork Rock Creek and Rock Creek						
EFRC-200†	0.27	0.57	1.22	0.52	0.92	1.65
RC-3†	2.67	5.70	12.14	4.92	8.80	15.74
RC-2000	4.13	8.80	18.74	7.56	13.53	24.21
East Fork Bull River						
EFBR-2†	1.37	2.93	6.24	2.56	4.57	8.18
EFBR-500†	1.74	3.71	7.90	3.23	5.77	10.33
EFBR at mouth	3.74	7.97	16.97	6.86	12.27	21.95

†Locations have drainage areas and/or precipitation values outside the range of values used to develop the equations, or are near the maximum and minimum values used in the equations, so results may be unreliable (Hortness 2006). Locations are shown on Figure 76.

The water balances developed for average annual precipitation and evaporation rates are provided in Chapter 2 in the *Water Use and Management* section of each mine alternative. The summary tables in section 3.11.4.4 use estimated $7Q_2$ flows to provide the total estimated change in annual low streamflow in the analysis area as a result of all mine-related activities (mine inflows, discharges, appropriations, diversions and evaporative loss). In this analysis, the agencies used $7Q_2$ flows to assess effects because the USGS method did not provide an equation to calculate $7Q_1$ flows, which are annual 7-day low flow. Although the $7Q_2$ flow would be lower than the 7-day annual low flow, it would occur with sufficient frequency (probable 2-year recurrence interval) to use in the analysis. Assuming that 15 percent of annual streamflow occurs in the baseflow period during late summer/early fall (see Appendix H), the predicted increase in annual streamflow from the existing land management activities in all the basins was proportionally estimated for the baseflow period.

3.8.4 Uncertainty, Monitoring, and Mitigation

The best available information was used to analyze the effects on water resources. While some uncertainty is inherent in all predictions, the uncertainties specific to these analyses are discussed in each of the following sections on geochemistry, hydrology, and water quality. To address these specific elements, monitoring plans have been developed and are described in Appendix C for the agencies' alternatives (Mine Alternatives 3 and 4, and Transmission Line Alternatives C-R, D-R, and E-R). A water resources monitoring plan is not needed for the Sedlak Park Substation and the loop line.

For water resources, the objective of the monitoring is to provide long-term assessment of the water resources and groundwater-dependent ecosystems that could be affected by the mine, as a basis for informing evidence-based management strategies throughout the life-of-mine. The agencies also developed mitigation designed to minimize the predicted effects. These mitigation measures are discussed in Chapter 2 in the agencies' alternatives. The following sections on geochemistry, hydrology, and water quality include a discussion on the anticipated effectiveness of the agencies' monitoring and mitigation measures.

3.9 Geology and Geochemistry

Geology is the primary framework for this environmental assessment, influencing the location of mineralization, proposed mining methods, environmental geochemistry, groundwater distribution and movement, and discharge to surface water. Together with hydrology, geology and geochemistry determine the potential impact of mining on ground and surface water resources. Geologic hazards, such as avalanches and landslides, are discussed in section 3.14, *Geotechnical Engineering.*

3.9.1 Analysis Area and Methods

The geochemical analysis area encompasses the underground zones from which ore and waste rock would be mined, and the surface locations on which waste rock or tailings would be placed. The agencies reviewed published studies of regional and local geological structure, stratigraphy, and mineralization and combined it with exploration data collected by NMC and MMC for the assessment. Much of the analysis and description of the geology of the proposed mine, tailings impoundment areas, and transmission line corridor alternatives presented in this section is based on the 1992 Montanore Project Final EIS (USDA Forest Service *et al.* 1992) and subsequent descriptions provided by MMC. These have been updated with recent literature (*e.g.*, Boleneus *et al.* 2005) and recent test results, where appropriate, but the fundamental geological description of the area and understanding of the mineral deposits has not changed since 1992. Elements of the geology that directly affect environmental geochemistry are emphasized within this description.

The following sections summarize the baseline information collected on environmental geochemistry and geology, and describe the approaches used by the lead agencies in analyzing potential effects. The subsequent sections on the Troy Mine, which has mined similar deposits for several decades, as a geochemical analog for the Montanore sub-deposit and on the geochemistry of Revett-style copper and silver deposits in Northwestern Montana describe the best available information regarding environmental geochemistry in the analysis area. The KNF and the DEQ determined that the baseline data and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on resources potentially affected by environmental geochemistry, and to enable the decision makers to make a reasoned choice among alternatives. Appendix C describes the additional environmental geochemistry and geologic data that would be collected during all phases of the project, including the Evaluation Phase and for final design. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.9.2 Affected Environment

3.9.2.1 Geologic Setting

3.9.2.1.1 Physiography

The Cabinet Mountains are bounded on the south by the Clark Fork River, on the east by Libby Creek, on the north by the Kootenai River, and on the west by the Purcell Trench in Idaho. The Bull River/Lake Creek valley separates the mountain range into east and west segments. The analysis area is in the southeast portion of the Cabinet Mountains and the part of the Fisher River watershed that lies between the Cabinet Mountains and Salish Mountains east of Libby. The Cabinet Mountains are a rugged northwest-trending mountain range of high relief. The maximum relief in the analysis area is about 5,000 feet. The highest elevation in the vicinity is Elephant

Peak at an elevation of 7,938 feet. The lowest elevations are 3,200 feet along Libby Creek and 2,900 feet along the Fisher River. The proposed plant site in Ramsey Creek is at an elevation of 4,400 feet; the elevation of the proposed tailings impoundment in Little Cherry Creek is at about 3,500 feet; and the elevation of the proposed Sedlak Park Substation is at 3,000 feet.

Area topography (Figure 44) is a function of the underlying rock types, structure (faults and folds), and geologic history. Slopes are generally steep (more than 30 percent) except along the axis of streams and rivers. Rocks in the area are relatively competent and not easily erodible. Most rock types weather into small fragments that form a colluvial (transported by gravity) mantle overlying bedrock.

Large faults bound the Cabinet Mountains on the east, south, and west. These faults are in part responsible for the location of valleys surrounding the Cabinet Mountains. The Clark Fork River, Libby Creek, Bull River-upper East Fork Bull River, and the East Fork Rock Creek valleys are all located along faults. A number of smaller streams in the analysis area also may be located along fault and fracture structures. The major land-forming features were created by the Rocky Mountain uplift and subsequent faulting. Topography in the analysis area has been influenced by Pleistocene-age glaciation (from 2 million to 10,000 years ago). In the northern part of the analysis area, Pleistocene alpine glaciers carved the landscape into a series of glacial features characterized by nearly vertical cliffs, ledges, steep colluvial slopes, and talus fields. The high peaks of the area (St. Paul, Rock, and Elephant peaks) are glacial horns formed by glaciers. Small- to moderate-sized lakes (tarns), such as Copper and Cliff lakes, have formed in the glacial cirque basins.

Pleistocene-age glaciation sculpted the mountain peaks, scoured some lower elevation areas, and deposited a veneer of glacial deposits. Glacial lakebed deposits (silt and clay accumulations 100 or more feet thick) were deposited in low-elevation drainages. Melt-waters from glaciers in the upper part of the analysis area carried large amounts of excavated rock debris into creeks draining the higher topographic areas, filling portions of the valley bottom. Older terraces of the former valley bottoms are exposed as higher-level benches along lower portions of many of the creeks. In many areas, the creek has since down-cut into the valley fill.

Higher elevation creeks generally flow through relatively narrow canyons and then spill into wider valleys at the periphery of the wilderness area. The wider valleys have flat to rolling bottoms, with lakebed and stream deposits capping and surrounding shallow to exposed bedrock.

3.9.2.1.2 Regional Geology

The Cabinet Mountains and surrounding areas are composed of a thick series of metasedimentary rocks referred to as the Belt Supergroup. These Belt rocks were deposited in a subsiding basin about 1,450 to 850 million years ago (Harrison 1972). Originally deposited as a series of muds, silts, and sands, the deposits were metamorphosed to argillites, siltites, and quartzites, respectively.

The Belt Supergroup can be divided into four major groups. In ascending order, these are the Lower Belt, Ravalli Group, Middle Belt carbonate (Table 88), and the Missoula Group (not shown in Table 88). Regionally, the Lower Belt is represented by the Prichard Formation. The Prichard Formation consists mostly of argillites, with some interbedded siltite and quartzite units. It is the lowest formation within the Belt Supergroup in this area and is mapped as the thickest at 25,000 feet.

Table 88. Stratigraphy of Montanore Analysis Area.

Supergroup	Group	Formation	Member
Belt	Middle Belt Carbonate	Wallace	Upper Middle Lower
	Ravalli	Empire / St. Regis	
		Revett	Upper (See detail below) Middle Lower (ore zone)
		Burke	—
	Lower Belt	Prichard	Transition Upper Lower

Formation	Member	Bed	Deposit
Revett	Upper	**Upper quartzite**	Troy
		Upper siltite	
		Middle quartzite	
		Lower siltite	
		Lower quartzite	Troy
	Middle		
	Lower	**A**	Rock Creek-Montanore
		B	
		C	
		D	
		E	
		F	
		G	Troy
		H	
		I	

Source: Boleneus *et al.* 2005.
Shaded areas with bolded text represent ore deposits.

The Ravalli Group in this part of the Belt Supergroup basin consists of, from oldest to youngest, the Burke, Revett, and St. Regis Formations. The Burke Formation is composed primarily of siltites and its contact with the underlying Prichard Formation is gradational. The Revett Formation is a north- and east-thinning wedge of quartzite, siltite, and argillite. In the Cabinet Mountains area, the Revett is informally divided into lower, middle, and upper members on the basis of the proportions of quartzite, siltite, and argillite. The lower and upper members are dominated by quartzites with interbedded siltite and argillite; the middle member is mostly siltite with interbedded argillite and quartzite. The St. Regis Formation is dominantly silty argillite and argillitic siltite.

The Middle Belt carbonate is separated into a western and eastern facies. The western facies Wallace Formation contains a conspicuous clastic component (but still contains a considerable proportion of carbonate material) and was deposited from a southern source terrain; the eastern facies Helena Formation is largely a carbonate bank (Grotzinger 1986). The two Formations interfinger or overlap along a broad zone that extends from Missoula northwest toward the Canadian border just east of Libby, Montana (Harrison 1972).

Regionally, Paleozoic sediments are represented by an occasional north-northwest trending exposure of shale, sandy shale, dolomite, magnesium-rich limestone, and sandstone, some of which are fossiliferous. The exposures are along US 2, south of Libby, MT, along MT 200 near the Montana-Idaho border, and in several other localities. These sediments are mapped as narrow fault-bound blocks that were caught between eastwardly thrusted Belt strata (Johns 1970). Because of their age and diagenesis, rocks in the analysis area are unlikely to be a source of significant paleontological resources.

The mine area bedrock has been extensively folded and faulted along generally north to northwest trends. Most of this structural activity was related to complex plate interactions that occurred between 24 and 200 million years ago, and resulted in the rocks being thrust eastward along shallow dipping faults over distances of up to 100 miles (Harrison *et al.* 1992). One of several prominent structures is the Hope Fault within the Clark Fork drainage.

Quaternary age deposits are reflected in Pleistocene glacial erosion and deposition of stratified and unstratified sediments. Large areas are covered by glaciofluvial and glaciolacustrine sediments to depths up to several hundred feet. Near Libby, Montana, bluffs of glaciolacustrine silts stand up to 200 feet above the recent floodplain. Glaciolacustrine silts and clays prone to sloughing from road cuts are found at elevations between 2,900 and 4,000 feet in the two tailings impoundment areas, along the Fisher River, and along lower Miller and West Fisher creeks. During recent times, this and older materials have been eroded and reworked by stream activity.

The western Montana copper belt, first named by Harrison in 1972, hosts several large strata-bound Revett-style copper-silver deposits in permeable quartzite beds of the Revett Formation (Boleneus *et al.* 2005). Several Revett-style deposits, which occur in the upper and lower members of the Revett Formation, have been intensively studied by numerous investigators (Clark 1971; Harrison 1972; Hayes 1983; Lange and Sherry 1983; Bennett 1984; Hayes and Einaudi 1986; Hayes 1990). The Rock Creek-Montanore deposit, currently under permitting review as two separate mining operations, and the Troy Mine (Spar Lake deposit) are each hosted in the Revett Formation. The Rock Creek portion of the deposit is separated from the Montanore (Rock Lake) portion by the Rock Lake Fault. This document follows the USGS nomenclature, which distinguishes the Rock Creek-Montanore deposit from the Troy deposit, as described by Boleneus *et al.* (2005). In cases where data have been collected solely from the Rock Creek or the Montanore portion of the Rock Creek-Montanore deposit, the term sub-deposit has been used. The USGS used the term “world class deposit” to describe the relationship of the Rock Creek and Montanore deposits to other known stratabound copper-silver deposits in North America. World-class deposits are significant because production from any of them would affect the world’s supply-demand relation for the metal. World-class deposits are those that exceed the 90th percentile of discovered metal, and contain more than 2.2 million tons of copper. Only three world-class stratabound copper-silver deposits are found in North America: the Rock Creek and Montanore deposit; the Kona deposit and the White Pine deposit in Michigan (Boleneus *et al.* 2005).

3.9.2.1.3 Mineralization

There appear to have been three mineralizing events in the Belt rocks of the analysis area. Most recently, Cretaceous to early Tertiary age granodiorite and quartz monzonite plutons intruded the highly folded and faulted Belt rocks in the central and northern portions of the Cabinet Mountains. This produced the mineralization of the prospects found along the eastern and southern flanks of the Cabinet Mountains. An older event involved the Precambrian age intrusions of igneous rock high in iron and magnesium that intruded the Wallace, Burke, and Prichard Formations. The Purcell Lava is an example of such an event, which created the vein-hosted deposits found in the Ten Lakes area northeast of the Cabinet Mountains. The oldest mineralizing event is the Precambrian age migration of metal-bearing solutions through select permeable zones within the Belt Supergroup, especially the Revett Formation, before or during lithification (Clark 1971; Hayes 1983; Lange and Sherry 1983).

Ore-grade stratabound copper-silver deposits in the Revett Formation (the Spar Lake deposit of the Troy Mine and the Rock Creek-Montanore deposit) exhibit the same mineral zonation patterns, with about the same volume percent sulfides in each of the mineral zones (Figure 61). The two deposits were formed at about the same time, a billion years ago, by the same geological processes, and in the same geological host rock, sandstone. Through geological processes, sandstone is now a quartzite and finer grained interbedded siltstones and claystones are now siltites and argillites. The deposits are concentrated along a pre-mineralization pyrite-hematite interface, in relatively coarse-grained quartzite that acted as a paleoaquifer for ore-forming fluids. The pre-mineralization pyrite and hematite quartzite is of regional extent, extending from the Vermillion river to north of the Troy Mine. The gradational mineralized zones of chalcocite, bornite, and chlorite, which are the ore zones, are between a chalcopyrite-galena-sphalerite zone and a chalcopyrite zone (Figure 61). The chalcopyrite-galena-sphalerite and chalcopyrite zones do not contain copper mineralization of economic grade nor do they contain silver. Following mineralization, the mineralized rock was subsequently cemented with calcite containing iron and magnesium. Mineralization is consistent throughout the Belt basin, with minor variations between defined deposits resulting from subtle variations in the stratigraphy of the interbedded quartzite, siltite, and argillites that comprise the Revett Formation. Boleneus *et al.* (2005) provide a comprehensive summary of regional stratigraphy, lithologic characteristics, and alteration patterns of the Revett Formation.

3.9.2.2 Site Geology

Site geology is described for the locations that are evaluated for potential water quality impacts, including the mine area (underground workings and surface faculties constructed using waste rock), the tailings impoundment, and the LAD Areas.

3.9.2.2.1 Mine Area - Underground Workings and Surface Facilities

The Cabinet Mountain region was subject to folding and faulting during mountain building. Structural features trend to the northwest or north, including primary faults, which tend to parallel fold axes. The mine area is bounded on the east by the Libby thrust belt and on the west by the Moyie thrust, two major east-directed north-northwest trending structural features. The Libby thrust belt is about 9 miles east of the Cabinet Mountains and the Moyie thrust is about 12 miles west. Intervening between the two thrust systems is the west-directed Snowshoe thrust, formerly known as the Snowshoe Fault. The main Snowshoe thrust can be traced from Rock Lake to the Montana border (Fillipone and Yin 1994). The Rock Lake Fault is a north-northwest striking fault, with a highly variable but generally steep dip, with younger Belt rocks on the east against older Belt rocks on the west. The fault crosscuts west-directed structures related to the Snowshoe thrust, making the Rock Lake Fault a younger feature. The Rock Lake Fault separates the Rock Creek-Montanore deposit into two portions that are proposed to be operated as the Rock Creek and Montanore Projects, respectively. Section 3.10, *Groundwater Hydrology* discusses how faulting was incorporated into the 3D groundwater model.

Table 88 presents general stratigraphy for the analysis area, and Figure 62 is a bedrock geology map for the portion of the CMW area that overlies the sub-deposit at Montanore. The Prichard Formation is the oldest unit at Montanore and consists primarily of quartzite, with argillite, siltite, and mudstone. The Burke, St. Regis, and Empire Formations of the Ravalli Group are predominantly siltite, argillite, and quartzite. The Revett Formation, also of the Ravalli Group, is subdivided into three members based on the amount of quartzite, silty quartzite, and siltite. The Rock Creek-Montanore, stratabound copper and silver deposit is found in the A-C quartzite beds in the uppermost portion of the lower member of the Revett Formation, which consists primarily of quartzite and layers of siltite and silty quartzite. The Wallace Formation is the younger Middle Belt Carbonate group of rocks in the analysis area.

Mine Development Associates (2005) report that Montanore sub-deposit mineralization occurs in the lower limb of a north-northwest plunging, breached overturned syncline. The syncline axis trends north 45° east and opens to the northwest (Figure 63 and Figure 64). This creates a progressively wider flat-lying lower limb. The lower limb is not folded but dips about 15 degrees to the northwest. Mineralization in the Montanore sub-deposit is observable in the outcrop where the Revett Formation was discovered, located on the north shore of Rock Lake.

The west-southwest boundary of mineralization is the northwest trending, near-vertical Rock Lake Fault that produced at least 2,500 feet of vertical displacement (Figure 63). The fault trends N35° W for about 12 miles with the down-dropped side to the northeast. The USGS (1981) reports three periods of movement can be distinguished for the Rock Lake Fault. The syncline is bound on the east by several splays of the Libby Lake Fault (Figure 63).

The Rock Creek-Montanore deposit occurs in the Revett Formation, which is subdivided into the upper, middle, and lower Revett, based upon the amount of quartzite, silty quartzite, and siltite. The majority of the silver and copper mineralization occurs in the A-C quartzite beds within the upper portion of the lower Revett. The mineralization is predominantly copper and copper-iron sulfides, including bornite, chalcocite, and chalcopyrite. Silver occurs as native silver, and in copper minerals. Localized concentrations of ore minerals reflect faults and increased permeability in the quartzite beds (Boleneus *et al.* 2005). Lead sulfides (galena) and iron sulfides (pyrite and pyrrhotite) occur around the ore zone, but do not occur in any significant quantities within the ore.

The silver and copper ore zones are separated by a low-grade barren zone of disseminated and vein-hosted galena. The barren zone varies in thickness from more than 200 feet toward the west to 18 feet in the eastern portions of the mine area. The barren zone may be absent to the northeast.

Mineral zones, defined by the appearance, disappearance, and abundance of sulfide and gangue (the commercially worthless mineral matter associated with economically valuable metallic minerals in a deposit) minerals, are developed that crosscut the stratigraphic units in the Revett Formation. This zonation is consistent with similar alteration mineralogy and crosscutting relationships observed in stratabound copper and silver deposits worldwide, and define the ore zone as well as key zones of environmental significance within the Revett Formation. The distribution and extent of mineral zonation in the Revett Formation is controlled by the migration paths of mineralizing fluids, which change in response to differences in porosity between the quartzite, siltite, and argillites that are variably interbedded across the basin. These zones are important, not only for the identification of ore, but also for identification of zones enriched in sulfides that are potentially acid generating when oxidized, such as pyrite and chalcopyrite, and those that are acid consuming, such as bornite, chalcocite, and digenite.

Mineralization within the Revett Formation is consistent throughout the depositional basin. As discussed by Maxim Technologies (2003) and Enviromin (2013b), the Rock Creek-Montanore deposit was deposited within the Proterozoic Revett basin under the same conditions as the Troy deposit, which is located in a mineralogically comparable setting, but in different stratigraphic zones within the Revett Formation. The Troy deposit has been mined over the past 30 years, and a substantial amount of geological, mineralogical, and water quality data are available for this deposit that provide full-scale estimates of environmental geochemistry behavior. Analyses of drill samples from the Rock Creek-Montanore deposit have generated laboratory-based sets of mineralogical and geochemical information for comparison with the larger set of data available from the Troy Mine. Comparison of data from the Rock Creek-Montanore and Troy deposits provides useful information regarding the potential geochemical effects of development of the Montanore sub-deposit.

Mineral zonation was studied in the Troy deposit, where alteration zones were described in detail based on the dominant sulfide and distinct non-sulfide minerals present, along with color. These alteration styles include the pyrite-calcite, galena-calcite, chalcopyrite-calcite, bornite-calcite, chalcocite-chlorite, chalcopyrite-ankerite, hematite-calcite, and albite zones (Hayes and Einaudi 1986). The pyrite-calcite and chalcopyrite-ankerite boundary represents the boundary between reduced and oxidized rocks, along which ore-grade minerals, bornite-calcite and chalcocite-chlorite zones were deposited. The chalcopyrite-calcite and galena-calcite zones lie between the ore and the pyrite-calcite zone. In the Montanore sub-deposit, the barren “lead” zone associated with the ore hosts galena as a primary mineral. The location and relative magnitude of the mineral zones is generally controlled by grain-size characteristics of individual stratigraphic units, although the alteration crosscuts stratigraphic units. A broad belt of pyrite-calcite occurs in the A-D beds of the lower Revett at both Troy and Rock Creek-Montanore deposits, with some variation in zone thickness related to local changes in sediment porosity (argillite vs. quartzite), as well as displacement by more recent structural activity. Because these zones host sulfide and carbonate minerals that could affect acid generation and neutralization potential, it is important to understand their occurrence within the Montanore sub-deposit.

In the Montanore sub-deposit, rock exposed in the workings and adits would include both ore and the barren lead zone of galena-calcite alteration zone within the Revett Formation. MMC’s mine plan would minimize disturbance of the barren lead zone to the extent possible. In the adits, lesser amounts of chalcopyrite-calcite and pyrite-calcite altered waste zones also may also be exposed within the lower Revett Formation, along with the Prichard and Burke formations in the Ramsey Adits. It is possible that a small amount of rock from Wallace Formation would be intercepted in the Ramsey Adits as well. Six distinct rock units would be exposed underground or mined as waste rock at the proposed mine.

MMC collected 11 representative samples from five drill holes and analyzed them for asbestos by Polarizing Light Microscopy. No asbestos fibers were detected in any sample (Jasper Geographics 2005).

3.9.2.2.2 Tailings Impoundments and LAD Areas Geology

Surficial geology at both the Little Cherry Creek and Poorman tailings impoundment sites is similar and dominated by Quaternary glacial deposits (Figure 65). Detailed geology and cross sections of the two tailings impoundment sites are provided in Figure 66. As much as 300 feet of unconsolidated silt, sand, and gravel overlie the Wallace Formation in both tailings impoundment areas. Fine-grained glacial lake (glaciolacustrine) materials dominate the center and eastern portion of tailings impoundment sites and interfinger with intermixed silt, sand, and gravel glaciofluvial materials on the western portion of the site. Based on borehole data, a buried glaciofluvial channel greater than 370 feet thick in some locations trends west to east through the center of the Little Cherry Creek Tailings Impoundment Site (Figure 66) (Klohn Crippen 2005).

Bedrock exposures are limited in the Little Cherry Creek Tailings Impoundment Site. Most of Little Cherry Creek is 50 feet or more above bedrock. Near the Little Cherry Creek Seepage Collection Pond proposed in Alternatives 2 and 4, the creek has eroded the surficial material and exposed less weathered bedrock. Weathered bedrock also was observed on the ridge where the tailings thickener plant proposed in Alternative 3. Most bedrock fractures appear to be related to sedimentary bedding planes, but drill samples also show occasional near-vertical joints and irregular fractures. The thickness of surficial sediments at the Little Cherry Creek Tailings Impoundment Site ranged from 10 feet at the South Saddle Dam to over 360 feet in a buried channel beneath the proposed Main Dam (Klohn Crippen 2005).

The surficial geology of the Poorman Tailings Impoundment Site is similar to that of the Little Cherry Creek Tailings Impoundment Site (Figure 65). Depth to bedrock is not well defined with the Poorman site. Based on a resistivity survey and available borehole data, the thickness of the unconsolidated deposits is generally 100 to 200 feet within the impoundment footprint (NewFields 2014a). The survey identified an apparent subsurface bedrock ridge that separates the two impoundment areas (Figure 66) (Chen-Northern 1989). The investigation did not identify a buried channel like those identified at the Little Cherry Creek site (Figure 66). Section 2.5.2.6.3, *Final Tailings Impoundment Design Process* discusses the site investigations that MMC would conduct at the Poorman Tailings Impoundment Site during the final design process.

The two LAD Areas are located on a low, flat ridge between lower Ramsey Creek and Poorman Creek. Geology at these locations is mapped as Quaternary glacial deposits, similar to those found in the tailings impoundment sites (Figure 65). These glacial deposits begin as a thin veneer at an elevation of about 4,000 feet on the flank of the Cabinet Mountains and thicken eastward to 200 feet in thickness (USDA Forest Service *et al.* 1992). Ravalli Group bedrock is present west of the LAD Areas and rocks of the Wallace Formation lie to the east.

3.9.3 Mining History

Mineral activity in this area dates back to the 1860s with the discovery of placer gold (gold in alluvial deposits) along Libby Creek on the east side of the Cabinet Mountains (Johns 1970). Subsequent exploration in the 1880s and 1890s led to the discovery of numerous small hard-rock mineral deposits (minerals found in hard consolidated rock). Many of these hard rock mineral deposits were discovered along the east side of the Cabinet Mountains. Production from these veined deposits and the area's placer deposits was sporadic and short-lived. None of these mineral deposits is currently in production.

In the late 1890s and then in the 1920s and 1930s, several small prospects were worked west of the Cabinet Mountains divide in and around the analysis area. The Heidelberg Mine is about 1 mile south of the proposed Montanore Mine, just south of Rock Lake. Most of these old workings were driven on gold-bearing quartz veins in what is probably the southern end of the Snowshoe thrust near its junction with the Rock Lake Fault. Numerous other diggings (generally shallow) occur along the northwest-trending faults that cut the area. All of these prospects were short-lived and very little, if any, production occurred (Gibson 1948).

In the 1960s through the 1980s, three major deposits and numerous smaller deposits containing stratabound copper and silver mineralization were discovered. These discoveries were confined to the Revett Formation and situated within a narrow belt extending from the Coeur d'Alene Mining District north to about the Kootenai River. ASARCO brought the 64-million-ton Spar Lake deposit into production in late 1981, producing about 4.2 million ounces of silver and 18,000 tons of copper per year from the Troy Mine. The 145-million-ton Rock Creek sub-deposit in the CMW is the second deposit. The Rock Creek Project proposes to mine this sub-deposit. The Montanore sub-deposit, proposed for mining by the Montanore Project, is the third deposit.

3.9.4 Environmental Geochemistry

The mineralogy and geochemistry of the Montanore deposit determines the potential for acid rock drainage (ARD) and trace metal release. Facility-specific geochemistry of underground mine workings, backfilled mine waste, or surface deposits of mined rock (including tailings) determines the extent of mineral oxidation, dissolution, or nutrient release. Affected groundwater would potentially mix with ambient groundwater and undergo further reaction with downgradient minerals until it discharges to surface water. The relative volume and quality of discharge from proposed facilities would change with the water balance throughout the life- of-mine cycle.

3.9.4.1 Geochemical Assessment Methods and Criteria

An environmental geochemical assessment of the waste rock and ore that would be exposed in underground workings, surface facilities, and the tailings impoundment was completed to evaluate the potential impact on downgradient surface water and groundwater quality. The specific geochemical issues are acid generation and the potential release of metals and metalloids, regardless of acidity. The leaching of nitrate from blasting residues on ore, waste rock, and tailings is also a concern. Factors of importance in predicting long-term environmental chemistry are therefore the occurrence and relative concentrations of metal and sulfide-bearing minerals (including non-acid generating sulfides), as well as their mode of occurrence (*i.e.*, in veins, on fractures, or encapsulated within quartzite) and proposed management practices (*i.e.*, blasting, ore processing, and material placement) in terms of potential exposure to water and air.

Following a review of the mechanisms of acid production and trace element release, and a discussion of the use of the Troy deposit as a geochemical analog for the Rock Creek-Montanore deposit, the environmental geochemistry of rock likely encountered during mining is described. Data are used from the Montanore and Rock Creek sub-deposits, as well as the Troy deposit, and include static whole rock metal concentrations, acid generation potential, and metal mobility test data, as well as kinetic test and *in situ* monitoring data. Release of nitrate associated with blasting residues from mining is also discussed. The extent of sampling and methods of analysis are described. Data are summarized by project (Montanore, Rock Creek, and Troy) for ore, tailings, and waste rock.

3.9.4.1.1 Acid Rock Drainage

ARD results from weathering of chemically unstable iron-sulfide minerals in oxidizing air- and water-rich environments. Iron sulfides, particularly pyrite (FeS_2), chalcopyrite ($CuFeS_2$), and pyrrhotite ($Fe_{1-x}S$), are the most common acid-producing minerals (Price and Errington 1998; International Network for Acid Prevention 2008). Some types of sulfides, such as bornite (Cu_5FeS_4), chalcocite (Cu_2S), and digenite (Cu_9S_5), actually inhibit or decrease acidity because they either do not produce acid or consume it during oxidation (Bevilaqua *et al.* 2010; Brunesteyn *et al*. 1989).

Acid generation begins with the oxidation of sulfide to sulfuric acid (H_2SO_4) and release of ferrous iron (Fe II or Fe^{+2}). At near-neutral pH, acidity results from the primary chemical oxidation of sulfide, with biological oxidation playing only a minor role in sulfide oxidation. At low pH, ferric iron (Fe III or Fe^{+3}) produced by acid-loving, iron-oxidizing bacteria speeds up sulfide oxidation, so that the amount of acid produced increases as pH declines. Thus, if the neutralizing potential of a rock material is exhausted and pH drops below 4, iron-oxidizing bacteria will rapidly oxidize ferrous iron (Fe II) to ferric iron (Fe III), which can directly oxidize the sulfide minerals independent of oxygen. *Acidiothiobacillus ferrooxidans* is a common bacterium that makes energy by oxidizing both iron and sulfide from minerals in acid environments (below pH 4) (Schippers *et al.* 2000).

Mineralogic texture and chemistry are important factors when testing for acid generation and metal release potential. For example, decreased contact with oxygen and water due to cementation and encapsulation of reactive minerals limits oxidation. Temperature, pH, and availability of water and oxygen also affect rock-water interactions. Impurities in a sulfide crystal structure, or differences between iron sulfides and copper, zinc or lead sulfides also will affect oxidation rates and resulting changes in water quality.

The potential for ARD formation depends on the balance between the rates of acid-generating and acid-consuming reactions, which are studied using static (fixed, single point in time) or kinetic (rate measured over time) methods. ARD potential is estimated using a static acid base accounting test, which calculates the difference in total concentration of acid neutralizing and acid generating minerals, *i.e.*, acid base potential = neutralization potential - acid potential (ABP = NP - AP), in units of tons as $CaCO_3$/thousand tons of rock ($TCaCO_3/kT$). The calculated ABP is then compared to guidelines, wherein values less than -20 are considered acid producing, greater than 20 are considered non-acid generating, and values between -20 and 20 are considered to have uncertain acid generation potential. An alternative approach, comparing the ratio of NP/AP, uses criteria of less than 1 as acid producing, greater than 3 as non-acid generating, and between 1 and 3 as having an uncertain potential for acid production (EPA 1994b, International Network for Acid Prevention 2008).

The net generation of acid from a rock or waste rock facility is related more to the reactivity of sulfide and neutralizing minerals than the total concentrations, so that static tests of finely ground samples may over-predict potential for acid generation. This is especially true when sulfide minerals are encapsulated in non-reactive minerals, such as silica, as is the case in the quartzites of the Revett Formation. The pH decrease associated with ARD occurs if acidity is produced at a faster rate than alkalinity or when neutralizing minerals, such as the carbonate minerals calcite and dolomite, and some silicates, are consumed by excess acid. The development of acid drainage is time-dependent and, at some sites, may form after many years of slow depletion in available alkalinity or slowly increasing sulfide oxidation (Price and Errington 1998). Kinetic test methods are used to evaluate rates of reaction when static methods suggest uncertain potential for ARD. Monitoring of long-term environmental chemistry in analogous geochemical settings also provides excellent predictive information. Microbial processes can speed up sulfide oxidation and significantly increase acid production, but also influence the attenuation of dissolved metals.

If acidity generated through these processes at the mineral surface is neutralized by buffering minerals (such as calcium carbonate), or water is not available to transport oxidation products away from the mineral surface, ARD is unlikely to develop. Where water is available, and there is insufficient neutralizing capacity (buffering) of the solution, ARD will occur.

3.9.4.1.2 Trace Element Release– Metals and Nutrients

The potential release of trace elements from mined rock is a concern regardless of the potential for acid generation because dissolved metals can remain soluble depending upon their individual sensitivity to pH and oxidation. Base metals, such as iron, lead, and copper, are most soluble at low pH and will be sorbed or precipitated from solutions with neutral to alkaline pH. Although acidic drainage presents the greatest potential for metal release, some metals (such as manganese and arsenic) can have enhanced solubility under neutral or alkaline conditions. Elevated concentrations of metals can also result from dissolution of metal-bearing salt minerals under neutral conditions.

Elevated concentrations of nutrients (nitrate and ammonia) can also occur in mine drainage, as a result of using explosives during mining. As the concentration of nitrate is determined by blasting practice and surface deposits of unconsumed agents on the surface of blasted rock, rather than the inherent characteristics of the rock itself, nitrate concentrations can only be measured empirically in blasted deposits.

The potential mobility of trace elements, both metals and nutrients, is determined by multiple variables, including dilution, potential for sorption, redox conditions, and biological activity. Due to the potential complexity of reactive transport, *in situ* monitoring data from geochemical analogs and full scale facilities provide an important “real world” basis for comparison. All data for metals or nutrients, determined in laboratory tests or *in situ* monitoring, are compared with relevant surface water and groundwater quality standards for the purposes of assessing potential risk. For potential releases from ore, tailings, or waste rock, groundwater quality standards apply to groundwater, and surface water standards apply to surface water such as streams, at the point of discharge, or at the edge of a mixing zone, if authorized by the DEQ.

3.9.4.2 Troy Mine as a Geochemical Analog for the Montanore Sub-Deposit

The Troy Mine, developed within the upper quartzites of the Revett Formation, is an excellent depositional and mineralogical analog for the zone of quartzite to be mined within the uppermost part of the lower Revett Formation of the Montanore and Rock Creek deposit. Geological analogs provide valuable models for predicting acid generation potential and/or water quality from a proposed mine site (Price and Errington 1998). This type of comparison is based on the geologic evidence that mineralization formed under comparable conditions within the same geological formation, which has undergone similar geological alteration and deformation, will have similar mineralogy and texture and, thus, similar potential for oxidation and leaching under comparable weathering conditions. Further, the ability to study environmental geochemical processes in the same rocks at full scale and under real-time weathering conditions provides a valuable basis for evaluation of laboratory test results.

Hayes (1983) and Hayes and Einaudi (1986) conducted detailed mineral studies of the Revett-style mineralization, and concluded that the geochemistry and risk for ARD from the Troy and Rock Creek-Montanore deposits are the same, as defined by the observed mineral zonation (Hayes 1995). Hayes found that the ore zones of both deposits contain no detectable amounts of pyrite. In another study, Maxim Technologies (2003) showed that the three Revett-style copper and silver deposits in northwest Montana cannot be statistically distinguished from one another based on copper or silver assay values.

Hayes reported that pyrite in the Revett Formation characteristically occurs in disseminated and encapsulated grains within the quartzite, where it is isolated from weathering, rather than on fracture surfaces. He also found that the post-sulfide cementation of quartz overgrowths on all grains resulted in an impermeable rock with little porosity. These conclusions were confirmed in independent studies of Rock Creek ore in a validation study conducted for the Forest Service in 2003 (Maxim Technologies 2003).

Four altered waste zones surrounding the ore zones in both the Troy and Rock Creek-Montanore deposits have potential to be mined as waste rock to varying degrees depending upon the geometry of underground workings at each mine. The amount of pyrite also varies within these four altered zones; therefore, potential for acid generation and trace element release varies more between the three projects for waste rock than it would for ore due to differences in the mass and type of waste rock to be mined. Other metal-bearing minerals, such as tetrahedrite(copper-antimony sulfide) and tennantite (copper-arsenic sulfide), occur in varying trace quantities, particularly at the outer periphery of the ore deposit and in surrounding altered waste zones. These minerals are potential hosts of arsenic and antimony, which have been measured in mine-affected water at the Troy Mine and the Libby Adit. The geometry of the Rock Creek subdeposit suggests the volume of waste rock to be mined from altered waste zones would be low. The consistent Revett-style Cu-Ag deposit mineralization throughout the Western Montana copper belt supports the use of the Troy deposit as a geochemical analog for the Rock Creek-Montanore deposit. This is especially true for the ore zones, which are essentially indistinguishable from one another, and for tailings. Waste rock is also similar, but shows some trace element variation within altered waste zones, particularly in arsenic, antimony, and lead. Differences among Troy, Montanore, and Rock Creek may occur due to the volumes mined from each zone due to geologic structure and mine design.

3.9.4.3 Geochemistry of Revett-style Copper and Silver Deposits in Northwestern Montana

Geochemical analyses of ore and waste rock sampled during exploration drilling at Rock Creek-Montanore (pre-2001) and during operations at Troy Mine, together with characterization of waste rock from the Montanore Libby Adit, tailings from Rock Creek metallurgical tests and Troy operations, and *in situ* water quality data from the Libby Adit and the Troy Mine comprise the environmental geochemistry baseline data for the impact analysis. These data, which address questions of acid generation and trace element and nutrient release potential, are described in part by Enviromin (2009, 2010, 2012, and 2013b) and Geomatrix (2007a), and discussed in detail in the following section. They are also organized within a database that includes all known, validated environmental geochemistry data for Revett Cu-Ag deposits. The database is in the project record.

MMC presented a comprehensive summary of the available static geochemistry data characterizing rock for the proposed Montanore and Rock Creek mines by test method in tables appended to their waste rock management plan (Geomatrix 2007a), as well as in their review of waste rock characterization (MMC 2009a). Average values for acid base potential, whole rock chemistry, and assays described in a summary report by Enviromin (2013b) for this project include data reported by Balla (2002), DEQ (1996), Maxim Technologies (2003), Golder (1996), USDA Forest Service *et al.* (1992), USDA Forest Service and DEQ (2001), and Schafer and Associates (1992, 1997); these data are presented for ore and tailings in Table 89 and for waste rock in Table 90. The number and type of metal mobility and kinetic humidity cell tests is also shown. Additional data presented in this section, which were not included in the Supplemental Draft EIS, Enviromin (2013b) or Geomatrix (2007a), include Rock Creek tailings metal mobility and kinetic test results (Enviromin 2013a), and Troy I- and C-bed ore static and kinetic test results (Enviromin 2009, 2010, and 2012).

These data have been collected over time by various investigators and reflect differences in style and methods of sampling for each of the three Revett-style copper and silver deposits. For example, considerably more waste rock data were collected for the Montanore sub-deposit where it was exposed in the Libby Adit (Table 90), while tailings characterization is more comprehensive for the Rock Creek sub-deposit (Table 89). The most detailed studies of Revett-style copper and silver ore mineralization have been conducted underground at the Troy Mine, where exposures could be studied in mine workings, and the environmental geochemistry of the C and I ore zones have been thoroughly evaluated. Together, the mineralogy and chemistry of ore, tailings, and waste rock from the Rock Creek-Montanore and Troy deposits provide a fairly comprehensive baseline assessment of the rock to be mined. For these reasons, the following discussion focuses on data collected specifically for the proposed Montanore Project, but also includes information for the Rock Creek sub-deposit and Troy Mine.

3.9.4.3.1 Mine Area – Ore in Underground Workings

As discussed above, ore in the Rock Creek-Montanore deposit contains the copper sulfide minerals bornite, chalcocite, and digenite. These minerals are not acid-generating and based on delineation criteria, no pyrite occurs in the ore zone. Minor chalcopyrite and galena, with trace tennantite and tetrahedrite, occur as interbeds and in zones with calcite at the periphery of the deposit. Fewer quantitative mineralogy analyses are available for the Montanore sub-deposit than have been collected for the Rock Creek and Troy deposits, but extensive hand specimen descriptions (for thousands of described intervals, as shown in Table 89) are available in drill logs for all of the deposits, as described in Table 89. Detailed mineralogy studies indicate that 90 percent of all sulfide is encapsulated in the silica matrix of the quartzite in the Revett Formation at the Troy Mine (Enviromin 2013b). Formation of quartz overgrowths were documented for both the Troy (Hayes 1983) and Rock Creek deposits (Maxim Technologies 2003). A summary of the average sulfur and acid generation potential data characterizing ore and tailings for the Rock Creek-Montanore and Troy deposits is presented in Table 89. Further detail on the range and distribution of data is presented by Enviromin (2013b).

Table 89. Geochemical Data for Ore and Tailings from Northwestern Montana Revett-Style Copper and Silver Deposits.

Test	Ore						Tailings					
	Montanore		Rock Creek		Troy		Montanore		Rock Creek		Troy	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Static Acid Generation Potential												
ABP, T $CaCO_3$/kT rock (NP:AP ratio)	36	-4 (0.9)	34	1 (3)	28	5 (3)	No data		2	10 (10)	3	1.5 (1.5)
Total sulfur, weight %	35	0.3	34*	0.2	28*	0.2	No data		1	0.01	2	0.08
Total sulfur, weight % adjusted**	No data		34	0.08	16	0.02	No data		No data		No data	
Whole Rock/Metals												
Copper, ppm	1	7,880	36	6,623	29	5,180	No data		31	348	2	682
Silver, ppm	1	66	36	31	29	33	No data		31	9.8	2	5.5
Assay Claim Validation												
Copper, %	213	0.55	347	0.67	282	0.71						
Silver, oz/ton	213	1.4	345	1.6	282	1.4						
Sulfur, weight %, calculated from Cu	213	0.23	347	0.17	282	0.30						
Mineralogical Analysis												
Quantitative/analytical			10		>100		No data		1+		1++	
Feet drilled	1,500		3,000		11,429							
Mineralogy descriptions+	1,000		1,500		4,798							
Assays	1,500		7,255		3,799							
Metal Mobility Tests												
EP toxicity (EPA Method 1310)	No data		No data		No data		No data		No data		1	
TCLP (EPA Method 1311)	1		No data		No data		No data		No data		2	
SPLP (EPA Method 1312)	No data		No data		12		No data		1		1	
Humidity Cell Tests, final pH, s.u.	1	6.92	1	6.83	2	7.90+++	1	8.94	1	7.87	No data	

n =number of samples; ABP = Acid Base Potential; NP = Neutralization Potential; AP = Acid Potential; T $CaCO_3$/kT = tons equivalent calcium carbonate per 1,000 tons rock
TCLP = Toxicity Characteristics Leaching Procedure (EPA Method 1311); SPLP = Synthetic Precipitation Leachability Procedure (EPA Method 1312); s.u. = standard units.
Detection limit used for samples that contain below detection limit values.
+CAMP 2011; ++ Landefeld 2011.
+++ Mean of the pH from the final week of the I-Bed (7.92) and C-Bed (7.88) humidity cell test tests.
* = includes samples reported as "reported non-sulfate S" as total sulfur based on the mineralogy of the deposit which lacks significant sulfate.
** = adjustment based on DEQ (1996) to remove the mass of sulfide represented by non-acid generating copper-sulfide minerals.
Data summarized includes duplicate and primary results, where known, due to differences observed between results.
Source: Balla 2000, 2002; DEQ 1996; Geomatrix 2007a; Golder 1996 (summary of two non-cement samples [RC0A and RC0B]); Maxim 2003; Schafer and Associates 1992, 1996; USDA Forest Service *et al.* 1992; USDA Forest Service and DEQ 2001.

Table 90. Geochemical Data for Waste Rock from Northwestern Montana Revett-Style Copper and Silver Deposits.

Test	Montanore		Rock Creek		Troy	
	n	Mean	n	Mean	n	Mean
Static Acid Generation Potential						
ABP, T $CaCO_3$/kT (NP:AP ratio)			24*	4 (5)	2	17 (8)
Prichard Formation	70	7 (4)	6	2 (4)	No data	No data
Burke Formation and Burke-Prichard Transition	19	15 (12)	No data	No data	No data	No data
Lower Revett Formation	72	4 (3)	10	4 (3)	2	17 (8)
Total Sulfur, weight %	No data	No data	24**	0.11	2	0.05
Whole Rock/Metals						
Copper, ppm	3	40	27	29	2	126
Silver, ppm	3	8	27	2	2	0.99
Mineralogical Analysis						
Quantitative/analytical			2		>100	
Feet drilled	2,375		4,000		45,000	
Mineralogy descriptions	2,000		3,000		22,500	
Assays	2,375		No data		No data	
Metal Mobility Tests						
EP toxicity (EPA Method 1310)	No data		3		No data	
TCLP (EPA Method 1311)	3		14		No data	
SPLP (EPA Method 1312)	No data		14		2	

n = Number of samples; ABP = Acid Base Potential; NP = Neutralization Potential; AP = Acid Potential; T $CaCO_3$/kT = tons equivalent calcium carbonate per 1,000 tons rock; TCLP = Toxicity Characteristics Leaching Procedure (EPA Method 1311); SPLP = Synthetic Precipitation Leachability Procedure (EPA Method 1312).
Detection limit used for samples that contain below detection limit values.
* = data for the "Rock Ck Waste Rock" sample (ABP = 82 T $CaCO_3$/kT) was assumed to be an outlier and was not included in the mean calculation.
** = includes the 10 samples reported by DEQ 1996 as "non-sulfate S" as total sulfur based on the mineralogy of the deposit which lacks significant sulfate.
Source: Balla 2000, 2002; DEQ 1996; Geomatrix 2007a; Golder 1996 (summary of two non-cement samples [RC0A and RC0B]); Maxim 2003; Schafer and Associates 1992, 1996; USDA Forest Service *et al.* 1992; USDA Forest Service and DEQ 2001.

Acid Base Potential. Results of whole rock analyses of ore from Montanore sub-deposit are summarized in Table 89 along with results for ore samples from the Rock Creek sub-deposit and the Troy Mine. Total sulfur ranged from <0.01 to 0.78 percent (averaging 0.2 percent) at the Rock Creek sub-deposit (number of samples [n]=34), and was quite similar to Montanore, where total sulfur ranged from 0.01 to 0.95 percent and averaged 0.3 percent (n=35). Total sulfur ranged from 0.06 to 0.34 percent (averaging 0.2 percent) at the Troy Mine (n=28).

Thirty-six ABP (n= 36) tests have been provided for samples of ore from Montanore drill core. Another 34 Rock Creek and 28 Troy Mine ore samples were analyzed for acid base potential, as summarized in Table 89. The Montanore sub-deposit static test data suggest that the ore has uncertain potential to generate acid, with an average acid base potential (ABP) of -4 T $CaCO_3$/kT and an NP:AP ratio of 0.9. The Rock Creek and Troy samples both have NP/AP ratios of 3 and average ABP of 1 T $CaCO_3$/kT and 5 T $CaCO_3$/kT, respectively, despite having total sulfur contents less than 0.3 weight %. Average ore sample ABP values were significantly lower at Rock Creek (1 T $CaCO_3$/kT) and Montanore (-4 T $CaCO_3$/kT) than at Troy (5 t $CaCO_3$/kT) due to differences in both the average AP and NP at each deposit. The ABP values for Rock Creek and Montanore were not statistically different. Statistical differences, which were based on a t-test, may be due to small geochemical differences between the deposits or could be a remnant of sampling error or changes in ore/waste classification because of use of different cutoff grades.

Static tests of acid generation potential are based on nitric acid digestion of all available sulfide from a finely ground rock flour, which as noted previously, conservatively estimates the potential for oxidation of encapsulated sulfides, as well as the potential for sulfides to generate acid because all sulfide is assumed to be acid-generating pyrite. The use of an acid base account without adjustment thus overstates the potential for acid generation by the copper sulfide minerals and ignores the effects of encapsulation. For this reason, in its study of the Rock Creek sub-deposit, the DEQ appropriately reduced the total sulfide by the amount of sulfur that would correspond to the measured copper concentration (based on the assumption that all sulfide is chalcocite, Cu_2S, so that there is one atom of sulfide for every 2 atoms of copper) to account for non-acid generating copper sulfides (DEQ 1996). The DEQ therefore adjusted the total reactive sulfur using the copper assays, reducing the estimated sulfide content for the Rock Creek sub-deposit from an average of 0.2 weight percent to 0.08 weight percent, as shown Table 89. The average sulfide for the Troy Mine was similarly reduced from 0.2 to 0.02 percent. Because copper concentrations were not reported for the Montanore sub-deposit samples, this correction cannot be made, although the principle is equally valid for the Montanore portion of the Rock Creek-Montanore deposit and would result in a predicted average value around 0.1 percent. The difference in inferred acid generation risk with and without this important mineralogical correction to account for non-acid generating copper sulfides is evident when comparing Chart 1 and Chart 2.

The neutralization and acid generation potential of ore from the various Revett Cu-Ag deposits are compared to the regulatory NP:AP ratio guidelines (acid <1; 1:3 uncertain; >3 non-acid) in Chart 1. These data, which are based on the conservative assumptions that sulfide is equal to total sulfur less sulfate sulfur and all sulfide is acid-generating pyrite, suggest that most samples of Revett ore have potential to generate acid or are uncertain in terms of ARD risk. These calculations overestimate the acid generation potential of the Montanore sub-deposit, which would more closely resemble the trends shown in Chart 2 for the Rock Creek sub-deposit and Troy deposit when corrected to remove non-acid generating copper sulfide minerals from the acid generation potential.

Chart 1. Acid Generation Potential of Ore using non-sulfate sulfur to calculate AP.

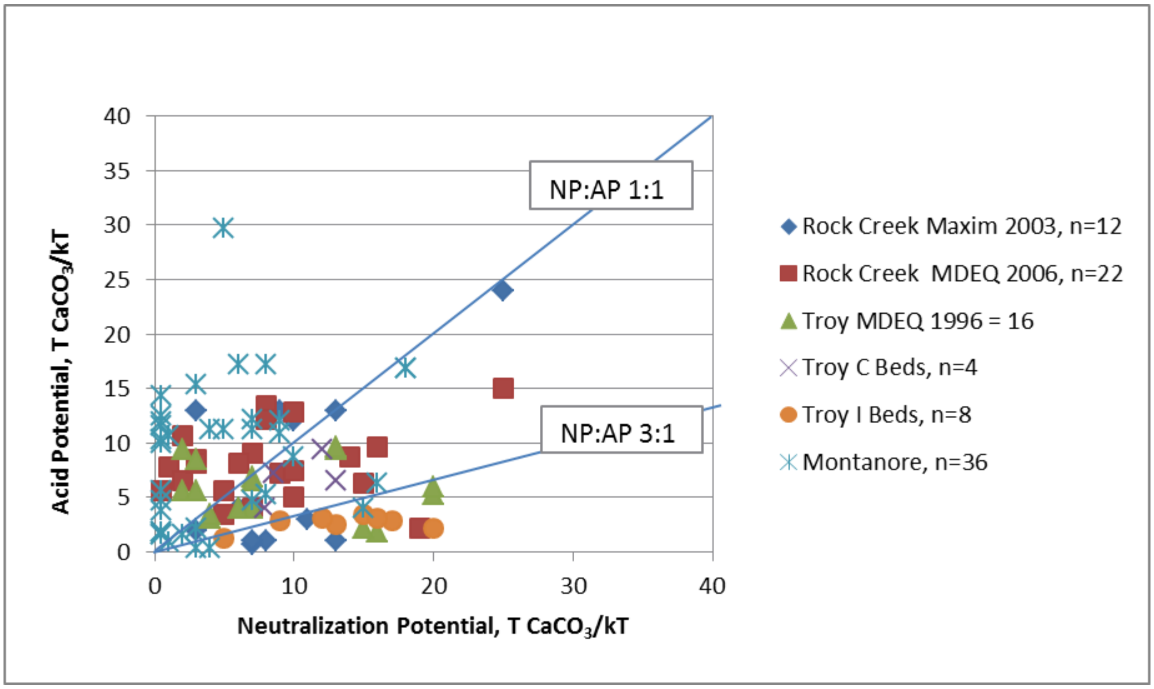
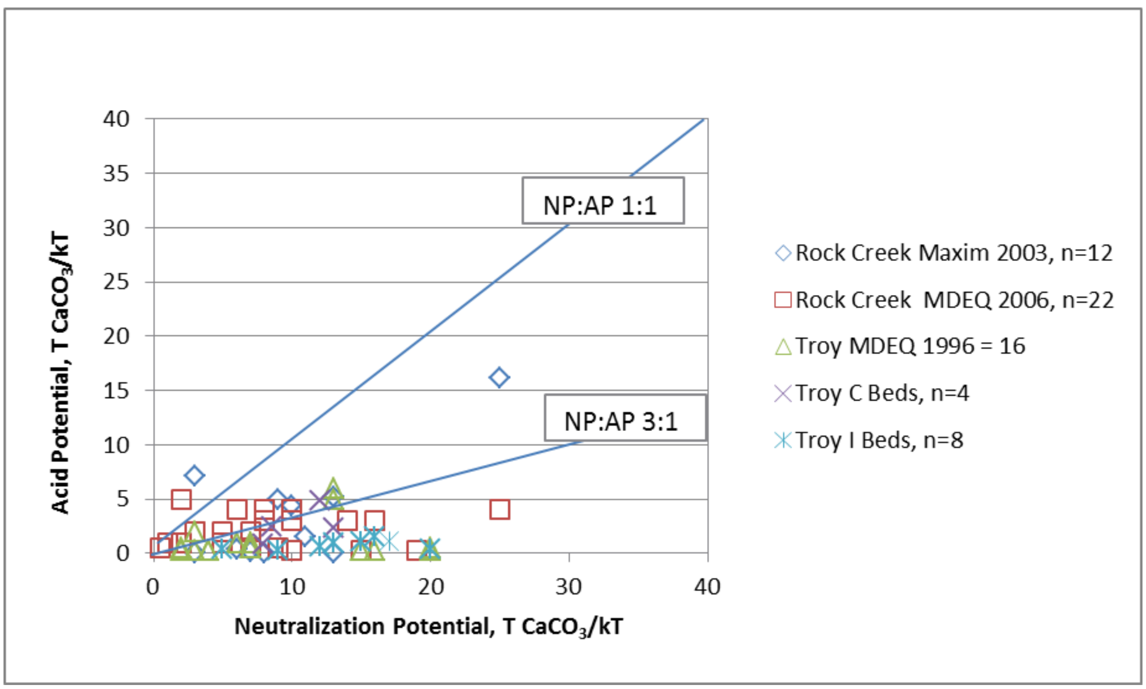


Chart 2. Acid Generation Potential of Ore using non-sulfate sulfur adjusted to remove copper sulfide from calculated AP.



Note: Montanore acid base accounting data did not include sulfur data and therefore, adjustment to remove copper sulfide data could not be performed on the Montanore dataset.

Additional important data characterizing sulfide content are the thousands of ore intercepts that were assayed for copper and silver, operationally at the Troy Mine and for validation of the Montanore, Rock Creek, and Troy claims. Given the very consistent copper sulfide mineralogy of the ore, it is possible to calculate the range of sulfide content based on the assumption that the copper to sulfur ratio of 2:1 for chalcocite represents the ore-grade chalcocite mineralization. Maxim compiled assay data for 213 samples of ore from Forest Service claim validation studies for the Montanore Project, along with 347 samples from the Rock Creek claims, and 282 samples from the Troy claims, as shown in Chart 3 (Maxim Technologies 2003). Very few samples have a calculated sulfide concentration more than 0.4 percent in any one of the deposits, and the average sulfide concentration is less than 0.2 percent in all of the deposits. This distribution agrees with the results reported by the DEQ (1996). Also, 88 percent, 91 percent, and 89 percent of samples (for the Troy, Montanore, and Rock Creek, respectively) have total sulfide concentrations less than 0.3 percent, which is a commonly accepted cutoff value below which potential acidification is typically not of concern (Jambor *et al.* 2000, Price *et al.* 1997). In other words, although concentrations above this commonly accepted threshold of 0.3 percent do occur, they represent a consistently small fraction of the samples from both the Troy and Rock Creek-Montanore deposits.

Acid Generation Rates. The rate of potential acid generation from the Montanore sub-deposit was tested for an ore composite in a standard humidity cell test (Schafer and Associates 1992). This ore composite, which had an uncertain acid generating potential with an ABP of -14.5 T $CaCO_3$/kT, showed a low amount of oxidation with a final pH of 7 and low concentrations of sulfate and acidity. In the composite leachate analyzed in week 6, a low copper concentration was detected; both copper and manganese were detected in week 12. Results of this analysis support the conclusion that Montanore ore would not be acid-generating but may release small amounts of trace elements at a near-neutral pH.

The rate of potential acid generation for the proposed Rock Creek Project was also tested for an ore composite in a standard humidity cell test (Schafer and Associates 1997). The sample, which had an uncertain static acid generating potential with an ABP of 4 T $CaCO_3$/kT, showed a low amount of oxidation with a final pH of 6.83 and low concentrations of sulfate and acidity. In the composite leachate analyzed in week 20, only manganese was detected at 0.05 mg/L. All other metals, including antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, selenium, silver, thallium, and zinc, were below detection. The humidity cell data for two samples from the Rock Creek-Montanore deposit therefore agree with empirical water quality data from ore exposed in the Troy Mine, which show no ARD, near-neutral pH, and low concentrations of copper and manganese.

Metal Content. Whole rock analyses were completed for 12 Rock Creek ore samples (Maxim Technologies 2003), with copper, lead, silver and zinc concentrations reported for an additional 22 ore samples from Rock Creek (Table 91). Twelve whole rock analyses were also completed for samples from the C-bed (n=4) and I-bed (n=8) ore zones in the lower Revett that are mined at Troy, together with another 16 copper, lead, silver and zinc analyses. These data indicate that ore from these deposits is enriched in copper, silver, and lead, with some variation in antimony, arsenic, cadmium, nickel, and zinc, consistent with the style of mineralization. One additional whole rock analysis was conducted for ore from the Montanore sub-deposit (Enviromin 2013b), which generally agreed with the results for Troy and Rock Creek as shown in Table 91.

Table 91. Average Whole Rock Geochemistry for Rock Creek/Montanore Subdeposits and Troy, for Ore, Tailings, and Waste Rock.

Whole Rock Type	Ore										Tailings		Tailings Paste		Waste Rock							
Project	Rock Creek				Troy				Montanore		Rock Creek		Troy		Rock Creek				Troy		Montanore	
Source	Maxim		DEQ RC		Enviromin		ASARCO		NMC		Maxim and Balla		Golder		Maxim various lithotypes		DEQ various lithotypes		Enviromin Revett Fm		MMI Revett Fm	
Method	MEMS 61		EPA 3050A		MEMS 61		EPA 3050A		alkali fusion		MEMS 61		6010A/ 7131/7041		MEMS 41		EPA 3050A		MEMS 61		alkali fusion	
Metal	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n	Ave.	n
Aluminum	4.2	12	No data		3.61	12	No data		3.53	1	3.14*	30	736	2	0.8	14	No data		5.48	2	4.23	3
Antimony	0.9	12	No data		19	12	No data		2.5	1	73	31	0.4	2	0.2	14	No data		1.3	2	<5	2
Arsenic	1.9	12	No data		11	12	No data		7	1	200	31	2.7	2	1.8	14	No data		1.7	2	8	3
Barium	574	12	No data		672	12	No data		520	1	442	31	1,830	2	91.8	14	No data		750	2	633	3
Cadmium	0.1	12	No data		0.05	12	No data		2.5	1	0.2	31	0.02	2	0.07	14	No data		0.07	2	<5	3
Copper	4,760	12	7,600	22	3,330	12	6,500	16	7,880	1	348	31	819	2	38	14	21	10	126	2	40	3
Lead	23*	11	19*	21	32	12	17	16	50	1	82	31	44.4	2	61	14	93	10	98.0	2	120	3
Manganese	351	12	No data		437	12	No data		310	1	5,380†	31	226	2	276	14	No data		650	2	452	3
Nickel	5	12	No data		4.0	12	No data		36	1	21	31	No data	0	14	14	No data		10	2	40	3
Silver	44	12	23	22	41.3	12	26	16	66	1	9.8	31	285	2	0.1	14	<5	10	0.99	2	8.3	3
Zinc	29	12	21	22	30	12	7	16	22	1	54	31	3.8	2	47	14	39	10	91	2	77	2

n = number of samples; ave.= average; < = all values used in average calculation are below detection limit.
All units are mg/kg, except for aluminum, which is percent for all data except Troy Tailings Paste data.
*Single outlier concentration of 9,040 ppm removed from the Maxim lead average; an outlier concentration of 9,200 ppm removed from the DEQ lead average; an outlier concentration of 421 ppm removed from the Maxim aluminum average.
†Sixteen values above range of method detection (>10,000 ppm).
Detection limit used for samples with concentrations above or below the detection limit when calculating averages.
Analytical Method: MEMS 41—ALS Chemex aqua regia digestion; MEMS 61—ALS chemex 4-acid digestion with ICP; EPA 3050—Total metal content extraction, comparable to MEMS-41.
Source: Balla 2002; DEQ 1996; Enviromin 2009, 2012; Geomatrix 2007a; Golder 1996 (summary of two non-cement samples [RC0A and RC0B]); Maxim 2003; Mines Management 2005.

Table 92. Metal Mobility Data for Revett Cu-Ag Deposits, for Ore, Tailings, and Waste Rock Compared to Montana Water Quality Standards.

Metal	Ore		Tailings		Waste Rock			Montana Water Quality Standards†	
Method—>	SPLP Ave.	SPLP Ave.	SPLP	SPLP	SPLP	SPLP	SPLP Ave.		
Project—>	Troy	Troy	Rock Creek	Troy	Troy	Troy	Rock Creek		
Material—>	C-bed ore	I-bed ore	Tailings	Tailings paste	C-bed waste	I bed waste	Revett, St. Regis and Prichard	Groundwater	Surface Water
# of samples—>	4	8	1	1*	1	1	14		
Aluminum	**2.91**	**2.56**	No Data	No Data	**4.2**	**3.1**	No Data	none	0.087
Antimony	**0.008**	0.0045	<0.003	<0.001	<0.003	<0.003	<1	0.006	0.0056
Arsenic	0.006	<0.003	<0.001	0.005	<0.003	<0.003	<1	0.01	0.01
Barium	0.080	0.11	No Data	0.362	0.183	0.117	<3	1	1
Cadmium	<0.00008	0.00009	**0.0004**	<0.0001	<0.00008	<0.00008	<0.05	0.005	0.000097
Chromium	0.009	0.004	No Data	<0.002	0.019	0.003	<0.3	0.1	0.1
Copper	**0.257**	**0.16**	**0.134**	**0.09**	**0.026**	0.01	<0.05	1.3	0.00285
Fluoride	0.3	<0.1	No Data	No Data	0.2	<0.1	No Data	4	4
Iron	**1.1**	1.0	No Data	0.202	**1.84**	**1.63**	0.2	none	1
Lead	**0.025**	**0.005**	**0.025**	0.005	**0.0028**	**0.0253**	<0.3	0.015	0.000545
Manganese	0.080	0.082	0.070	<0.011	0.074	0.104	No Data	none	none
Mercury	<0.02	0.00002	<0.0006	<0.0002	<0.02	<0.00001	<0.001	0.002	0.00005
Nickel	<0.01	<0.01	No Data	No Data	<0.01	<0.01	<0.3	0.1	0.0161
Phosphorus	0.03	0.009	No Data	No Data	0.04	<0.006	No Data	none	none
Selenium	<0.001	<0.001	<0.001	<0.005 J	<0.001	<0.001	<1	0.05	0.005
Silver	**0.0060**	**0.003**	<0.003	<0.003	<0.0005	<0.0005	<0.3	0.1	0.000374
Thallium	<0.0004	<0.0006	No Data	No Data	<0.0002	<0.0005	<1	0.002	0.00024
Uranium	0.00037	0.00033	No Data	No Data	0.00025	0.00022	No Data	0.03	0.03
Zinc	<0.1	<0.1	0.02	<0.014 J	<0.1	<0.1	<0.5	2	0.037

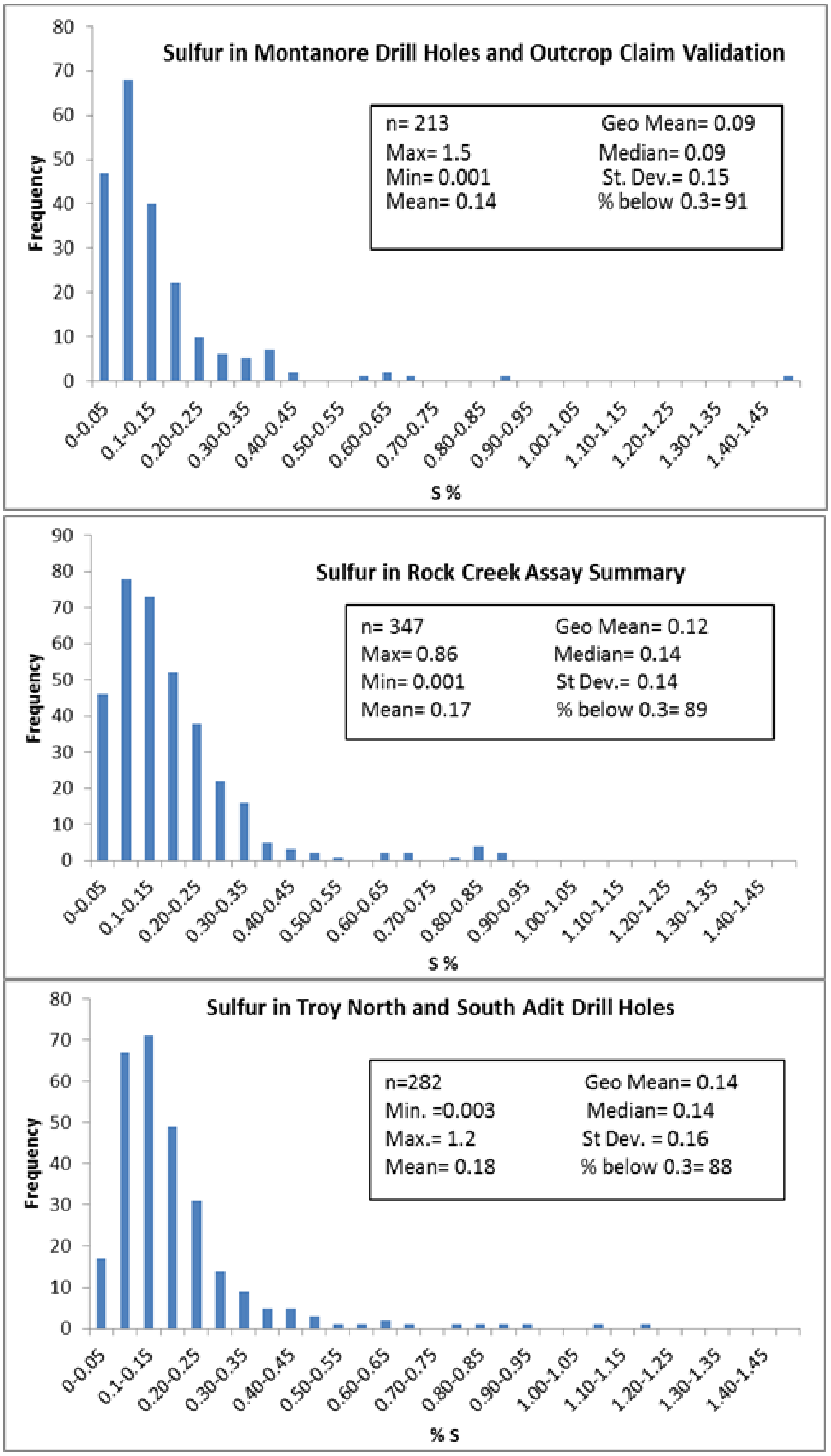
See next page for footnotes

Table 92. Metal Mobility Data for Revett Cu-Ag Deposits, for Ore, Tailings, and Waste Rock Compared to Montana Water Quality Standards. (cont'd)

Metal	Ore	Tailings	Waste Rock				MT Water Quality Standards†	
Method—>	TCLP	TCLP	TCLP Ave.	TCLP	TCLP	TCLP		
Project—>	Montanore	Troy	Rock Creek	Montanore	Montanore	Montanore		
Material—>	Raw Ore	Tailings Paste	Revett	Revett Footwall	Revett Hanging Wall	Lower Revett Waste Zone	Groundwater	Surface Water
# of samples—>	1	2*	14	1	1	1		
Aluminum	No Data	No Data	No Data	No Data	No Data	No Data	none	0.087
Antimony	No Data	0.002	<1	No Data	No Data	No Data	0.006	0.0056
Arsenic	<0.004	<0.002	<1	<0.004	<0.004	<0.004	0.01	0.01
Barium	0.1	**3.33**	<3	0.4	0.3	<0.1	1	1
Cadmium	<0.01	**0.0001**	<0.05	<0.01	<0.01	<0.01	0.005	0.000097
Chromium	<0.02	0.003	<0.3	<0.02	<0.02	<0.02	0.1	0.1
Copper	**1.4**	**20.2**	**0.08**	**0.04**	**0.06**	**0.05**	1.3	0.00285
Fluoride	No Data	No Data	No Data	No Data	No Data	No Data	4	4
Iron	No Data	**5.00**	**6.9**	No Data	No Data	No Data	none	1
Lead	**0.26**	**0.521**	**0.37**	**0.05**	**0.09**	**0.64**	0.015	0.000545
Manganese	No Data	4.91	No Data	No Data	No Data	No Data	none	none
Mercury	<0.01	<0.0002	No Data	<0.01	<0.01	<0.01	0.002	0.00005
Nickel	No Data	No Data	<0.3	No Data	No Data	No Data	0.1	0.0161
Phosphorus	No Data	No Data	No Data	No Data	No Data	No Data	none	none
Selenium	<0.025	<0.005	<1	<0.025	<0.025	<0.025	0.05	0.005
Silver	<0.01	<0.003	<0.3	<0.01	<0.01	<0.01	0.1	0.000374
Thallium	No Data	No Data	<1	No Data	No Data	No Data	0.002	0.00024
Uranium	No Data	No Data	No Data	No Data	No Data	No Data	0.03	0.03
Zinc	No Data	**0.125**	<0.5	No Data	No Data	No Data	2	0.037

All units are mg/L
Ave.=average; < = all values used in average calculation are below detection limit; J = estimated value
Detection limit used for samples with concentrations below the detection limit when calculating averages
†Surface water values are the lower of the human health standards and acute and chronic aquatic life standards
*summary of non-cement samples (RC0A and RC0B)
Bolded values are those detected concentrations that exceeded a Montana water quality standard. For potential releases from ore, tailings, or waste rock, standards apply to the receiving water at the point of discharge, or, if authorized by the DEQ, at the edge of a mixing zone.

Chart 3. Distribution of Sulfide Calculated Based on Copper Assays for Montanore, Rock Creek, and Troy Deposits.



Source: Enviromin 2013b.

Metal Release Potential. Two additional sources of metal mobility data for ore are from the proposed Montanore Project. The sample tested in a humidity cell (described above) indicated copper concentrations between 0.02 and 0.04 mg/L and manganese concentrations of 0.03 mg/L (Schafer and Associates 1992). In another test of Revett ore from the Montanore deposit using the EPA Method 1311 (Toxicity Characteristic Leaching Procedure, TCLP) analysis, copper and lead were detected in the leachate at concentrations greater than the groundwater standard. The TCLP analysis is a conservative test designed more for landfill waste classification than for prediction of meteoric water leachate from mined rock, which is expected to yield higher metal concentrations due to the acidic (fixed pH 5) conditions created in the test. Because of differences in acidity, reactive surface area, and different rock:water ratios in the TCLP and SPLP methods, these results are better suited to identify the list of metals that may be mobile than they are to providing quantitative predictions of future field chemistry.

Composites of ore from the Troy C-bed and I-bed zones were also tested in kinetic humidity cell tests (Enviromin 2010, 2012). Both tests showed no potential for acid production, with final pH values of 7.88 (C-bed) and 7.92 (I-bed), low sulfate, and available alkalinity throughout the tests. The four composited C-bed ore samples have a range in total sulfur concentration from 0.15 to 0.34 weight percent with a positive average ABP of 3 T $CaCO_3$/kT and an average NP/AP ratio of 1.6 The eight composited I-bed samples have a range in total S content from 0.06 to 0.12 weight percent, with an ABP of 10 T $CaCO_3$/kT and an average NP/AP ratio of 5. In spite of the lack of acid generation potential, both composites of ore released concentrations of antimony and copper above aquatic standards. Antimony exceeded the relevant groundwater standard as well. The C-bed also released cadmium, lead, and silver at concentrations that exceeded aquatic standards in some weeks, but that did not exceed groundwater standards. The trends in metal concentrations for the C-bed and I-bed humidity cell tests are shown in Chart 4 through Chart 7.

In-Situ Water Quality Data. None of the Revett ore zone has been exposed in the Libby Adit at Montanore, but *in situ* water monitoring in the Troy workings provides a useful measure of potential trace metal release from ore and waste rock exposed together in underground workings. Comparison of dissolved and total metal concentrations in water from the Troy workings (where ore was exposed underground) shows that low concentrations of some dissolved metals (copper, manganese, lead, and silver) are detected in mine water, but the majority of detected total metals (aluminum, arsenic, barium, copper, lead, manganese, silver, and zinc) are associated with suspended sediment and thus detected only in total recoverable analyses (Enviromin 2013b).

At Troy, the use of explosives underground has influenced nutrient concentrations in mine water, with detectable nitrate in all samples and measurable ammonia present in eighty-seven percent of monitoring samples (Table 93). As measured in the adit pipe and ditch samples collected during restart of mining activities (Service Adit P and Service Adit D), nitrate plus nitrite ranged from 0.70 to 20 mg/L, while ammonia was detected at concentrations ranging from 0.070 to 10.7 mg/L.

Ore Summary. Collectively, the geochemical data characterizing ore from the Montanore subdeposit as well as the Rock Creek subdeposit and Troy Mine indicate uncertain potential for acid generation based on static test results, which is not supported by mineralogy, kinetic leach testing, or *in situ* monitoring at Troy Mine or the Libby Adit. The presence of silica encapsulated, nonacid-producing copper sulfide minerals in the ore zone, and the neutral to alkaline pH conditions observed in leach tests and water monitoring data indicate a very low risk of acid production in spite of uncertain static test results. Metal mobility tests from Troy, together with *in situ* monitoring, indicate potential for a release of low levels of aluminum, antimony, copper, iron, lead, manganese, silver, and thallium from the ore zone where it would be exposed underground, in spite of the negligible risk of acid production. Remaining uncertainties, including specifics of metal mobility at relevant detection limits for samples of ore from Montanore, are addressed in the Geochemistry Sampling and Analysis Plan for the evaluation adit program in Appendix C.

Table 93. Nutrient Concentrations Measured in Troy Mine Water.

Troy Service Adit Pipe and Ditch	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)
# of samples	16	16
Detections	14	16
Minimum Detected	0.070	0.70
Maximum Detected	10.7	20
Representative Concentration	<1.6	3.1

Additional data discussion provided in Appendix K-7.
Source: Hydrometrics 2013.

Chart 4. Metal Concentrations in Humidity Cell Effluent from the Troy C-bed Ore Zone.

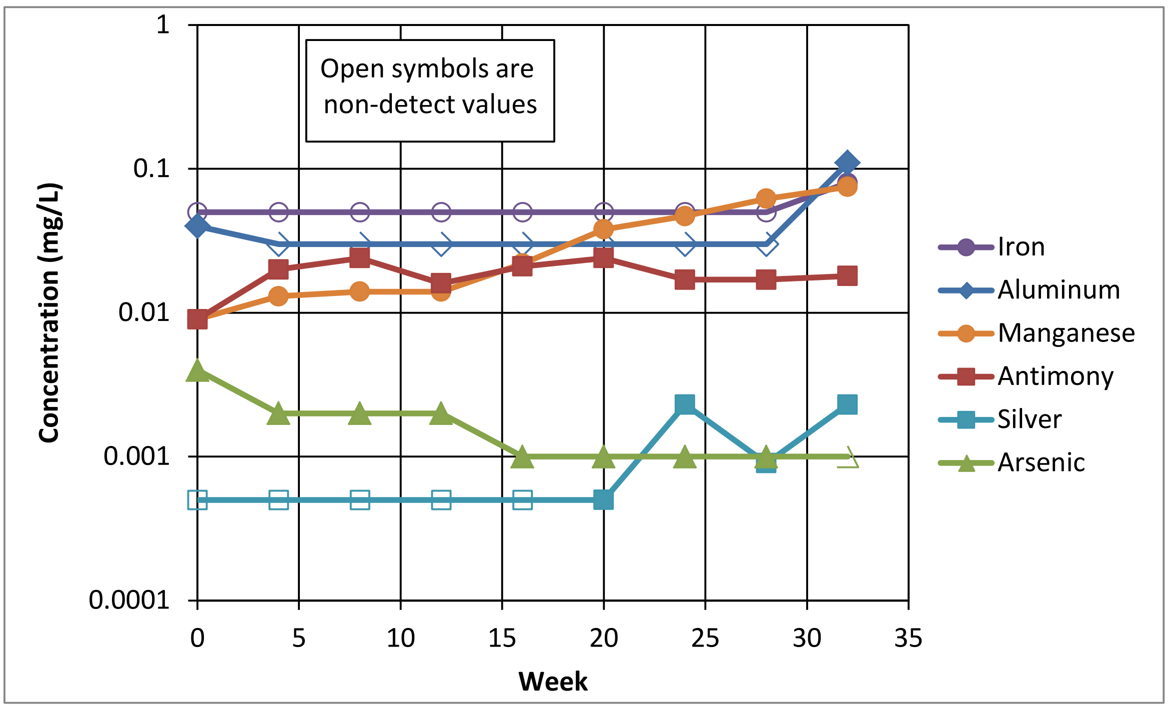


Chart 5. Metal Concentrations in Humidity Cell Effluent from the Troy C-bed Ore Zone.

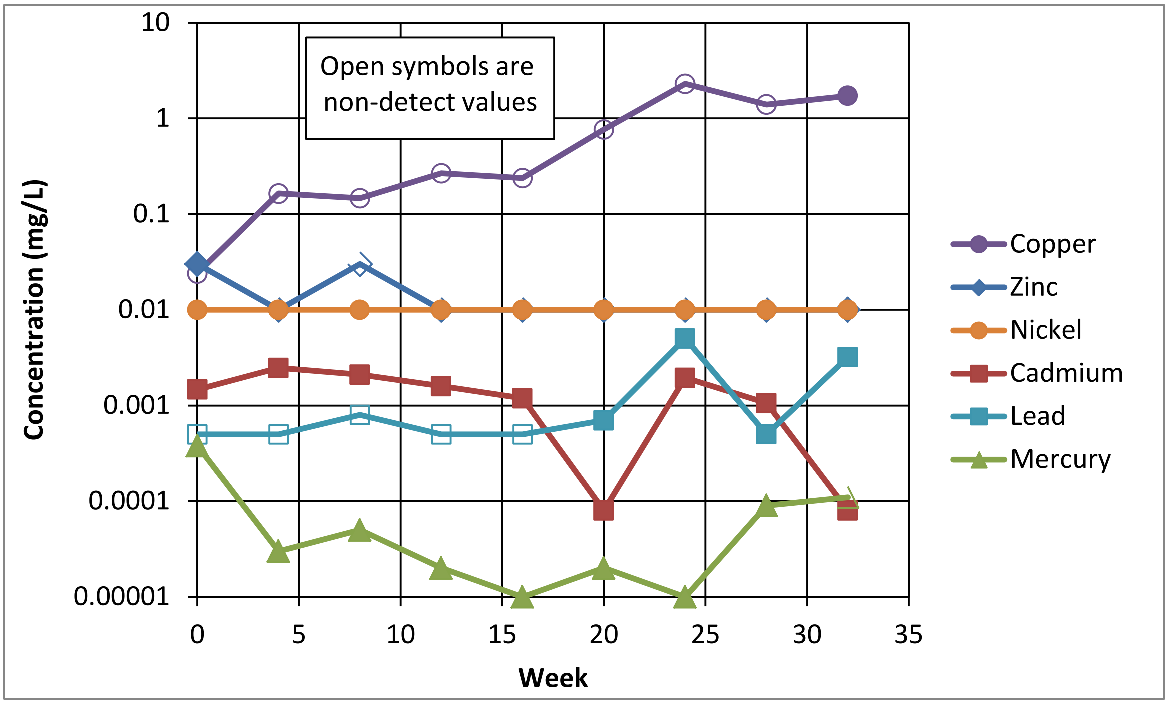


Chart 6. Metal Concentrations in Humidity Cell Effluent from the Troy I-bed Ore Zone.

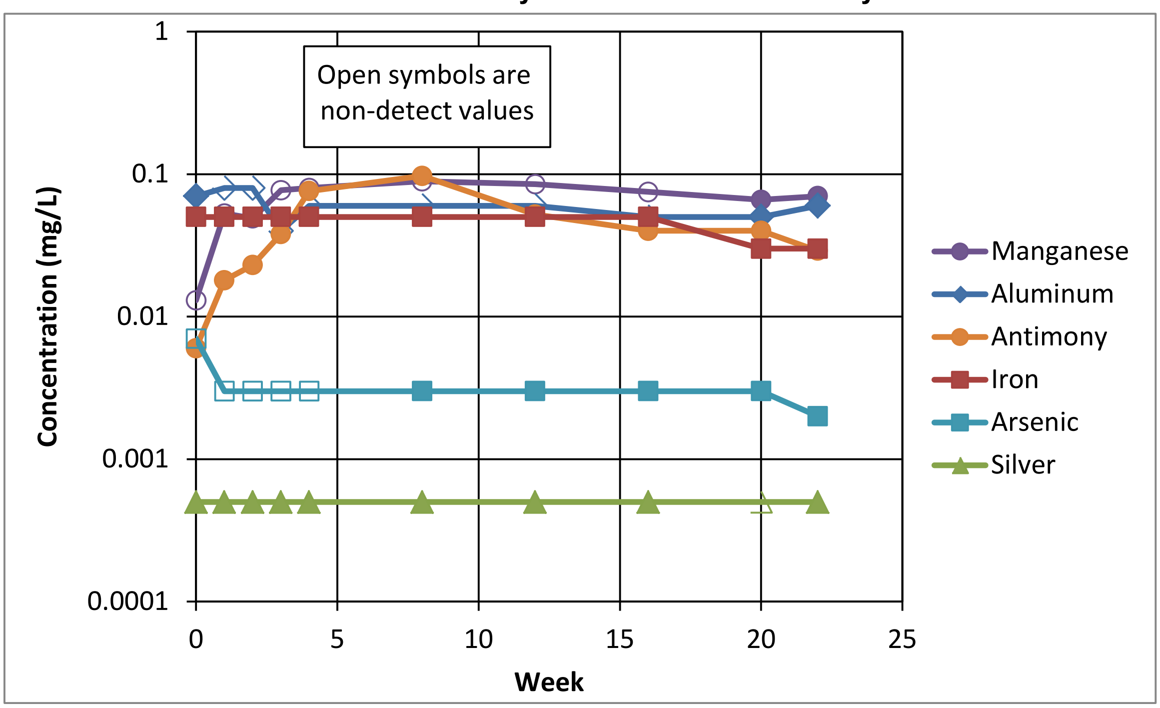
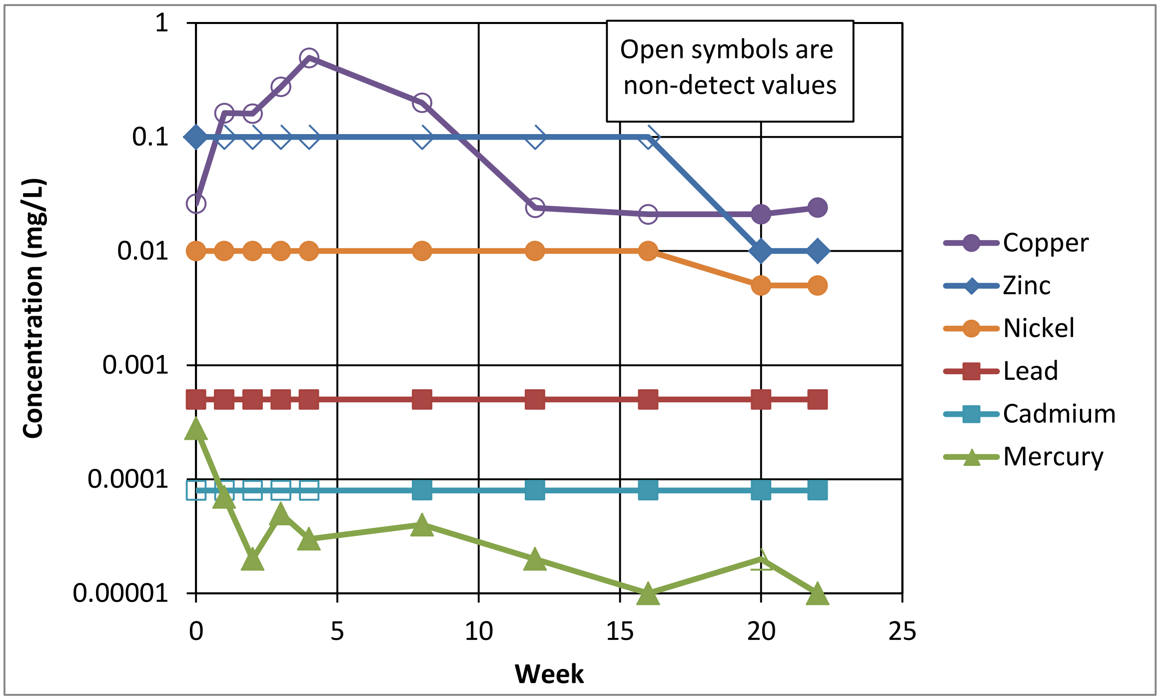


Chart 7. Metal Concentrations in Humidity Cell Effluent from the Troy I-bed Ore Zone.



3.9.4.3.2 Mine Area – Tailings

Tailings chemistry is dominated more by the metallurgical process of sulfide and metal removal than by minor differences in the sulfide mineral content of ore, particularly within the very narrow range of sulfide content observed in Revett-style deposits. The process MMC proposes to use at the Montanore mill would involve conventional flotation of rock ground to a range of particle sizes comparable to that in use at the Troy mill and proposed for the Rock Creek Project (MMI 2005a, MMC 2008). The ore would be finely ground, so that surface area available for interaction between the ground ore and water is greater than in the intact quartzite matrix, to optimize sulfide recovery during flotation.

Acid Base Potential. Total sulfur measured in 15 samples from Rock Creek averaged 0.02 weight percent sulfur. A total sulfur value of 0.01 weight percent was reported for a tailings composite tested in a humidity cell test for the Montanore Project, which had an ABP of 8T $CaCO_3$/kT with a NP/AP ratio of 25.8 (Schafer and Associates 1992). Values reported by Golder (1996) for Troy mill tailings had a lower average ABP value of 1.5 T $CaCO_3$/kT. Both the tailings effluent for the Montanore ore sample and water from the Troy tailings pond show neutral pH values and comparable (generally low) concentrations of major cations and anions, with excess alkalinity (ERO Resources Corp. 2011c). These results agree with those obtained during humidity cell tests, which show near-neutral pH and low level metal release. Metal release humidity cell test data for tailings composite samples from Rock Creek are shown in Chart 8 and Chart 9.

The measured total sulfur values reported for tailings in Table 89 range from 0.01 to 0.08 percent. Additional testing of tailings generated through metallurgical testing of ore from archived Rock Creek core indicated copper recovery ranging from 75 to 99 percent with an average of 91 percent and sulfide recovery ranging from 80 to 99.2 percent, with an average of 94 percent

(Maxim Technologies 2003). Whole rock analysis of sulfur in the Rock Creek tailings subsamples was at or below detection at 0.01 percent in 13 of 14 samples; the 14th sample had a sulfur content of 0.02 percent. Although sulfide recovery was not measured for the Montanore ore metallurgical test, the copper recovery reported for the Montanore ore ranged from 86 to 97.5 percent and averaged 93 percent, implying good agreement with the results reported for Rock Creek. Removal of 90 percent of the sulfur shown for the Montanore ore in Chart 3 (Table 89) suggests that less than 0.03 percent sulfur (average) would remain in the tailings. The total sulfide content of rock in the ore zone ranges from below detection to 1.4 percent with the majority of samples below 0.4 percent. Removal of 90 percent of the sulfide during processing yields a limited range of sulfide values between 0.002 and 0.15 percent, values which would have essentially no acid generation potential (Jambor *et al*. 2000). Similarly, the copper and silver content of the ore also would be reduced to one-tenth of the original concentrations, similar to the reduction in whole rock concentrations described for Rock Creek and Troy in Table 89. The overall risk of ARD formation by tailings from Montanore is therefore estimated to be low (Klohn Crippen 2005).

Although the NP/AP ratios for the Troy tailings ranged from <0.2 to 3.33, with an average value of 2.0, which suggests potential for ARD formation, the sulfur concentration measured in tailings was less than 0.1 percent. Such a low concentration of sulfide is unlikely to generate acid. The reported ratio values therefore reflect the sensitivity of ratios calculated for low NP and AP values, which can vary when values in the numerator or denominator are small, and do not necessarily indicate acid generation potential. Further, water from the Troy tailings impoundment is not acidic after nearly 20 years of monitoring (ERO Resources Corp. 2011c).

Acid Generation Rates. The similar mineralogy and range of silver and copper assay values for the Rock Creek-Montanore and Troy deposits, as well as the use of the same flotation method for all three mills, implies that tailings chemistry would be comparably alkaline at the three mines. This is confirmed by results of humidity cell tests of ore (prior to removal of sulfide by flotation) from the Montanore and Rock Creek ore, which were not acid generating and released little to no trace metal (Schafer and Associates 1992, 1997).

Similar results were observed in a humidity cell test of bulk tailings that was produced by Hazen in a 2003 metallurgical test of Rock Creek ore (Table 89). This composite is the same rock that was tested in the SPLP analysis described for Rock Creek tailings in Table 92, which had a total Sulfur content of 0.01 weight percent with an ABP of 9 T $CaCO_3$/kT and a NP/AP ratio of more than 30. The humidity cell test was conducted over a 96-week period with effluent pH being alkaline during the duration of the test, an oxidizing redox potential, minimal iron, and sulfate release, and acidity not detected in any weekly extract. During the first 2 weeks of the test, cadmium, copper, lead, manganese, mercury, and silver were detected above their respective surface water standard. Between weeks 3 and 20, copper, lead, and manganese were detected above their respective surface water standard. At week 24, copper and manganese were detected above their respective surface water standard and arsenic was detected above both the groundwater and surface water standard. Based on the arsenic concentration of 0.013 mg/L detected at week 24, the test was resumed after having been stopped at week 20. Arsenic varied cyclically, with modest increases to concentrations below the surface water and groundwater standard of 0.010 mg/L followed by drops to concentrations at or near detection (0.001 mg/L). Following week 52, the arsenic concentration stabilized between 0.001 and 0.003 mg/L up to the termination of the test at week 96. Between week 24 and 46, except for arsenic, no metals were analyzed in the effluent. From week 46 to week 96, aluminum was the only metal detected above its respective surface water standard. Enviromin (2013a) details the Rock Creek tailings humidity cell test.

To better understand the arsenic detections, a mineral liberation analysis using electron microscopy/energy dispersive spectroscopy of non-weathered Rock Creek tailings and the weathered tailings sample from week 53 of the humidity cell test (Enviromin 2013a). The arsenic-bearing minerals arsenopyrite, tennantite, and scorodite were identified in the non-weathered samples at concentrations less than 0.01 weight percent but were not found in the weathered sample. Although the arsenic-bearing minerals are relatively low in abundance, they are sufficient enough to produce measureable changes in effluent arsenic concentrations.

Metal Content. Tailings have significantly reduced copper, silver, and sulfide concentrations (Table 89), but otherwise comparable to that reported for ore. Multi-element analyses of the tailings were reported in detail by Maxim Technologies (2003) for Rock Creek.

Metal Release Potential. No metal mobility tests of Montanore tailings were conducted. SPLP testing of tailings from Troy indicates that tailings seepage would not yield highly elevated metal-enriched leachate, although the metals arsenic, barium, copper, iron, and lead were detected at low concentrations (Golder 1996; Table 92). TCLP analyses of Troy tailings from the Golder study of paste technology indicated potential for higher concentrations of barium, copper, and lead to exceed groundwater standards, and for zinc to exceed aquatic standards, presumably due to the more strongly acidic character of the test. Analysis of tailings liquids obtained in bench scale flotation tests of Rock Creek ore indicated a similar suite of detectable total recoverable aluminum, cadmium, copper, iron, lead, manganese, and silver (ASARCO 1992).

In situ Monitoring. Nutrient loading has been associated historically with the tailings impoundment at Troy. In the Troy decant pond, nitrate plus nitrite and ammonia were detected in the majority of samples collected. Following the restart of mining activities in the late 2005, nitrate plus nitrite concentrations ranged from 5.7 to 37.5 mg/L and ammonia concentrations ranged from 0.39 to 10.4 mg/L (Table 94).

Summary. A comparison of the various laboratory test results with the chemistry of water measured in the Troy tailings decant pond supports the conclusion that any water affected by tailings during operations would have neutral pH, with low but detectable concentrations of metals. The suite of metals detected in metal mobility and kinetic humidity cell leach tests of tailings agree well with those observed in the Troy impoundment.

The potential for changes in metal concentration, as observed in tailings water and monitored groundwater below the Troy impoundment, would be the same for the Montanore tailings impoundment. MMC would collect tailings seepage using pumpback wells, returning it to the impoundment followed by treatment, during operations and at closure, until it met BHES Order limits or applicable nondegradation criteria in receiving waters.

As additional ore samples became available for metallurgical testing during final exploration and early operations, a more representative tailings sample would be tested. Additional testing of acid generation and metal release potential would be required to supplement available test data and long-term monitoring data from the Troy tailings impoundment. In particular, future analysis would address any preferential concentration of reactive minerals (such as pyrite) due to use of a cyclone to separate coarse and fine fractions. This would allow any necessary modification of planned treatment for tailings decant water before the start of processing. Any analyses based on pilot scale metallurgical tests would be more consistent than is expected under processing plant conditions, where variations in efficiency and recovery are not only anticipated but documented daily. Such operational monitoring can be used to check for changes in sulfide content of tailings as well.

Table 94. Troy Decant Pond Water Quality 2006-2010.

Parameter	N	n-BDL	Minimum Detected	Maximum Detected	Representative Concentration
pH, s.u.	17	0	7.1	8	7.8
Ammonia, mg/L	18	0	0.39	10.4	4.4
Nitrate/Nitrite, mg/L	17	0	5.71	37.5	13
Aluminum, mg/L	6	4	0.12	0.18	<0.13
Antimony, mg/L	8	0	0.0080	0.062	0.023
Arsenic, mg/L	8	4	0.0013	0.0020	<0.0017
Cadmium, mg/L	7	4	0.00091	0.00126	<0.00097
Copper, mg/L	8	0	0.006	0.043	0.026
Iron, mg/L	8	0	0.010	0.38	0.050
Lead, mg/L	7	5	0.0026	0.010	<0.0030
Manganese, mg/L	8	0	0.101	0.791	0.51
Silver, mg/L	8	8	-	-	<0.0018
Zinc, mg/L	8	6	0.006	0.02	<0.010

n = Number of samples; n-BDL = Number of samples with concentrations below the detection limit; s.u. = standard units; mg/L = milligrams per liter.
< = one or more below detection values were included in the representative concentration determination
Metals data based on dissolved sample fraction.
Additional data discussion provided in Appendix K-7.
Source: Hydrometrics 2013.

Chart 8. Metal Concentrations, Rock Creek Tailings Composite Humidity Cell Test.

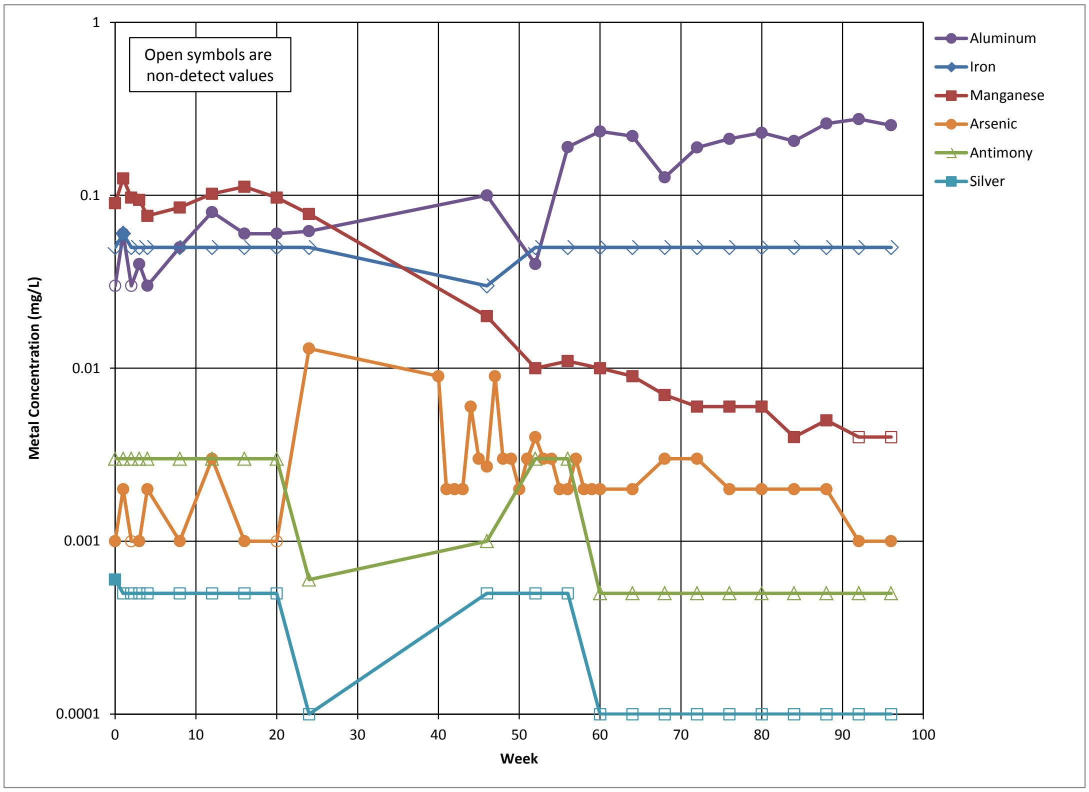
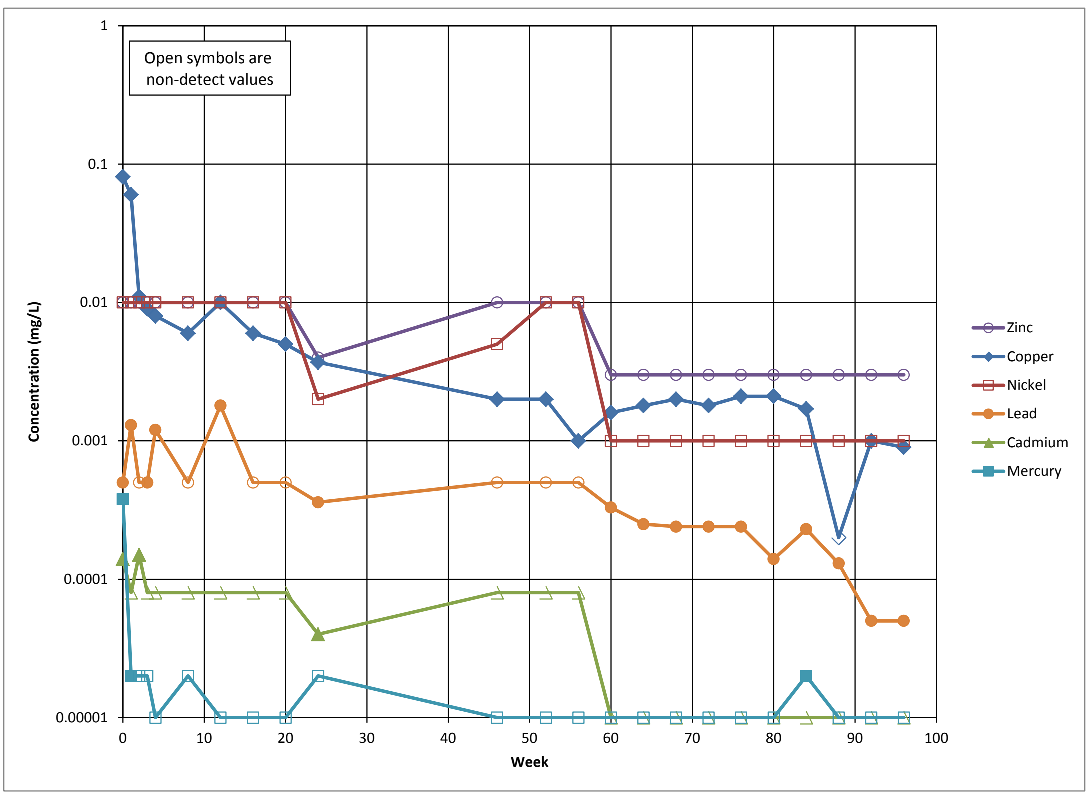


Chart 9. Metal Concentrations, Rock Creek Tailings Composite Humidity Cell Test.



3.9.4.3.3 Mine Area – Waste Rock in Surface Facilities and Backfill

According to MMC, 3.9 million tons (MT) of waste rock would be generated by the Montanore Project throughout mine life (Geomatrix 2007a; Table 21 in Chapter 2). MMC estimates that, in addition to the 0.42 MT of Prichard and Burke already on the pad at the Libby Adit, 0.54 MT of combined Revett waste rock would be produced during the Evaluation Phase. Another 2.25 MT of waste rock would be produced during construction, from the Prichard Formation (1.16 MT), the Burke Formation (0.15 MT), and the lower Revett Formations (0.93 MT). Another 0.68 MT of rock would be mined from the Revett Formation as waste rock during mining operations. About 75 percent of this rock would be used for tailings impoundment dam construction, with the remaining 25 percent used underground as backfill. Waste rock also would be used to construct portal patios and the plant site in Alternative 2. Waste rock used for construction would be stockpiled temporarily at LAD Area 1 in Alternative 2 (or within the footprint of the tailings impoundment under Alternatives 3 and 4) along with ore produced during development work. A detailed description of waste rock production, and MMC's proposed handling, placement, and management is provided in MMC's waste rock management plan (Geomatrix 2007a) and summarized in the Geochemistry Sampling and Analysis Plan provided in Appendix C.

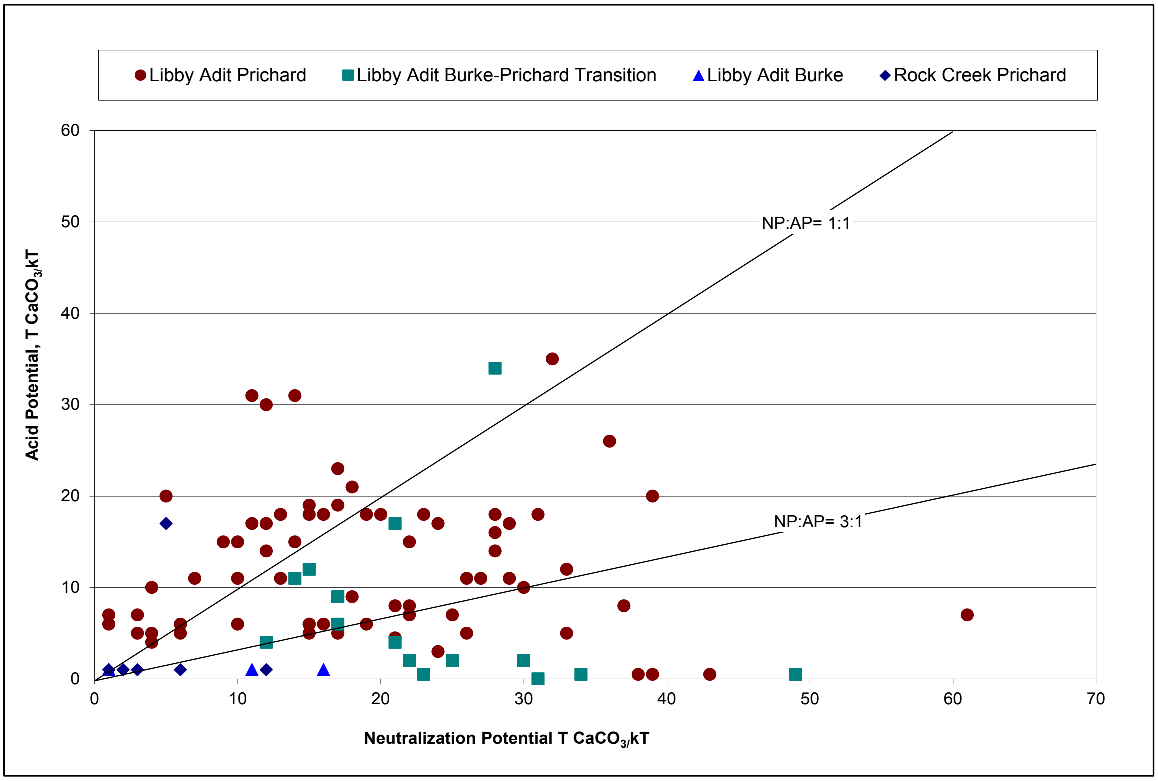
The first waste rock (0.5 MT) to be produced would come from the Burke and lower Revett Formations, where they would be exposed in the Libby Adit. Waste rock from the zones of the lower Revett Formation in these workings would presumably include rock from the chalcopyrite-calcite and pyrite-calcite altered waste zones, as well as the galena-calcite zone (barren lead zone), although the proposed mining method would minimize production in the barren lead zone operationally. The exact thickness of the altered waste zones has not yet been described and their relative tonnage is unknown. About 1.2 MT of additional waste rock would be mined from the Prichard, Burke, and Wallace Formations during construction of the Ramsey Adits, which may have variable mineralogy and chemistry between the Rock Creek-Montanore and Troy deposits. Six geologically distinct units would therefore be mined as waste rock, assuming three altered waste zones within the Revett Formation and one each from the remaining formations, which are listed above. An estimated 0.95 MT of lower Revett Formation waste rock would be generated during preproduction development. Much of this rock would be used for constructing portions of the tailings dam. Of this rock, 0.14 MT would be produced from the barren lead zone, which would be placed on a lined facility or as backfill. Remaining waste rock would remain underground in mined-out areas (Geomatrix 2007a).

Of the three Montana Revett-style mine projects, the majority of waste rock characterization was completed for the Montanore Project. Most data for the Prichard and Burke Formations are from data collected for the 1992 Montanore Project Final EIS from the Libby Adit (USDA Forest Service *et al.* 1992). A total of 155 acid base account analyses have been reported as shown in Table 90. A smaller number of waste rock samples (n=24) also were characterized for the Rock Creek sub-deposit, which included 10 samples of lower Revett, 2 samples of upper/middle Revett, and 6 samples each of the Prichard and St. Regis. Two composites of waste rock from the Revett Formation, one from the C-bed and one from the H-bed, have been characterized for acid generation potential, metal content, and SPLP at Troy (Enviromin 2009 and 2012).

Prichard and Burke Formations Waste Rock. ABP data comparing Prichard and Burke waste samples from Montanore Libby Adit are shown in Chart 10. The ABP reported for the Prichard at Rock Creek (n=6) is 2 T $CaCO_3$/kT with a NP/AP ratio of 4.0. Acid generation and neutralization potential data for 89 samples of Prichard and Burke formations waste rock from the Libby Adit at

Montanore (Chart 6) suggest these waste rock lithologies have variable potential to generate acid and release trace elements at a near-neutral pH. The Prichard Formation ABP varies from -20 to 54 T $CaCO_3$/kT (NP:AP 0.1 to 43), with an average of 7 T $CaCO_3$/kT (NP/AP 3.7) for 70 samples. The Burke Formation (which in this summary includes the Burke-Prichard transition zone) has an ABP that varies from -6 to 49 T $CaCO_3$/kT (NP:AP 0 to 49), with an average ABP of 15 T $CaCO_3$/kT (average NP/AP equals 12) for 19 samples. The Burke and the Prichard at Rock Creek appear to have low potential for acid generation based on these data, while the more extensive sample population from the Prichard at Montanore indicates a range of acid generation potential, with the majority of samples having uncertain or potential to generate acid based on static tests. More detailed analysis of these data is provided in a geochemistry technical summary report (Enviromin 2013b).

Chart 10. Acid Generation Potential of Waste Rock, Libby Adit, Montanore.



Two humidity cell tests of Prichard Formation waste rock from the Montanore sub-deposit were reported by Schafer and Associates (1992) and are summarized by Geomatrix in Tables B-1, B-2, and B-3 (Geomatrix 2007a). One sample of Prichard Formation waste rock had a moderately low ABP value of -2 T $CaCO_3$/kT, while the second had a higher ABP of 18 T $CaCO_3$/kT. Although pH of effluent started at about pH 7 for both cells, final pH was 6.9 with low conductivity and sulfate concentrations for both cells. The humidity cell test with lower ABP produced more sulfate over the life of the test, along with higher acidity which exceeded alkalinity late in the week 20 of the 20-week test.

These kinetic test data, which do not indicate acid generation from the Prichard Formation, agree with the monitoring data from the Libby Adit, where sulfide oxidation does not appear to be occurring in the exposed portions of the Prichard and Burke Formations within the Libby Adit after 20 years of monitoring (ERO Resources Corp. 2011c). Sulfate concentrations reported in 1997, 1998, and 2007 were less than 23 mg/L, indicating that few reactive sulfides are oxidizing to form sulfate. The average pH in the Libby Adit water has remained consistently neutral. In 1993, the reported pH was 7.7, while in 1997 pH ranged from 6.6 to 7.9 and averaged 7.4. In 1998, pH ranged from 7 to 8.6 and averaged 7.6. Elevated nitrate concentrations and two low mercury concentrations in 1997 decreased to near background concentrations or were not detected in 1998. Together with the humidity cell data, these *in situ* data suggest that static tests may over-predict acid generation potential for the Prichard Formation.

Apart from the kinetic work, there are no metal mobility tests of waste rock samples from the Prichard and Burke Formations for the Montanore sub-deposit. Metal concentrations in humidity cell effluent for two tests of the Prichard Formation waste rock from Montanore showed low, but detectable concentrations of arsenic, iron, manganese, and zinc (Schafer and Associates, 1992). Occasional low concentrations of iron, manganese, and zinc were detected in Libby Adit water during 1997 and 1998 (ERO Resources Corp. 2011c). Low dissolved metal concentrations were also measured in Libby Adit water collected in 2007.

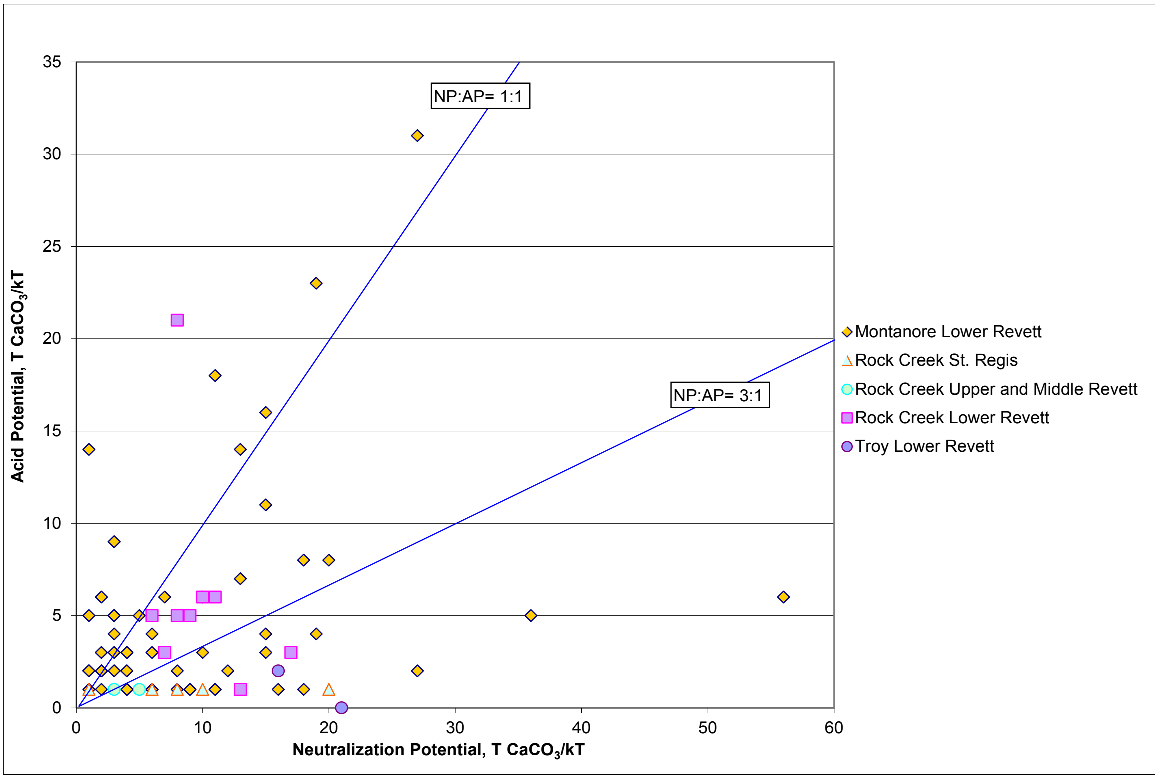
Prichard and Burke waste rock was stockpiled on the portal pad outside the Libby Adit, and MMC has monitored the quality of water collected in the sump at that location. Elevated concentrations of nitrate and ammonia were detected immediately following placement of this rock, and the concentrations dropped substantially since that time (Table 95). Metals were also detected in water collected from the waste rock sump include aluminum, antimony, arsenic, copper, lead, and manganese, a portion of which exceeded relevant surface water standards (ERO Resources Corp. 2011c).

Due to the moderate acid generation potential in some static tests of acid base potential, as well as the need for more complete analysis of metal release potential, the agencies would require additional sampling and analysis during the Evaluation and Construction Phases. This sampling and analysis would support kinetic testing of the Prichard to confirm previous results and updated metal mobility characterization of both the Prichard and Burke formations, as discussed in Appendix C. Samples of the silty carbonate-rich Wallace Formation, which has not been characterized in terms of acid generation or trace metal release potential, would be obtained for testing during adit construction.

Lower Revett Formation Waste Rock. Whole rock data for three representative samples from the lower Revett Formation waste rock and an average for three samples collected from the Rock Creek waste rock (analysis by previous unknown method) are summarized by Geomatrix (2007a). Whole rock data are presented for 14 additional samples of Revett Formation waste rock from the Rock Creek sub-deposit by Maxim Technologies (2003). These samples are variably enriched in copper, iron, lead, and zinc, depending upon style of alteration.

ABP data comparing Lower Revett waste samples from Montanore, Rock Creek, and Troy are shown in Chart 11. At Montanore, average acid base potential for waste rock in the lower Revett Formation ranges from 3 to 60 T $CaCO_3$/kT with NP/AP values ranging from 2.2 to 4.6 (Chart 11). The average ABP for the lower Revett Formation waste rock at Montanore was 4, with an NP/AP ratio of 3 for 72 samples. Because of the silica encapsulation of sulfide minerals within the Revett quartzite, static numbers are most likely conservative in estimating the true acid generation potential of the rock. Additional ABP analyses of composites of lower Revett Formation waste rock are described by Geomatrix (2007a).

Chart 11. Acid Generation Potential of Revett Waste Rock.



Metal mobility for samples of Revett Formation waste rock was evaluated using multiple test methods. The DEQ collected and analyzed 10 additional samples of waste rock from the Rock Creek sub-deposit (DEQ 1996). Half of these samples fall into the uncertain range based on NP/AP criteria ((acid <1; 1:3 uncertain; >3 non-acid), and all of the samples fall into that category based on ABP (acid < - 20; -20 to 20 uncertain; > + 20 non-acid) criteria. The non-sulfate sulfur concentration (which, effectively, represents the total concentration of sulfur in this very low sulfate rock) is low, ranging from 0.01 to 0.20 weight percent and averaging less than 0.1 percent in the 10 samples collected by DEQ.

During a third-party geochemical review of the Rock Creek Project funded by the Forest Service, analyses of acid generation potential, whole rock metal content, and metal release potential were conducted to supplement the analyses originally provided for samples of waste rock from the Revett Formation (Maxim Technologies 2003). As shown in Table 90; these samples have an average ABP of 4 T $CaCO_3$/kT, with an NP/AP ratio of 5. A summary table comparing waste rock from the Rock Creek and Montanore sub-deposits is provided as Table A-7 by Geomatrix (2007a). The data illustrate the strong similarity in acid base potential and NP/AP ratios for waste rock to be mined from the two projects proposed for development within the Rock Creek-Montanore deposit. A portion of the rock to be mined from the lower Revett has potential to generate acid, based on static tests, which would be further evaluated during the Evaluation Phase of the project.

Humidity cell tests of two samples of Revett Formation waste rock from Montanore also were reported by Schafer and Associates (1992). These represent the hanging wall (with an ABP of -15 T $CaCO_3$/kT) and the barren lead zone (with an ABP of -1 T $CaCO_3$/kT). The hanging wall sample showed low sulfate release with an ending pH over 8, while the barren lead zone was consistently lower at pH 6. Both tests showed rates of acid production that exceeded alkalinity throughout the test and data indicate that these rocks, particularly the barren lead zone, have potential to generate acid. These samples had low but detectable concentrations of copper and manganese. The lead-rich barren zone also produced elevated concentrations of lead and zinc. Portions of the barren zone have elevated concentrations of lead, and soluble copper and lead also were detected in weak-acid extracted samples of the lower Revett Formation. The suite of trace elements run for these samples would be expanded during operational validation, by testing for a more complete suite of regulated trace elements.

Composites of lower Revett waste rock from the C and H beds at Troy contained 0.04 and 0.05 weight percent sulfur, respectively. These samples had an average ABP of 17 T $CaCO_3$/kT and an NP/AP ratio of 8. SPLP tests of these samples indicated potential for release of copper, iron, lead, and manganese (Table 92) at concentrations exceeding groundwater and surface water standards.

Three TCLP analyses of Revett waste composited from samples of footwall, hanging wall, and barren lead zone waste rock were reported by ASARCO in the 1992 Montanore Project Final EIS. Results shown in Table 92 indicate potential release of copper, iron, and lead from Revett waste rock. These results are similar to results reported for the SPLP (EPA method 1312), and TCLP (EPA method 1311) metal mobility tests that were completed for the 14 Rock Creek waste rock samples described above (as reported by Maxim Technologies 2003 in Enviromin 2013b) (Table 90 and Table 92). Apart from calcium and magnesium, no metals were detected in SPLP extracts of the waste rock.

Concentrations of copper and lead in the waste rock were detected in the more strongly acidic TCLP extractions, although at considerably lower concentrations than reported for the ore zone. Iron was also detected at a relatively high concentration (up to 29 mg/L) in the TCLP extraction (buffered pH 5 organic acid). In contrast, of the unbuffered SPLP analyses of the same waste rock, only one had a detectable iron concentration of 0.2 mg/L, well below the applicable standard. This indicates that the TCLP, a test designed for the identification of hazardous wastes rather than measurement of metal mobility, overestimates potential metal mobility.

In the Troy Mine, the overlying galena zone and the pyrite zone were not mined and are therefore not exposed in the workings, due to site-specific geological factors influencing mine facility design. Undisturbed, these zones are not creating acid rock conditions, as samples of the underground mine water following seepage through these zones consistently show neutral to slightly alkaline pH values between 7.2 to 7.4. The Troy Mine has modestly elevated levels of metals and nutrients at near-neutral pH. None of the lower Revett rock was exposed in the Libby Adit, so it is not possible to evaluate its weathering chemistry using those monitoring data.

In situ measurements of the nutrients ammonia, nitrate, and nitrite illustrate how nutrient release has been associated with prior mining of waste rock. At Montanore, in the Libby Adit, waste rock has been exposed following blasting for almost 20 years. In water quality data reported following blasting for sumps in 2008, concentrations were highest immediately after blasting and declined significantly during the following year to concentrations near background concentrations. A summary of ammonia, nitrate, and nitrite data from samples collected in the Libby Adit Water Treatment Plant inflow, Libby Adit Waste Rock Sump, and groundwater beneath the Libby Adit is shown in Table 95. The highest nutrient data were collected from Libby Adit Waste Rock Sump located outside the Libby Adit where waste rock was stockpiled on a liner while nutrient concentrations were low in groundwater beneath the Libby Adit, as a result of the containment provided by the lined pad (Table 95). The waste rock sump samples represent a small volume of waste rock excavated from the existing Libby Adit when MMC began dewatering the adit. Water samples from the waste rock sump were collected from 2008 through 2012. After initially high ammonia and nitrate plus nitrite concentrations were measured, water samples from the waste rock sump were collected at an increased frequency, with 6 nitrate plus nitrite samples and 10 ammonia samples collected during the month of October 2008. During that time, ammonia and nitrate plus nitrite concentrations were at their peak, ranging from 1.47 to 12.1 mg/L for ammonia and from 118 to 419 mg/L for nitrate plus nitrite. Sampling was decreased in frequency the following month to only three sample events, and the ammonia decreased to a low of 0.64 mg/L and nitrate plus nitrite concentration decreased to a low of 21.7 mg/L. From 2009 to 2012, ammonia concentrations averaged about 0.05 mg/L and nitrate plus nitrite concentrations averaged about 0.9 mg/L and sample frequency was reduced to about monthly. Emulsions were not used by MMC during the blasting that created the waste rock.

Table 95. Nutrients Measured in Water Samples from Libby Adit and Associated Waste Rock Sump.

Facility	Variable	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate + Nitrite (mg/L)
Libby Adit Untreated Water[1]	# of Samples	69	58	57	60
	# of Detections	17	50	14	60
	Minimum Detected	0.010	0.015	0.00080	0.017
	Maximum Detected	0.566	2.73	1.6	2.73
	Representative Concentration	<0.050	<0.12	<0.010	0.045
Libby Adit Waste Rock Sump[2]	# of Samples	50	48	48	40
	# of Detections	32	39	24	39
	Minimum Detected	0.010	0.0096	0.0026	0.010
	Maximum Detected	21.9	687	40	419
	Representative Concentration	<1.8	<87	<2.5	<54
Libby Adit Groundwater[3]	# of Samples	120	120	122	101
	# of Detections	26	102	13	99
	Minimum Detected	0.010	0.020	0.00050	0.020
	Maximum Detected	0.549	1.6	0.444	1.6
	Representative Concentration	<0.040	<0.16	<0.010	<0.17

[1]Additional data discussion provided in Appendix K-6.
[2]Additional data discussion provided in Appendix K-10.
[3]Additional data discussion provided in Appendix K-4.
Source: MMC 2008, 2009b, 2010, 2011b, 2012g, 2013.

Waste Rock Summary. The majority of waste rock would be produced from the Prichard and Revett formations, portions of which have an uncertain potential to generate acid, as well as potential to release metals including arsenic. For this reason, these rocks require further characterization during the Evaluation Phase, as described in Appendix C. The Burke Formation has low potential to generate acid, but little is known about its potential to release metals. The

Burke Formation would be evaluated during the Evaluation Phase of the project, as discussed in Appendix C.

3.9.4.3.4 Geochemistry Summary

The risk of acid generation for rock exposed in underground workings or tailings at Montanore would be low, with some potential for release of select metals under near-neutral pH and release of nitrate due to blasting. Low acid generation potential exists for some of the waste rock from the Prichard Formation, with moderate potential suggested by static tests for a portion of this rock. *In situ* monitoring of Prichard Formation, where it is exposed underground in the Libby Adit, does not support acid drainage risk. Moderate potential for ARD exists within the altered waste zones of the Revett Formation (particularly of the barren lead zone), which MMC proposes to mitigate through selective handling and backfilling of underground workings. It is likely that the volume of rock to be produced from the Revett altered waste zones would be very small. Further sampling and analysis of weathering characteristics for Prichard and Revett waste rock would allow refinement of the waste rock management plan, and additional detail on trace metal release potential of tailings would guide water treatment design. Results of Evaluation and Operations Phase testing would be used for long-term predictions of water quality for closure design. Criteria to be used for evaluation of individual sample results include comparison of whole rock analyses with standard crustal abundance for elements of concern and comparison of metal mobility results with water quality standards.

3.9.4.4 Irreversible and Irretrievable Commitments

Up to 120 million tons of ore would be removed by the Montanore Project, with the remainder of the ore body left for structural support of the mine workings. The future recovery of the remaining metals left for structural support would be unlikely.

3.10 Groundwater Hydrology

Groundwater occurs in fractures of the bedrock formations beneath the analysis area and in unconsolidated glacial and alluvial sediments along and adjacent to drainages throughout the analysis area. Although hydraulically connected in many areas, the two water-bearing geologic materials behave differently because of their respective hydraulic characteristics. Conceptual and numerical models (as defined in section 3.10.3.1.2, *Conceptual Hydrogeological Model of the Montanore Mine Area*) of the mine area hydrogeology have been developed to understand the characteristics of the groundwater flow system and evaluate potential impacts of the proposed project on the environment.

3.10.1 Regulatory Framework

The Organic Administration Act authorizes the Forest Service to regulate the occupancy and use of National Forest System lands. The Forest Service's locatable minerals regulations are promulgated at 36 CFR 228, Subpart A. The regulations apply to operations conducted under the U.S. mining laws as they affect surface resources on National Forest System lands under the jurisdiction of the Secretary of Agriculture. One of the mineral regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. All waters within the boundaries of National Forests may be used for domestic, mining, or irrigation purposes, under applicable state laws. 36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations."

The Wilderness Act allows mineral exploration and development under the General Mining Law to occur in wilderness to the same extent as before the Wilderness Act until December 31, 1983, when the Wilderness Act withdrew the CMW from mineral entry, subject to valid and existing rights. 36 CFR 228.15 provides direction for operations within the National Forest Wilderness. Holders of validly existing mining claims within the National Forest Wilderness are accorded the rights provided by the U.S. mining laws and must comply with the Forest Service Locatable Minerals Regulations (36 CFR 228, Subpart A). Mineral operations in the National Forest Wilderness are to be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and to preserve the wilderness character consistent with the use of the land for mineral development and production.

The DEQ is responsible for administering several water quality statutes, including the Public Water Supply Act, Montana Water Quality Act, and the Montana Water Use Act. Water quality is discussed in detail in section 3.13*, Water Quality.*

3.10.2 Analysis Area and Methods

3.10.2.1 Analysis Area

The groundwater analysis area for direct, indirect, and cumulative effects consists of all areas around the proposed mine facilities: mine, adits, LAD Areas, and tailings impoundment sites. The Libby Loadout, the transmission line, the proposed Sedlak Park Substation, and the loop line area would not affect groundwater and is not discussed further in this section. The groundwater analysis area includes a large area around the facilities, bounded by US 2 to the east, Bull River and Clark Fork River on the west and southwest, Big Cherry Creek to the north, and Silver Butte Fisher River to the southeast. The analysis area is depicted in Figure 67.

3.10.2.2 Baseline Data Collection

Bedrock groundwater observations were noted in the area overlying the ore body during an exploration drilling program in the 1980s. Exploration data included observations of groundwater and depth to water in several core holes that encountered groundwater. NMC collected additional bedrock groundwater data between 1990 and 1998, before sealing the Libby Adit. The adit data included water discharge records, detailed descriptions of fractures and faults intersecting the adit, and groundwater quality (Geomatrix 2011a; MMC 2008, 2009b, 2010, 2011d, 2012g, 2013). In December 2008, MMC dewatered the Libby Adit to the 7200-foot level and began collecting periodic adit groundwater inflow data. The “7200 foot level” is defined as 7,200 feet along the adit from the portal. MMC completed seven hydraulic tests in the Libby Adit between September and November of 2009 to characterize the hydraulic properties of underground fracture systems (Geomatrix 2011a). In late 2010, MMC began to continuously record hydraulic head data in one of the piezometers located at the 5200 foot level, and reported the data for 1 year. MMC completed Groundwater Dependent Ecosystem (GDE) surveys in the mine area between 2009 and 2013 and continued monitoring of the GDEs in 2010 through 2014 (Geomatrix 2009a, 2010b, 2011d; NewFields 2013a, MMC 2014d, Klepfer Mining Services 2015a). Monitoring in the CMW overlying the mine area is described in Appendix C under *Water Resources.* Water samples for isotope analyses were collected by MMC and DEQ since 2010, and by Gurrieri (2001) in 1999; Gurrieri (2015) summarized isotope data collected by MMC.

Considerable groundwater data were collected at the Little Cherry Creek Tailings Impoundment site, including distribution of groundwater heads, aquifer characteristics of the various hydro-stratigraphic units, and water quality (Geomatrix 2006c). Eight monitoring wells, and several test pits were installed in the area of the proposed Poorman Tailings Impoundment in 1988 (Chen-Northern 1989). The data were used to define groundwater flow direction and subsurface geology; four wells were tested to determine hydraulic conductivity. This information was supplemented with a resistivity survey to determine depth to bedrock beneath the surficial deposits.

The basic hydrogeology data are representative of current conditions, based on comparison of pre-2003 and 2005 data to the current conditions. Although depth to groundwater may have changed slightly due to seasonality or changing climate cycles, the fundamental direction of groundwater flow has not changed. The aquifer characteristics measured in the 1980s and 1990s are not expected to change within the timeframe of the project.

3.10.2.3 Baseline Data Adequacy

The preceding section summarizes the baseline information collected for groundwater and the affected environment and the following sections describe the approaches used by the lead agencies in analyzing potential effects. The mine related data include among other things subsurface geology, water levels in existing exploration bore holes over the ore body, spring and seep inventories, subsurface geologic and hydrologic data from the Libby Adit, and USGS mapping that shows perennial and intermittent streamflow. The tailings groundwater data summarized in the previous section include subsurface geology, water levels from monitoring wells, test pits, resistivity surveys, and groundwater levels. The subsequent section on the affected environment describes the best available information regarding groundwater resources in the analysis area.

The KNF has determined that these baseline data and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on groundwater and groundwater-dependent ecosystems in the mine and tailings impoundment areas and enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.10.2.4 Additional Data Collection

3.10.2.4.1 Mine Area Information

Underground mine development occurs in rock formations that are hundreds to thousands of feet in the subsurface, hidden from view, and inaccessible other than through mine development or drillholes. The inaccessibility limits the amount of data initially available and means a degree of uncertainty is inherent in evaluating the specific environmental impacts related to groundwater prior to actual mine development. Models and estimates of groundwater conditions can be developed based on the best available information to provide a scientifically accepted basis to determine the reasonably foreseeable significant adverse effects. However, actual knowledge of underground conditions may not be fully known, or knowable, until underground operations are underway and additional data can be collected.

Some of the specific additional geologic and hydrologic characteristics of the ore body that would be available and gathered in the future as underground operations were underway include information such as the precise underground location and attributes of geologic structures and discontinuities; the location, orientation, and density of faults and fractures; the exact nature of hydraulic conductivity and storativity of faults, fractures, and unfractured rock; and the specific groundwater potentiometric surface overlying the ore body. Much of this information would be collected and evaluated through underground drilling operations that would be conducted in advance of the underground mining (see Appendix C).

Some data regarding the hydrologic characteristics of the streams, seeps and springs and GDEs above the mine area are incomplete or unavailable. These include the precise location where subsurface bedrock groundwater overlying the mine area discharges to surface water, the specific relationship between the rate of bedrock groundwater discharged to surface water and the rate of total surface flow, and the precise nature and timing when bedrock groundwater overlying the mine area discharging to surface water is the dominant component of streamflow. Some of the additional information, such as the precise relationship between the rate of bedrock groundwater discharged to surface water and the rate of total streamflow, could only be obtained with decades of data collection and the overall cost would be exorbitant.

The KNF carefully considered the adequacy of the existing baseline information to meet NEPA requirements in evaluating reasonably foreseeable significant adverse effects on groundwater and groundwater-dependent ecosystems overlying the mine area. The KNF concludes that it has sufficient data to make a reasoned choice among alternatives and to evaluate the reasonably foreseeable significant adverse effects on groundwater and groundwater dependent ecosystems.

The KNF concludes that the additional information is not essential to make a reasoned choice among alternatives and is not necessary to evaluate the reasonably foreseeable significant adverse effects on groundwater, groundwater-dependent ecosystems, and surface water for the following reasons:

1. The location and distribution of mineable mineral resources would be the same in all mine alternatives. Consequently, the mine void, the pumping necessary to dewater the mine void and the effect on baseflow of streams in the area would be relatively similar in all mine alternatives. These effects on groundwater and groundwater-dependent ecosystems were estimated using a 3D groundwater model used and widely accepted in the scientific community.

2. The agencies developed mitigation to protect groundwater and related resources (surface water and aquatic resources) and to address the uncertainty in the model predictions because of incomplete or unavailable information. More information would not change the mitigation measures that were implemented to minimize impacts. The agencies' mitigation includes maintaining a mining buffer ("no mining zone") 300 feet from the known Rock Lake Fault and 1,000 feet from Rock Lake, restricting mining activities within 100 feet of other faults, leaving barrier pillars across the entire width of the deposit at strategic locations to divide the deposit into discrete compartments to minimize changes in pre-mining groundwater conditions, and placing multiple adit plugs in each adit at closure. These adit plugs would be evaluated technically and hydrologically, and designed based on site-specific conditions of each adit. Additional groundwater information is not needed to know that such mitigations would reduce effects on groundwater and groundwater-dependent ecosystems and effects on stream flows overlying the mine void nor would additional information change the type of mitigation. The analysis provided by the 3D groundwater model along with the required mitigation measures provided the basis for making a reasoned choice among alternatives.

3. Surface water in the CMW overlying the ore body, such as the headwaters of the East Fork Rock Creek, Rock Lake, and East Fork Bull River, are considered outstanding resource waters under the Montana Water Quality Act. Section 3.13.1 discusses that the DEQ cannot authorize degradation of outstanding resource waters. Degradation does not include changes that the DEQ determine to be nonsignificant. Current nondegradation rules provide that if an activity increases or decreases the mean monthly flow of a stream by less than 15 percent or the 7-day, 10-year ($7Q_{10}$) low flow of a stream by less than 10 percent such changes are nonsignificant for purposes of the statute prohibiting degradation of state waters (ARM 17.30.715(1)(a)). The DEQ is a joint lead agency for the Montanore Project EIS. In consultation with the DEQ, the KNF concludes that changes in streamflow that are not degradation also would not be significant under NEPA, as defined in 40 CFR 1508.27.

4. The Forest Service's locatable mineral regulations require operators to comply with applicable Federal and State water quality standards, including Clean Water Act regulations (36 CFR 228.8(b)). Forest Service mineral regulation 36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations." The KNF will rely on the DEQ decision regarding nondegradation and will not allow MMC to proceed with mining until DEQ's decision is made. The KNF concludes the effects on groundwater and groundwater-dependent ecosystems in the CMW would not be significant because MMC must first obtain DEQ approval and DEQ could only approve the mine if it determines streamflow changes are nonsignificant.

5. Additional subsurface geologic and hydrologic data would be collected during the completion of the evaluation adit with its associated underground drilling (see section 2.5.2.6.5, *Final Groundwater Model Development.*

6. Although the current 3D groundwater model has been developed and run using the best available information, the 3D model would be refined and rerun after data that can only be obtained during mining operations were incorporated into the model (see section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including effectiveness of mitigation measures, would be refined and the model uncertainty would decrease.

7. The agencies would use adaptive mitigation to modify the mitigation plans described in section 2.5.7, *Mitigation Plans,* if necessary to incorporate the revised model results. The additional data would be used to assess if substantial changes in the selected alternatives that are relevant to environmental concerns are necessary. The KNF would conduct additional NEPA analysis if monitoring data require substantial changes in the selected alternatives that are relevant to environmental concerns or identify significant new circumstances or information relevant to environmental concerns and bearing on the proposed action, as required by 40 CFR 1502.9(c)(1). If monitoring data caused MMC to require mining plans materially different from the selected alternatives, the DEQ would require MMC to submit an application to modify its operating permit. The DEQ would conduct the appropriate level of MEPA review on the application.

3.10.2.4.2 Tailings Impoundment Area Information

Considerable geologic and hydrologic information has been collected as part of the baseline data for the alternative tailings impoundment areas, as summarized in section 3.10.2.2, *Baseline Data Collection* and described in section 3.10.3.2, *Tailings Impoundment Areas and LAD Areas*. Additional information that would be collected in the future as part of a final design of the Poorman Tailings Impoundment Site prior to construction approval include specific information on the depth to bedrock, particularly between the footprint of the proposed Poorman Impoundment and wetlands south of Little Cherry Creek; the specific areal extent, thickness, and hydraulic conductivity of glaciolacustrine deposits; the specific areal extent, thickness, and hydraulic conductivity of other subsurface materials that may provide a preferential pathway for tailings seepage; and the existence of artesian pore water pressure conditions and the soil units that are affected by such artesian conditions.

This information would be necessary for final detailed design of the tailings impoundment to ensure the impoundment would be designed, constructed, operated, and reclaimed in accordance with applicable regulations. Although such data would be needed for final design, the KNF concludes that the additional information is not essential to making a reasoned choice among alternatives and is not necessary to evaluate the reasonably foreseeable significant adverse effects on groundwater, groundwater-dependent ecosystems, and surface water for the following reasons:

1. The primary groundwater effect in the tailings impoundment sites would be the dewatering effect of the pumpback well system on groundwater-supported wetlands and adjacent streams, specifically Little Cherry Creek, Poorman Creek, Ramsey Creek, and Libby Creek. The effect on groundwater-supported wetlands was adequately estimated using a 3D groundwater model widely used and accepted in the scientific community.

2. Section 3.24, *Wetlands and Other Waters of the U.S.* discussed that the Montanore Project must comply with the 404(b)(1) Guidelines for discharge of dredged and fill material into wetlands and other waters of the U.S. (40 CFR 230). The tailings impoundment would be the site where most of the discharge of fill material would occur. The 404(b)(1) Guidelines specify "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse effect on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." The Poorman Impoundment would have less adverse effect on the aquatic ecosystem than the Little Cherry Creek Impoundment, even assuming all wetlands in the Poorman Impoundment and Little Cherry Creek were adversely affected, and would not have other significant adverse environmental consequences.

3. The Corps will make a determination regarding MMC's compliance with the 404(b)(1) Guidelines. The KNF will rely on the Corps to make the decision regarding effects on aquatic resources from the discharge of fill and will not allow MMC to proceed with construction and operations of the mine until Corps' decision was made. The Forest Service's locatable mineral regulations require operators to comply with applicable Federal and State water quality standards, including Clean Water Act regulations (36 CFR 228.8(b)). Forest Service mineral regulation 36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations.

4. Additional subsurface data from the Poorman Impoundment Site would be collected during the final design process of the Poorman Impoundment (see section 2.5.2.6.3, *Final Tailings Impoundment Design Process* in Chapter 2 and Appendix C). Site data to be collected include an assessment of a subsurface bedrock ridge adjacent to Little Cherry Creek and the effect it may have on pumpback well performance, aquifer pumping tests to refine the impoundment groundwater model and update the pumpback well design, and site geology to identify conditions such as preferential pathways that may influence the seepage collection system, the pumpback well system, or impoundment stability.

5. MMC also would be required to complete aquifer testing at the Poorman Impoundment Site and finalize the design of the pumpback well system. The 3D model would be refined and rerun after data from the Evaluation Phase were incorporated into the model (see section C.10.4, *Evaluation Phase* in Appendix C). MMC would update the pumpback well design and analysis using the additional data, with a focus on minimizing drawdown north of the impoundment.

6. Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including effectiveness of mitigation measures, may change and the model uncertainty would decrease. The agencies would use adaptive mitigation to modify the mitigation plans described in section 2.5.7, *Mitigation Plans,* if necessary to incorporate the revised model results. The KNF would conduct additional NEPA analysis if monitoring data require substantial changes in the selected alternatives that are relevant to environmental concerns or identify significant new circumstances or information relevant to environmental concerns and bearing on the proposed action, as required by 40 CFR 1502.9(c)(1). If monitoring data caused MMC to require mining plans materially different from the selected alternatives, the DEQ would require MMC to submit an application to modify its operating permit. The DEQ would conduct the appropriate level of MEPA review on the application.

3.10.2.4.3 Summary

Based on the preceding, the KNF concludes 1) additional baseline groundwater or surface water information is not essential to making a reasoned choice among alternatives; 2) additional baseline information is not needed to evaluate the reasonably foreseeable significant adverse effects; and 3) therefore the requirements of 40 CFR 1502.22(b) have been met.

3.10.2.5 Impact Analysis

For each alternative, an impact analysis was conducted for groundwater hydrology during five phases of mine life—evaluation, construction, operations, closure, and post-closure, as defined in section 3.8.2, *Project Water Balance, Potential Discharges, and Impact Assessment Locations*.

3.10.2.5.1 Mine Area Groundwater Hydrologic Models

The agencies relied on two separate numerical groundwater models widely accepted in the scientific community to evaluate and refine the site conceptual model and to evaluate potential hydrology impacts. A hydrogeology committee consisting of representatives from the KNF, DEQ, MMC, and ERO Resources Corp., the agencies' EIS contractor, was established to guide the development of the agencies' 2-dimensional (2D) numerical model. The results of the agencies' 2D model were provided in the Draft EIS (USDA Forest Service and DEQ 2009). Subsequently, MMC prepared a more complex and comprehensive 3D model of the same analysis area. The results of both models were used to evaluate the site hydrogeology and analyze potential impacts due to mining. Although the results of the two models were similar, the 3D model provides a more detailed analysis, by incorporating known or suspected fault behavior with respect to hydrology; more recent underground hydraulic testing results; a more comprehensive calibration process, and better simulation of vertical hydraulic characteristics of the geologic formations to be encountered during the mining process. A complete description of the agencies' 2D model, including assumptions, results, and calibration is provided in a *Final Hydrogeology Technical Report* (ERO Resources Corp. 2009). A complete description of the 3D model is provided in Geomatrix (2011a). A second, site-specific, 3D model was used by MMC to analyze potential pumping rates and tailings seepage capture for the pumpback well system that would be located below the Poorman Tailings Impoundment.

For the purpose of analyzing the effects of possible mitigations, MMC simulated two options: grouting, during Operations Phase, of the sides of the three uppermost mine blocks and corresponding access ramps, as well as installing two bulkheads in two mining blocks in the mine at Closure. Geomatrix (2011a) describes the specific assumptions regarding how the mitigations were simulated. The agencies considered the modeling of the bulkheads to be an equivalent simulation of the agencies' mitigation of leaving a barrier, if necessary, during the Operations Phase and constructing bulkheads at the access openings at closure. The effectiveness of MMC's modeled mitigation is discussed in section 3.10.4.3.6, *Effectiveness of Agencies' Proposed Monitoring and Mitigation*. The following discussion describes the predicted baseflow reductions for each of the drainages with and without MMC's modeled mitigation. MMC also completed two additional model runs to simulate grouting along the ceilings of the mine workings and along the ceilings and walls of the adits. The agencies did not use these additional model runs because of concerns about technical feasibility, long-term effectiveness of extensive grouting of a room-and-pillar mine, and the nature of the model simulation. Effects presented with MMC's modeled mitigation do not include mitigation measures not provided in MMC's 3D model report such as increasing buffer zones or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase.

3.10.2.5.2 Tailings Impoundment Areas Groundwater Hydrology

MMC developed a groundwater model of the Little Cherry Creek watershed using a 2D finite element program, SEEP/W (Klohn Crippen 2005). The SEEP/W program models mounding of the groundwater beneath water retention structures such as tailings impoundments and changes in pore-water conditions within earth slopes due to infiltration from the structures. The agencies independently performed a SEEP/W analysis, using the geologic and hydrologic model developed by MMC with various inputs (USDA Forest Service 2008). The agencies used the same estimates for the Poorman Impoundment Site because of the similarity in the geologic conditions observed from the drill log data collected from the Little Cherry Creek Impoundment Site and the Poorman Impoundment Site (Morrison-Knudsen Engineers, Inc. 1989a, Morrison-Knudsen Engineers, Inc. 1989b). In addition, the proposed underdrain system at both sites would be similar. The rate of seepage not collected by the underdrain seepage collection system is likely more influenced by the effectiveness of the underdrain seepage collection system than the underlying geologic materials. A SEEP/W analysis of the Poorman site would be completed during final design.

In addition to the seepage analysis, MMC evaluated a pumpback well system designed to capture all seepage from the tailings impoundment that would not otherwise be collected by the underdrain system (Geomatrix 2010c). The Poorman Impoundment in Alternative 3 was modeled. The analysis consisted of developing a 3D groundwater model that incorporated the known hydrogeologic characteristics of the Poorman Impoundment Site to provide a preliminary well field design capable of capturing all groundwater from beneath the impoundment site.

3.10.3 Affected Environment

3.10.3.1 Mine Area

3.10.3.1.1 Site Hydrogeology

Bedrock in the mine area consists of metamorphosed sediments known as the Belt Supergroup. The sediments were originally deposited as a series of muds, silts, and sands which were subsequently metamorphosed to argillites, siltites, and quartzites, respectively. The primary porosity and permeability (intergranular porosity and permeability) of the bedrock is very low. The primary hydraulic conductivity may be as low as 10^{-11} cm/sec (2.8×10^{-8} ft/day) with the primary effective porosity approaching zero (Stober and Bucher 2000). All bedrock units are fractured and faulted to various degrees, depending on proximity to large fault structures and depth. Fractures and faults result in secondary hydraulic conductivity and secondary porosity values that are much higher than primary hydraulic conductivity values. Secondary hydraulic conductivity may range from 10^{-4} to 10^{-6} cm/sec (0.0028 to 0.28 ft/day) (Gurrieri 2001). Various estimates of the bulk hydraulic conductivity (which considers both the primary and secondary hydraulic conductivities) have been made (Gurrieri 2001; Klohn Crippen 2005; Geomatrix 2006c).

The agencies' 2D numerical model of the site hydrogeology was calibrated using a bulk or average hydraulic conductivity of the bedrock in the mine area of 1×10^{-7} cm/sec (ERO Resources Corp. 2009). The 3D model domain was divided into seven vertical layers, each with decreasing hydraulic conductivity. For the layers above and below the ore body, the 3D model used bulk hydraulic conductivities of 2×10^{-7} to 6×10^{-8} cm/sec. The 3D model assigned hydraulic conductivities to specific formations and structures (Geomatrix 2011a). Within the area of the Libby Adit, the MMC model used specific hydraulic conductivity values for the fractured and unfractured rock, based on the hydraulic testing results from within the adit.

The Rock Lake Fault bounds the western side of the mine area and extends northwest and southeast through the mine area. The fault is a major structure with as much as 2,500 feet of vertical displacement (USGS 1981). The fault zone is 7 to 16 feet wide where exposed and contains strongly striated fine-grained breccia and clay gouge. The abundance of veins and fragmented wall rocks in the fault zone indicates the brittle nature of the fault. Filled extension gashes indicative of dilation across the fault zone are present as much as 165 feet from the main fault trace (Fillipone and Yin 1994). North of St. Paul Pass, 7 to 8 miles of the Rock Lake Fault is generally coincident with the drainage of the East Fork Bull River.

The two numerical groundwater models were used to explore the fault's role in the mine area hydrogeology. Various hydraulic conductivity values were assigned to the fault zone, as reported in ERO Resources Corp. (2009) and Geomatrix (2011a). The fault zone may contain areas of higher or lower hydraulic conductivities along its length. The 3D model was able to more definitively explore the conductance of groundwater along its length than the 2D model, specifically in the Rock Creek and East Fork Bull River drainages. The 3D model also included several other faults mapped within the Libby Adit (Figure 63). Both models used hydraulic conductivities for the faults higher than the surrounding rock and decreased hydraulic conductivity with depth. The hydraulic conductivity of fractures and joints tends to decrease with depth, due to confining pressures of the rock reducing the fracture apertures (Snow 1968). In brittle crystalline rock such as the Belt Supergroup, fracture apertures can be maintained to considerable depths. This was evidenced by inflows during the construction of the Libby Adit and also by reports of groundwater inflows from numerous deep hardrock mines around the world. This phenomenon is particularly true when the fractures are associated with large structures (Galloway 1977), such as the Rock Lake Fault.

As is typical for mountainous areas, the potentiometric surface generally follows topography. A water level contour map for the mine area cannot be constructed because water level data are lacking. Available data and observations suggest a potentiometric surface exists within much of the mine area. For example, the depth to water was measured in a few of the exploration boreholes (HR-19 and HR-26) with a consistent water surface elevation of about 5,000 to 5,600 feet (Chen-Northern 1989). The depth to water in exploration boreholes adjacent to Rock Lake (HR-7, 8, 9, and 10) and St. Paul Lake (HR-29) was the same elevation as the lake (Chen-Northern 1989). Several borehole logs did not report a depth to groundwater or that groundwater was encountered.

NMC began Libby adit construction in February 1990 and ceased construction in November 1991. The adit is nearly 14,000 feet long; the first 700 feet were excavated in colluvium and the remainder in fractured bedrock, primarily the Prichard Formation. The initial 700 feet is nearly horizontal and the remainder of the adit declines at a 6 percent slope. NMC extensively grouted in advance of the face in portions of the adit, primarily in the first 5,000 feet of the Libby Adit. Between December 27, 1991 and January 4, 1992, NMC drilled ten boreholes into water-bearing zones in bedrock between PR3590 and PR12800, 3,590 and 12,800 feet from the portal, respectively (Table 96). The objectives of the borings were to characterize water-bearing zones and to identify a source of water for adit/mine construction. The two boreholes with highest flow rates were flow-tested for a minimum of 1 hour. Beyond about PR8000, the drilling did not identify any sources of water at distances of 84 to 168 feet from the adit. The water producing structures encountered in the first three boreholes listed in Table 96 were either not encountered by the adit or if encountered, the structures had different hydraulic characteristics so that less water was produced to the adit than measured in the piezometers. NMC also measured water pressure in the piezometers that produced water. The reported pressure readings do not include a narrative as to when the measurements were taken with respect to the flow testing.

MMC recorded some hydraulic pressures in piezometers at six locations in the Libby Adit between PR3110 and PR5220 in 2009 and 2010 (MMC 2012e). Pressures ranged from 123 feet at PR3110 to 427 feet at PR5220. MMC began recording hydraulic pressure in piezometer PR5220 on September 10, 2010, about 2 years after MMC began dewatering the Libby Adit. MMC reported pressure data through October 3, 2011. Although the pressure data represent pressure heads after the local potentiometric surface had been drawn down for about 2 years, and the data were reported for 1 year, the data provide information regarding the seasonal nature of the potentiometric surface and minimum pressure head elevations under dewatering conditions.

Table 96. Summary of NMC's Post-Construction Boreholes in Libby Adit.

Location	Approximate Date of Construction	Date of Test	Total Depth (feet)	Target	Inflow (gpm)
PR3590	6/90	12/91 to 1/92	92	Fault/fracture	60
MB5300	11/90	12/91 to 1/92	132	Fault	120
PR7945	3/91	12/91 to 1/92	104	Fault	8
PR8005	3/91	12/91 to 1/92	168	Fault	0
PR8953	4/91	12/91 to 1/92	108	Fault	0
PR9300	5/91	12/91 to 1/92	84	Fault	0
PR9343	5/91	12/91 to 1/92	108	Fault/fracture	0
PR9520	6/91	12/91 to 1/92	96	Fault	8
PR10843	7/91	12/91 to 1/92	156	Fractures	0
PR12800	10/91	12/91 to 1/92	118	Fault/fracture	0

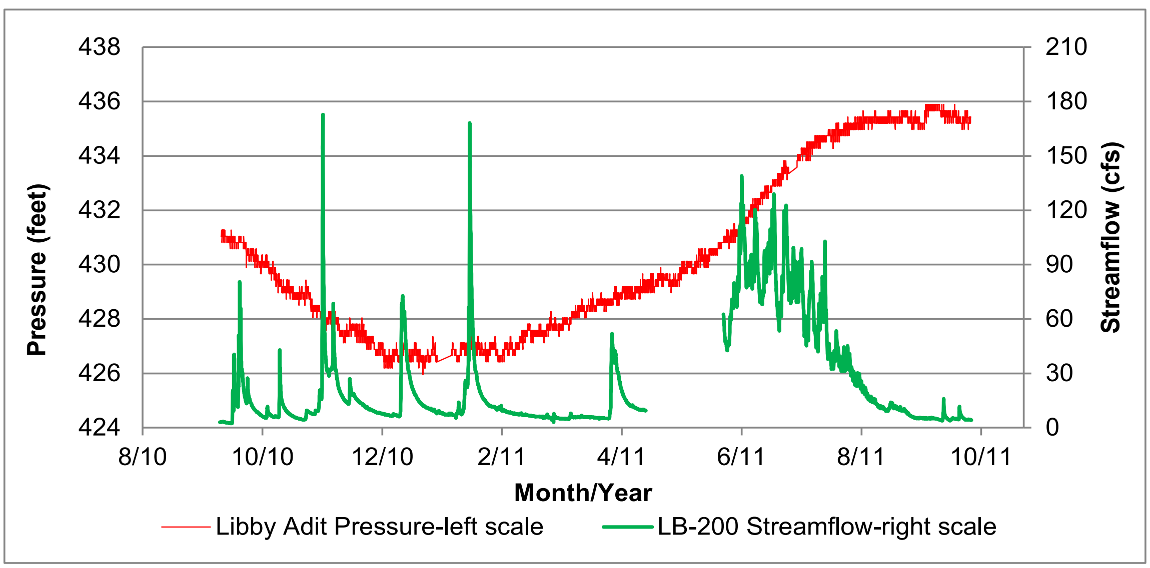
Source: Adkins 1992 in Geomatrix 2011a, Appendix B.

The recorded pressure data exhibit a seasonal trend with the lowest pressure occurring during the winter months, increasing during the spring and summer, and reaching a peak pressure during late summer/early fall (Chart 12). The total pressure variation was about 10 feet during the 2010-2011 recording period. Because only 1 year of data has been reported, it is not possible to conclude whether the observed pressure range is typical or whether the apparent seasonal cycle represents recharge and discharge for the same time period. Based solely on the available data, groundwater in bedrock fractures at the depth of the piezometer at PR5220 (1,330 feet below ground surface) appears to respond relatively quickly to seasonal trends in precipitation and runoff at the surface.

Piezometer PR5220 is located at an elevation of about 3,771 feet, which is about 1,330 feet vertically below ground surface. As of October 2011, the elevation of the water surface above this piezometer was 4,207 feet, or about 890 feet below the ground surface. Because pre-dewatering water level data do not exist, it is not possible to determine how much drawdown above the adit has occurred as a result of dewatering. The potentiometric surface elevation, as measured in PR5220 as of October 2011, appears to be at essentially the same elevation as Libby Creek, located south of the trace of the Libby Adit. This geometry is likely the result of Libby Creek and its alluvium providing recharge to the ongoing dewatering of the Libby Adit. As a result, Libby Creek appears to be behaving as a hydrologic boundary or area of fixed head, which maintains local water level elevations, despite the ongoing dewatering. This observation, as well as the apparent seasonal variation in head (similar to the seasonal variation in Libby Creek flows), implies that sufficient hydraulic conductivity exists between Libby Creek and Libby Adit to move water from the Libby Creek drainage to the adit. Section 3.10.4.3 provides a comparison of model predicted drawdown and Libby Adit water level data. Chart 12 provides a comparison between groundwater pressure measured from within the Libby Adit and flow in Libby Creek. Small duration fluctuations in creek flow are dampened out in the relatively low permeability bedrock and there appears to be a 2-month delay between peaks of the two data sets. Otherwise, both data sets show a similar seasonal response.

Specific isotopes of oxygen and hydrogen can be used to evaluate the relationship between surface water and groundwater. Water samples from the analysis area were collected since 1999 by various entities, including MMC and the DEQ, for isotope analysis (Gurrieri 2013). The oxygen and hydrogen isotope results were plotted along with the 70 sample results from Gurrieri and Furniss (2004). The oxygen and hydrogen isotope results for two water samples collected from the Libby Adit near the portal and down to PR1920 (which is about 500 feet below the ground surface) are similar to recent snow and surface water samples. This indicates that inflow into the adit down to at least the 1920 level is from recent snowmelt. Water samples collected from deeper in the adit plot along with results from other groundwater sources.

Chart 12. Hydrograph of Libby Adit 5220-Piezometer and LB-200 Streamflow.

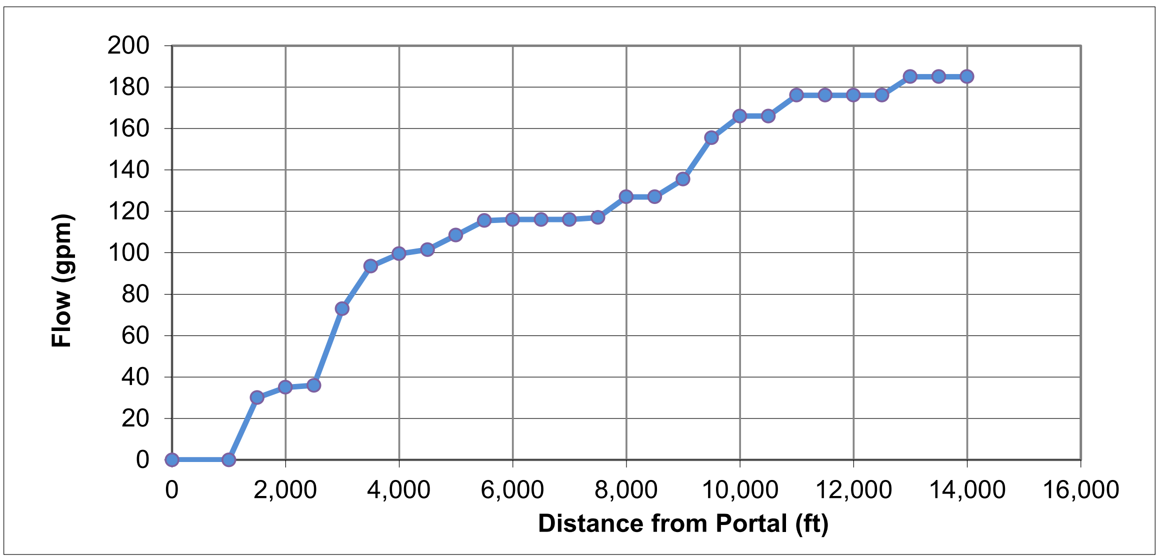


Source: MMC 2012b.

In addition to the oxygen and hydrogen isotopes, the water samples were analyzed for tritium. Because the only source of tritium to the atmosphere is from nuclear explosions, primarily during the 1950s and 60s, tritium can be used as an indicator of the water's age, relative to the those events. Gurrieri (2013) concluded that water collected in the adit near the portal is modern (post - 1952) water, as are samples from snow and surface water sources. Water collected from deeper in the adit appear to be a combination of modern water and pre-1952 water. Of the deeper samples, the deepest sample from the 5220 level contains the highest proportion of modern water to pre-1952 water. This result indicates that groundwater does not necessarily become older the deeper the fracture, but rather that the source of water at depth is dependent on the hydraulic conductivity and continuity of the individual fractures. This observation is consistent with the pressure response from the same level and apparent connection to the Libby Creek drainage, as described previously.

Chart 13 provides a cumulative flow record of adit inflows measured during construction of the adit. The inflow data indicate that most of the total inflow was observed in the first 10,000 feet of the adit, with a stretch between 10,500 and 13,000 feet that produced little inflow, and a slight increase in inflow between 13,000 and 14,000 feet. Between 2009 and 2013, the average annual adit inflow rate ranged decreased from 125 gpm in 2009 to 53 gpm in 2013, based on the volume of water delivered to the Water Treatment Plant. The total annual adit inflow ranged from 27,659,419 to 65,621,930 gallons during the same time period (MMC 2009b, 2010, 2011b, 2012g, 2013, 2014b).

Chart 13. Cumulative Water Inflow Rates in Field Sections Reported During Adit Construction.



Source: Geomatrix 2007c.

Based on observation, springs and perennial portions of streams in the mine area generally start at elevations of 5,000 to 5,600 feet (USGS 1983; Wegner, pers. comm. 2006b). The depth to water measurements and site observations indicate that a water table or potentiometric surface exists at a depth of about 500 feet below land surface in the higher areas, and near or at the surface in areas below an elevation of about 5,000 to 5,600 feet. A September 2007 field review by the agencies located a perennial bedrock spring (SP-41, renumbered from SP-31 in the Draft EIS and Supplement Draft EIS to avoid conflict with springs in the Poorman Impoundment Site) in the

East Fork Rock Creek drainage (Figure 68) at an elevation of 5,625 feet, slightly above the estimated range of 5,000 to 5,600 feet. MMC completed an initial survey of East Fork Rock Creek and found perennial flow started at an elevation of about 5,600 feet (NewFields 2013a). Based on the geology and characteristics of this spring, its elevation is considered to be within the estimated range for intersection of the potentiometric surface with the ground surface.

The source of water to springs in the analysis area is groundwater from either fractured bedrock or from unconsolidated deposits. Based on the conceptual model (see section 3.10.3.1.2, *Conceptual Hydrogeological Model of the Montanore Mine Area*) and the results of the numerical models, springs that overlie the ore body at elevations greater than about 5,600 feet (or greater than 5,625 feet) are most likely associated with a shallow groundwater flow path in weathered bedrock, glacial or alluvial deposits, or shallow fractures or bedding planes. While observations, such as discharge during the dry season, indicate that springs could issue from bedrock fractures connected to a deeper groundwater flow path, but there are no data to support this possibility. Springs located below an elevation of about 5,600 feet are likely the result of discharge from shallow weathered bedrock or glacial/alluvial deposits. At lower elevations the shallow and deeper flow paths are most likely hydraulically connected, and some component of the total spring flow may be from the deeper flow path. The ratio of deep and shallow groundwater issuing as springs probably varies between springs and may vary seasonally. Numerous springs were identified in the analysis area by MMC (Geomatrix 2006b, 2006d, 2009a, 2009b, 2010b, 2011c; NewFields 2013a; MMC 2014d; Klepfer Mining Services 2015a). Nine identified springs are within the CMW, with estimated discharge ranging from less than 5 gpm to 50 gpm (Figure 68, Table 97).

Table 97. Flow Measurements and Elevations for Identified Springs in the CMW.

Spring ID	Elevation (feet)	Flow Rate (gpm)	Number of Measurements	Date Range of Measurements
SP-1R	4,900	<0.01-20	10	10/98 – 10/13
SP-2R	4,850	4	1	10/98
SP-4R	6,490	5	1	9/05
SP-05/3R	4,200	5, 22	2	8/98 – 10/98
SP-16	4,600	40-50 (estimated)	1	Unknown
SP-41	5,625	27	4	9/07 - 9/13
SP-42	5,400	22	1	8/21/13
Spring 8	4,360	22	3	9/10 – 9/12
Spring 13	4,520	1-2	1	Unknown
GDE-1	6,588-6,708 (four seeps)	No measurable flow	1	8/13
GDE-2	6,747-6,825 (five seeps)	<2	1	8/13
GDE-3	5,703	<10	1	8/13

gpm = gallons per minute.
Source: Geomatrix 2006b, 2006d, 2009a, 2010b, 2011c; NewFields 2013a; MMC 2014d; Klepfer Mining Services 2015a; McKay, pers. comm. 2007; September 2007 agencies' field review of Rock Lake area.

One of the objectives of the GDE surveys and ongoing monitoring is to determine the source of water to each spring. The agencies' September 2007 field review identified that spring SP-05/3R

(Figure 68), uphill from the Heidleberg Adit in the East Fork Rock Creek drainage, discharges from the Rock Lake Fault. The agencies considered the observed thickness of surficial material above the spring to be insufficient to support an estimated discharge rate of 30 to 40 gpm during a period of little to no precipitation. This spring was reported to have had a flow rate of 5 and 22 gpm during the late 1990s (Table 97). A previously unidentified spring (SP-41) or a series of springs along East Fork Rock Creek above Rock Lake at an elevation of up to 5,625 feet produced a total flow of about 40 to 50 gpm from the fracture zone associated with the Rock Lake Fault. Also, the stream bed above the spring consisted of exposed bedrock (no alluvium), indicating that there was no surface water or shallow groundwater contribution to the springs from higher elevations in the drainage upstream of SP-41.

Springs SP-41 and SP-42 are located along the Rock Lake Fault in the upper East Fork Rock Creek and East Fork Bull River drainages, respectively (Figure 68). Springs SP-41 and SP-42 were re-numbered in the Draft EIS and Supplement Draft EIS to avoid conflict with springs in the Poorman Impoundment Site. Spring SP-41 discharges groundwater directly from the fault or fractures associated with the fault. During the late summer and early fall of typical precipitation years, SP-41 may be the only source of water to Rock Lake (other than direct discharge of groundwater to the lake). Spring SP-42 discharges groundwater from along the Rock Lake Fault at a similar elevation as SP-41, but on the north side of St. Paul Pass.

During normal to dry years when winter snows have completely melted, deeper groundwater discharge from the Rock Lake Fault may be the only source of water to St. Paul Lake during late summer to early fall. Because St. Paul Lake is on a relatively permeable glacial moraine, the lake is reported to be dry during extended periods of low or no precipitation. This indicates that the lake drains at a faster rate than input from groundwater.

The 700-foot long Heidelberg Adit, located in the East Fork Rock Creek drainage below Rock Lake, discharges water to East Fork Rock Creek. During a geotechnical evaluation of the Heidelberg Adit (Morrison-Knudsen Engineers, Inc. 1989b), groundwater flow in the adit was estimated to be 80 gpm and during a hydrologic investigation, Chen-Northern (1989) reported a flow of 40 to 50 gpm. Gurrieri (2001) reports adit flows ranging from 49 to 128 gpm. Discharge from the adit appears to vary seasonally, suggesting the flow may be a combination of shallow and deep groundwater. The shallow groundwater contribution to the adit is more responsive to seasonal changes in precipitation. During the agencies' September 2007 field review, the estimated flow from the adit was between 40 and 50 gpm. NewFields (2013) reported measured flows from the adit ranging from 84 to 164 gpm between 1999 and 2012. The two measured flows in July and October 2012 are consistent with the concept that flows from the Heidelberg adit vary seasonally.

Recent observations inside the Heidelberg Adit in 2011 by MMC show that the first section of adit (450 feet) closest to East Fork Rock Creek was dry. At 450 and 685 feet, the adit intersected narrow fracture or shear zones that strike north-south, with minor dripping at 450 feet, and about 15 gpm flowing at 685 feet. A drill hole just beyond 685 feet was producing about 50 gpm flow; length of the drill hole is unknown. The adit was dry from the drill hole to the face at 705 feet, except for another smaller drill hole in the middle of the face that was producing about 5 gpm. Therefore, about 75 percent of water discharging from the Heidelberg adit is coming from two drill holes that appear to intersect north-south trending fracture/shear zones related to the Rock lake Fault. The remaining 25 percent of flow was coming directly from exposed fractures. Rock between the fracture/shear zones was completely dry, similar to what has been observed in the Libby Adit.

3.10.3.1.2 Conceptual Hydrogeological Model of the Montanore Mine Area

A conceptual hydrogeological model is a commonly used tool for extending knowledge beyond what is specifically known about a hydrogeologic system. With the conceptual model approach, the response of the hydrogeologic system to changes that may occur due to proposed mining activities can be predicted or estimated. Specifically, the conceptual model can be the basis for a numerical model that can integrate known hydrologic data to determine potential impacts on groundwater levels and groundwater contributions to surface water flow. The conceptual hydrogeological model for Montanore is based on the following key components:

- Metasedimentary rocks in the mine area have very low primary permeability (hydraulic conductivity)
- Fractures and other structures provide pathways for groundwater movement
- Fracture or secondary permeability is greater than primary permeability

Unfractured bedrock within the metasediments of the Belt Supergroup has minimal primary porosity and is relatively impermeable. Therefore, groundwater flow in bedrock is primarily through interconnected fractures. Where the fractures are sparse and interconnection is poorly developed, the hydraulic conductivity approaches the rock matrix conductivity (very low, but not zero). Conversely, areas with a higher degree of interconnected fractures, the fractures dominantly control the hydraulic conductivity and the rock matrix permeability provides a relatively small contribution to the bulk hydraulic conductivity. If fracture zones are intercepted by voids, water would initially drain from storage, but because they are not connected with other fractures that transmit water, the long-term water yield would be low. Site-specific data indicate that near-surface bedrock, which is subject to freeze/thaw and may be experiencing unloading or decompression (as evidenced by the presence of talus slopes at the base of exposed bedrock), is more densely fractured than the deeper bedrock. The weathered and fractured near-surface bedrock is expected to transmit water more rapidly via secondary permeability (fracture flow).

Geologic structure may play a significant role in groundwater flow in bedrock. Faults can act as conduits for flow, barriers to flow, or both. The hydraulic characteristics of major structures, such as the Rock Lake Fault, have not been investigated. NMC obtained some information regarding the hydraulic behavior of the fractured rock during advancement of the Libby Adit, and MMC obtained additional information by performing hydraulic tests in discrete fractures in the Libby Adit. The data indicate that the hydraulic conductivity of the fractured rock decreases with depth and that the hydraulic conductivity of the relatively unfractured rock between fractures is very low.

The 3D model incorporated the assumption that mapped faults near the mine area have greater hydraulic conductivity than the surrounding bedrock. Faults incorporated into the model include the Moyie Thrust System (including Rock Lake Fault), Hope Fault, Snowshoe Fault and primary splay, Libby Lakes Fault and primary splay, Copper Lake Fault, and Moran Fault. Each fault was assigned decreasing permeability values with depth. The fault widths vary somewhat based on element size, but in general were between 150 and 330 feet (~50 and 100 meters) in width. The widths represented the fault core and adjacent damage zone based on geologic mapping of the surface and within the Libby Adit. Where information was available, faults were simulated in the

3D model with a plunging angle; otherwise, the faults were simulated as vertical and extending through all layers. Approximate plunge angles were taken from a cross-section along the Libby Adit for the Snowshoe Fault (53°) and Libby Lakes Fault (45°) (Geomatrix 2011a). Minor faults and fracture zones were represented by the bulk permeability used in the model.

The source of all water (surface water and groundwater) in the Cabinet Mountains is precipitation that falls within the mountain range. There are no regional aquifers beneath the range that derive their water from outside the range. Groundwater in the area is recharged by precipitation and snow melt that infiltrates to the subsurface through unconsolidated colluvial, glacial and alluvial deposits, and through open fractures and joints in exposed bedrock. Due to the topographic relief, the occurrence of more permeable surficial geologic deposits, and the low overall hydraulic conductivity of the bedrock, a significant component of the recharge migrates laterally through more permeable shallow flow systems that discharge to adjacent drainages. A small percentage of the total recharge percolates vertically to the deeper groundwater-bedrock system. It is likely that the more fractured rock associated with the prominent northwest trending regional fault zones provide preferential pathways for groundwater recharge to the deeper bedrock.

Recharge rates vary seasonally in response to snow melt and wetter and drier periods. The seasonal nature of recharge would result in variable flow rates in the higher permeability shallow fracture systems and surficial materials. Flow in deeper fractures would be less affected by variable recharge. At elevations higher than about 5,000 to 5,500 feet, the surficial deposits are nonexistent or relatively thin and discontinuous, but they may store and discharge infiltrated precipitation over the course of a year. In typical or dry precipitation years, it is likely that all groundwater drains from the deposits by the end of the summer season. In wetter years, groundwater may not fully drain by the end of the season.

In the upper Libby and Ramsey creek drainages, there are surficial deposits within some of the avalanche chutes that may store and transmit shallow groundwater through much of the summer, depending on residual snow pack at the head of each chute. Flow rates measured late in the season from upper Libby Creek are similar to the model predicted baseflow, indicating that there may be little if any contribution from surficial deposits late in the season of some years. This condition would vary from year to year, depending on snow pack and late season precipitation.

Two groundwater flow paths with different characteristics are assumed to be present in the analysis area: a deep path and a shallow path. The two paths likely result from the contrast between the very low hydraulic conductivity of the deeper fractured bedrock and the higher hydraulic conductivity of the shallow weathered bedrock and/or surficial deposits, and the difference between the infiltration rates of the deeper bedrock and shallow surficial material. The shallow and deeper flow paths do not appear to be hydraulically connected via a saturated zone above an elevation of about 5,000 to 5,600 feet. Groundwater may leak at low rates from the shallow more conductive deposits through vertically-oriented fractures that extend downward into fractured bedrock and eventually enter the deep groundwater flow path.

The observation that analysis area streams become perennial and bedrock springs occur consistently at an elevation of about 5,000 to 5,600 feet in the mine area indicates that a potentiometric surface has developed within interconnected fractures and the potentiometric surface appears to intersect the ground surface at an elevation of about 5,000 to 5,600 feet. The potentiometric surface most likely slopes upward beneath areas above 5,600 feet, subparallel to topography and may be 500 feet or more deep beneath the highest areas in the range (Figure 69). Springs exist above and below 5,000 to 5,600 feet elevation range. Those springs above this elevation range are assumed to be part of the shallow flow path and those below this elevation range are assumed to be connected to both flow systems. Below an elevation of between 5,000 and 5,600 feet, there are two distinct groundwater flow paths due to very different hydraulic conductivities, but the two flow paths are hydraulically connected. Shallow groundwater flows through shallow weathered and fractured bedrock and surficial material where present, and deeper groundwater flows through fractures in unweathered bedrock. In general, the deep, unweathered fractured bedrock has a much lower hydraulic conductivity than the shallow materials (Freeze and Cherry 1979). Figure 69 provides a 3D view of the mine area with typical groundwater flow directions.

Baseflow is defined as the volume of flow in a stream channel that is not derived from surface runoff but rather from groundwater seepage into the channel. Streams in the area may be at baseflow for about 1 to 2 months between mid-July to early October; periods of baseflow may also occur during November through March. Baseflow is maintained during the driest part of each year in the upper perennial reaches of each drainage by groundwater flowing from bedrock fractures. In the lower, flatter areas, groundwater also flows from thicker surficial deposits to stream channels. In the flatter areas, groundwater flowing from surficial deposits accounts for a much higher contribution to baseflow than that from bedrock fractures in the upper reaches. During the year, the ratio of the contribution of shallow groundwater to deeper bedrock groundwater to any one stream varies. When higher than normal precipitation occurs in later summer/early fall and/or when residual snow pack continues to melt through late summer/early fall, streamflow in the analysis area would contain surface runoff in addition to baseflow. Without continuous flow measurements, it may not be possible to know whether streamflow is reduced to only the baseflow contribution in any given year.

The agencies' field review of the East Fork Rock Creek drainage during the driest portion of 2007 (September) indicated that stream flow in East Fork Rock Creek above Rock Lake was the result of groundwater from bedrock springs. During the review, there was no surface water runoff or evidence that shallow springs maintained by snowmelt and/or recent rainfall had contributed any water directly to the drainage. At least one small spring was observed flowing down a bedrock wall near St. Paul Pass; the source of the spring's water was likely a small snowfield high on Rock Peak. It appeared that water from the spring did not enter the East Fork Rock Creek drainage as surface water, indicating that the spring water was either consumed by evapotranspiration and never reached the Rock Creek drainage or infiltrated via fractures into the bedrock, or some combination of both. Precipitation records from the SNOTEL site near Bear Mountain, Idaho, which is the site most representative of the upper Cabinet Mountains, indicate that the summer of 2007 had the second longest period (51 days) without precipitation since continuous precipitation data collection began in 1983. A bedrock spring from the Rock Lake Fault zone along the East Fork Rock Creek drainage above Rock Lake accounted for 100 percent of the flow in the stream, which was estimated at 30 to 40 gpm. No flow was observed in the drainage above this spring. Groundwater discharge to the stream started at an elevation of about 5,625 feet. At the time of the field review, bedrock groundwater appeared to be the sole source of water to Rock Lake. Streamflow gradually increased downstream from an estimated 40 to 50 gpm below Rock Lake to an estimated 1 cfs (450 gpm) within 0.5 miles and 2 cfs before the stream enters Rock Creek Meadows. Between Rock Lake and upstream from Rock Creek Meadows along the channel, there are few if any surficial material deposits. Other sources of water to Rock Creek Meadows include a tributary than joins East Fork Rock Creek from the southeast and possibly surficial deposits on the south side of the channel. These observations are consistent with the conceptual model of the mine area that deeper bedrock groundwater is connected to shallow groundwater and surface water at elevations below about 5,600 feet.

3.10.3.2 Tailings Impoundment Areas and LAD Areas

3.10.3.2.1 Site Hydrogeology

Groundwater occurs within the valley-fill deposits of the narrow mountain valleys. The deposits contain colluvial, alluvial, and glacial materials in a heterogeneous mixture of clay, silt, sand, and larger-sized particles. Valley-fill deposits follow the valley bottoms, are not extensive, and are discontinuous because bedrock crops out along the stream channel bottoms. Geophysical surveys indicate that the valley-fill deposits are 30 to 70 feet thick at the Libby Adit Site, and 24 to 70 feet thick at the Ramsey Plant Site. Groundwater was encountered within the valley-fill deposits during drilling, at depths of 12 to 16 feet at the Libby Adit Site and at 22 feet at the Ramsey Plant Site.

The valley-fill systems are recharged by precipitation, streamflow, and subsurface discharge from bedrock groundwater systems. Groundwater flow follows the topography along the valley bottoms. The valley-fill discharges to surface water, or to more extensive glaciofluvial and glaciolacustrine deposits, along the mountain front.

At the tailings impoundment sites, the Libby Plant Site, and the LAD Areas, groundwater occurs as saturated zones in the surficial deposits, and as a regional water table in the underlying bedrock. The saturated zones in the unconsolidated glaciofluvial and glaciolacustrine deposits are subject to varying degrees of confinement. Perched saturated zones are the result of interfingering of relatively impervious clayey silt within more pervious sediments (Morrison Knudsen Engineers 1990). The thickness of surficial sediments at the Little Cherry Creek Tailings Impoundment Site ranged from 10 feet at the South Saddle Dam to over 360 feet in a buried channel beneath the proposed Main Dam (Klohn Crippen 2005). Depth to bedrock is not well defined with the Poorman site. Based on a resistivity survey and available borehole data, the thickness of the unconsolidated deposits generally is 100 to 200 feet within the Poorman Impoundment footprint (NewFields 2014a). The glacial deposits form a wedge along the eastern flank of the Cabinet Mountains, beginning at an elevation of about 4,000 feet and increasing in depth away from the mountains. The glaciofluvial and glaciolacustrine deposits are interfingered (having a boundary that forms distinctive wedges, fingers, or tongues between two different rock types) and, at many locations, glaciolacustrine deposits overlie glaciofluvial deposits. The glaciolacustrine deposits are finer-grained than glaciofluvial deposits and act as a barrier to groundwater flow, and therefore behave locally as a confining layer. In the Little Cherry Creek Tailings Impoundment Site, a buried preglacial valley underlies the glaciolacustrine deposits. This valley is filled with over 370 feet of fluvial sediments similar to the glaciofluvial deposits.

The glaciofluvial/glaciolacustrine groundwater system at both impoundment sites is recharged by precipitation, discharge from fractured bedrock, and streamflow along the flank of the mountains. Groundwater flow at both potential impoundment sites is generally easterly following the surface topography (Figure 70). Surface topography appears to be controlled by a subsurface bedrock surface, which according to geophysical surveys performed in the two impoundment areas (Chen Northern 1989), is very similar to the surface topography. As a result, the low permeability bedrock influences groundwater flow direction, such as the apparent subsurface bedrock ridge that separates the two impoundment areas (Chen Northern 1989). Corresponding to the subsurface bedrock ridge, there appears to be a groundwater divide that separates groundwater flow to the north and south of the ridge.

The water table or potentiometric surface gradient (hydraulic gradient) is low in both the Little Cherry Creek and Poorman Tailings Impoundment sites (0.05 and 0.07, respectively). Groundwater flow in the impoundment sites is to the east, following the surface topography. Groundwater at the Little Cherry Creek Tailings Impoundment Site discharges to Little Cherry Creek and eventually to the alluvium of Libby Creek. Some flow may discharge to Libby Creek via the deep buried alluvial channel. Groundwater beneath the Poorman Tailings Impoundment Site also flows to the east along topography and discharges to the alluvium of either Libby or Poorman creeks. Both sites have areas of potential artesian flow in the lower portions of the impoundment footprints due to low permeability clay layers. Some of the water flowing beneath the Little Cherry Creek Impoundment Site discharges as springs in the proposed site and downstream along Little Cherry Creek. Springs also are found at the Poorman Impoundment Site, upgradient of the Main Dam crest.

In addition to those along the Little Cherry Creek channel, groundwater discharge from the glacial deposits in the lower portion of the valley supports large areas of wetland vegetation. Groundwater discharges as discrete springs, many of which have been identified, and as diffuse flow over larger areas where the water table intersects the ground surface. The groundwater supported wetland areas are the result of discharge from both shallow perched groundwater and deeper confined water-bearing zones where the confining layer is thin or missing due to erosion. Similar springs are in the Poorman Impoundment Site, but they are less numerous and do not appear to support extensive wetland areas, as observed in the Little Cherry Creek drainage. The difference may be the result of steeper topography and less seasonally reliable groundwater discharge to the surface.

Groundwater in the LAD Areas discharges to Ramsey, Poorman, or Libby creeks. Of the wells established in the LAD Areas, one exhibited artesian heads above the ground surface. Based on the available groundwater data, the hydraulic gradient in the LAD Areas is about 0.06.

Aquifer tests were conducted in the glaciofluvial deposits and in the filled channel in the tailings impoundment sites. The hydraulic conductivity of the glaciofluvial deposits in the Little Cherry Creek watershed ranges from 1×10^{-6} to 1.9×10^{-3} cm/sec (0.0028 to 5.3 ft/day) (Geomatrix 2006c). Estimates of the hydraulic conductivity of channel fill (alluvium along Libby Creek) range from 0.053 to 0.18 cm/sec (150 to 500 ft/day) (Geomatrix 2006c). In the Poorman Tailings Impoundment Site, the hydraulic conductivity of the glaciofluvial deposits ranges from 1.3×10^{-4} to 6.8×10^{-3} cm/sec (0.37 to 19.4 ft/day) and averages 2.6×10^{-3} cm/sec (7.35 ft/day), based on six aquifer tests reported by Chen-Northern (1989).

The glaciofluvial deposits are capped by relatively impermeable glaciolacustrine units. The deposits allow hydraulic pressures to build and create the confined or artesian flow conditions observed at the Poorman and Little Cherry Creek Tailings Impoundment sites. The water levels observed in monitoring wells at the tailings impoundment sites are quite variable, ranging from beneath the bedrock-soil contact to above the ground surface, indicating artesian conditions along the lower portions of the valleys. It is not known whether the low permeability fine-grained material in the Poorman Tailings Impoundment Site is laterally connected to the glaciolacustrine type deposits found in the Little Cherry Creek drainage, but the units appear to function in the same manner.

Hydraulic conductivities of the glaciolacustrine deposits in the Little Cherry Creek Tailings Impoundment Site range from 1 x 10^{-6} to 2.6 x 10^{-5} cm/sec (0.003 to 0.075 ft/day) (Geomatrix 2006c). Although saturated, the fine-grained glaciolacustrine deposits did not yield measurable water in the boreholes. No aquifer tests were performed on the fine-grained deposits in the Poorman Tailings Impoundment Site. Due to similarities in subsurface geology, the range of hydraulic conductivity values in the Poorman area is probably similar to those measured in the Little Cherry Creek drainage.

Most of the springs identified in the proposed facility areas occur in the Little Cherry Creek and Bear Creek drainages, or the Poorman Tailings Impoundment Site between Little Cherry Creek and Poorman Creek (Table 98 and Figure 69). All of the identified springs have measured flows of less than 5 gpm, except for the spring near the Libby Adit that was measured at 9 gpm. Some of the springs cease flowing in mid- to late-summer. Ten additional springs or seeps not shown in Table 98 (SP-31 through SP-40 shown on Figure 69) were identified in the Poorman Tailings Impoundment site in 2011 (Kline Environmental Research 2012). The flow rate of these springs has not been measured and they are not included in Table 98. Additional springs may be identified in the upper portions of the watershed during future GDE surveys (see Appendix C).

3.10.3.2.2 Conceptual Hydrogeological Model for the Proposed Tailings Impoundments Areas

Groundwater that occurs in the proposed impoundment areas is the result of infiltration of precipitation within each watershed and groundwater flow from the underlying fractured bedrock into the surficial deposits. For pumpback well analysis, Geomatrix (2010c) used an infiltration rate of 14 percent. The majority of the total precipitation either runs off as surface water or percolates into the soil where it is either evaporated or transpired by vegetation. The portion of the infiltrated water that continues to move downward eventually reaches the saturated zone where groundwater moves downhill from the upper elevations to areas of lower elevation along the drainages.

An unconfined saturated zone develops in the glaciofluvial gravels within the upper and middle reaches of each impoundment area. As the groundwater flows beneath the younger glacio-lacustrine silts, the groundwater system changes from an unconfined potentiometric surface to a confined system, due to the low vertical hydraulic conductivity of the fine-grained silts. Due to the confinement, artesian pressures develop, such that groundwater would flow vertically upward to the surface via wells and springs. Springs probably occur where the glaciofluvial deposits are thin or discontinuous due to erosion. Short-lived springs (those that only flow during high precipitation periods or during periods of snowmelt) may be the result of groundwater perched above the glaciolacustrine deposits. The finer grained deposits not only restrict upward vertical groundwater flow but also downward vertical flow, and therefore may perch groundwater locally.

3.10.3.3 Groundwater Use

Private land immediately within the Little Cherry Creek Tailings Impoundment Site in Alter-natives 2 and 4 is owned by MMC. Private land immediately downgradient of LAD Area 2 in Alternatives 2 and 4 and downgradient of the Poorman Impoundment Site in Alternative 3 is not owned by MMC. No groundwater users have been identified in the analysis area. Section 3.12, *Water Rights* discusses analysis area water rights.

Table 98. Flow Measurements and Elevations for Springs in the Proposed Facility Areas.

Spring ID	Location	Elevation (feet)	Flow Rate (gpm)	Number of Measure-ments	Date Range of Measure-ments
SP-01	North of Little Cherry Creek Impoundment Site	3,500	2-3 (estimated)	1	6/88
SP-02	Little Cherry Creek Impoundment Site	3,320	1-2 (estimated)	1	6/88
SP-10	Little Cherry Creek Impoundment Site	3,350	1 (estimated)	1	Unknown
SP-11	Near Bear Creek	3,370	0.5 (estimated)	1	Unknown
SP-12	Little Cherry Creek Impoundment Site	3,390	Seep	1	Unknown
SP-13	Little Cherry Creek Impoundment Site	3,410	Unknown	1	Unknown
SP-14	Near Libby Creek	3,350	0.2 (estimated)	1	Unknown
SP-15	Little Cherry Creek Impoundment Site	3,420	1.5-2 (estimated)	1	Unknown
SP-17	Little Cherry Creek Impoundment Site	3,560	0.5 (estimated)	1	Unknown
SP-18	Little Cherry Creek Impoundment Site	3,550	2 (estimated)	1	Unknown
SP-19	North of Libby Plant Site	3,950	Dry to 9	2	1992 – 09/09
SP-20	Near Ramsey Creek south of LAD Area	3,850	<1-4	1	Unknown
SP-21	Between LAD Areas	3,800	1	1	8/07
SP-22	Ramsey Adit Site	4,240	<3	1	Unknown
SP-23	Little Cherry Creek Impoundment Site	3,680	<5	1	Unknown
SP-24	Little Cherry Creek Impoundment Site	3,450	<3	1	Unknown
SP-25	South of Libby Plant Site	3,840	3-5	2	8/07 – 9/09
SP-26	Poorman Impoundment Site	3,320	0.5-10	2	8/07 and 10/12
SP-27	Poorman Impoundment Site	3,840	2	1	8/07
SP-28	Poorman Impoundment Site	3,500	4	1	8/07
SP-29	Poorman Impoundment Site		10	1	10/12
SP-30	Poorman Impoundment Site	3,420	5	1	8/07

gpm = gallons per minute.
Springs in the Little Cherry Creek or Poorman Impoundment Sites are shown on Figure 69.
Source: Geomatrix 2006b, 2006d, 2009b, 2010b; NewFields 2013a; McKay, pers. comm. 2007.

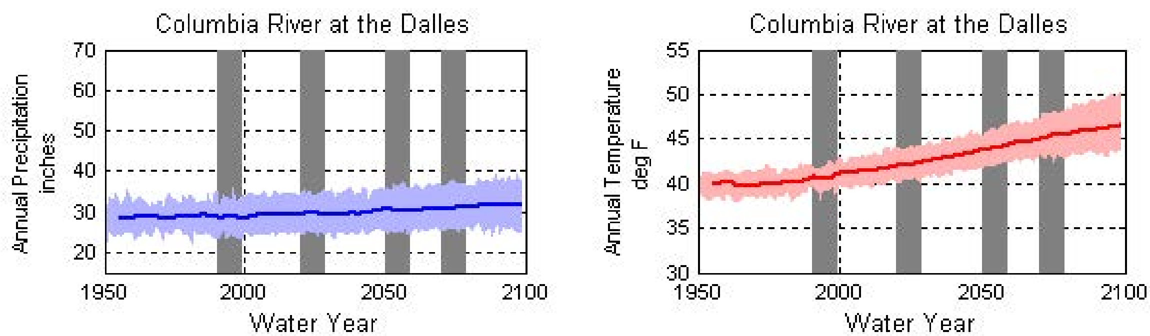
3.10.3.4 Climate Change

Climate models considered in the KIPZ Climate Change Report are unanimous in projecting increasing average annual temperatures over the coming decades in the Pacific Northwest. The KIPZ Climate Change Report indicated annual temperatures will increase 2.2° F by the 2020s and 3.5° F by the mid-21st century, compared to the average for 1970 to 1999. Temperature increases are projected to occur during all seasons, with the greatest increases projected in summer. Beyond mid-century, model projections diverged substantially, with increases in average annual temperature ranging from 5.9°F to 9.7°F in the Pacific Northwest by the end of the 21st century.

Projected changes in Pacific Northwest precipitation are more variable among models, but generally suggest no substantial change in the average annual precipitation from the variability experienced during the 20th century. Given the variability in results among models, projections of precipitation are considered less certain than temperature projections. Most of the models project decreases in summer precipitation, increases in winter, and little change in the annual mean (USDA Forest Service 2010a).

Reclamation's synthesis was similar; air temperatures throughout the Columbia River Basin may increase steadily, with basin-average mean-annual temperature predicted to increase by 6 to 7°F by the end of the 21st century (Chart 14). Variation in annual air temperatures also is projected to increase slightly through time. Increased air temperatures may increase water temperatures (Reclamation 2011c). Mean annual precipitation, averaged over the Columbia River basin, is not expected to change significantly through the 21st century. Precipitation is projected to remain relatively static during the early 21st century and then slightly increase during the last half of the 21st century (Chart 14). Variation in annual precipitation also is projected to increase slightly through time (Reclamation 2011c).

Chart 14. Simulated Annual Climate Averaged over the Columbia River Basin.



Annual conditions represent spatially averaged results over the basin. Darker colored lines indicate the median-annual condition through time, sampled from 112 climate simulations, and then smoothed using a 5-year running average. Lighter-colored areas represent the time-series range of 10th to 90th percentile annual values from simulated 1950 through simulated 2099.
Source: Bureau of Reclamation 2011c.

For the Columbia River Basin in general, warming is expected to diminish the accumulation of snow during the cool season (late autumn through early spring) and the availability of snowmelt to sustain runoff during the warm season (late spring through early autumn). Increased rainfall in December through March is expected to increase runoff during those months. Decreased snow-pack volume could result in decreased groundwater infiltration, decreased spring/summer snow-pack runoff, increased rain-on-snow events, and ultimately decreased contribution to baseflow in streams (USDA Forest Service 2010a; Reclamation 2011c).

Decreases in snowpack are expected to be more substantial in the portions of the basin where existing cool season temperatures are closer to freezing thresholds and more sensitive to projected warming. Runoff effects would vary by location, depending on baseline climate and the predicted temperature and precipitation changes (Reclamation 2011a). In the more northern subbasins, increases in precipitation, either as rainfall or snowfall, may offset the effects of decreased warm season runoff due to warming. The projected slight increase in precipitation in the last half of the 21st century may offset changes in baseflow in areas sufficiently cold to experience projected warming without loss of snowpack, such as the northern and higher elevation eastern portions of the basin (Reclamation 2011c).

3.10.4 Environmental Consequences

3.10.4.1 Alternative 1 – No Mine

The No Mine alternative would not change groundwater levels or baseflow. Disturbances on private land at the Libby Adit Site and changes in baseflow and groundwater levels would remain until the adits were plugged and the site reclaimed in accordance with existing permits and approvals. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ's approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land that did not affect National Forest System lands.

3.10.4.2 Alternative 2 – MMC's Proposed Mine

3.10.4.2.1 Evaluation through Operations Phases

Mine Area

In all action alternatives, the mine plan would include an underground mine and three adit declines. The mine void would be the same in all action alternatives. In Alternative 2, two adits would originate in the Ramsey Creek drainage, and the existing Libby Adit would be used for ventilation. The mine and adits would intersect saturated fractures and faults in the bedrock and, therefore, would produce groundwater at various rates. Mine and adit inflows would be pumped from underground structures and used for processing ore.

Possible effects of Alternative 2 on groundwater hydrology are lowering of groundwater levels and changes in baseflow in adjacent drainages. A detailed discussion of the effects of Alternative 2 on the hydrogeology was provided in the Draft EIS, based on the agencies' 2D numerical model. Subsequent analyses (the MMC 3D model) were based on facilities associated with Alternative 3. With respect to the hydrogeology of the mine area, the only difference between Alternatives 2 and 3 would be the location of the adits. In Alternative 3, all of the adits would be constructed in the Libby Creek drainage, rather than locating two adits in the Ramsey Creek drainage. A discussion of the effects of mining on the hydrogeology is provided in the discussion of Alternative 3 (section 3.10.4.3). The effect of Alternative 3 would be very similar to the effects of Alternative 2, with two exceptions. Alternative 2 would result in more drawdown in the Ramsey Creek watershed and less drawdown in the Libby Creek watershed upstream of Ramsey Creek compared to Alternatives 3 and 4. As a result, the predicted change in baseflow due to mine dewatering would be slightly greater in Ramsey Creek and slightly less in Libby Creek upstream of Ramsey Creek than predicted for Alternatives 3 and 4. Based on preliminary estimates of hydraulic properties of the bedrock and Rock Lake Fault, Evaluation Phase mining activities in Alternatives 3 and 4 would be limited to within 300 feet of the Rock Lake Fault and 1,000 feet of Rock Lake to minimize the risk of high water inflow rates and resulting reduction in groundwater levels.

Tailings Impoundment Area

Groundwater Drawdown and Changes in Baseflow

The Little Cherry Creek Tailings Impoundment is designed with an underdrain system to collect seepage from the tailings and divert intercepted water to a Seepage Collection Pond downgradient of the impoundment. After being discharged into the impoundment, the tailings would consolidate, and water would pool in a reclaim water pond within the tailings impoundment. Water from the reclaim water pond would be pumped back to the mill, but some would percolate downward and be captured by the underdrain system. Some of the percolating water would seep into the underlying fractured bedrock aquifer. Geotechnical investigations near the Seepage Collection Pond indicate that bedrock is fractured at the surface in the Little Cherry Creek channel beneath the proposed Seepage Collection Dam and farther downstream (Morrison-Knudsen Engineers, Inc. 1990). The Seepage Collection Pond may intercept some of the tailings seepage in the fractured bedrock aquifer. Because bedrock crops out downstream of the proposed dam location, tailings seepage in the fractured bedrock aquifer not intercepted by the Seepage Collection Pond or captured by a pumpback well system, depending on its design, would likely flow into the former Little Cherry Creek channel (USDA Forest Service 2008). Some of the seepage may flow to Libby Creek via a buried channel beneath the impoundment site. Klohn Crippen (2005) estimated 80 percent of the existing groundwater flows toward Little Cherry Creek and 20 percent flows toward Libby Creek via the buried channel. Any tailings seepage is likely to follow existing groundwater flow paths if not intercepted.

Tailings seepage not collected by the underdrain is expected to flow to groundwater at a rate of about 25 gpm and, after the impoundment is reclaimed, slowly decrease to 5 gpm (Klohn Crippen 2005). The operational seepage estimate was verified by the lead agencies in their independent analysis (USDA Forest Service 2008). The estimated groundwater flux (volume per unit time) beneath the impoundment was estimated to be about 35 gpm (Geomatrix 2007b) using a DEQ standard mixing zone thickness of 15 feet (ARM 17.30.517) and a hydraulic conductivity for the impoundment area of 0.4 ft/day. A conductivity value of 0.4 ft/day is higher than the mean values reported by Klohn Crippen (2005) to estimate tailings seepage for glacial till beneath the Little Cherry Creek Impoundment Site (0.1 ft/day) and for fractured bedrock (0.3 ft/day). The saturated zone beneath the impoundment would be able to accommodate the addition of about 25 gpm from seepage and would respond with a rising water table (slightly increasing the hydraulic gradient) to convey the additional water from beneath the impoundment. Little Cherry Creek appears to be a gaining stream downgradient of the proposed impoundment based on streamflow measurements and the occurrence of numerous springs.

MMC committed to implementing seepage control measures, such as pumpback recovery wells, if required to comply with applicable standards. Seepage pumpback wells could be installed along the downstream toe of the tailings dam. Given the heterogeneity of the foundation soils, additional wells could be required to ensure that all flow paths were intercepted. The wells may require active pumping, depending on the artesian pressures within the wells (Klohn Crippen 2005). The presence of a buried channel in the Little Cherry Creek site and the construction of saddle dams adjacent to the Little Cherry Creek Diversion Channel would likely require a more complex pumpback well system than required at the Poorman site. Drawdown resulting from a pumpback well system would also reduce baseflow in adjacent streams, such as Bear Creek and the diverted Little Cherry Creek. The estimated depletion to the Libby Creek drainage from the pumpback wells, based on the estimated pumping rate for the Poorman Impoundment Site, would be 0.55 cfs. The actual depletion would be directly related to the actual pumping rate, which would be determined after performing additional aquifer tests.

Springs and Seeps

Numerous springs and seeps were identified in the area surrounding the Little Cherry Creek Impoundment Site (Figure 70) (Geomatrix 2006b, 2009b; Kline Environmental Research 2012). Springs SP-15, 23, and 24 would be covered by the impoundment, and a fourth spring (SP-10) would be covered by the Seepage Collection Pond. Three other springs would be in the disturbance area. Seeps in Little Cherry Creek also would be covered by the impoundment. A pumpback well system required to capture seepage not collected by the underdrain system would lower groundwater levels and reduce groundwater discharge to springs, seeps, and wetlands surrounding of the impoundment. Ten known springs outside of the disturbance area may be affected by the pumpback well system. Operation of a pumpback well system, if installed, may not affect water levels and five of the springs south of Little Cherry Creek because of an apparent subsurface bedrock ridge that separates groundwater flow between the watershed of Little Cherry Creek from those of Drainages 5 and 10 in the Poorman Impoundment Site (Chen Northern 1989).

LAD Areas

MMC anticipates the LAD Areas would be able to receive 558 gpm of water (Geomatrix 2007b). There are several considerations for disposal of water on the LAD Areas to avoid runoff from the LAD Areas and minimize the risk of developing springs and seeps downgradient of the LAD Areas. The two basic issues are:

- The maximum application rate that would not result in runoff from the site given site characteristics.
- The maximum application rate that could be conveyed away from the LAD Areas by the existing groundwater system.

The EPA (2006b) and the Corps (1982) published guidelines for the design and operation of LAD Areas that address the first issue. The guidelines provide recommended design percolation rates that consider long-term issues such as wetting and drying cycles, clogging of the soil, etc. Using the guidelines, the maximum application rate that would not result in surface runoff for the LAD Areas is 344 gpm.

The existing groundwater flux beneath the LAD Areas was estimated to determine the capacity of the underlying shallow aquifer to receive and transport additional water. The agencies initially estimated a groundwater flux of 141 gpm, based on the following assumptions:

- Maximum saturated thickness of 56 feet (as reported in well logs), which is greater than the 15 feet using the dispersion assumptions in ARM 17.30.517 for standard mixing zones, but represents actual conditions to the maximum drilled depth
- Mixing zone width beneath the LAD Areas of 6,860 feet, which is increased to 8,060 feet using the dispersion assumptions in ARM 17.30.517 for standard mixing zones, where the mixing zone width is equal to the width plus the distance determined by the tangent of 5 degrees times the length of the LAD Area on both sides
- Existing hydraulic gradient of 0.06 (Geomatrix 2007b)

- A hydraulic conductivity value of 1 ft/day reported by Geomatrix (2007b)

The estimated groundwater flux using the reported hydraulic conductivity value requires an unrealistic net infiltration of precipitation rate of about 52 percent of annual precipitation to maintain the groundwater flux of 141 gpm through the defined cross sectional area. It is likely that the average hydraulic conductivity value used in the calculation is too high and does not reflect site conditions. The groundwater flow direction is generally perpendicular to surface topography contours or downslope and, therefore, groundwater recharge is local and discharge is to the adjacent streams. A small fraction of the total net infiltration may travel along deeper flow paths in the fractured bedrock.

The hydraulic conductivity of 1 ft/day is the only value in the flux calculation that was not directly measured, but rather was selected by MMC as being more representative of the LAD hydraulic conductivity than the value derived from pit tests. The agencies reduced the hydraulic conductivity value slightly to achieve a groundwater flux that is consistent with a reasonable net infiltration rate. The agencies considered 10 percent to be a reasonable net infiltration value to use in the flux calculation for three reasons. In the tailings impoundment design report, Klohn Crippen (2005) indicated "groundwater recharge from infiltration [at the Little Cherry Creek Impoundment Site] was estimated to be 10 percent of yearly precipitation. Infiltration rates could be as low as 5 percent and are not expected to be greater than 12 percent. The relatively low precipitation and forest cover suggest that 10 percent should be the maximum infiltration." MMC also used a 10 percent infiltration rate in the SEEP/W analysis (Klohn Crippen 2005) to model seepage from the Little Cherry Creek Tailings Impoundment; the agencies' used the same rate in their independent SEEP/W analysis (USDA Forest Service 2008). The LAD Areas are 2 miles south of the Little Cherry Creek Tailings Impoundment and have similar geology. A 10 percent infiltration rate in areas of less than 30 percent slope also was used in the agencies' numerical groundwater model (ERO Resources Corp. 2009).

An infiltration rate of 10 percent would support a groundwater flux of 31 gpm for the LAD Areas. This is similar in magnitude to what was calculated by MMC for the groundwater flux through a similar cross sectional area beneath the Little Cherry Creek Tailings Impoundment (35 gpm). Using a groundwater flux of 31 gpm (rather than 141 gpm) requires the hydraulic conductivity to be lower (0.22 ft/day) because the other variables in the equation are fixed (gradient and cross sectional area). A conductivity value of 0.22 ft/day is slightly higher than the mean value for glacial till beneath the Little Cherry Creek Impoundment Site (0.1 ft/day) reported by Klohn Crippen (2005).

The agencies calculated the maximum amount of water that could be conveyed away from the site using a hydraulic conductivity value of 0.22 ft/day, and assuming the water table could rise to within about 10 feet of the surface beneath the LAD Areas. The agencies assumed the water table should remain 10 feet below ground surface beneath the LAD Areas so there would be sufficient unsaturated zone to receive the percolating applied water. Because the cross-sectional area and aquifer characteristics would not change during LAD operation, the hydraulic gradient would steepen to allow more water to flow away (downgradient) from the LAD Areas. The increased gradient is estimated to be 0.122. The calculated gradient value of 0.122 is assumed to be the maximum possible gradient with a depth to groundwater of 10 feet beneath the LAD Areas. The agencies estimate the groundwater flux (preexisting groundwater flux plus infiltrated application water) is about 63 gpm, or about 32 gpm of LAD applied water (the difference between maximum possible flux (63 gpm) and the pre-application groundwater flux (31 gpm)). Factoring in precipitation and evapotranspiration, the total maximum application rate to the LAD Areas would be about 130 gpm for a LAD Area of 200 acres (Appendix G).

The estimated application rate of 130 gpm that could be conveyed from the LAD Areas is more restrictive than 344 gpm, a rate the agencies calculated using the EPA and Corps guidelines to avoid runoff (EPA 2006b; Corps 1982). To reduce the likelihood that springs and seeps would develop downgradient of the LAD Areas or that the water table would come to the surface in the LAD Areas, the agencies estimate the maximum application rate would be 130 gpm (for the 200 acres proposed by MMC for land application at LAD Areas 1 and 2). MMC's proposed application rate of 558 gpm would likely result in surface water runoff and increased spring and seep flow on the downhill flanks of the LAD Areas.

The agencies estimated a groundwater velocity and travel time between the LAD Areas and the nearest surface water body to aid in planning downgradient groundwater monitoring. Using a range of effective porosity values of 1 to 10 percent, ground velocity is calculated to range from about 100 feet per year to 1,000 feet per year. Assuming the nearest stream is about 800 feet downhill from the LAD Areas, the groundwater travel time is estimated to be between less than 1 year and 8 years. This calculation does not consider the existence of preferential flow paths that would allow for higher groundwater velocities, and a possible shorter travel time.

MMC proposed an alternate set of values for hydraulic conductivity (0.3 ft/day) and cross-sectional width (15,000 feet) in calculating the maximum application rate (Geomatrix 2008a). Because of the subsurface data available for the LAD Areas, it is not possible to refine the estimated application rate beyond what is presented in this EIS. Therefore, the analysis presented in this EIS uses more conservative assumptions versus what was suggested by MMC. The maximum application rate would depend on the site conditions, and would be determined on a performance basis by monitoring both water quality and quantity changes to the existing groundwater system. It is possible that monitoring would determine that the maximum application rate would be higher or lower than estimated by this analysis. The LAD application rates would be selected to ensure that groundwater did not discharge to the surface as springs between the LAD Areas and downgradient streams.

The discharge rate of the existing spring (SP-21 shown on Figure 70) between the two LAD Areas may increase as a result of land application of excess water. The proposed application rate of 558 gpm would likely result in increased flow from springs and seeps located downhill of the LAD Areas. The analysis described above indicates that the LAD Areas could not accept the proposed application rate of 558 gpm without a risk of runoff from the site and increased spring flow due to rising water levels. If the LAD Areas were operated at the maximum application rate of 130 gpm, as indicated by this analysis, and the evaporation and precipitation rates assumed in the calculation were representative of site conditions, the number of springs and/or seeps downgradient of the LAD Areas should not increase. Springs or seeps could develop because of unidentified geologic heterogeneities that would result in preferential flow paths to the surface. An increase in groundwater levels beneath the LAD Areas as a result of applying a maximum of 130 gpm would have no adverse impacts, with the exception of possible preferential flow paths that could result in increased spring activity.

Make-up Water Wells

If total mine/adit inflow were not adequate to supply water for process purposes, MMC would likely install groundwater wells for make-up water. MMC has not identified specific well locations; the most likely location would be along a major drainage, such as Libby Creek. The amount of make-up water required would depend primarily on mine inflows, water production from tailings impoundment pumpback wells, and precipitation at the impoundment site. The water balance for Alternative 2 indicates that up to 150 gpm of additional water on an annualized basis would be required during the Operations Phase to meet mill needs (Table 14). MMC would not be able to beneficially use any diversions from Libby Creek whenever flow was less than 40 cfs at LB-2000. Consequently, additional diversions for make-up water beyond that shown in Table 14 would be needed to avoid adversely affecting senior water rights. Because MMC would not withdraw any surface water (via groundwater pumping) for operational use whenever flows at the point of withdrawal were less than the average annual low flow, groundwater pumping would likely be restricted to the period between April and July, and would pump at rates up to 450 gpm.

Groundwater withdrawals from Libby Creek alluvium would decrease groundwater level near the pumping wells while the wells were in operation. Because of the relatively high hydraulic conductivity of the alluvium and the hydraulic connection with the active stream, groundwater levels in the alluvium is expected to fully recover between periods of pumping. Groundwater levels downgradient of the pumping wells would decrease while the wells were pumped. Appropriately designed, located, and operated make-up wells providing up to 450 gpm would not substantially reduce upgradient alluvial groundwater levels. If the well field were located in the vicinity of the proposed pumpback well system, the make-up wells would increase the area and magnitude of the predicted drawdown cone, when in operation.

3.10.4.2.2 Closure and Post-Closure Phases

Mine Area

A detailed discussion of drawdown during the Post-Closure Phase for Alternative 2 predicted by the 2D model was provided in the Draft EIS. Because MMC's 3D model analysis was developed for Alternative 3, a detailed discussion of closure and post-closure drawdown is provided in the Alternative 3 section (section 3.10.4.2.3). The predicted post-closure drawdown for Alternative 2 would be slightly greater than with the agencies' mitigation incorporated into Alternatives 3 and 4. The time it would take for water levels to reach equilibrium or steady state conditions would be shorter than Alternatives 3 and 4.

Tailings Impoundment Area

During the Closure and Post-Closure Phases, the seepage collection and pumpback well systems would continue to operate until any ongoing seepage met BHES Order limits or applicable nondegradation criteria in all receiving water. After seepage met BHES Order limits or nonsignificance criteria of all receiving waters, operation of the pumpback wells would be terminated and the wells plugged and abandoned. Groundwater levels would fully recover in a relatively short period of time (on the order of weeks to a few months). After groundwater levels recovered, springs that were buried by the impoundment, such as SP-23 and SP-24, may again flow, but into the impoundment's gravel underdrain system. Any springs outside of the impoundment footprint affected by the pumpback wells would likely return to pre-mine conditions and may contribute to baseflow to channels outside of the impoundment.

LAD Areas

The LAD Areas would continue to be operated during the Closure Phase, if necessary, to dispose of excess water in the impoundment. Operation of LAD Areas during the Closure Phase would be consistent with guidelines and requirements developed during the Operations Phase. The length of time that these activities would occur is not known, but may be decades or more. After disposal of excess water was no longer necessary, the LAD Areas would be reclaimed and water levels would return to pre-mine conditions.

3.10.4.2.3 Climate Change

The combined impacts of Alternative 3 and climate change were not quantified because of the possible range in effects of climate change on groundwater resources. It is difficult to predict how the hydrologic systems in the Montanore Project analysis area would respond to the forecasted regional effects of climate change. The Bureau of Reclamation (2011c) states that "the projected changes have geographic variation; they vary through time, and the progression of change through time varies among climate projection ensemble members" and that "some geographic complexities of climate change emerge over the Columbia River Basin when climate projections are inspected location by location." The KIPZ Climate Change Report (USDA Forest Service 2010a) described several key sources of uncertainty associated with estimating hydrologic responses of individual sub-basins and watersheds to projected climate changes, including:

- "Hydrologic models often rely on output from global and regional climate models to evaluate potential hydrologic effects. Global climate models have relatively poor skill in simulating regional and local-scale precipitation, due in part to their coarse spatial resolution and limited ability to account for local topographic influences on the hydrologic processes of small to medium sized watersheds (*e.g.*, 6th and 5th hydrologic unit codes).
- There is limited availability of locally-specific field data and analyses on the relative influence of temperature, precipitation, elevation, dust, and black soot on observed snowmelt and runoff trends in mountainous areas.
- We currently lack multiple, high-resolution regional climate models that can resolve fine-scale circulation patterns, snow-albedo feedback, and other environmental features that influence hydrologic processes."

The following paragraph describes potential effects of Alternative 2 and climate change for a range of trends.

Depending on the extent and location of reduced snowpack, groundwater infiltration could decrease in some parts of the analysis area, which could lower the groundwater table and potentially reduce groundwater flow to wilderness lakes. Decreased groundwater infiltration could reduce the project's mine and adit inflows. Because baseflow to streams may also decrease, the percentage change to stream baseflow may remain the same. If mine and adit inflows decreased, discharges to Libby Creek would be less and makeup water requirements would increase. The Bureau of Reclamation (2011c) predicted that climate change would reduce the accumulation of snow and increase runoff in the winter and reduce summer and fall runoff and baseflow in the Columbia River Basin. If climate change did not reduce infiltration enough to change mine and adit inflows from those projected without climate change, any increase in winter flows due to climate change would moderate the effect of mine inflows during the winter low flow periods, and any decrease in fall flows would magnify the effect of mine inflows during the fall low flow periods. As described in Appendix C, MMC would monitor mine inflows and monitor changes in baseflow at potential impact area sites and benchmark sites (similar to project area sites, but outside the area of potential mine impacts) to evaluate baseflow trends due to mining compared to trends due to non-mining effects such as climate change.

3.10.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

The following discussion for Alternative 3 describes mining activities and their potential impacts on the site groundwater hydrology through the five phases of mining and closure. In some cases, phases are combined in the discussion because of the similarities in effects between sequential phases. The 3-D hydrologic analysis was performed with and without two specific mitigations (partial grouting and bulkheads). The effectiveness of grouting and leaving barrier pillars with limited constructed bulkheads at access openings, and other possible mitigations, such as increased buffer zones between Rock Lake and the Rock Lake Fault, are discussed in section 3.10.4.3.6, *Effectiveness of Agencies' Proposed Monitoring and Mitigation*.

In general, the effects on the groundwater hydrology and related changes in stream baseflow would gradually increase through the Construction, and Operations Phases, as mine inflow increased due to increased mine void volume. Also, because of the low overall permeability of the bedrock, the groundwater system would be somewhat slow to respond to dewatering. Impacts on groundwater hydrology, as indicated by drawdown and related changes in stream baseflow are predicted to reach a maximum after mining ceased (in the Post-Closure Phase) and then slowly recover, reaching steady state conditions 1,150 to 1,300 years after mining ended.

3.10.4.3.1 Evaluation through Operations Phases

Mine Area

The two numerical models were used to approximate where and to what degree groundwater drawdown could occur, and to estimate changes in baseflow for drainages flowing from the area to be mined. The 3D model was configured to simulate the location of mine void and adits proposed in Alternative 3.

Mine and Adit Inflows

As mining activity progressed through the Evaluation, Construction, and Operations Phases, the average mine inflow would increase with predicted short-term spikes in flow as new adits and mine areas were opened (Figure 71). At full build out, the 2D numerical groundwater model predicted that the total steady state inflow to the mine and adits would be about 450 gpm (for the fault scenario, as defined in the 2D model). The 3D model provides considerable detail concerning predicted inflows during the various phases of mining, providing both average and stabilized dewatering rates. The dewatering rate at full mine build out during the 22-year life of mine (Evaluation through Operations Phases) is predicted by the 3D model to be about 370 gpm, with possible short-term inflow peaks of nearly 800 gpm during the mine Construction Phase (Figure 71). The short-term peak of 800 gpm assumes instantaneous development of two new adits and therefore over-estimates peak inflows.

Blasting during development of the adits and mine void and the presence of a mine void may result in stress redistribution that could affect local groundwater flow in fractures around the mine and adits. The stress redistribution may open some fractures and close others, depending on the actual stress regime. It is unlikely this would result in a change in the steady state inflows to the mine and adits. It is possible that changes to the fracture network resulting from the stress redistribution could affect (increase or decrease) drawdown beneath local areas and alter inflow to specific portions of the mine void and adits, but it is not possible to predict if or where this may occur.

Groundwater Drawdown

Both the 2D and 3D models provided estimates of drawdown during various phases of mining (ERO Resources Corp. 2009 and Geomatrix 2011a, respectively). The accuracy of the 2D model drawdown prediction is limited by the various assumptions described in the *Final Hydrogeology Technical Report* (ERO Resources Corp. 2009). Because the 3D model was able to include a more representative simulation of the known geologic structure, the 3D model's predicted extent of drawdown is considered to be more accurate than that of the 2D model.

The 3D model predicted that groundwater drawdown would be greatest along the trend of the adits, ranging between 10 and greater than 500 feet by the end of the Operations Phase. The greatest drawdown would occur along fault and fracture trends (generally northwest-southeast) that are intersected by the mine and adits. Near the mine void, the 3D model predicted that without mitigation, drawdown would generally be between 10 and greater than 100 feet, with an area between 100 and 500 feet in the upper portion of Rock Creek, upstream of Rock Lake. Drawdown exceeding 10 feet and less than 100 feet would extend about 1 mile from the mine and adits along the Rock Lake Fault, Libby Lakes fault, and Snowshoe fault (Geomatrix 2011a).

The pressure data collected from a piezometer at PR5220 in the Libby Adit provides some insight as to how groundwater levels may respond to dewatering, in comparison to the 3D model-predicted drawdown. As described in section 3.10.3.1.1, *Site Hydrogeology,* water pressure was measured for 1 year in a piezometer located about 1,330 vertical feet from the surface. Because pre-dewatering data are not available, the amount of drawdown due to dewatering of the Libby Adit cannot specifically be determined. The 3D model predicted that the maximum drawdown in the vicinity of the eastern (shallower) half of the Libby and adjacent adits would be between 100 and 500 feet. If the potentiometric surface was at or near the ground surface before dewatering, then 440 feet of drawdown could have occurred as a result of the recent Libby Adit dewatering. Libby Creek may be acting as a fixed head boundary, supplying water to the ongoing dewatering of the Libby Adit, and preventing any additional drawdown. A fixed head boundary is one in which the potentiometric head or water table is held constant by some external force (a source of water) such as a river or lake. The calculated 440 feet of actual drawdown is a maximum possible value, because the elevation of the potentiometric surface before dewatering is unknown, the maximum possible drawdown value suggests that the 3D model predictions are a reasonable estimate of possible drawdown in the Libby Adit area.

Applying this information to other areas, the apparent hydraulic connection between the Libby Creek drainage and the adit via fractures 1,330 feet below the ground surface confirms that it is possible for mine dewatering to intercept surface water where faults or fractures have sufficient hydraulic conductivity and continuity. This observation supports the basic concepts developed in the numerical models. The specific location and frequency of occurrence of these structures are not currently known.

Changes in Baseflow

The effects of groundwater drawdown due to dewatering of the mine and adits are best expressed by estimating changes to baseflow (see section 3.8 for a discussion of baseflow). As part of the 2D and 3D numerical model calibration process, the model-predicted baseflow values were compared to measured flows considered to be baseflow in streams in the analysis area. In general, streamflow measurements were from gaging stations located on the periphery of the numerical model domain (Figure 67). Flow data from the upper reaches of the various streams are insufficient to quantify baseflow at these locations. Because the models were calibrated to flow data at the periphery of the model domain and to several other direct observations, the baseflow predictions at various locations along the streams are considered reasonable estimates of actual baseflow. There is considerable uncertainty regarding the annual variability of baseflow in the drainage reaches where baseflow has not been directly measured. The model results are also based on the assumption that the predicted baseflow is representative of a typical precipitation year. During a field review in September 2007, the agencies estimated that baseflow in the upper reaches of East Fork Rock Creek (above and just below Rock Lake) was similar to that predicted by the 2D and 3D numerical models. Precipitation records discussed in section 3.10.3.1.2, *Conceptual Hydrogeological Model of the Montanore Mine Area* indicated that the summer-fall period in 2007 was particularly dry.

Baseflow for the three periods (pre-mining, operations, and closure/post-closure) was modeled for locations along five streams (Libby, Ramsey, East Fork Rock, and Rock creeks, and East Fork Bull River) using the 2D numerical model (ERO Resources Corp. 2009). The same analysis was performed using the MMC 3D model, except slightly different locations along the streams were reported and the time periods used were also slightly different (Geomatrix 2011a). Geomatrix also included a location on the Bull River in its cumulative effects analysis. For consistency, the results of the baseflow analysis are reported for similar locations along three streams that originate in the analysis area (East Fork Rock Creek, East Fork Bull River, and Libby Creek); at or near the Forest Service gaging station, at the CMW boundary, and within the wilderness (Table 99). For two other creeks located farther from the mine and adits (Ramsey and Poorman), only predicted changes at the CMW boundary are reported (Figure 67).

Baseflow is predicted to start changing during the Evaluation and Construction Phases (Geomatrix 2011a). Because of the characteristics of the site groundwater hydrology, dewatering of the mine and adits would decrease groundwater levels (or cone of depression) that would slowly expand away from the mine openings, intercepting groundwater that would otherwise discharge to area streams. At the end of the Evaluation Phase, the 3D model predicted small reductions in baseflow of less than 3 percent in Libby Creek, East Fork Rock Creek, and East Fork Bull River. At the end of the Construction Phase, the baseflow reductions in Libby Creek increase to 12 percent at LB-300 and 9 percent at the CMW boundary, primarily due to adit dewatering. Baseflow reductions in the other streams are predicted to remain low through the Construction Phase. The Libby Adit was originally dewatered by NMC in late 1991 and allowed to reflood starting in late 1997. Once reflooded, water within the adit exited the adit via colluvium near the portal at an unknown flow rate until MMC reopened the adit and partially dewatered the Libby Adit beginning in 2008. Based on the historical information for the adit, it is inferred that the potentiometric head in the vicinity of the adit never fully recovered after the initial dewatering in 1991 and was farther drawn down with the subsequent MMC dewatering.

The 3D model used the calibrated heads as the initial head condition and apparently did not consider the actual head conditions in the vicinity of the adit. This situation may affect the predicted timing of impacts on the Libby Creek baseflow, but the magnitude of the changes would likely be unaffected. For example, the current adit dewatering has likely resulted in a reduction in Libby Creek baseflow upstream of the current point of discharge for the Water Treatment Plant but the effect is not detected because either the reduction is very small and/or there are insufficient pre-Libby Adit baseline data for comparison to current conditions.

Libby, Ramsey, and Poorman Creeks. The numerical model-predicted changes in baseflow in Libby and Ramsey creeks at the end of the Operations Phase would increase from the previous Phases (Table 99). The estimated baseflow reductions along Libby Creek would range from 14 percent in the wilderness to 22 percent at the CMW boundary. With MMC's modeled mitigation, the baseflow reductions would be slightly less (0.01 cfs) in the wilderness, but would otherwise be the same. Ramsey and Poorman creeks would have slightly less baseflow reduction at the CMW boundary with MMC's modeled mitigation.

Rock Creek and East Fork Rock Creek. The 3D model-predicted baseflow for the upper reaches of East Fork Rock Creek (above and below Rock Lake) is consistent with streamflow observed by the agencies during a September 2007 field review. In September 2007, no surface runoff was contributing to the stream. All of the observed flow was likely from deep bedrock groundwater discharge to the drainage. The flow rate out of Rock Lake was similar to the flow from East Fork Rock Creek above the lake. Additional monitoring proposed in Alternatives 3 and 4 (see Appendix C) would assess the source of flow in upper East Fork Rock Creek.

The 3D model predicted that changes in baseflow at the end of mining due to mine dewatering would reduce the deeper groundwater contribution to East Fork Rock Creek above the lake by about 0.01 cfs or about 25 percent and 21 percent at the CMW boundary (Geomatrix 2011a) (Table 99). With MMC's modeled mitigation, the reduction would be slightly less at the CMW boundary.

East Fork Bull River. The same effects predicted in the upper reaches of East Fork Rock Creek are predicted by the two numerical models for the upper reaches of the East Fork Bull River drainage. The DEQ reported spring (SP-42) discharge in a drainage above St. Paul Lake near the trace of the Rock Lake Fault at about 200 feet lower in elevation than the spring (SP-41) observed in the East Fork Rock Creek drainage (McKay, pers. comm. 2007). During normal to dry years when winter snows have completely melted, deeper groundwater discharge may be the only source of water to St. Paul Lake during late summer to early fall. Spring SP-42 has not been confirmed to flow during the late summer baseflow period, so it is uncertain whether this spring contributes water to St. Paul Lake during the late summer season. Because St. Paul Lake is located on a relatively permeable glacial moraine, the lake is reported to be completely dry during extended periods of low or no precipitation. This indicates that the lake drains at a faster rate than input from groundwater during the late season, and the lake level is maintained by runoff from snowmelt early in the season.

The 3D model predicted the baseflow at the end of mining in the upper reaches of East Fork Bull River (below St. Paul Lake) would be reduced by about 0.05 cfs or by 17 percent (Geomatrix 2011a). The baseflow reductions would be the same with MMC's modeled mitigation during this phase.

Table 99. Predicted Changes to Baseflow – End of Operations Phase.

Drainage and Location (Figure 67)	Model-Predicted Pre-mining Baseflow (cfs)	Without MMC's Modeled Mitigation			With MMC's Modeled Mitigation		
		Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow	Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow
Rock Creek and East Fork Rock Creek							
At mouth (RC-2000)	7.70	7.64	-0.06	-1%	7.64	-0.06	-1%
CMW Boundary (EFRC-200)	0.29	0.23	-0.06	-21%	0.24	-0.05	-17%
In CMW (EFRC-50)	0.04	0.03	-0.01	-25%	0.03	-0.01	-25%
East Fork Bull River							
At mouth (Lower East Fork Bull River)	11.34	11.25	-0.09	-1%	11.27	-0.07	-1%
CMW Boundary (EFBR-500)	4.36	4.29	-0.07	-2%	4.29	-0.07	-2%
In CMW (EFBR-300)	0.29	0.24	-0.05	-17%	0.24	-0.05	-17%
Libby Creek							
Libby Creek at US 2	19.83	19.56	-0.27	-1%	19.57	-0.26	-1%
LB-300	1.22	1.02	-0.20	-16%	1.02	-0.20	-16%
CMW Boundary (~LB-100)	0.54	0.43	-0.12	-22%	0.43	-0.11	-20%
In CMW (LB-50)	0.28	0.24	-0.04	-14%	0.25	-0.03	-11%
Ramsey Creek							
CMW Boundary (~RA-100)	0.38	0.34	-0.04	-11%	0.35	-0.03	-8%
Poorman Creek							
CMW Boundary (PM-100)	0.12	0.11	-0.01	-8%	0.12	0.00	0%

cfs = cubic feet per second ("cfs" is the accepted unit for reporting streamflow. Because it is a large unit (1 cfs = 448.8 gpm), predicted changes in terms of cfs appear to be very precise (*i.e.,* reported to 0.01 cfs). If the results were converted to gallons per minute, they would be reported to the nearest 5 gpm. Section 3.11.4.4.6. *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.
With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
Source: Geomatrix 2011a.

Springs and Seeps

Based on the results of the numerical models, groundwater drawdown would occur around the mine as a result of dewatering of the mine void and adits. Flow from springs hydraulically connected to the deeper groundwater flow path would be reduced. Because springs located below an elevation of about 5,000 to 5,600 feet may derive their water from both shallow and deep groundwater flow paths at various ratios, it is not possible to predict the amount (if any) of flow reduction for any one spring. Some springs and seeps in the mine area have been inventoried, but the inventory has not yet identified the specific groundwater source for each spring or seep. The GDE monitoring described in Appendix C would require that specific analyses be performed to determine the source of water to specific springs.

Tailings Impoundment Area

Groundwater Drawdown and Changes in Baseflow

The Poorman Tailings Impoundment proposed in Alternative 3 would be between the Poorman Creek and Little Cherry Creek drainages. The available hydrogeologic data from the impoundment location indicate that the Poorman site is similar to the Little Cherry Creek site with the exception of having generally higher hydraulic conductivity than the Little Cherry Creek site. The effects of Alternative 3 would be similar to Alternative 2 (see section 3.10.4.2.1, *Evaluation through Operations Phases*), with the following differences:

- Based on available data, the Poorman site does not appear to have a buried channel, as does the Little Cherry Creek site, which reduces the concern of having a very deep, high hydraulic conductivity conduit beneath an impoundment that could become a preferential flow path for seepage from the impoundment.
- The Poorman Impoundment would be located directly upslope from Libby Creek. Consequently, the predominant groundwater flow direction from beneath the impoundment is to the east toward Libby Creek, rather than toward the much smaller Poorman Creek.

A pumpback well system would be installed downgradient of the impoundment and designed to capture all seepage from the impoundment that was not collected by the underdrain system. The pumpback well system would consist of a series of groundwater extraction wells designed to provide 100 percent capture of all groundwater moving from beneath the footprint of the impoundment. A preliminary pumping well system has been designed, based on existing site data, that has 16 extraction wells pumping at a combined rate of 247 gpm (Geomatrix 2010c). Geomatrix constructed a 3D groundwater model of the Poorman Impoundment Site to assist in design of the system. To establish full capture of the impoundment seepage, a drawdown cone would be created by the 16 extraction wells. Water levels from north of Ramsey Creek to north of Little Cherry Creek are predicted to be reduced (Figure 73). As a result of lower groundwater levels, the model predicted that operation of the pumpback well system would reduce baseflow in Poorman Creek by 0.18 cfs (81 gpm), Little Cherry Creek by 0.04 cfs (18 gpm), and in Libby Creek downstream of the confluence of Little Cherry Creek by 0.55 cfs (247 gpm). During the Operations Phase, water removed by the pumpback well system would be pumped to the impoundment for use in the mill.

The 3D model for the pumpback well system included an apparent subsurface bedrock ridge between the Little Cherry Creek and Poorman Creek watersheds. The low permeability bedrock ridge appears to separate groundwater flow between the watershed of Little Cherry Creek from those of Drainages 5 and 10 in the Poorman Impoundment Site (Chen Northern 1989). The bedrock ridge and resulting groundwater divide were interpreted from a resistivity survey performed on behalf of NMC and from drill logs, as interpreted by Klohn Crippen (2005). All available geologic and hydrogeologic data from the Little Cherry Creek and in the Poorman Impoundment areas were reviewed and discussed in detail by NewFields (2014a). NewFields concluded that the bedrock ridge would limit drawdown in the Little Cherry Creek watershed, but drawdown could still extend between watersheds unless the bedrock ridge provided a complete barrier to cross-boundary groundwater flow. According to NewFields (2014a), perched groundwater conditions occur beneath most wetlands in the Little Cherry Creek and Poorman Impoundment areas and the hydrologic support for the wetlands appears to be direct precipitation and upgradient runoff water that infiltrates into the subsurface. NewFields concluded the operation of the pumpback wells would have little or no effect on most wetlands in the Little Cherry Creek watershed. If NewFields' interpretation proved to be accurate, it is likely that groundwater drawdown from pumping in the Poorman Impoundment Site would have limited effect on surface resources in the Little Cherry Creek drainage. The pumping rate required to capture all seepage would potentially be lower without recharge from the Little Cherry Creek watershed. Because geologic and hydrologic data from the area between the Little Cherry Creek and Poorman drainages are lacking, they are not sufficient to eliminate the possibility of the pumpback well system adversely affecting surface resources, particularly groundwater-supported wetlands.

Additional subsurface data, such as aquifer pumping tests, from this area would be collected during the final design process of the Poorman Impoundment (see section 2.5.2.6.3, *Final Tailings Impoundment Design Process* in Chapter 2 and Appendix C). Site data to be collected would include an assessment of artesian pressures and their potential influence on impoundment stability, an assessment of a subsurface bedrock ridge between Little Cherry Creek and the effect it may have on pumpback well performance, aquifer pumping tests to refine the impoundment groundwater model and update the pumpback well design, and site geology to identify conditions such as preferential pathways that may influence seepage collection system, the pumpback well system, or impoundment stability. MMC also would complete aquifer testing at the Poorman Impoundment Site and finalize the design of the pumpback well system. After the system was designed, at least seven groundwater monitoring wells would be installed downgradient of the pumpback wells before construction of any of the impoundment facilities (see Figure C-7 in Appendix C). At least four of these wells would be constructed as nested pairs to monitor both shallow and deeper flow paths from the impoundment. The wells would be located so that the cross-sectional area below the impoundment was adequately covered by the monitoring wells. If any preferential flow paths were encountered during the construction of the impoundment or installation of monitoring wells, they would be monitored independently. The installation of pairs of nested wells is intended to monitor a reasonable vertical thickness of the saturated zone. These data would be used to confirm the geophysical results and the MMC's hydrogeologic interpretation. The 3D model would be rerun to evaluate the site conditions with the additional data. MMC would update the pumpback well design and analysis using the additional data, with a focus on minimizing drawdown north of impoundment.

In Alternative 2, MMC indicated make-up water may be necessary (see Table 14 in Chapter 2). For analysis purposes, the agencies identified a possible location for alluvial groundwater wells to supply make-up water to the mine, should mine inflow and water from the pumpback well system be inadequate for process purposes.

Section 2.5.4.3, *Water Use and Management* discusses a different water management approach for Alternatives 3 and 4. To provide adequate water for ore processing when Libby Creek water could not be used beneficially (whenever Libby Creek flow at LB-2000 was less than 40 cfs), MMC would, under Alternative 3, install an infiltration gallery along Libby Creek and divert up to 760 gpm of water during periods of high flow (April through July). The infiltration gallery would be along Libby Creek northeast of the Poorman Tailings Impoundment (Figure 25). The amount of make-up water required would depend on mine inflows, water production from tailings impoundment pumpback wells, and precipitation at the impoundment site. MMC would not withdraw any water for use whenever flows at the point of withdrawal were equal to or less than 40 cfs. Water rights are discussed in detail in section 2.5.4.3.2, *Water Rights* and section 3.12, *Water Rights*.

Groundwater withdrawals from Libby Creek alluvium would decrease groundwater level near the infiltration gallery while the gallery was in operation. Because of the relatively high hydraulic conductivity of the alluvium and the hydraulic connection with the active stream, groundwater levels in the alluvium is expected to fully recover between periods of pumping. Groundwater levels downgradient of the infiltration gallery would decrease while diversions were made. Appropriately designed, located and operated infiltration gallery providing up to 760 gpm would not substantially reduce upgradient alluvial groundwater levels. If the infiltration gallery were located in the vicinity of the proposed pumpback well system, the infiltration gallery may increase the area and magnitude of the predicted drawdown cone, when in operation.

Springs and Seeps

Numerous springs were identified in the area surrounding the Poorman Impoundment Site (Figure 70). Thirteen known springs are within the Alternative 3 impoundment disturbance area; five other springs would be outside of the disturbance area, but may be affected by the pumpback well system. As in Alternative 2, it is possible that the increase in hydraulic head over the springs by placement of saturated tailings would prevent future flow from the springs. Alternately, the springs could discharge to the underdrain system beneath the impoundment and be collected by the Seepage Collection System. The flow from springs located outside of the impoundment main dam may be affected by the pumpback well system. The predicted area of groundwater drawdown extended northward to Little Cherry Creek and beyond. Springs that could be affected by the pumpback well system are SP-10, 14, 15, 24 and 38 (Figure 73). Four of the springs potentially affected by the pumpback well system are north of a bedrock ridge that may limit drawdown effects north of it. Effects on wetlands are discussed in section 3.23, *Wetlands and Other Waters of the U.S.*

LAD Area

Alternative 3 does not include the use of LAD for disposal of mine wastewater and groundwater in the LAD Areas would not be affected. The capacity of the Water Treatment Plant would be expanded in Alternatives 3 and 4. If there was the need to dispose of water from the tailings impoundment during the Operations Phase in excess of the water treatment system capacity, MMC would use enhanced evaporation techniques within the footprint of the impoundment.

3.10.4.3.2 Closure Phase

Mine Area

The Closure Phase would start at the end of mining (Year 22) and extend through completion of site reclamation (Year 30). The years discussed in this and other sections are used for analysis purposes, and may vary from actual mining phases. The modeling of MMC's modeled mitigation assumed the construction of bulkheads in the year mining ceased (Year 22) when mine closure would actually take several years to implement. In addition, the following discussion is based on the results of the 3D model that did not consider multiple plugs in the adit for water rights mitigation. During the Closure Phase, dewatering of the mine void and adits would cease, the adits would be plugged, and the voids would begin to fill with groundwater. Plugging of the adits during the Closure Phase would result in recovery of baseflow in the Libby, Ramsey, and Poorman watersheds, after reaching a maximum baseflow reduction soon after the adits were plugged (between Years 22 and 25). Groundwater levels in the mine area are not expected to recover during this phase because groundwater would continue to flow into the dewatered mine void. Groundwater levels in the mine area would continue to decrease as water continued to flow into the mine void. Changes to baseflow in the East Fork Rock Creek and East Fork Bull River would continue to decrease, reaching a maximum during the early Post-Closure Phase, with the exception of East Fork Rock Creek above Rock Lake that would reach a maximum reduction during the Closure Phase (Table 100).

In addition to the grouting mitigation analyzed for the Operations Phase, a second mitigation would be implemented during the Operations and Closure Phases. During the Operations Phase, MMC would leave one or more low permeability barrier pillars at appropriate locations within the mine void to compartmentalize the large void into smaller sections if necessary to minimize post-mining changes in East Fork Rock Creek and East Fork Bull River streamflow and water quality. If pillars were left in place, concrete bulkheads would be constructed at any access opening through the barrier pillars. For the Closure and Post-Closure Phase analyses, the mitigated results assumed both grouting during the Operations Phase and the barrier pillars were in place after mining ceased. The process for determining the need for barrier pillars is discussed in Chapter 2 (see p. 139 for Evaluation Phase, p. 162 for Operations Phase, and p. 178 for Closure Phase).

Based on the 3D model simulation and not considering water rights mitigation, the portal area of the adits would be plugged soon after the Operations Phase ended (Year 22). drawdown would reach a maximum in the area above the adits between Years 22 and 25 and groundwater levels would begin recovering as the adits filled with water. Maximum baseflow reductions in Libby, Ramsey, and Poorman creeks are predicted to occur soon after the adits were plugged. As groundwater levels rose, the impact on baseflow in the Libby Ramsey, and Poorman watersheds would begin to decrease from the maximum soon after the adits were plugged. Table 99 provides predicted baseflow changes for Year 22 (end of Operations Phase) and Table 100 provides predicted baseflow changes for Year 25 (Closure Phase without multiple adit plugs). The trend of increasing water levels is predicted to continue until groundwater levels reached steady state in Year 1,172 without MMC's modeled mitigation (Table 103). Mitigation implemented during the Operations Phase (grouting and low permeability barriers) and at closure (bulkheads at access openings in the barriers (unmined ore); multiple adit plugs), would reduce impacts on baseflow slightly in all streams and may change the timing of maximum impact, as described in the footnotes to Table 101.

To avoid adversely affecting senior water rights in the Libby Creek and Ramsey Creek drainages, MMC would install plugs at the base of each adit soon after mining operations ceased. Because the adits would then be hydraulically isolated from the mine void, groundwater levels would begin to recover. Steady state groundwater conditions would occur in the Libby Creek and Ramsey Creek drainages within an estimated 10 to 20 years. The estimate is based on an inflow rate to the adits of 100 to 200 gpm to all three adits, the assumption that during 8 months of the year water would be pumped from the adit for water rights mitigation, and filling of the adits from the mine void to the ground surface. Actual length of time would depend on location of the initial plugs and adit inflow rate at Closure. The time to fill the adits could be reduced to a few years if MMC used water diverted from Libby Creek during high flows to fill the adits during the Closure Phase. Baseflow changes in Libby Creek and Ramsey Creek would be similar to those shown in Table 100, but the effects would decline more rapidly with multiple adit plugs. Multiple adit plugs would not affect predicted baseflow changes in the East Fork Rock Creek and East Fork Bull River shown in Table 100.

Tailings Impoundment Area

The effects at the tailings impoundment area are discussed in the following Post-Closure Phase.

Table 100. Predicted Changes to Baseflow – Closure Phase.

Drainage and Location (Figure 67)	Model-Predicted Pre-mining Baseflow (cfs)	Without MMC's Modeled Mitigation			With MMC's Modeled Mitigation		
		Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow	Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow
Rock Creek and East Fork Rock Creek							
At mouth (RC-2000)	7.70	7.51	-0.19	-8%	7.54	-0.16	-2%
CMW Boundary (EFRC-200) at outlet of Rock Lake	0.29	0.11	-0.18	-62%	0.14	-0.15	-51%
In CMW (EFRC-50)	0.04	0.00	-0.04	-100%	0.00	-0.04	-100%
East Fork Bull River							
At mouth (Lower East Fork Bull River)	11.34	11.22	-0.12	-1%	11.25	-0.09	-1%
CMW Boundary (EFBR-500)	4.36	4.20	-0.16	-4%	4.21	-0.15	-3%
In CMW (EFBR-300)	0.29	0.17	-0.12	-41%	0.18	-0.11	-37%
Libby Creek							
Libby Creek at US 2	19.83	19.58	-0.25	-1%	19.58	-0.25	-1%
LB-300	1.22	1.03	-0.19	-16%	1.04	-0.18	-15%
CMW Boundary (~LB-100)	0.54	0.44	-0.10	-19%	0.44	-0.10	-19%
In CMW (LB-50)	0.28	0.24	-0.04	-14%	0.25	-0.03	-11%
Ramsey Creek							
CMW Boundary (~RA-100)	0.38	0.35	-0.03	-7%	0.35	-0.03	-7%
Poorman Creek							
CMW Boundary (PM-100)	0.12	0.12	0.00	0%	0.12	0.00	0%

Effects shown do not include mitigation measures not provided in MMC's 3D model report such as increasing buffer zones or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase.
cfs = cubic feet per second ("cfs" is the accepted unit for reporting streamflow. Because it is a large unit (1 cfs = 448.8 gpm), predicted changes in terms of cfs appear to be very precise (*i.e.,* reported to 0.01 cfs). If the results were converted to gallons per minute, they would be reported to the nearest 5 gpm. Section 3.11.4.4.6. *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.
Baseflow changes reported for Year 25 for all locations.
With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
Source: Geomatrix 2011a.

Table 101. Predicted Changes to Baseflow – Post-Closure Phase (Maximum Baseflow Change).

Drainage and Location (Figure 67)	Model-Predicted Pre-mining Baseflow (cfs)	Without MMC's Modeled Mitigation			With MMC's Modeled Mitigation		
		Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow	Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow
Rock Creek and East Fork Rock Creek							
At mouth (RC-2000)	7.70	7.05	-0.65	-8%	7.55	-0.15	-2%
CMW Boundary (EFRC-200) at outlet of Rock Lake	0.29	0.00 (-0.15)[§]	-0.29 (-0.44)[§]	-100%	0.12	-0.17	-59%
In CMW (EFRC-50)	0.04	0.00	-0.04	-100%	0.00	-0.04	-100%
East Fork Bull River							
At mouth (Lower East Fork Bull River)	11.34	11.01	-0.33	-3%	11.02	-0.32	-3%
CMW Boundary (EFBR-500)	4.36	3.96	-0.40	-9%	3.97	-0.39	-9%
In CMW (EFBR-300)	0.29	0.00	-0.29	-100%	0.01	-0.28	-97%
Libby Creek							
Libby Creek at US 2	19.83	19.72	-0.11	-1%	19.73	-0.10	-1%
LB-300	1.22	1.10	-0.12	-10%	1.10	-0.12	-10%
CMW Boundary (~LB-100)	0.54	0.47	-0.07	-12%	0.48	-0.06	-11%
In CMW (LB-50)	0.28	0.24	-0.04	-14%	0.25	-0.03	-11%
Ramsey Creek							
CMW Boundary (~RA-100)	0.38	0.36	-0.02	-4%	0.36	-0.02	-4%
Poorman Creek							
CMW Boundary (PM-100)	0.12	0.12	0.00	0%	0.12	0.00	0%

[§]Negative value represents reduction of baseflow to zero and loss of water from storage in Rock Lake without MMC's modeled mitigation. The baseflow change of -0.44 cfs would result from a change in baseflow of 0.29 cfs plus a reduction in lake storage at the rate of 0.15 cfs.
cfs = cubic feet per second ("cfs" is the accepted unit for reporting streamflow. Because it is a large unit (1 cfs = 448.8 gpm), predicted changes in terms of cfs appear to be very precise (*i.e.,* reported to 0.01 cfs). If the results were converted to gallons per minute, they would be reported to the nearest 5 gpm. Section 3.11.4.4.6. *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.
With and Without MMC's modeled mitigation - maximum model predicted baseflow reductions occur at Year 38 for the Rock Creek drainage and Year 52 for the East Fork Bull River drainage. East of the divide, the maximum model predicted baseflow reductions in the Libby Creek watershed would occur between Year 22 (as reported in Table 99) and Year 25 (as reported in Table 100). Baseflow changes for east slope watersheds in this table are for Year 38. Effects shown do not include mitigation measures not provided in MMC's 3D model report such as increasing buffer zones or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase.
With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
Source: Geomatrix 2011a; East Fork Bull River results from Geomatrix, pers. comm. 2011c.

3.10.4.3.3 Post-Closure Phase

The 3D model predicted the effect of the agencies' mitigation would be most noticeable in the Post-Closure Phase. Table 102 summarizes the difference in effects with and without mitigation. The following sections describe effects predicted by the 3D model, with and without mitigation.

Mine Area

Groundwater Drawdown without Mitigation

The Post-Closure Phase would begin in about Year 31 after all active reclamation activities were completed. Without mitigation, the mine void would continue to fill with water and groundwater levels would begin to recover around the deepest part of the mine void. Groundwater levels above the shallow end of the mine void (south end) would continue to decline, as the deep end of the mine void filled with water. Maximum drawdown is predicted to occur about 30 years after mining, with a maximum drawdown of more than 1,000 feet over the mine void north of Rock Lake (Figure 72). Water levels over the mine void closest to Rock Lake (in mining block 18) are predicted to reach maximum drawdown in Year 38, or 16 years after mining ceased (Chart 15).

Geomatrix (2011a) reported that the 3D model predicted that without mitigation the mine void and adits would require 493 years (or Year 515) to fill to an elevation of 4,800 feet (Chart 15). MMC proposed to maintain a 500-foot buffer from Rock Lake, which has an elevation of 4,958 feet. Although the upper mine void elevation would be less than 500 feet below the lake's elevation, the mine void would be 500 feet laterally from the lake. The upper mine void elevation may be less than 4,800 feet with a 500-foot buffer (Figure 11). Much of the mine void would be substantially filled in less time, but as the mine void filled, the inflow rate would decrease, requiring a predicted 493 years to completely fill the mine void to an elevation of 4,800 feet.

Chart 15. Predicted Water Levels Above Mine Void over Mining Block 18 Near Rock Lake, Without Mitigation.

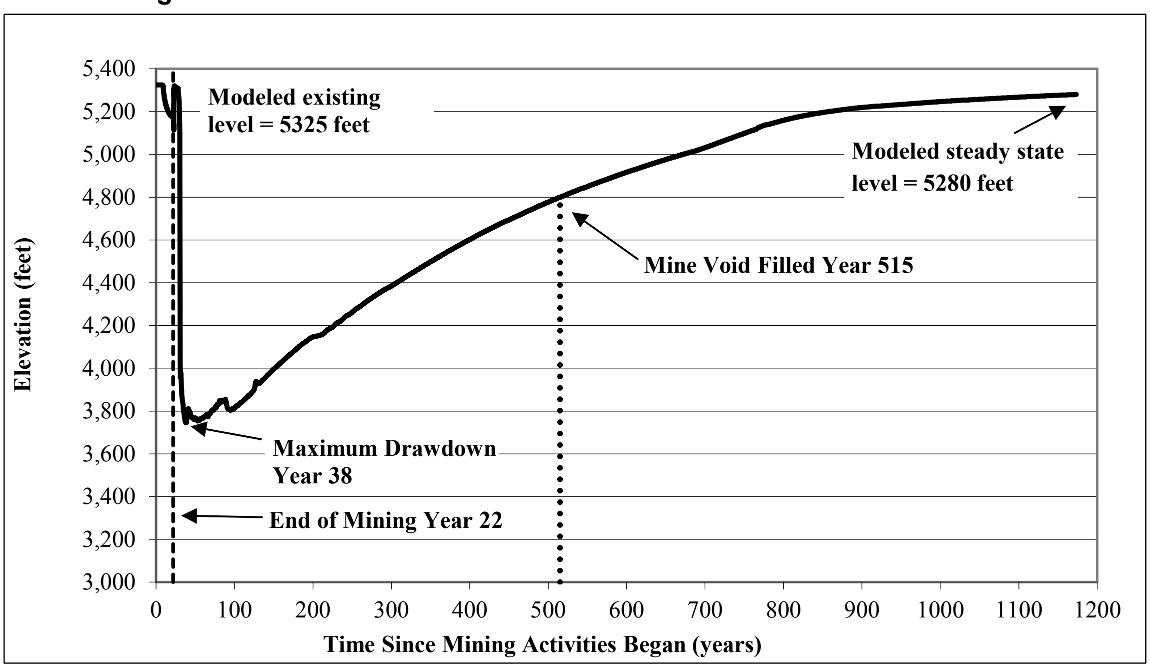


Table 102. Comparison of Groundwater Changes with and without Agencies' Mitigation.

Characteristic	Without Agencies' Mitigation	With Agencies' Mitigation
Mitigation		
Mine void barriers	None	Two or more barriers of unmined ore with bulkheads at access openings, if necessary
Mining buffer zones	500 feet from Rock Lake and 100 feet from Rock Lake Fault (Figure 11)	1,000 feet from Rock Lake and 300 feet from Rock Lake Fault (Figure 11)
Adit plugs	One plug near adit portal	Two or more, site-specifically designed plugs: one near mine void and one near adit portals
Grouting	None	Grout the sides of the three uppermost mine blocks and corresponding access ramps; additional grouting as necessary
3D Model Predictions		
Timing of maximum drawdown	16 years after mining for East Fork Rock Creek (Year 38) and 30 years after mining for East Fork Bull River(Year 52)	Similar to the without mitigation scenario
Timing of maximum drawdown in mining block 18 (closest to Rock Lake)	16 years after mining (Year 38)	2.8 years after mining (Year 25)
Timing of steady state conditions in groundwater levels over entire mine void	1,150 years after mining (Year 1,172)	1,300 years after mining (Year 1,322); multiple adit plugs not modeled but would increase time required to reach steady state
Timing of steady state conditions in groundwater levels over mining block 18 (closest to Rock Lake)	1,150 years after mining (Year 1,172) (Chart 15)	40 years after mining (Year 62)
Permanent effect on water levels overlying mining block 18	45 feet below pre-mine conditions (Chart 15)	Return to near pre-mine conditions
Timing of steady state conditions in groundwater levels over adits	130 years after mining	10 to 20 years after mining
Permanent effect on water levels overlying adits	Between 10 and 100 feet in some locations (Figure 74)	Not modeled; less than shown in Figure 74
Baseflow change in upper East Fork Rock Creek at maximum drawdown	0.29 cfs reduction at CMW boundary; 0.15 cfs loss of water from Rock Lake (Table 101)	0.17 cfs reduction at CMW boundary; no loss of water from Rock Lake (Table 101)
Baseflow change in upper East Fork Bull River at maximum drawdown	0.40 cfs reduction at CMW boundary (Table 101)	0.39 cfs reduction at CMW boundary (Table 101)
Baseflow change in upper East Fork Rock Creek at steady state	0.03 cfs reduction at CMW boundary (Table 103)	No change at CMW boundary (Table 103)
Baseflow change in East Fork Bull River at steady state	0.05 cfs increase at mouth (Table 103)	0.01 cfs reduction at mouth (Table 103)

With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
cfs = cubic feet per second.

After the mine void and adits filled, water levels in fractures overlying the mine void and adits would continue to return to pre-mine conditions. Groundwater levels overlying the mine void and adits are predicted to reach equilibrium or steady state conditions in about Year 1,172 without MMC's modeled mitigation. Water levels are predicted without MMC's modeled mitigation to permanently remain greater than 100 feet below pre-mine conditions over portions of the mine void and between 500 and 1,000 feet in a small area 1,800 feet north of Rock Lake (Figure 74). Without mitigation, water levels overlying mining block 18 (the block closest to Rock Lake) are predicted to remain 45 feet below pre-mine conditions (Chart 15). Because of model uncertainties due to limited data, the time required for mine void refilling and the time required to reach steady state would be re-evaluated during the Evaluation Phase when more hydrogeologic data were available.

Groundwater Drawdown with Mitigation

With MMC's modeled mitigation as modified by the agencies, one or more barrier pillars would be left if necessary to minimize post-mining changes to East Fork Rock Creek and East Fork Bull River streamflow and water quality. The barrier pillars, if retained, would create two or more "compartments" within the mine void, with each filling at a rate controlled by the hydraulic conductivity of the surrounding rock. With the agencies' mitigation, groundwater levels above each compartment of the mine would continue to decline, as water filled each compartment created by the low permeability barriers. Because the hydraulic conductivity likely decreases with depth, the shallowest compartments of the mine void would fill sooner than the deeper sections. The shallowest compartments (those closest to Rock Lake) with mitigation would fill sooner than without mitigation. For example, lowest water table elevation over mining block 18 at the south end of the mine void is predicted, with MMC's modeled mitigation, to occur 2.8 years after closure, or 25 years after the onset of mining. With the agencies' mitigation of increased buffer of 1,000 feet, the highest mine void elevation would be several hundred feet deeper and the mining block closest to Rock Lake would fill within 10 to 20 years (Appendix G in Geomatrix 2011a). The agencies' mitigation in the mine area would reduce the maximum drawdown and the maximum change to baseflow.

As result of the water rights-related mitigation implemented during the Closure Phase, the adits would recover much sooner than predicted by the 3D model. Because the adits would be hydraulically isolated from the mine void, the adits would reflood and groundwater levels in the Libby, Ramsey, and Poorman creek drainages would reach steady state conditions independently from water levels over the mine void, within an estimated 10 to 20 years after operations ceased. The effect would be reduced to a few years if MMC used water diverted from Libby Creek during high flows to fill the adits during the Closure Phase. The residual drawdown in the Libby Creek drainage with the agencies' mitigation would be less than that shown in Figure 74.

With MMC's modeled mitigation, much less post-mining drawdown would be propagated to the water table on the south end of the mine void. Water levels closest to Rock Lake (overlying mining block 18) are predicted to return to near pre-mine conditions in about 40 years after mining (Appendix G in Geomatrix 2011a). Groundwater levels over the entire mine void are predicted to reach equilibrium or steady state in about Year 1,322 with MMC's modeled mitigation. Groundwater levels with MMC's modeled mitigation are predicted to take longer to reach steady state conditions because the rate of filling in the deeper sections would be slower than the average rate over the entire mine void without mitigation. Multiple adit plugs, which are a component of the agencies' mitigation that were not simulated in the model, would also increase the time to reach steady state conditions over the mine void because adit inflows would not fill the void. Because of model uncertainties due to limited data, the time required for mine void refilling and the time required to reach steady state would be re-evaluated during the Evaluation Phase when more hydrogeologic data were available.

Changes in Groundwater Storage

Assuming a reasonably range of storage values for the bedrock, such as those used in the 3D model, groundwater storage in the flooded mine void and adits would be significantly larger than groundwater stored in fractures in the same area before mining. If 120 million tons of ore and 3.2 million tons of waste rock were mined, the estimated increase in groundwater storage would be about 11.3 billion gallons or 34,600 acre feet of water without mitigation. With mitigation of increased buffers and barrier pillars, if necessary, the mine void and the increase in groundwater storage would be slightly smaller.

Changes in Baseflow

The predicted reductions presented in Table 103 would be permanent changes to pre-mining baseflow because groundwater levels would be at steady state and below pre-mine levels (Figure 74). Residual drawdown near the upgradient end of the mine is predicted to be greater along the Rock Lake, Libby Lake, and Snowshoe faults. As discussed in the Closure Phase section, a second mitigation of leaving barrier pillars, if necessary, would be designed using all available hydrologic data collected during mining and implemented during the Operations and Closure Phases.

The following discussion provides a summary of baseflow changes in the affected drainages during the Post-Closure Phase. Section 3.11.4.4.6, *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.

The 3D model simulation of the Post Closure Phase indicates that effects on baseflow in the east slope drainages would reach a maximum during the Closure Phase and continue well into the Post-Closure Phase (hundreds of years without MMC's modeled mitigation). At steady state, the model predicted no impact on baseflows in the east slope drainages. The 3D model did not consider water rights mitigation that would greatly shorten the recovery time for the east slope groundwater levels, and therefore, stream baseflows. The adit plugging mitigation, as described in section 2.5.4.3.2*, Water Rights* and section 3.12, *Water Rights*, would hydraulically isolate the adits from the mine void and significantly reduce the refilling time of the adits. As a result, stream baseflow is expected to return to pre-mining rates within 10 to 20 years of the end of the Operations Phase, or within the first few years of the Post Closure Phase. The effect would be reduced to a few years if MMC used water diverted from Libby Creek during high flows to fill the adits during the Closure Phase.

As described previously, the groundwater levels above the mine void would continue to decline after dewatering ceased because the mine void would continue to draw from groundwater as it began to fill. As a result, the maximum drawdown in the area above the south end of the mine void would occur, without MMC's modeled mitigation, about 16 years after the adits were plugged (about Year 38) (Table 101). Starting some time before Year 38, the baseflow in upper East Fork Rock Creek (above Rock Lake, and at the outlet of Rock Lake in the vicinity of EFRC-200) would be reduced to zero. Without MMC's modeled mitigation, the 3D model also predicted that, in addition to 100 percent baseflow reduction to Rock Lake, the potentiometric surface

Table 103. Predicted Changes to Baseflow – Post-Closure Phase (Steady State).

Drainage and Location (Figure 67)	Model-Predicted Pre-mining Baseflow (cfs)	Without MMC's Modeled Mitigation			With MMC's Modeled Mitigation		
		Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow	Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow
Rock Creek and East Fork Rock Creek							
At mouth (RC-2000)	7.70	7.67	-0.03	-0.4%	7.71	0.01	0.1%
CMW Boundary (EFRC-200) at outlet of Rock Lake	0.29	0.26	-0.03	-10%	0.29	0.00	0%
In CMW (EFRC-50)	0.04	0.02	-0.02	-50%	0.03	-0.01	-25%
East Fork Bull River							
At mouth (Lower East Fork Bull River)	11.34	11.39	0.05	0.4%	11.33	-0.01	-0.1%
CMW Boundary (EFBR-500)	4.36	4.35	-0.01	-0.2%	4.35	-0.01	-0.2%
In CMW (EFBR-300)	0.29	0.27	-0.02	-7%	0.27	-0.02	-7%
Libby Creek							
Libby Creek at US 2	19.83	19.83	0.00	0%	19.83	0.00	0%
LB-300	1.22	1.22	0.00	0%	1.22	0.00	0%
CMW Boundary (~LB-100)	0.54	0.54	0.00	0%	0.54	0.00	0%
Wilderness (LB-50)	0.28	0.28	0.00	0%	0.28	0.00	0%
Ramsey Creek							
CMW Boundary (~RA-100)	0.38	0.38	0.00	0%	0.38	0.00	0%
Poorman Creek							
CMW Boundary (PM-100)	0.12	0.12	0.00	0%	0.12	0.00	0%

cfs = cubic feet per second ("cfs" is the accepted unit for reporting streamflow. Because it is a large unit (1 cfs = 448.8 gpm), predicted changes in terms of cfs appear to be very precise (*i.e.,* reported to 0.01 cfs). If the results were converted to gallons per minute, they would be reported to the nearest 5 gpm. Section 3.11.4.4.6. *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.
Steady state conditions predicted to occur at Year 1,172 without MMC's modeled mitigation and at Year 1,322 with MMC's modeled mitigation.
With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
Source: Geomatrix 2011a.

would be sufficiently lowered to cause water in storage in Rock Lake to move into the groundwater system at the rate of 0.15 cfs. The water balance developed by Geomatrix (2011a) for Rock Lake indicates the lake receives water directly from the groundwater system, which is an indication that the lake is hydraulically connected to the groundwater system. Predicted impacts on Rock Lake are discussed in section 3.13.4, *Surface Water Hydrology*.

Because the baseflow reduction along East Fork Rock Creek would occur in the area overlying the predicted drawdown cone of depression (Figure 72), most if not all of the baseflow reduction would occur between EFRC-50 and upstream of Rock Creek Meadows. Based on the 3D model, groundwater discharges to the creek, and therefore baseflow, just upstream of the Rock Creek Meadows are predicted to be reduced by 0.29 cfs, without MMC's modeled mitigation.

As groundwater levels began to recover during the Post-Closure Phase (after Year 38), the changes in baseflow would decrease, reaching steady state by Year 1,172 without MMC's modeled mitigation. Because the 3D model predicted that groundwater levels would not recover to pre-mining levels, there would be a permanent loss of baseflow in upper East Fork Rock Creek (above Rock Lake) and a permanent reduction in baseflow in East Fork Rock Creek and Rock Creek (Table 103).

The primary predicted effect of MMC's modeled mitigation on the Rock Creek drainage during maximum baseflow reduction would be the elimination of the loss of water from storage in Rock Lake and a reduction in the change in baseflow in the vicinity of the lake by about half. Because groundwater levels would not recover to pre-mining levels, there would be permanent changes to baseflow in the Rock Creek drainage, but the effects would be smaller than those predicted without MMC's modeled mitigation.

Based on the results of both numerical models, reduced baseflow would persist during the Post-Closure Phase for a portion of the East Fork Bull River drainage until the mine void refilled with water and the regional potentiometric surface stabilized. As the regional potentiometric surface reached steady state conditions (Year 1,172 without MMC's modeled mitigation), both numerical models predict a slight increase in groundwater contribution to portions of the East Fork Bull River compared to pre-mining conditions (ERO Resources Corp. 2009 and Geomatrix 2011a). A change in groundwater flow path would occur because the mine void would interconnect the two watersheds, resulting in the diversion of groundwater from the East Fork Rock Creek to the East Fork Bull River drainage. The groundwater exchange rate between drainages is predicted to be very small (0.07 cfs). The only difference between the predictions of the two models is the location along East Fork Bull River where this may occur. The 3D model predicted the increase flow would occur mostly in the lower portion of the river below the CMW boundary, whereas the 2D model predicted the increased flow would occur in the upper reaches of the river within the wilderness.

As with the 2D model, the MMC 3D model also predicted, without MMC's modeled mitigation, that a potential for groundwater to flow from the East Fork Rock Creek watershed to the East Fork Bull River watershed via the mine void because of the void that would connect to the watersheds. Whether this occurred would depend on the location of sufficiently permeable faults and/or fractures between the distal end of the mine void and the Rock Lake Fault because the mine void would be located about 3,000 feet below the drainage. The 2D and 3D models showed that low permeability barriers within the completed mine void would control the level to which groundwater levels would recover, and therefore the direction of groundwater flow within the mine void.

There is uncertainty regarding the nature and extent of the Rock Lake Fault in the vicinity of East Fork Bull River. There is not sufficient mapping data to determine whether the near vertical normal Rock Lake Fault terminates within the East Fork Bull River, extends northward beyond the drainage, or transitions to a mapped thrust fault that extends down the drainage. This uncertainty in the 3D model simulation of the faults in this area would not impact any other part of the simulation or predictions of that model. The location of the discharge within East Fork Bull River is only relevant for the analysis of possible impacts on water quality from mine void water (see section 3.13.4.2.3, *Closure and Post-Closure Phases (Years 25+)*).

With MMC's modeled mitigation, the maximum reduction in baseflow along East Fork Bull River would be somewhat less (Table 101). The primary difference between the mitigated and unmitigated scenarios would be in the reversal of the hydraulic gradient at steady state, minimizing the flow of water from the mine void to East Fork Bull River. There would be a small permanent loss of baseflow to the river with MMC's modeled mitigation. The potential direction of post-mining groundwater flow direction within the mine void would be better defined using all hydrologic data collected during mining. The low permeability barrier design would be based on an analysis of these data.

Tailings Impoundment Area

At the beginning of the Closure Phase, the mill would cease operation and the tailings impoundment would no longer receive tailings. Because the mill would no longer use water from the impoundment, impoundment seepage collected by the seepage collection system and the pumpback well system would be treated at the Water Treatment Plant before discharging it. If the total rate collected by the two systems exceeded the capacity of the treatment system, MMC would pump any water in excess of the treatment system capacity back to the impoundment. Current Water Treatment Plant capacity is 500 gpm, which would be increased in Alternatives 3 and 4. Once all of the standing water was removed from the impoundment, the surface of the impoundment would be reclaimed. The seepage collection and pumpback well systems would continue to operate until flow from the impoundment met BHES Order limits or applicable nondegradation criteria of all receiving waters. As adjacent compliance wells met applicable standards, individual pumpback wells may be shut down and adjacent compliance wells still monitored. As long as the pumpback well system operated, its operation would reduce baseflow to Libby, Poorman, and Little Cherry Creek and reduce flow to springs and wetlands within the area of groundwater drawdown. When operating, the pumpback well system would pump at a rate necessary to maintain full capture of seepage from the impoundment. After flow from the impoundment met BHES Order limits or applicable nonsignificance criteria of all receiving waters, operation of the seepage collection system and the pumpback wells would be terminated and the wells plugged and abandoned. Assuming pumpback wells operated at 250 gpm until all pumping ceased, groundwater levels would mostly recover in 13 years after pumping ceased with an estimated residual flow depletion to Libby Creek of 0.1 cfs (50 gpm) and fully recover in about 25 years (NewFields 2013a). Groundwater levels may recover sooner if pumping rates were reduced during the Closure Phase in response to tailings consolidation and impoundment reclamation. As groundwater levels recovered, springs that were buried by the impoundment, such as SP-26 and SP-28, may again flow, but into the impoundment's gravel underdrain system. Springs outside of the impoundment footprint that were affected by the pumpback wells would likely return to pre-mine conditions and may contribute to baseflow to channels outside of the impoundment.

3.10.4.3.4 Climate Change

The effects of climate change in combination with Alternative 3 would be the same as Alternative 2.

3.10.4.3.5 Groundwater Model Uncertainty

Both the 2D and 3D model reports include a discussion of the respective model's sensitivity to a range of hydrologic characteristics (ERO Resources Corp. 2009; Geomatrix 2011a). The sensitivity analysis for the 3D model indicates that varying hydraulic conductivity of the various layers by one order of magnitude (10 times) in either direction provides results that may be considered feasible, but the model calibration was poorer than for the selected values for hydraulic conductivity. The sensitivity analysis of varying hydraulic conductivity using the 3D model resulted in a range of mine inflows of 130 to 1,800 gpm. Based on historical and current inflow data from the Libby Adit, steady state mine inflows of 130 or 1,800 gpm are unlikely, indicating that the hydraulic conductivity values used in the calibrated model run provide a reasonable estimate of mine inflow, groundwater drawdown, and changes to baseflow within the constraints of other parameters used in the models.

Each model report discusses overall uncertainty of the respective model results. There is uncertainty associated with the hydraulic properties of the bedrock and faults; predictions of mine inflows and impacts on water resources are sensitive to permeability of major fault zones. In addition to varying the bulk hydraulic conductivity, Geomatrix (2011a) varied the hydraulic conductivity of layers adjacent to faults. The modified fault analysis did not provide a good match with flow tests performed within the Libby Adit and over-predicted observed adit inflow. The modified fault analysis predicted greater depletion in baseflow to nearby streams, compared to the calibrated model runs (Geomatrix 2011a).

With the data currently available, the model results provide a potential range of mine dewatering and pumping (in the case of the tailings impoundment model) rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models (mine area and tailings impoundment area) would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease.

To avoid confusion, this EIS uses the activity years reported in the 3D model report. The 3D model report assigns predictions to the nearest year, such as Year 22 or Year 1172. There is uncertainty as to the actual year any specific event would occur, particular for those events that would occur beyond end of mining.

In addition to model uncertainty, there is also the issue of measurability. The numerical models predict baseflow changes at various locations along streams draining the mine area, but the models do not consider what is possible to detect or measure. Other factors should be considered when reviewing and interpreting predicted baseflow. For example, baseflow at any one location along a stream may not be easily defined within the range of the model-predicted changes. Impacts from dewatering the mine and adits may be expressed in other ways, such as changing the elevation at which streams began to flow. Mine dewatering (and resultant groundwater drawdown) may cause this elevation to be lower in a drainage. Section 3.11.4.4.6, *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.

3.10.4.3.6 Effectiveness of Agencies' Proposed Monitoring and Mitigation

Monitoring

Groundwater Levels

The most effective method for monitoring groundwater levels would be the installation of piezometers in the area overlying the ore body. This method is typically used to establish baseline groundwater conditions and monitor changes due to mine activities. Because the ore body is located within the CMW, the Forest Service did not include the installation of piezometers in the CMW in the agencies' alternatives. Drilling in the CMW would have required the use of helicopter supported drilling in an important grizzly bear corridor. To avoid affecting the bear from drilling in the CMW, the agencies developed a detailed underground monitoring program, provided in Appendix C. Underground monitoring would be effective if implemented as discussed in Appendix C.

In Alternatives 3 and 4, MMC would monitor groundwater level changes from numerous locations from within the mine and adits (Appendix C). This information would be effective in establishing seasonal and long-term trends resulting from mine dewatering, and in understanding the hydrogeology to be used in refining the 3D model. Because the underground piezometers would be installed after the dewatering process had started, this monitoring would not fully characterize pre-mining conditions. Also, once mining ended, the monitoring locations would not be accessible for collecting groundwater recovery data.

Groundwater levels downgradient of the tailings impoundment would be monitored both continuously using data loggers and by hand monthly (Appendix C). Water quality monitoring in adjacent compliance wells also would be monitored. Monitoring data would be effective in establishing whether all groundwater flowing from beneath the impoundment was captured by the pumpback well system. Additional monitoring locations may be required if review of the initial monitoring network indicated that capture could not be confirmed due to inadequate data. This performance-based approach would require that the pumpback well system be modified, as necessary, to ensure that all tailings seepage was captured.

Changes in Spring Flow

The agencies would require that MMC collect flow data from springs in the area predicted by the groundwater model to be affected by groundwater drawdown due to mine dewatering. The monitoring would be initiated before the Evaluation Phase and would continue through the Operations and Closure Phases (Appendix C). Springs selected for flow measurement would be those that derive most or all of their water from bedrock sources, such as SP-41. Flow of the selected springs would be measured at least annually when accessible (typically early July through October), and others would be recorded continuously during the same time period.

With annual flow measurements of springs, many years of data collection would be required to identify potential spring flow decreases due to mine dewatering. Because of natural variability and flow measurement precision, it would be difficult to identify any flow changes other than large, obvious decreases in flow. To improve the effectiveness of spring flow measurements, the agencies would require that reference springs be identified in areas not expected to be affected by mine dewatering (Appendix C). The flow trends from the reference springs would be used to identify background trends that would otherwise complicate interpretation of flow measurements. Even with reference springs, it would be difficult to discern mine impacts from natural variability.

Changes in Stream Baseflow

The agencies would require that MMC collect flow data from stream reaches predicted to be affected by mine dewatering. The monitoring would be initiated before any additional dewatering of the Libby Adit for areas east of the Cabinet Mountains divide and before implementation of the Evaluation Phase for areas west of the divide. Monitoring would continue through the Operations and Closure Phases (Appendix C). Continuous data recorders would be used at some monitoring locations, where feasible, to obtain stream flow, particularly during periods of low flow. Because periods of high flow are dominated by surface water runoff, they are of less interest to this monitoring program. This monitoring requirement would be effective in obtaining year-to-year flow data, but because of natural variability, it would be less effective in identifying impacts on stream baseflow in any one year. Effectiveness would increase as data from multiple years were evaluated to establish long-term trends in baseflow.

Mitigation

Buffers

The 3D modeling was performed using buffers of 100 and 500 feet from the Rock Lake Fault and Rock Lake, respectively, and the data were reported to the agencies as requested. MMC did not report to the agencies the results of any additional modeling with larger buffers. Based on preliminary estimates of hydraulic properties of the bedrock and Rock Lake Fault, Evaluation Phase mining activities would be limited to within 300 feet of the Rock Lake Fault and 1,000 feet of Rock Lake to minimize the risk of high water inflow rates and resulting reduction in groundwater levels. To increase the effectiveness of this requirement, the agencies would re-evaluate the hydrogeology with the 3D model after obtaining additional hydraulic data from underground monitoring during the Evaluation Phase (as required in Appendix C). The evaluation would be used to increase or decrease the buffer zones between the Rock Lake Fault and Rock Lake, as necessary to reduce the risk of high mine inflows and excessive impacts. The agencies also would monitor underground mine development relative to the proscribed buffers (see section C.7.2 in Appendix C).

Grouting

For the purpose of analyzing the effects of possible mitigations, MMC simulated two options: grouting, during Operations Phase, of the sides of the three uppermost mine blocks and corresponding access ramps, as well as installing two 20-foot thick concrete pressure grouted wall bulkheads with a hydraulic conductivity of 1×10^{-9} cm/sec in two mining blocks across the mine void at Closure.

Because this mine would be of room-and-pillar design, grouting of fractures would be difficult, but technically feasible. Historically, grouting of fractures in the Libby Adit has been effective in reducing inflows, and MMC would be able to maintain grouting in the mine void and adits during construction and operations. With proper maintenance, grouting would be effective in reducing mine and adit inflows. Should certain threshold inflow rates be observed, as described in Appendix C, MMC would be required to report the conditions and the agencies would evaluate whether specific actions would be required, such as grouting. The effectiveness of grouting over the long term (*i.e.*, 100 years or more) is uncertain. Limited information is available on the functionality of fracture grouting in mines once mining is completed, and there are no data on the design life of grout in an underground flooded environment. The uncertainty of constructed concrete bulkheads also would apply to fracture grouting.

Grouting during the Operations Phase, particularly in mining blocks closest to Rock Lake, would be a possible mitigation to reduce changes in baseflow in nearby watersheds, particularly East Fork Rock Creek. Implementation of this mitigation during the Operations Phase is predicted to result in minimal improvement in the predicted baseflow changes (Table 99). Other mitigation, such as increasing the buffer zones between the mine void and Rock Lake Fault, and the mine void and Rock Lake, may be more effective than MMC's modeled mitigation. In addition to increased buffers, additional grouting of other mining blocks would be possible, but the long-term effectiveness of this mitigation has not been established. Additional mitigation measures would be evaluated with the 3D model after obtaining additional hydraulic data from underground monitoring during the Evaluation Phase.

Barrier Pillars with Bulkheads at Access Openings

In the agencies' 2D model, a bulkhead was simulated to assess the effect of a low-permeability barrier on groundwater conditions at closure. In MMC's 3D model, a similar simulation was completed, with the bulkheads being described as concrete pressure-grouted wall bulkheads in two mining blocks in the mine at closure. The long-term effectiveness of constructed low permeability bulkheads is not documented as there are no available data on service life for time horizons commensurate with the Post-Closure modeling scenario. Current bulkhead design guidelines were developed principally to address water management problems in operating mines, and they emphasize design, construction and maintenance for ongoing operations. A common bulkhead design frequently involves a combination of a constructed barrier, usually made of concrete, along with grouting of the bedrock around the bulkhead perimeter. While bulkheads and grouting have quantifiable and measurable results, the success of these types of mitigations depends on the ability to monitor the bulkheads and to take remedial action, such as supplemental grouting, to stem any persistent inflows. Much of the information pertaining to the use of hydraulic barriers in underground mining comes from applications in operating coal mines (Harteis *et al.* 2008, Chekan 1985, EPA 1977). There is limited information on functionality of hydraulic barriers once mining is completed, and there are no data on the design life of these structures. The agencies concluded that they cannot confirm the long-term effectiveness of constructed bulkheads across the entire mine void and their ability to maintain a very low hydraulic conductivity across the entire mine void over time. With constructed bulkheads across the entire mine void, baseflow may increase from the East Fork of Rock Creek drainage toward the East Fork of Bull River drainage as predicted by the 3D model. Werner (2014) describes the agencies' evaluation of the effectiveness of constructing bulkheads across the mine void in more detail.

As an alternative to constructed bulkheads with unknown long-term efficacy, the agencies propose to leave barrier pillars across the entire width of the deposit at strategic locations to divide the deposit into discrete compartments to minimize changes in pre-mining groundwater conditions, which would minimize movement of water between the watersheds of the East Fork Rock Creek and East Fork Bull River. There would be a limited number of access points through the barrier pillars for ore haulage, personnel and equipment access. At closure, bulkheads would be placed across these access points. The bulkheads would differ from those described in the modeling reports in that their dimensions would be on the order of feet rather than entire width of the mine void (up to 2,400 feet wide). Leaving barrier pillars would overcome some of the limitations associated with constructed bulkheads, such as long-term effectiveness (Werner 2014). Although a constructed bulkhead would be made of concrete and grout and a barrier pillar would be made of in-place unmined rock, they both would function in a similar manner to reduce the hydraulic conductivity between sections of the mine void. Consequently, the agencies considered the modeling of the bulkheads to be an equivalent simulation of the agencies' mitigation of leaving one or more barriers, if necessary, during the Operations Phase and constructing bulkheads at the access openings at closure.

Because the constructed concrete bulkheads would represent a relatively small proportion of the total bulkhead cross section that would mostly consist of unmined rock, the long-term effectiveness of the constructed bulkhead would be less of a concern, than if the entire mine void opening were plugged with a constructed bulkhead. The long-term effectiveness of constructed low permeability bulkheads is not documented as there are no available data on service life for the time horizon considered with the Post-Closure modeling scenario. The constructed bulkhead may begin to leak at some point in the future, but small increases in hydraulic conductivity as a result of leakage would not likely significantly increase the groundwater flow rate along the mine void. As water levels in the mine void recover on either side of a barrier, the pressure differential would decrease, reducing the flow rate through an intact barrier or through a partially failed constructed bulkhead. Because groundwater flow is proportional to both the hydraulic conductivity and groundwater pressure, groundwater flow through a barrier/bulkhead during the later stages of groundwater level recovery would decrease as the pressure differential decreases. Any increase in the hydraulic conductivity of the barrier/bulkhead due to small failures of a man-made bulkhead during the later stages of groundwater level recovery would be offset by decreases in the differential pressure. This would be particularly true because the man-made barriers would represent a relatively small proportion of the total mine void cross-sectional area.

The agencies' evaluation concluded that man-made concrete bulkheads within a larger barrier created by leaving unmined rock or pillars in place would likely provide the necessary mitigation during much of the groundwater level recovery period. Eventual failure of the constructed portion of the bulkhead would not likely result in significant increases in the total groundwater flow through the mine void.

By the fifth year of operations, MMC would assess the need for barrier pillars to minimize post-mining changes in East Fork Rock Creek and East Fork Bull River streamflow and water quality. If needed, MMC would submit a revised mine plan with one or more barrier pillars with constructed bulkheads at access openings to the agencies for approval. One or more barriers would be maintained underground, if necessary, after the plan's approval. Implementation of this mitigation would decrease the hydraulic head in the north end of the mine void and reduce the maximum baseflow changes at the CMW boundary along East Fork Rock Creek during the Post-Closure Phase from those predicted for the unmitigated baseflow changes. This mitigation is predicted to eliminate the loss of water from storage in Rock Lake during the same time period. The potential direction of post-mining groundwater flow direction within the mine void would be better defined using all hydrologic data collected during mining. The low permeability barrier design would be based on an analysis of these data to improve its effectiveness.

Multiple Adit Plugs

MMC proposed that a single water-retaining plug (bulkhead) would be installed in competent bedrock near the opening of each adit. In the agencies' alternatives, MMC would place two or more plugs in each of the three mine adits. The plugs would be located to isolate the adits hydraulically from the mine void and to ensure any groundwater tributary to Libby and Ramsey creeks would flow into the adits, and remain within the Libby Creek and Ramsey Creek watersheds during the period of groundwater recovery. Without multiple plugs, as simulated by the 3D model, a considerable amount of time (hundreds of years) would be required for the adits to resaturate because any water produced in the adits would flow downhill toward the mine void. A plug at the base of the adits would be effective in hydraulically isolating the adits from the mine void. Without these plugs, as simulated by the 3D model, a considerable amount of time (hundreds of years) would be required for the adits to resaturate because any water produced in the adits would flow downhill toward the mine void. Plugs would prevent adit inflow water from leaving the adits, and allow the adits to reach steady state conditions independently from water levels over the mine void, within an estimated 10 to 20 years after operations ceased. The effect would be reduced to a few years if MMC used water diverted from Libby Creek during high flows to fill the adits during the Closure Phase. Two or more plugs in each adit would provide additional confidence that the plugs would continue to be effective while groundwater levels recover beyond that provided a single plug. Multiple low permeability plugs within an adit, evaluated technically and hydrologically and designed based on site-specific conditions of each adit, would reduce the total groundwater pressure on the bottom plug by segmenting the open adit into compartments, increasing the overall effectiveness of the plugging approach. As groundwater levels recovered, both in the adits and the mine void, the differential pressure between compartments separated by a plug would decrease, which would decrease the potential for failure of a plug and decrease the potential for flow of groundwater through a plug, even if a plug partially failed.

Groundwater Pumpback Well System at Impoundment Site

A groundwater pumpback well system downgradient of the tailings impoundment can be an effective means of collecting seepage from the impoundment that may bypass the underdrain system (estimated to be about 25 gpm). To be effective, a pumpback system would have to be designed to accommodate likely heterogeneities in the groundwater system beneath and down-gradient of the impoundment and be properly monitored to make adjustments in well placement and pumping rates. The goal of a pumpback system would be to establish and maintain complete hydraulic capture of all groundwater moving downgradient from the impoundment, as confirmed by measuring water levels at strategically located monitoring wells. The actual performance of the capture system would be determined by monitoring water quality downgradient of the capture zone. Should water quality changes attributable to tailings seepage be observed, the pumpback well system would be adjusted to improve hydraulic capture.

3.10.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

3.10.4.4.1 Evaluation through Post-Closure Phases

Mine Area

Alternative 4 would have the same effects and uncertainties on groundwater levels and springs and seeps overlying the ore body and baseflow in East Fork Rock, Libby, Ramsey, and Poorman creeks and East Fork Bull River as Alternative 3 (section 3.10.4.3.1, *Evaluation through Operations Phases*). The effects of the Libby Adits would be the same as Alternative 3. The effect of make-up wells on groundwater levels in Alternative 4 would be the same as Alternative 2.

Tailings Impoundment Area

Numerous springs and seeps were identified in the area surrounding the Little Cherry Creek Impoundment Site (Figure 70) (Geomatrix 2006c, 2009b; Kline Environmental Research 2012).

Springs SP-15, 23, and 24 would be covered by the impoundment, and a fourth spring (SP-10) would be covered by the Seepage Collection Pond. Two other springs would be in the disturbance area. Seeps in Little Cherry Creek also would be covered by the impoundment. A pumpback well system required to capture seepage not collected by the underdrain system would lower groundwater levels and reduce groundwater discharge to springs, seeps, and wetlands surrounding of the impoundment. Eleven known springs outside of the disturbance area may be affected by the pumpback well system. Operation of a pumpback well system may not affect water levels and six of the springs south of the Little Cherry Creek watershed because of an apparent subsurface bedrock ridge that separates groundwater flow between the watershed of Little Cherry Creek from those of Drainages 5 and 10 in the Poorman Impoundment Site (Chen Northern 1989). Additional subsurface data from this area would be collected during the final design process of the Little Cherry Creek Impoundment to confirm the geophysical results. A 3D model of the pumpback well system would be developed to evaluate the effect of the wells.

During final design, MMC would collect whatever data were necessary to develop a 3D model for a pumpback well system. The additional data would include investigation of a subsurface bedrock ridge that may exist between the Little Cherry Creek and Poorman Creek watersheds. The low permeability bedrock ridge may separate groundwater flow between the watershed of Little Cherry Creek from those of Drainages 5 and 10 in the Poorman Impoundment Site (Chen Northern 1989). If a ridge and hydrologic divide separates the two areas, it is unlikely that pumping in the Poorman Impoundment Site would affect groundwater levels in the Little Cherry Creek drainage. The pumping rate required to capture all seepage would potentially be lower without recharge from the watersheds of the drainages in the Poorman Impoundment Site, such as Drainages 5 and 10.

The amount of seepage collected by the seepage collection facilities may be increased compared to Alternative 2 by locating the Seepage Collection Pond with respect to the local geologic conditions. Geotechnical investigations at the Little Cherry Creek Impoundment Site were conducted on behalf of NMC between 1988 and 1990. NMC reported that bedrock is exposed in the Little Cherry Creek channel and bedrock extends about 800 feet downstream of the proposed Seepage Collection Dam (Morrison-Knudsen Engineers, Inc. 1990). Groundwater modeling conducted by MMC (Klohn Crippen 2005) and independently verified by the agencies (USDA Forest Service 2008) assumed that the fractured bedrock in the Little Cherry Creek drainage is the primary aquifer for groundwater flow at the site. The modeling indicated that any tailings seepage not intercepted by the seepage collection and pumpback well systems would likely discharge to the Little Cherry Creek watershed through the fractured bedrock aquifer (USDA Forest Service 2008). If not intercepted, some of the seepage may flow to Libby Creek via a buried channel beneath the impoundment site. Klohn Crippen (2005) estimated 80 percent of the existing groundwater flows toward Little Cherry Creek and 20 percent flows toward Libby Creek via the buried channel. Any tailings seepage is likely to follow existing groundwater flow paths. Consequently, siting the Seepage Collection Dam at or below the location where bedrock outcrops in the Little Cherry Creek drainage would increase the likelihood that the seepage would be collected by the dam. In Alternative 4, MMC would conduct additional geotechnical work near the Seepage Collection Dam during final design and site the dam lower in the drainage if technically feasible.

Other effects in the tailings impoundment area would be the same as Alternative 2. The potential impacts on Libby Creek alluvial groundwater from appropriations during high-flow periods would be the same for Alternatives 3 and 4.

LAD Areas

The use of LAD Areas is not proposed for Alternative 4 and groundwater in the LAD Areas would not be affected.

3.10.4.4.2 Climate Change

The effects of climate change in combination with Alternative 4 would be the same as Alternative 2.

3.10.4.5 Cumulative Effects

3.10.4.5.1 Past and Current Actions

The Heidelberg Adit is a horizontal tunnel that was constructed in the 1920s. The adit extends about 790 feet into a cliff face located along East Fork Rock Creek about 850 vertical feet below Rock Lake. Groundwater flow from the adit is reported to range from 45 to 135 gpm (Gurrieri 2001). During the agencies' September 2007 field review, flow from the adit was estimated to be 50 gpm and, because of dry conditions at the time of the site visit, this rate is considered to be baseflow from bedrock. Because flow data were apparently not collected before construction of this adit, it is not known if the adit outflow affected baseflow in nearby East Fork Rock Creek.

The Libby Adit was constructed between 1990 and 1991 by NMC and is about 14,000 feet long and slopes downward toward the ore body at a 6 percent slope. Groundwater inflow to the adit increased as the adit was driven, peaking at 239 gpm. The steady state flow from the adit was 150 gpm. Surface flow monitoring was insufficient to identify possible reductions in baseflow in Libby Creek. No groundwater piezometers were installed at the time the adit was constructed to identify changes in groundwater levels near the adit as result of dewatering.

3.10.4.5.2 Rock Creek Project

The two Montanore numerical groundwater models (2D and 3D) were used to assess the cumulative effects of the Montanore and Rock Creek mines. The approximate footprint of the Rock Creek Mine was used in both models. The models were used to predict the effects of simultaneous operation of the two mines by predicting the amount of drawdown in the region during the Post-Closure Phase and the resulting reduction in groundwater contribution to surface water.

The Montanore 3D numerical model predicted that the combined drawdown from the Rock Creek and Montanore mines would merge in a small area beneath the East Fork Bull River watershed (Figure 75). As a result, there would be a small incremental reduction in the baseflow (about 2 percent) to East Fork Bull River at the CMW boundary and a 1 percent decrease in baseflow at the mouth of East Fork Rock Creek as a result of a cumulative effect during the Post-Closure Phase (Table 104). The model predicted that most of the cumulative effect would occur in the lower reaches of the drainages. Streams in the Libby Creek watershed would not be cumulatively affected.

Table 104. Predicted Cumulative Changes to Baseflow – Post-Closure (Maximum Baseflow Change).

Drainage and Location (Figure 67)	Model-Predicted Pre-mining Baseflow (cfs)	Without MMC's Modeled Mitigation			With MMC's Modeled Mitigation[†]		
		Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow	Model-Predicted Baseflow (cfs)	Predicted Change in Baseflow (cfs)	Percent Change in Baseflow
Rock Creek and East Fork Rock Creek							
At mouth (RC-2000)	7.70	7.02	-0.68	-9%	7.51	-0.19	-2%
CMW Boundary (EFRC-200)	0.29	0.00 (-0.15)[§]	-0.29 (-0.44)[§]	-100%	0.12	-0.17	-59%
In CMW (EFRC-50)	0.04	0.00	-0.04	-100%	0.00	-0.04	-100%
East Fork Bull River							
At mouth (East Fork Bull River)	11.34	10.98	-0.36	-3%	10.99	-0.35	-3%
CMW Boundary (EFBR-500)	4.36	3.88	-0.48	-11%	3.91	-0.47	-11%
In CMW (EFBR-300)	0.29	0.00	-0.29	-100%	0.01	-0.28	-97%
Based on RCR's Model Results*							
Rock Creek at mouth (RC-2000)	7.8	6.7	-1.1	-14%			
East Fork Bull River at mouth	10.4	9.5	-0.9	-9%			

[†]Geomatrix 2011a did not report cumulative effects with mitigation nor did it report Year 52 reductions for East Fork Bull River. The agencies determined the incremental unmitigated cumulative effect and added that effect on the direct mitigated effect.

[§]Negative value represents reduction of baseflow to zero and loss of water from storage in Rock Lake without MMC's modeled mitigation. The baseflow change of -0.44 cfs would result from a change in baseflow of 0.29 cfs plus a reduction in lake storage at the rate of 0.15 cfs.

[*] Reported values are based on the sum of Montanore and RCR model results. RCR did not model effects with mitigation.

cfs = cubic feet per second ("cfs" is the accepted unit for reporting streamflow. Because it is a large unit (1 cfs = 448.8 gpm), predicted changes in terms of cfs appear to be very precise (*i.e.,* reported to 0.01 cfs). If the results were converted to gallons per minute, they would be reported to the nearest 5 gpm. Section 3.11.4.4.6. *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability.

With and without MMC's modeled mitigation - maximum model predicted baseflow reductions occur at Year 52 for East Fork Bull River, Year 38 for the Rock Creek drainage. Effects shown do not include mitigation measures not provided in MMC's 3D model report such as increasing buffer zones or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase.

With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.

Source: Geomatrix 2011a; East Fork Bull River results based on Geomatrix, pers. comm. 2011c; RCR model results based on Hydrometrics 2014.

A Rock Creek 3D model prepared by Hydrometrics (2014) on behalf of Rock Creek Resources provided results specifically for the proposed Rock Creek Mine. The model simulation included more site specific detail concerning the mine, geologic structures, and mine operation than was available during preparation of the Montanore 3D for the same area. Adding the results from the Rock Creek Resources and Montanore models for the period of greatest drawdown, assuming these periods would occur at the same time for the two mines, the predicted cumulative baseflow impacts from the two mines would be 0.2 to 0.3 cfs greater in Rock Creek and East Fork Bull River than predicted by the cumulative analysis performed by Montanore.

In addition, during the period of maximum drawdown, based on the Montanore 3D model, the Montanore Mine is predicted, without mitigation, to reduce baseflow in East Fork Rock Creek at the CMW boundary by 0.29 cfs (100 percent of the predicted baseflow) and reduce storage in Rock Lake by 0.15 cfs (for a total “demand” of 0.44 cfs). The Rock Creek 3D model predicted a baseflow at the CMW boundary of 0.7 cfs compared to 0.29 cfs from the Montanore model. Because the Montanore model predicted a total “demand” from mine dewatering of 0.44 cfs, 0.15 cfs (0.44 minus 0.29 cfs) would come from Rock Lake storage. If the baseflow were greater than 0.44 cfs (as predicted by the Rock Creek 3D model), all of the Montanore “demand” would come from baseflow, rather than a combination of baseflow and lake storage. In such a scenario, cumulative baseflow reduction at the mouth of Rock Creek would be 0.15 cfs greater than what is reported in Table 104 because all of the Montanore “demand” would be met from baseflow, rather than lake storage.

3.10.4.5.3 Other Reasonably Foreseeable Actions

Two reasonably foreseeable mining operations, Libby Creek Ventures drilling plans, and the Wayup Mine would not affect groundwater conditions and would not have cumulative effect with the Montanore Project. No other reasonably foreseeable actions would have cumulative effects on groundwater flow.

3.10.4.6 Regulatory/Forest Plan Consistency

3.10.4.6.1 Organic Administration Act and Forest Service Locatable Minerals Regulations

The Forest Service is responsible for ensuring that mine operations on National Forest System lands comply with Forest Service locatable mineral regulations (36 CFR 228 Subpart A) for environmental protection. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest System surface resources. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8 because MMC did not propose to implement feasible measures to minimize adverse environmental impacts on surface resources. The agencies’ alternatives (Mine Alternatives 3 and 4 and Transmission Line Alternatives C-R, D-R, and E-R) would incorporate additional feasible measures to minimize adverse environmental impacts on National Forest System surface resources. The measures would include increasing mining buffer zones, installing multiple, site-specifically designed adit plugs at closure, grouting, and, if necessary, leaving mine void barriers. Using thickened tailings would reduce MMC’s appropriation from the Libby Creek and minimize effects on Libby Creek streamflow. The agencies’ alternatives expanded MMC’s proposed monitoring plans and would include action levels on mine inflows and changes in surface water flow and lake levels that would trigger corrective measures to be implemented by MMC (see Appendix C).

3.10.4.6.2 Wilderness Act

All mine alternatives have the potential to indirectly affect wilderness qualities. Mitigation measures identified in Chapter 2 for Alternatives 3 and 4 and monitoring required for Alternatives 3 and 4 (Appendix C) would be implemented to minimize potential changes in wilderness character. Mitigation measures, such as increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring coupled with final design criteria submitted for the agencies' approval, would reduce the risk of subsidence and measurable hydrological indirect effects to the surface within the wilderness.

Mitigation measures and monitoring requirements in Alternatives 3 and 4 are reasonable stipulations for protection of the wilderness character and are consistent with the use of the land for mineral development. Alternatives 3 and 4 would be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and to preserve the wilderness character consistent with the use of the land for mineral development and production in compliance with 36 CFR 228.15 and the Wilderness Act. The agencies' mine and transmission line alternatives would comply with the Wilderness Act. Alternatives 3 and 4 would minimize adverse environmental impacts on surface resources within the wilderness, and thereby comply with the regulations (36 CFR 228, Subpart A) for locatable mineral operations on National Forest System lands.

36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations." DNRC's permit decision and associated conditions on beneficial water use permits would constitute compliance with Montana groundwater use requirements.

3.10.4.7 Irreversible and Irretrievable Commitments

Most of the total precipitation that falls in the Cabinet Mountains flows from the mountains as surface water and groundwater. The total water yield varies from year-to-year as a function of the total precipitation and varying amounts of evapotranspiration. Some water would be used consumptively by the project, reducing the total yield of the region by that amount. Relative to the total yield of the affected watersheds, the consumptively used volume would be small. The reduction in yield would be an irretrievable commitment of resources.

In addition to water consumptively used, the estimated increase in groundwater storage due to the mine void would be about 34,600 acre feet, assuming 120 million tons of ore and 3.2 million tons of waste rock were mined. With mitigation of increased buffers and barrier pillars, if necessary, the mine void and the increase in groundwater storage would be slightly smaller. This volume of groundwater required to fill the mine void would be an irretrievable commitment of resources.

After the mine void filled, the total water yield of the region would return to pre-mining conditions, but because of the large mine void, the distribution of water produced along the headwaters of the four major streams that drain the area would be permanently changed. Without mitigation, the large mine void with an infinitely high hydraulic conductivity would permanently change the groundwater flow paths from the East Fork Rock Creek watershed toward the East Fork Bull River watershed. Mitigation would be designed to minimize post-mining changes in East Fork Rock Creek and East Fork Bull River streamflow and water quality. Without mitigation, the change in groundwater flow paths would be an irreversible commitment of resources.

Because of the potential for permanent change in groundwater flow paths, there may be slight changes in the relative contribution of deeper and shallow groundwater to surface water bodies such as Rock Lake. Springs would be irreversibly covered by the tailings impoundment in all action alternatives.

3.10.4.8 Short-term Uses and Long-term Productivity

As described above, there would be a short-term reduction in available water from this portion of the Cabinet Mountains equal to the consumptive use of the mine. Given the overall flow rate of streams from this area, the total short-term change would be small. Long-term, water availability of this area would not be reduced, but the distribution among the four major drainages may be slightly altered.

3.10.4.9 Unavoidable Adverse Environmental Effects

The consumptive use of groundwater by the project would unavoidably reduce the total water yield from this portion of the Cabinet Mountains. The anticipated consumptive use would be small relative to the total water yield of this area. Water yield would remain reduced until the project no longer consumptively uses water, and then slowly return to the pre-mining yield as the mine void filled, which would require about a predicted 493 years and longer with the agencies' mitigation. Without mitigation, water levels over portions of the mine void would permanently remain greater than 100 feet below pre-mine conditions and between 500 and 1,000 feet in a small area north of Rock Lake. Without mitigation, water levels closest to Rock Lake (in mining block 18) are predicted to remain 45 feet below pre-mine conditions, and less with mitigation. Total yield would be the same after the mine void reached steady state conditions, when recharge equaled discharge.

3.11 Surface Water Hydrology

This section provides information on analysis area streams, springs and lakes, and potential consequences to streamflow, spring flows, and lake levels resulting from the mine and transmission line alternatives. Surface water quality is discussed in section 3.13*, Water Quality*.

3.11.1 Regulatory Framework

3.11.1.1 Federal Requirements

The Organic Administration Act authorizes the Forest Service to regulate the occupancy and use of National Forest System lands. The Forest Service's locatable minerals regulations are promulgated at 36 CFR 228, Subpart A. The regulations apply to operations conducted under the U.S. mining laws as they affect surface resources on National Forest System lands under the jurisdiction of the Secretary of Agriculture. One of the mineral regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. 36 CFR 228.8 also requires that mining operators comply with applicable state and federal water quality standards including the Clean Water Act; take all practicable measures to maintain and protect fisheries and wildlife habitat which may be affected by the operations; and reclaim the surface disturbed in operations by taking such measures as preventing or controlling onsite and off-site damage to the environment and forest surface resources. All waters within the boundaries of National Forests may be used for domestic, mining, or irrigation purposes, under applicable state laws. 36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations."

The Wilderness Act allows mineral exploration and development under the General Mining Law to occur in wilderness to the same extent as before the Wilderness Act until December 31, 1983, when the Wilderness Act withdrew the CMW from mineral entry, subject to valid and existing rights. 36 CFR 228.15 provides direction for operations within the National Forest Wilderness. Holders of validly existing mining claims within the National Forest Wilderness are accorded the rights provided by the U.S. mining laws and must comply with the Forest Service Locatable Minerals Regulations (36 CFR 228, Subpart A). Mineral operations in the National Forest Wilderness are to be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and to preserve the wilderness character consistent with the use of the land for mineral development and production.

The Federal Water Pollution Control Act (Clean Water Act) is designed to protect and improve the quality of water resources and maintain their beneficial uses. Proposed mining activities on National Forest System lands are subject to compliance with Clean Water Act Sections 401, 402 and 404 as applicable. Analysis and discussion related to Section 404 and Executive Order 11990 is located in section 3.23, *Wetlands and Other Waters of the U.S.* The 2015 KFP direction considered in the analysis of streamflow is:

> **GOAL-WTR-01.** Maintain or improve watershed conditions in order to provide water quality, water quantity, and stream channel conditions that support ecological functions and beneficial uses.

FW-DC-WTR-01. Watersheds and associated aquatic ecosystems retain their inherent resilience to respond and adjust to disturbance without long-term, adverse changes to their physical or biological integrity.

FW-DC-WTR-02. Water quality meets applicable state water quality standards and fully supports beneficial uses. Flow conditions in watersheds, streams, lakes, springs, wetlands, and groundwater aquifers fully support beneficial uses, and meet the ecological needs of native and desirable non-native aquatic species and maintain the physical integrity of their habitats.

FW-DC-WTR-03. Stream flows provide for channel and floodplain dimensions that mimic reference conditions. Stream flows allow for water and sediment conveyance and overall channel maintenance. Sediment deposits from over-bank floods allow floodplain development and the propagation of flood-dependent riparian plant species. Surface and groundwater flows recharge riparian aquifers, provide late-season stream flows, cold water temperatures, and sustain the function of surface and subsurface aquatic ecosystems.

FW-DC-WTR-06. Cooperate with other landowners, agencies, and partners to monitor, maintain, and improve watershed and stream channel conditions.

Executive Order 11988, Floodplain Management requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The order applies to impacts on 100-year floodplains designated by the Federal Emergency Management Agency (FEMA).

3.11.1.2 State Requirements

3.11.1.2.1 Nondegradation Rules

The Montana Water Quality Act requires the DEQ to protect high quality waters from degradation; these provisions implement the requirement of the Clean Water Act to adopt a statewide antidegradation policy. The current rules were adopted in 1994 in response to amendments to Montana's nondegradation statute in 1993 and apply to any activity that is a new or increased source that may degrade high quality water. All of the waters in the analysis area are high quality waters, except surface waters that have zero flow or surface expression for more than 270 days during most years. High quality waters are defined in the Montana Water Quality Act (75-5-103(13), MCA)). The Montana Water Quality Act prohibits degradation of high quality waters unless the DEQ issues an authorization to degrade. The nondegradation rules do not apply to water quality parameters for which an authorization to degrade was obtained prior to the 1993 amendments to the statute. NMC, MMC's predecessor, obtained an authorization to degrade in 1992 for certain water quality parameters. For those parameters, the limits contained in the authorization to degrade apply. For those parameters not covered by the authorization to degrade, such as flow, the applicable nonsignificance criteria established by the 1994 rules, and any subsequent amendments, apply (ARM 17.30.715), unless MMC obtained an authorization to degrade under the current statute.

The Montana Water Quality Act defines "degradation" as a change in water quality that lowers the quality of high-quality waters for a parameter, unless the change is nonsignificant. Current nondegradation rules provide that if an activity increases or decreases the mean monthly flow of a stream by less than 15 percent or the 7-day, 10-year ($7Q_{10}$) low flow of a stream by less than 10 percent such changes are not significant for purposes of the statute prohibiting degradation of state waters (ARM 17.30.715(1)(a)). Notwithstanding compliance with the nonsignificance criteria in ARM 17.30.715(1), the DEQ may determine under ARM 17.30.715(2) that a change in water quality is degradation based on the following criteria: a) cumulative impacts or synergistic effects; b) secondary byproducts of decomposition or chemical transformation; c) substantive information derived from public input; d) changes in flow; e) changes in the loading of parameters; f) new information regarding the effects of a parameter; or g) any other information deemed relevant by the DEQ and that relates to the criteria in ARM 17.30.715 (1). Under ARM 17.30.715(3), the DEQ may determine that a change in water quality is nonsignificant based on information submitted by an applicant that demonstrates conformance with the guidance found in 75-5-301(5)(c), MCA which is: i) potential for harm to human health, a beneficial use, or the environment; ii) strength and quantity of any pollutant; iii) length of time the degradation will occur; and iv) the character of the pollutant so that greater significance is associated with carcinogens and toxins that bioaccumulate or biomagnify and lesser significance is associated with substances that are less harmful or less persistent. Such a determination would be submitted for public comment before making a decision. Under the Montana Water Quality Act, no authorization to degrade may be obtained for outstanding resource waters, such as surface waters within a wilderness.

3.11.1.2.2 Other State Requirements

Under the Montana Floodplain and Floodway Management Act, the DNRC regulates flood-prone lands and waters to prevent and alleviate flooding threats to life and health and reduce private and public economic losses. The following uses are prohibited within floodways and floodplains, unless a variance is obtained:

- A structure or excavation that would cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway
- The construction or permanent storage of objects subject to flotation or movement during flood events (76-5-403, MCA)

Some mine facilities would be located in a floodplain, based on conceptual designs presented in Chapter 2. Transmission line facilities are not subject to the Montana Floodplain and Floodway Management Act. If at final design mine facilities would be in a floodplain, a variance application would be submitted to the DNRC that provides details on the obstruction or use of a floodway/ floodplain and a permit would be required before construction. DNRC's permit issuance is based on the danger to life and property downstream, availability of alternate locations, possible mitigation to reduce the danger, and the permanence of the obstruction or use (76-5-405, MCA).

The MFSA directs the DEQ to approve a facility if, in conjunction with other findings, the DEQ finds and determines that the facility would minimize adverse environmental impacts considering the state of available technology and the nature and economics of the various alternatives. A floodplain permit would not be needed for the transmission line if a MFSA certificate was issued.

The Montana Natural Streambed and Land Preservation Act requires a 310 Permit for any activity that physically alters or modifies the bed or bank of a perennially flowing stream (see section 1.6.2.4, *Montana Department of Natural Resources and Conservation* in Chapter 1). The permit application must be submitted to the local Conservation District. The project must be designed and constructed to minimize adverse impacts on the stream, minimize erosion, retain the original stream length or otherwise provide hydrologic stability, protect streambank vegetation, and minimize impacts on aquatic life.

3.11.2 Analysis Area and Methods

3.11.2.1 Analysis Area

The analysis area for direct, indirect, and cumulative effects on surface water hydrology and water quality consists of all areas where surface water may be measurably affected either by the construction, operations or closure of the mine the transmission line or Sedlak Park Substation and loop line. The analysis area consists of four major watersheds and their tributaries: Libby Creek and its tributaries Howard Creek, Ramsey Creek, Poorman Creek, Midas Creek, Little Cherry Creek, Bear Creek and its tributary Cable Creek, Big Cherry Creek, and Swamp Creek; the Fisher River and its tributaries Sedlak Creek, West Fisher Creek and its tributary Standard Creek, Miller Creek, and Hunter Creek; Rock Creek and its tributary East Fork Rock Creek; and East Fork Bull River and its tributaries Placer Creek and Isabella Creek (Figure 76). Three other streams, Flower Creek, Copper Gulch, and West Fork Rock Creek, are briefly described in the Affected Environment section because they may be used for bull trout mitigation. Streams located outside the analysis area, such as Libby Creek below US 2, the Bull River, or the Clark Fork River, may be affected by the project, but effects would be negligible. Swamp Creek and Wanless Lake, both on the west side of the Cabinet Mountains, would not be affected by the project and would serve as benchmark monitoring locations. Lakes in the analysis area include Howard Lake, Ramsey Lake, Rock Lake, St. Paul Lake, Isabella Lake, and Libby Lakes; some of these lakes are not expected to be affected by the project. Other lakes in the CMW, such as Cliff and Copper lakes, are outside the analysis area because the 3D model did not predict they would be affected by the project.

3.11.2.2 Baseline Data Collection

This section summarizes the baseline information collected for surface water hydrology and the affected environment, and the following sections describe the approaches used by the lead agencies in analyzing potential effects. The mine-related data include spring and seep inventories, spring flow, streamflow and lake level measurements, and USGS mapping that shows locations of perennial and intermittent streamflow. The tailings impoundment site surface water data included spring and seep inventories, and measurements of spring flow and streamflow. The subsequent section on the affected environment describes the best available information regarding surface water resources in the analysis area. The KNF determined that the baseline data and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on surface water and groundwater-dependent ecosystems in the analysis area, and to enable the decision makers to make a reasoned choice among alternatives. Section 3.10.2.4, *Additional Data Collection* and Appendix C describe the additional water quality data that would be collected during all phases of the project, including the Evaluation Phase and for final design. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

Surface water investigations included a review of previous permits and approvals, existing water use, an analysis of the watersheds potentially impacted by the project, floodplain mapping, streamflow, spring flow, peak streamflow calculations, lake levels and surface water quality sampling. Water resource baseline investigations were initiated in the analysis area by U.S. Borax in 1986 and 1987, continued by NMC in 1988 through 1994 and by MMC in 2004, 2005, and 2007 to 2013. In addition, the DEQ collected water resources information in the CMW in 1998 to 2000, followed by additional surface water data collection in the CMW by MMC in 2005. Streamflow measurements were collected in the analysis area by the KNF between 1960 and 2010. Additional streamflow measurements also were collected by NMC and MMC from 1998 through 1995 and 2001 through 2013 and by the DEQ in 1998 to 2000. Streamflow monitoring stations are shown on Figure 76. KNF gaged streamflow sites are on Libby Creek at US 2, West Fisher Creek, Miller Creek, lower East Fork Bull River, and lower Rock Creek. Four gaged sites also are on the Fisher River. MMC began continuously measuring the flow of upper Libby Creek in the summer of 2009. MMC also began continuously measuring the level of Rock Lake in the summer of 2009. Gurrieri (2001) and Gurrieri and Furniss (2004) measured and reported lake stage, surface inflows and outflows, and precipitation at Rock Lake in 1999 to complete a lake water balance. Available data collected by these various entities through 2013 are included in the EIS analysis.

MMC completed Groundwater Dependent Ecosystem (GDE) surveys in the mine area between 2009 and 2013 and continued monitoring of the GDEs in 2010 through 2014 (Geomatrix 2009a, 2010b, 2011d; NewFields 2013a, MMC 2014d, Klepfer Mining Services 2015a). GDE inventories and monitoring data and the agencies' proposed monitoring in the CMW overlying the mine area are described in Appendix C under *Water Resources.*

3.11.2.3 Impact Analysis

3.11.2.3.1 Streamflow

Streamflow changes may occur due to mine and adit dewatering, pumpback well system operation around the impoundment, evaporative losses from a tailings impoundment or LAD Areas (in Alternative 2), water appropriations from the Libby Creek watershed during high flows, discharges from a Water Treatment Plant or to the LAD Areas (the latter in in Alternative 2), vegetation clearing, and potable water use. To determine changes in streamflow and lake levels that may occur during the five mine phases, the capture, use, and discharges of water within each affected watershed for each mine alternative were evaluated. In addition, because the mine would intercept groundwater that may be a source of water to springs, lakes, and streams, the effects on surface water from underground mining also were evaluated.

A 2D numerical model of the mine area was developed to assess mine inflow and changes to baseflow (ERO Resources Corp. 2009). The primary objective of using a 2D model was to establish a hydrogeologic framework that could be used to evaluate potential mine impacts and develop possible impact mitigation. The baseflow of the mine area streams was modeled, as was the interaction of stream baseflow with the groundwater system. The agencies used the 2D model results for the basis of the hydrology effects analysis in the Draft EIS. Subsequently, MMC prepared a more complex 3D model of the analysis area (Geomatrix 2011a). The 3D model used the facility configuration in Alternative 3 in the analysis. Although the results of the two models are similar, the 3D model better represents the anticipated effects on streamflow and the 3D model results are used for the effects analysis. Similarly, the results of a 3D model of a pumpback well system at the Poorman Impoundment Site were used to assess effects of groundwater pumping on streamflow (Geomatrix 2010c). The effects on streamflow of Alternatives 2 and 4 have not been quantified and would be similar to effects described for Alternative 3 for east side streams and the same as Alternative 3 for west side streams. The effects of Alternatives 2 and 4 are discussed qualitatively and the effects of Alternative 3 are discussed quantitatively.

Sensitivity analyses were performed for each of the groundwater models and the results provided in ERO (2009) and Geomatrix (2011a). In addition, each model report discusses overall uncertainty of the respective model results. There is uncertainty associated with the hydraulic properties of the bedrock and faults; predictions of mine inflows and impacts on water resources are sensitive to permeability of major fault zones. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both groundwater flow models would be refined and rerun after data collected during the Evaluation Phase were incorporated into the models (see section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease.

Streamflow effects are described for four different flow periods: estimated $7Q_{10}$ flow, or in the case of higher elevation sites, baseflow, estimated $7Q_2$ flow, average flow, and peak flow. Values for these flow periods cannot be determined because none of the analysis area streams have been continuously gaged for a sufficient length of time. For this reason, flows used for the effects analysis have been estimated or simulated for specific locations.

As discussed in section 3.8.3, 7-day, 10-year ($7Q_{10}$) low flow and 7-day, 2-year ($7Q_2$) low flow were derived for specific stream locations and the estimated $7Q_{10}$ and $7Q_2$ flow used to analyze the effects of mine activities on streamflow. The $7Q_{10}$ and $7Q_2$ low flows were estimated using a USGS method developed for ungaged watersheds (Hortness 2006). The equations used to estimate the $7Q_{10}$ and $7Q_2$ low flows used drainage area and mean annual precipitation as the location-specific variables (Hortness 2006). The estimated range of the $7Q_2$ and $7Q_{10}$ flows for analysis area streams is provided in Table 87 in section 3.8.3. With the exception of EFRC-200, LB-100, and LB-300, the estimated $7Q_{10}$ flow for the stream locations used in the streamflow analysis is lower than modeled baseflows. At EFRC-200, LB-100, and LB-300, where the estimated $7Q_{10}$ flow is greater than the modeled baseflow, the agencies used the lower modeled baseflow instead of the estimated$7Q_{10}$ flow to analyze effects. The use of estimated $7Q_2$ and $7Q_{10}$ flow (and modeled baseflow in lieu of $7Q_{10}$ flow at EFRC-200 and LB-300) provides an analysis of project effects when such effects would be most measurable.

The agencies used eight different locations to summarize streamflow effects from mine activities (Table 109 through Table 114); these locations are shown on Figure 76. The East Fork Rock Creek site, EFRC-200, is at the outlet of Rock Lake at the CMW boundary. The Rock Creek site, RC-2000, is at the mouth of Rock Creek above the confluence of the Clark Fork River. The East Fork Bull River site, EFBR-500, is at the CMW boundary. The sites on Little Cherry, Poorman, and Ramsey creeks are near the confluences of these creeks with Libby Creek. Two sites are on Libby Creek: LB-300 below the Libby Adit Site, and LB-2000 just above the confluence with Bear Creek. The effect on baseflow at LB-100 near the CMW boundary due to mine inflows was also evaluated.

Three additional locations that are important aquatic habitat stream segments (described in section 3.6, *Aquatic Life and Fisheries*) were analyzed to provide effects due to mine inflows at these locations (Figure 76). One site is on Libby Creek (LB-2), located about 1 mile upstream of Little Cherry Creek, where the pumpback wells would reduce streamflow. Another site on the East Fork Rock Creek (RC-3) is about 1 mile upstream of the confluence with the West Fork Rock Creek, and the third site on the East Fork Bull River (EFBR-2) is at the confluence with Isabella Creek in the CMW. Effects due to mine inflows were predicted using the 3D groundwater model. In August through October 2012, KNF hydrologists collected stream cross-section measurements and measured stream velocity during various flow regimes at LB-2, RC-3, and EFBR-2. These data were used to calculate stream discharge at these locations and develop a relationship during low flows between the wetted cross section area (a total of 25 or more width and water depth measurements taken across a stream cross section, each multiplied and then added to derive total wetted perimeter at the cross section) and discharge. The wetted perimeter-discharge relationship for each site was used to estimate changes in the wetted cross-sectional area of the stream at these locations due to the project (ERO Resources Corp. 2012a). Additional data collection at RC-3 and EFBR-2 during low flows (proposed in the Appendix C Water Resources Monitoring Plan) would provide a more precise estimate of the relationship between discharge and wetted perimeter.

For all alternatives, construction of the tailings impoundment would alter the size of the watershed and the direction of runoff within the existing watersheds. Some of the runoff would be redirected by the configuration of the tailings impoundment to a watershed different from that of pre-mining conditions. To assess the effects of streamflow changes resulting from these changed watershed boundaries, the agencies analyzed the changes in watershed areas as an indicator of possible streamflow changes (ERO Resources Corp. 2010a in Appendix H). NewFields (2014b) completed a similar analysis for the watersheds in which the Poorman Impoundment would be constructed. NewFields analysis used for detailed LIDAR topographic mapping to assess changes in the Poorman Impoundment Site watersheds, and consequently the watershed sizes vary slightly. The differences between the two analyses were negligible. The agencies assumed that watershed area is directly related to streamflow in the receiving stream of each watershed. Use of watershed or drainage area is consistent with the Hortness (2006) method of estimating $7Q_2$ and $7Q_{10}$ flows at ungaged, unregulated streams. The agencies also assumed any differences in runoff due to elevation, soil type, vegetation cover, slope, and aspect are negligible across the analysis area. Within the small watersheds of the tailings impoundment sites (2.6 square miles in Alternatives 2 and 4, and 1.2 square miles in Alternative 3), these differences are likely small. The existing footprints for the tailings impoundments and associated facilities were plotted over the watershed boundaries. Changes to all watersheds were either added or subtracted from the existing watershed area, depending on whether the change would increase or decrease watershed area, and therefore water, to the watershed. Calculations were completed for the three alternatives for Operations and Post-Closure Phases. The watershed analysis is presented in Appendix H and summarized in the Environmental Consequences section for each alternative.

Forest clearing for roads or other activities can alter normal streamflow dynamics, particularly the volume of peak flow and baseflow. The degree to which streamflow changes depends on the road density, percentage of total tree cover removed from the watershed, and the amount of soil disturbance caused by the harvest, among other things. For example, if harvest activities remove a high percentage of tree cover and cause light soil disturbance and compaction, rain falling on the soil would infiltrate normally. Due to the loss of tree cover, evapotranspiration (the loss of water by plants to the atmosphere) would be lower than before. The combination of normal water infiltration into the soil and decreased uptake of water by tree cover results in higher streamflow.

In general, timber clearing on a watershed scale results in water moving more quickly through the watershed because of decreased soil infiltration and evapotranspiration. Water yield estimates for the analysis area were determined using the KNF Equivalent Clearcut Acres Calculator (ECAC) (Appendix H). The ECAC was designed as a tool to estimate the potential effects of ground disturbing activities such as road, transmission line, and other land clearing disturbances. The ECAC results are provided in Appendix H. Regression equations created from R1-WATSED outputs were used to determine the number of required equivalent clearcut acres to generate a 1 percent increase in peak flow and also the number of equivalent clearcut acres that recover each year in a watershed.

The removal of vegetation on a landscape has been shown to also increase annual water yields. Annual water yield predictions for the Montanore Project were based on both water yield modeling programs (ECAC and WATSED) used by the KNF. The ECAC model is used by the KNF to evaluate potential impacts on water yields from land management activities. The equivalent clearcut acres are calculated using the relationships developed from the R1-WATSED model. Numerous WATSED model outputs with similar watershed characteristics, were used to calculate relationships between annual water yield increases and predicted peak flow increase. The regression equations are included in the project record. The agencies estimated peak flow increases for all project alternatives (Appendix H). WATSED and the ECAC analysis were not designed or used to develop exact estimates of flow. The utility of the analysis is that it provides a consistent method for comparing alternatives. The values generated are used, in concert with other water resource information, to interpret the potential effects on a stream channel as a result of implementing a proposed land management activity. Effects are analyzed with regard to normal or average conditions. Episodic climatic events such as rain-on-snow, high intensity thunderstorms, mass soil movement, or short-duration peak flows cannot be addressed in the model. Analysis of these types of events, where needed, must be completed using professional judgment or other models (KNF 2013).

3.11.2.3.2 Lake Levels and Volume

Potential changes in Rock Lake volume, level, and surface area without and with MMC’s modeled mitigation (partial grouting in the mine near Rock Lake and installing two bulkheads post-mining) were quantitatively estimated using the 3D model results (ERO Resources Corp. 2012b). Gurrieri (2001) developed an estimate of the volume of Rock Lake and a relationship of volume to lake level and surface area. Uncertainties in the volume/stage/surface area relationships result from the low number of soundings collected at the lake, the inexact method of locating the soundings on the map, and the fact that few, if any, soundings were collected in the shallow areas of the lake near the shoreline (where the predicted effects on Rock Lake discussed in section 3.11.4 would occur). The 3D model predicted that as a result of a decline in the potentiometric surface due to mine inflows, the supply of bedrock groundwater to Rock Lake would decrease during all phases of mining (Geomatrix 2011a). The effects on Rock Lake during the mine phases and post-mining were quantified for a 2-month late summer/early fall period when the only source of supply to Rock Lake is assumed to be deep bedrock groundwater. The effect on the lake was also quantified for a 7-month winter period when Rock Lake is frozen and the only source of supply is assumed to be deep bedrock groundwater.

To be able to quantify the effects during the 2-month late summer/early fall period, the agencies assumed that without the effect of the mine, the lake is in equilibrium (lake inflow=lake outflow), no runoff from precipitation or snowmelt occurs during the 2-month period, and the lake is full at the start of the period. The reductions in groundwater flow to Rock Lake provided for each mine phase and after mine closure in the 3D model were used to estimate the change in lake volume and corresponding change in lake level for the 2-month period.

For the 7-month winter period, to quantify the effect of the mine post-closure, the agencies assumed the lake is in equilibrium (lake inflow=lake outflow), the lake is frozen for the entire period and no water evaporates from the lake, and water flows out of the lake downstream in a rate equal to groundwater flow into the lake. Due to late fall precipitation, Rock Lake was assumed to be full at the beginning of the 7-month winter period. The only change expected to occur during the 7-month winter period would be a change in water stored in Rock Lake when the potentiometric surface would be lower than the surface of the lake.

The analysis of effects on Rock Lake is based on the conceptual model of the groundwater flow systems used in both the 2D and 3D numerical models. Based on the conceptual model and the results of the 3D model, the agencies developed a water balance for Rock Lake that included groundwater inflow to the lake, evaporation, and surface inflow and outflow. A previous investigation (Gurrieri 2001) of Rock Lake used a different approach to develop a water balance for the lake. Using measured surface water inflow and outflow and water chemistry, Gurrieri developed a water balance that had an estimated groundwater outflow component. Using this water balance, Gurrieri analyzed the effects to Rock Lake of mine dewatering. The effects of the Gurrieri analysis were slightly greater, but within the range of model-predicted effects (Table 115 and Table 116).

Based on the following information, other lakes in the analysis area were dismissed from detailed analysis. St. Paul Lake is located within glacial moraine material, which causes the lake level to fluctuate to a much greater extent than does Rock Lake. Another difference between the two lakes is that the watershed above St. Paul Lake is north facing (Rock Lake's is south facing), and the snowpack above St. Paul Lake melts more slowly. Because the Libby Lakes and Isabella Lake are at an elevation of about 7,000 feet, and perched above the regional potentiometric surface, they likely would not be affected by mining dewatering. The KNF began monitoring the level of Lower Libby Lake in 2010; the recorder housing failed in 2013 and it was replaced in 2014. MMC would continue monitoring the water level of Lower Libby Lake (see Appendix C). Howard Lake is at an elevation of 4,100 feet southeast of the Libby Adit, and would be too far from mine dewatering to be affected. Ramsey Lake, near the proposed Ramsey Plant Site and the Ramsey Adits proposed in Alternative 2, is at an elevation of about 4,450 feet. Ramsey Lake is fed mostly by snowmelt and water flowing in shallow surface deposits in the Ramsey Creek drainage (Wegner, pers. comm. 2008). In September 2012, no flow was observed into the lake and an estimated 1 to 2 gpm was flowing out of the lake (NewFields 2013a). The Ramsey Lake level varies substantially and changes in the lake level due to mine inflows probably would not be detectable. Effects on Isabella Lake, St. Paul Lake, the Libby Lakes, Howard Lake, and Ramsey Lake are not discussed further. Effects on springs are discussed in section 3.10.4, *Groundwater Hydrology*.

3.11.2.3.3 Floodplains and Stream Crossings

To determine if mine or transmission line facilities would be located within 100-year floodplains designated by the FEMA, a GIS analysis was completed by overlaying the proposed facilities over the FEMA floodplain data for Sanders and Lincoln counties. GIS analysis for the transmission line alternatives included comparing the stream and floodplain crossings required for the mine and transmission line alternatives, providing the watershed acreage for Class 1 and 2 streams where roads would be built or trees cleared for other purposes, and determining the acreages of disturbance for impaired streams. The Alternative 2 and 4 tailings impoundments would be located with the floodplain of Little Cherry Creek, which has not been designated as a 100-year floodplain by FEMA. Kline Environmental Research (2005a) provided the approximate area of floodplain that would be affected by the Little Cherry Creek tailings impoundment in Alternatives 2 and 4.

3.11.3 Affected Environment

3.11.3.1 Relationship of Surface Water and Groundwater

Lakes and streams that exist above an elevation ranging between 5,000 and 5,600 feet within the analysis area are likely not connected hydraulically to deeper bedrock groundwater, but rather are supplied by surface runoff, snowmelt, and/or drainage from unconsolidated, discontinuous surface deposits that store precipitation and snowmelt water. Streams located below the range of 5,000 to 5,600 feet generally are perennial, supplied by surface runoff, shallow groundwater, and groundwater from deeper bedrock fractures that intersect the ground surface. Some sections of these streams flow intermittently during some parts of the year due to the loss of surface flows into the underlying alluvium. At both tailings impoundment sites, the plant sites and the LAD Areas, groundwater occurs in unconsolidated glaciofluvial and glaciolacustrine deposits. The deposits range in thickness from 0 feet at bedrock outcroppings near the Little Cherry Creek impoundment site to more than 200 feet thick at the Poorman Impoundment Site. Groundwater discharges from these deposits to springs, alluvium, and Libby, Poorman and Ramsey creeks. Section 3.10.2.4, *Affected Environment* of the *Groundwater Hydrology* section discusses the relationship of groundwater, springs, and streams in the analysis area. Chart 16 and Chart 17 portray conceptually the relationship of the various components of streamflow in watersheds in the analysis area.

3.11.3.2 Watersheds, Floodplains and Water Sources

Underground mining would occur beneath a divide separating three drainages: East Fork Rock Creek, East Fork Bull River, and Libby Creek. Except for a small ventilation adit near Rock Lake, proposed surface mine facilities in all mine alternatives would be located in the Libby Creek drainage. The mine area is drained on the east by Libby Creek and its tributaries: Ramsey, Poorman, Little Cherry, and Bear creeks (Figure 76). Libby Creek flows north from the analysis area to its confluence with the Kootenai River near Libby. The East Fork Rock Creek flows southwest, joining West Fork Rock Creek to form Rock Creek, which flows into the Clark Fork River downstream of Noxon Reservoir. The East Fork Bull River flows northwest into the Bull River. Several alpine lakes occur in the analysis area (Figure 76). Many of these lakes are located in glacial cirques that act as collection basins for runoff and snowmelt.

Chart 16. Typical Relationship of Various Components of Annual Streamflow in Analysis Area Watersheds.

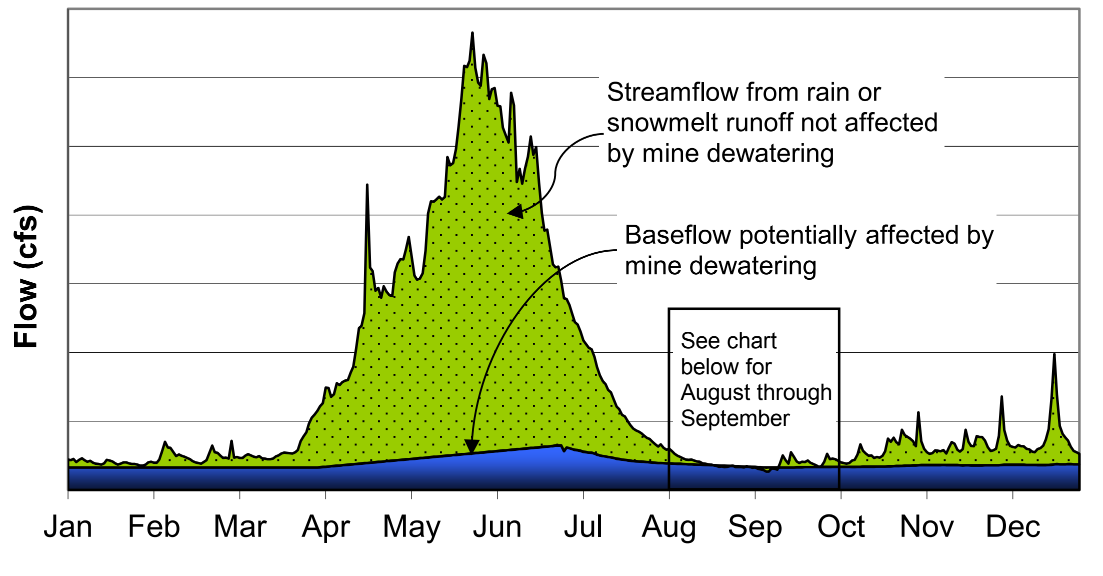
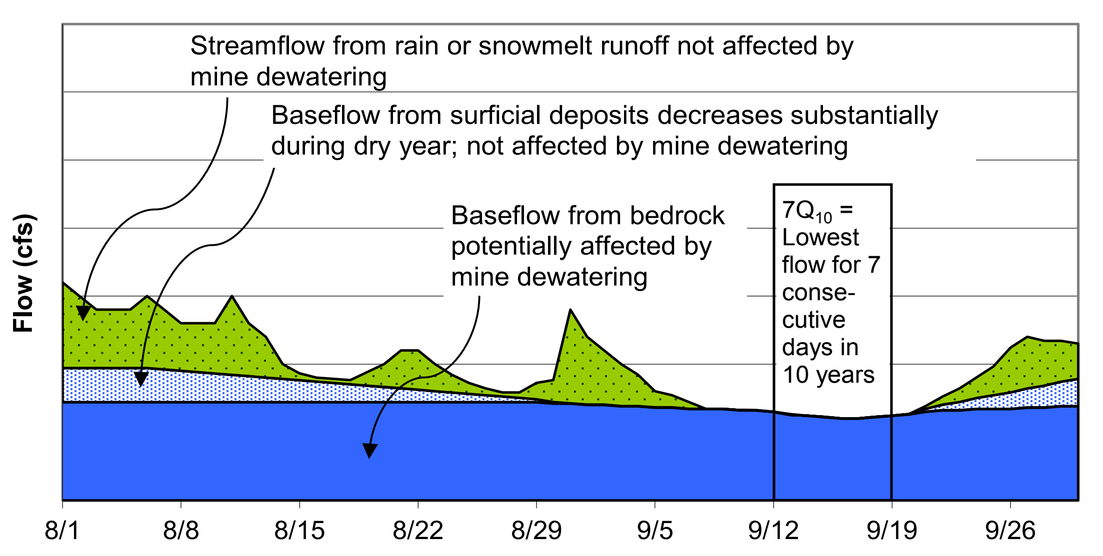


Chart 17. Typical Relationship of Various Components of Streamflow during $7Q_{10}$ Flow in Analysis Area Watersheds.



The transmission line corridor area is drained by the Fisher River and its tributaries: Sedlak Creek, Hunter Creek, Standard Creek, West Fisher Creek, and Miller and North Fork Miller creeks; and by Libby Creek and its tributaries: Howard Creek, Midas Creek, and Ramsey Creek, all perennial streams. Numerous unnamed ephemeral streams also drain the analysis area (Figure 76). One hundred-year floodplains have been designated along the Fisher River, Miller Creek, an unnamed tributary to Miller Creek, Ramsey Creek, and Libby Creek (Power Engineers, Inc. 2006a).

Snowmelt, rainfall, and groundwater discharge are the main sources of supply to streams, lakes, and ponds in the analysis area. Precipitation ranges from 100 inches per year at higher elevations in the Cabinet Mountains to about 30 inches per year at the tailings impoundment site. The highest precipitation occurs in November through February and the lowest in July through October.

Baseflow is the contribution of near-channel alluvial groundwater and deeper bedrock groundwater to a stream channel. Baseflow does not include any direct runoff from rainfall or snowmelt into the stream. Because the near surface geology varies between the upper and lower reaches of streams in the analysis area, the source of groundwater to streams also varies. The sources in the analysis area are unconsolidated deposits (alluvium and colluvium), weathered bedrock, and fractured bedrock. In some of the upper stream reaches, little if any alluvium, colluvium, or weathered bedrock are present. Other reaches, such as in the upper Libby and Ramsey creek drainages, contain surficial deposits within avalanche chutes that may store and transmit shallow groundwater through much of the summer depending on remaining snow pack at the head of each chute. Flow rates measured during late summer/early fall in upper Libby Creek are similar to the 3D model predicted baseflows, indicating that there may be little if any contribution from surficial deposits during late summer/early fall during years with little or no late season snow pack or precipitation. The primary source of baseflow to streams in the upper reaches is fractured bedrock up to an elevation in the analysis area of between 5,000 and 5,600 feet. Drainages above an elevation of about 5,000 to 5,600 feet are above the regional potentiometric surface and receive water from surface water runoff and from limited perched shallow groundwater in unconsolidated deposits such as talus. The shallow groundwater is from precipitation and drains quickly. The smallest, highest first order streams are ephemeral, while the second order channels (such as upper Libby Creek) into which the first order streams flow are generally intermittent. Second order channels become perennial when they intersect the regional potentiometric surface below between 5,000 and 5,600 feet. In general, the thickness of the unconsolidated surficial deposits increases in a downstream direction, and the deposits can store more groundwater where they are thicker. The fractured bedrock is hydraulically connected to the weathered bedrock and surficial deposits, so it is difficult to separate the individual sources of groundwater flow to streams in the middle and lower reaches of the drainages. Baseflow in the lower reaches is likely dominated by groundwater flow from the thicker surficial deposits. During the year, there is probably an ever-changing ratio between shallow groundwater (from the surficial deposits and weathered bedrock) and deeper bedrock groundwater contributions to any one stream. Streams in the analysis area do not reach baseflow every year.

Few streamflow data from the upper reaches of most analysis area streams draining the CMW are available. It is likely that during non-baseflow periods, streamflow is probably much greater than during the baseflow period, but actual flow rates are unknown. The agencies reviewed the hydrograph from three perennial stream locations (Granite Creek and Flower Creek, located near Libby, Montana, and Boulder Creek, near Leonia, Idaho) where between 22 and 50 years of continuously recorded annual flow data exist (ERO Resources Corp. 2009). Based on these three streams, which are analogous to streams in the lower reaches of the Montanore Project analysis area, it appears that perennial streams in the area with a baseflow component may flow at baseflow for about 1 to 2 months sometime between mid-July to early October. The stream hydrographs indicate that periods of baseflow also may occur during November through March.

3.11.3.2.1 Watershed Descriptions

Libby Creek and Libby Lakes

Libby Creek is the primary watershed within the analysis area. Libby Creek flows northward and joins the Kootenai River near the town of Libby. Libby Creek is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). Within the analysis area, the primary tributaries to Libby Creek are Ramsey, Poorman, Little Cherry, and Bear creeks (Figure 76). The highest elevation of the Libby Creek watershed is 8,740 feet. Libby Creek originates in a steep, glacial-carved basin, and discharges to the Kootenai River 29 miles downstream at an elevation of 2,060 feet. Libby Creek drains an area of about 68 square miles upstream of where the stream crosses US 2. The first 0.5 mile of Libby Creek flows intermittently. The Libby Creek valley widens downstream, where more erodible alluvial, glaciolacustrine, and glaciofluvial deposits are encountered. Where Libby Creek is perennial, flow is sustained by groundwater discharge. The average slope of upper Libby Creek is 6.6 percent (up to 30 to 40 percent near the top), and the creek contains pools, glides, riffles, rapids and cascades (Kline Environmental Research and NewFields 2012). The creek is a third-order stream near the proposed mine facilities. It is primarily restricted to a narrow channel flowing through bedrock canyons, erodible valley fill material, and glaciolacustrine sediment. Unstable stream channel characteristics in the Libby Creek drainage can be attributed, in part, to historical placer mining by hand (late 1800s), hydraulic and dredge mining (early to mid-1900s), and logging/clearcutting (early to mid-1900s).

The Libby Lakes are small and lie within closed depressions along the crest of the Cabinet Mountains. Drainage from Upper Libby Lake is tributary to the East Fork Rock Creek above Rock Lake and Middle and Lower Libby Lakes are tributary to Libby Creek.

A FEMA-designated 100-year floodplain is mapped along Libby Creek, from 4,000 feet above the confluence with Howard Creek to US 2.

Ramsey Creek and Ramsey Lake

The highest elevation of the Ramsey Creek watershed is 7,940 feet. Ramsey Creek is 5.3 miles long, and discharges to Libby Creek at an elevation of 3,425 feet. Its entire length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). The total drainage area for Ramsey Creek is about 6.5 square miles. The upper part of the creek has two tributaries, one from the north and one from the south. The southern tributary originates at 5,598 feet, is 3,200 feet in length, and has a slope of 43 percent (Kline Environmental Research and NewFields 2012). The northern tributary is not in the GDE inventory area. The upper watershed is poorly drained and contains both a marshy area and Ramsey Lake, a small lake of about 2 acres (Figure 76). Water in the marsh flows through a series of ponds and meanders through grassy, wet meadows. Downstream of the meadows, Ramsey Creek is a high-energy stream flowing through a series of narrow bedrock canyons and glacial moraine material. Ramsey Creek is a perennial stream with heavily forested banks. The mainstem of Ramsey Creek is a second-order stream, is fairly flat and contains glides, pools and riffles (Kline Environmental Research and NewFields 2012).

A FEMA-designated 100-year floodplain is mapped along 4,000 feet of headwaters of Ramsey Creek near the CMW boundary.

Poorman Creek

The highest elevation of the Poorman Creek watershed is 7,655 feet. Poorman Creek is 5.3 miles long, and joins Libby Creek at an elevation of 3,320 feet. Its entire length is rated as outstanding

(Class 1) for fisheries habitat by the FWP (FWP 2012). The drainage area is about 6 square miles. Poorman Creek is a small, perennial stream located south of the Poorman Tailings Impoundment Site and north of the LAD Areas. Near the proposed mine facilities, Poorman Creek is a second-order stream. In the uppermost reach, which originates at 5,574 feet, the creek is steep (gradient typically between 25 and 40 percent), and cascades over bedrock. When the gradient decreases, there are glides and pools in the creek. The creek flows in a narrow, straight channel with several small intermittent tributaries, heavily forested banks, and a boulder, cobble, and gravel bed. Streamflow is relatively constant both upstream and downstream (Kline Environmental Research and NewFields 2012).

Little Cherry Creek

The highest elevation of the Little Cherry Creek watershed is 7,040 feet. Little Cherry Creek is a perennial stream that drains about 1.9 square miles, and flows 3.1 miles to its confluence with Libby Creek at an altitude of 3,120 feet. Its entire length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). Streambed material ranges from boulders to sand and silt. Little Cherry Creek is incised into glaciolacustrine and glaciofluvial sediment, with a steep gradient reach where bedrock crops out in the lower section near its confluence with Libby Creek. The most complete synoptic flow data collected in Little Cherry Creek (Table 106) indicate that the creek gains water from groundwater discharges throughout its length (Geomatrix 2008b). Little Cherry Creek is a second-order stream.

The upper portion of the watershed is forested and the lower portion has been logged. In logged areas, streambanks are collapsed, and small shrubs and forbs have become established. The average bankfull width of upper Little Cherry Creek is 8 feet and 14 feet in the lower creek. Bankfull width is the width of the stream when carrying the 1.5- to 2-year peak flow (Rosgen 1996). The floodplain is estimated to range from 0 to 33 feet wide in the lower mile of the creek, and 33 to more than 100 feet wide above that location (Kline Environmental Research 2005a). The floodplain identified by Kline Environmental Research is not a FEMA-designated 100-year floodplain.

Bear Creek

Bear Creek is the largest tributary of Libby Creek in the analysis area, draining a 15-square mile area. The highest elevation of the Bear Creek watershed is 7,200 feet. Originating in a glacial basin, Bear Creek flows perennially 8.2 miles, converging with Libby Creek at an elevation of 3,050 feet. Its entire length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). Bear Creek is incised into lake bed (glaciolacustrine) silt, although small areas of exposed bedrock occur in portions of the channel area. Most of the watershed is heavily forested. The streambed material is composed primarily of cobbles and gravels.

Cable Creek

Cable Creek is a tributary to Bear Creek, with headwaters in the CMW. The highest elevation of the Cable Creek watershed is 7,195 feet, and enters Bear Creek at 3,650 feet in elevation. The entire 4.2 miles of Cable Creek is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). The agencies expect that streamflow in Cable Creek would not be affected by the mine or transmission line, and it is not discussed further in this section.

Big Cherry Creek

The highest elevation of the Big Cherry Creek watershed is 8,740 feet, and its lowest elevation is 2,150 feet where it enters Libby Creek. Big Cherry Creek originates in a 5-acre lake and flows 19.2 miles to Libby Creek about 2 miles upstream of the Kootenai River. The stream shifts and braids within a wide, unvegetated cobble floodplain. Its entire length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). The agencies expect that streamflow in Big Cherry Creek would not be affected by the mine or transmission line, and it is not discussed further in this section.

Howard Creek and Howard Lake

Howard Creek is a tributary to Libby Creek. The highest elevation of the Howard Creek watershed is 6,870 feet and enters Libby Creek at 3,570 feet in elevation. Howard Lake is located near the headwaters of Howard Creek at an elevation of 4,100 feet and is 33 acres in size. The lake is adjacent to a KNF campground. All of the transmission line alternatives would cross lower Howard Creek and two of the transmission line alternatives would cross upper Howard Creek at its headwaters. The drainage area is about 2.3 square miles, and the watershed begins at about 5,380 feet. The creek is about 2.8 miles long. The entire length of Howard Creek is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). About 1,400 feet of Howard Creek above the confluence with Libby Creek is mapped as a FEMA-designated 100-year floodplain. A narrow band around Howard Lake also is mapped as a FEMA-designated 100-year floodplain.

Midas Creek

The highest elevation of the Midas Creek watershed is 5,600 feet. Midas Creek is a tributary to Libby Creek that flows from the southeast into Libby Creek at an elevation of 3,290 feet a short distance downstream of Poorman Creek. The North Miller and Modified North Miller transmission line alternatives would cross into the upper Midas Creek watershed. The drainage area is about 6 square miles, and the watershed begins at about 5,750 feet. The creek is about 3.3 miles long. The entire length of Midas Creek is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012).

Swamp Creek

The highest elevation of the Swamp Creek watershed is 5,850 feet. It flows 10.4 miles to its confluence with Libby Creek near US 2 at an elevation of 2,720 feet. In Alternatives 3 and 4, MMC would acquire a 67-acre parcel along US 2 through which Swamp Creek flows for wetland mitigation. The agencies expect that the streamflow and water quality in Swamp Creek would not be affected by the mine or transmission line. Swamp Creek is not rated by the FWP for fisheries habitat (FWP 2012).

Fisher River

The Fisher River is a tributary to the Kootenai River. The river is formed by two tributaries, Silver Butte Fisher River and Pleasant Valley Fisher River. Miller Creek and West Fisher Creek flow into the river 3 to 4 miles below the confluence of the two tributaries. The river is 63 miles long and has a watershed area of 838 square miles. The highest elevation of the watershed is 7,565 feet and joins the Kootenai River at 2,115 feet in elevation just downstream from Libby Dam. In the analysis area, the river is rated as substantial (Class 3) for fisheries habitat (FWP 2012). A FEMA-designated 100-year floodplain is mapped along all segments of the Fisher River in the analysis area.

Miller Creek

Miller Creek is a tributary to the Fisher River located southeast of the mine area. Segments of three transmission line alignment alternatives are in the Miller Creek watershed. The drainage area is about 12 square miles; the highest elevation of the watershed is 5,595 feet and it joins the Fisher River at 2,885 feet in elevation. Its entire 6.2-mile length is rated as moderate (Class 4) for fisheries habitat by the FWP (FWP 2012). Sections of Miller Creek in the lower reaches near the confluence with the Fisher River are dry most of the year where water in the channel sinks below the channel bottom. The stream connects with the Fisher River only during spring high flows, or during rain-on-snow events. The transmission line alignment in Alternatives B and C-R would parallel an unnamed tributary to Miller Creek that flows from the north into Miller Creek. The drainage area of this tributary is 1.9 square miles, the top of the watershed begins at about 5,400 feet, and the length of the tributary is about 2.4 miles. A FEMA-designated 100-year floodplain is mapped along Miller Creek and its unnamed tributary, from 2,000 feet above the confluence of the two drainages to Miller Creek's confluence with the Fisher River.

West Fisher Creek

West Fisher Creek is also southeast of the mine area and is a tributary to the Fisher River. The West Fisher Creek transmission line alignment generally parallels the creek for about 5 miles. It has a large drainage area (44 square miles); the highest elevation of the watershed is 7,610 feet (in the CMW) and the lowest elevation is 2,900 feet where it joins the Fisher River. The creek has several lakes in its headwaters and numerous tributaries. Its entire 13.3-mile length is rated as moderate (Class 4) for fisheries habitat by the FWP (FWP 2012). A FEMA-designated 100-year floodplain is mapped along West Fisher Creek, from 2,000 feet above the confluence with Lake Creek to its confluence with the Fisher River. All transmission line alternatives except Alternative B would cross the creek.

Hunter Creek

Hunter Creek, a tributary of the Fisher River, has a small drainage area (1.64 square miles) that originates east of US 2. The highest elevation of the watershed is 5,345 feet with its lowest elevation at 2,910 feet where it joins the Fisher River. Alternative B is the only transmission line alternative that would cross the creek. Most of the watershed is on Plum Creek lands. Hunter Creek's 2-mile length is rated as moderate (Class 4) for fisheries habitat by the FWP (FWP 2012).

Sedlak Creek

The Sedlak Creek watershed is immediately south of Hunter Creek. Sedlak Creek flows into the Pleasant Valley Fisher River about 1,000 feet east of the proposed Sedlak Park Substation Site. Sedlak Creek has a small drainage area (1.04 square miles); the highest elevation of the watershed is 4,440 feet and its lowest elevation is 2,995 feet where it joins the Pleasant Valley Fisher River. Most of the watershed is on Plum Creek lands. Sedlak Creek's 2-mile length is rated as moderate (Class 4) for fisheries habitat by the FWP (FWP 2012).

Standard Creek

Standard Creek, a tributary to West Fisher Creek, drains a portion of the transmission line corridor area and would not be affected by the mine or by construction and maintenance of the transmission line. The highest elevation of the watershed is 6,870 feet and its lowest elevation is 3,450 feet where it joins West Fisher Creek. Short segments of the Miller Creek and West Fisher Creek transmission line alternatives would be within the Standard Creek watershed, but the line and any associated access roads would be located more than 1 mile from the creek. The agencies expect that streamflow and water quality in Standard Creek would not be affected, and it is not discussed further.

Rock Creek Watershed

Rock Creek is formed by the convergence of the east and west forks of the creek, which drain an area of about 33 square miles of steep, high-elevation terrain. In its uppermost ephemeral reaches, the source of water supply to the East Fork Rock Creek is surface water runoff, but where the stream becomes perennial, bedrock groundwater is also a source of water to the creek. The reach above Rock Lake is 0.4 mile in length, has a gradient between 10 and 20 percent, and cascades over boulders and bedrock. Below Rock Lake, the East Fork Rock Creek to the confluence with the West Fork Rock Creek is 5.3 miles long, has an average slope of 8 percent, and contains pools, glides, riffles, rapids, and cascades (Kline Environmental Research and NewFields 2012).

Underground mining would occur under the headwaters of the East Fork Rock Creek. The highest elevation of the East Fork Rock Creek watershed is 7,610 feet and its lowest elevation is 2,770 feet where it joins the West Fork of Rock Creek to create the mainstem of Rock Creek. The East Fork Rock Creek and Rock Creek are rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). The East Fork Rock Creek flows perennially, but loses water near the confluence with the West Fork (USFWS 2007a).

Rock Creek Meadows is a 50-acre wetland outside the CMW where the topography flattens along the East Fork Rock Creek drainage. Several tributaries to the East Fork Rock Creek drain directly to Rock Creek Meadows; the drainage area of these tributaries is 2,970 acres. The drainage area of the East Fork Rock Creek upstream of the Meadows is 1,070 acres. The wetlands, when observed during an agency field review during a very dry period in September 2007, had a visibly high water table, and an inflow from the East Fork Rock Creek of about 2 cfs.

The West Fork Rock Creek flows 3.5 miles to the mainstem of Rock Creek. The substrate is dominated by gravel and rubble, with high amounts of fine sediment. The drainage is subject to high flow events and intermittent flow. West Fork Rock Creek may be used for bull trout mitigation. The agencies expect that the streamflow and water quality in West Fork Rock Creek would not be affected by the mine or transmission line, and it is not discussed further in this section.

Rock Creek downstream of the confluence of the East and West forks has a gradient of about 2 percent, and contains pools, glides, riffles, and rapids (Kline Environmental Research and NewFields 2012). Rock Creek flows into the Clark Fork River below Noxon Reservoir. Rock Creek is characterized by high velocities and large flow volumes during snowmelt runoff. The creek flows intermittently during baseflow periods, except for short reaches where perennial flow is maintained by alluvial groundwater and discharge from Engle Creek, Orr Creek, and alluvial groundwater from Big Cedar Gulch (Salmon Environmental Services 2012). The perennial flow downstream of Engle Creek is maintained by a bedrock spur about 3,000 feet upstream of MT 200. The bedrock probably prevents surface flow from entering the coarse subsurface alluvium, and may also force alluvial groundwater back into the channel. The surface flow becomes intermittent again when it reaches alluvium about 2,000 feet upstream from MT 200.

The Forest Service has been continuously gaging Rock Creek at RC-2000, located about 100 feet upstream of MT 200, since May 2011 (KNF 2011b, 2014a, 2014b). The estimated bankfull flow is 900 cfs. The highest flow measured was 782 cfs on May 13, 2013. During 2011, 2012 and

2013, streamflows peaked in mid-May. Flows of 100 cfs or greater occurred in 2011 during most days between mid-May and to the first week of July. 2012 and 2013 were wetter years, with flows of 100 cfs or greater starting at the end of March/beginning of April and occurring during most days through early to mid-July. Flows declined to less than 1 cfs or less in 2011 from September 20 through January 4, 2012, in 2012 from September 20 to October 19, and in 2013 from September 4 to September 23. Flows were also low (typically 2 to 5 cfs) in January to early March.

Rock Lake, at an elevation of 4,958 feet, has a 1.43 square mile watershed, a 58-acre surface area, a mean depth of 30 feet, and a maximum depth of 70 feet. The estimated volume of Rock Lake is 1,302 acre-feet (Gurrieri, pers. comm. 2011). Due to the steep, rocky shoreline, Rock Lake has a narrow, rocky littoral zone with very little littoral zone vegetation, based on the agencies' September 2007 site visit and review of aerial photographs. Rock Lake is included in the GDE inventory area described in Appendix C.

Rock Lake is located along the Rock Lake Fault and is fed by a short perennial stream. Water sources include snowmelt (particularly during the spring and early summer), rainfall (particularly in October and November), and groundwater via a shallow flow path during the runoff period and deeper bedrock groundwater throughout the year (Gurrieri 2001). The Rock Lake watershed receives an estimated average 78 inches of precipitation annually (ERO Resources Corp. 2012c). The volume of groundwater inflow to Rock Lake is a small fraction of the annual hydrologic budget; the annual water balance is dominated by surface water (Gurrieri 2001). The residence time of the lake water is very short during the spring snowmelt period (a few days), and lengthens significantly later in the year. The lake is a flow-through system; the lake gains water from surface runoff, from groundwater from the springs above it that flow to the lake, and directly from bedrock groundwater surrounding it. The lake loses water via evaporation, a surface outlet, and possibly groundwater outflow. Stage changes in Rock Lake were measured from mid-June through mid-October in 1999; the total decrease in lake level during that time was 1.29 feet (Gurrieri 2001). Lake stage measurements have been collected occasionally since 1999, and MMC began continuously recording lake stage changes in 2009. The lake measurements show that the lake level generally rises in late April to May as the snowpack melts, begins to decline in August, increases in October, and then remains relatively constant during the winter (NewFields 2013a, MMC 2014d). During the 2009 to 2013 period, the lake level fluctuated by about 2 feet (MMC 2014d).

East Fork Bull River Watershed

The East Fork Bull River has several tributaries that drain an area of about 26 square miles of the CMW. The highest elevation of the East Fork Bull River watershed is 7,940 feet and its lowest elevation is 2,290 feet where it enters the Bull River. Its entire 8-mile length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012).

In its uppermost ephemeral reaches, the source of water supply to the East Fork Bull River basin is surface water runoff, but where flow becomes perennial at an elevation of about 5,400 feet, flow from a spring (EFBR-10), which may be associated with the Rock Lake Fault, is a source of bedrock groundwater to the stream. St. Paul Lake, elevation 4,715 feet, is located along the Rock Lake Fault near the top of the East Fork Bull River watershed. Five tributaries, one of which runs along the trace of the Rock Lake Fault, flow into the lake. The eastern tributary has two branches, one that originates at 5,589 feet and one that originates at 5,348 feet. Another tributary originates at 5,595 feet and is 2,950 feet in length. The tributaries are primarily bedrock-controlled cascades, with average gradients ranging from 17 to 34 percent (Kline Environmental Research and NewFields 2012). St. Paul Lake is perched on a moraine at the junction of two mountain valleys. The glacial moraine material beneath the lake is very coarse. Outflow from the lake is through the glacial gravels to the East Fork Bull River drainage. Flow resurfaces at a small wetland 330 feet northwest of St. Paul Lake at an elevation of 4,706 feet (Kline Environmental Research and NewFields 2012) (Figure 76).

St. Paul Lake has a 9-acre surface area and a drainage area of 1.5 square miles. The major source of water to the lake is snowmelt. Seasonal stage changes have not been measured in St. Paul Lake; the lake level has been observed to fluctuate to a much greater extent than does Rock Lake due to leakage through the relatively high permeability moraine material (Gurrieri, pers. comm. 2008). St. Paul Lake can become completely dry during extended periods of little to no precipitation.

Below St. Paul Lake, the river is steep (average 12 percent gradient), with rapids and cascades. After the gradient begins to flatten, there are also pools, glides, and riffles in the river (Kline Environmental Research and NewFields 2012). Two tributaries that join the East Fork Bull River within the CMW are 1.8-mile long Isabella Creek, and 1.2-mile long Placer Creek. Placer Creek drains a small watershed east of St. Paul Lake, and Isabella Creek drains a larger watershed along the mountain divide. Isabella Lake is small and lies within a closed depression along the crest of the Cabinet Mountains. Isabella Lake has no defined stream channel from the lake to Isabella Creek.

The flow of the East Fork Bull River just upstream of the confluence with the Bull River has been gaged by the Forest Service since May 2009 (KNF 2011c, 2011d, 2011e, 2012, 2014c). The estimated bankfull flow at the gage is 694 cfs. During the 2009 to 2013 period, streamflows peaked in mid-May, with the highest flow (820 cfs) occurring on May 16, 2011. Peak flows also occurred due to rain-on-snow events that occurred in December 2009 (740 cfs) and January 2011 (672 cfs). During spring runoff, flows exceeding 100 cfs occurred for 22 days in May 2009, from April 20 to July 5 in 2010, from May 5 to July 27 in 2011, from April 12 to July 21 in 2012, and from April 2 to 13 and April 27 to July 6 in 2013. During the period of record, lowest flows (15 cfs or less) occurred in the last week of August, September, and October, and at times during the winter months.

Swamp Creek and Wanless Lake

On the west side of the Cabinet Mountains, Swamp Creek flows 14.7 miles from Wanless Lake to the Clark Fork River. The highest elevation of the Swamp Creek watershed is 7,610 feet and its lowest elevation is 2,350 feet where it enters the Clark Fork River. The creek is rated as substantial (Class 3) for fisheries habitat (FWP 2012). Wanless Lake, elevation 5,100 feet, is slightly larger than Rock Lake, has a slightly larger watershed with similar topography, is located within the Revett Formation, and is bisected by the Rock Lake Fault. Swamp Creek and Wanless Lake are outside the area of predicted effects from mining, and would be used as benchmark monitoring sites (see Appendix C, Section C.10).

Copper Gulch

Copper Gulch flows 4.6 miles to Bull River. Its entire length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). The highest elevation in the watershed is 7,714 feet and the lowest elevation is 2,270 feet where it enters the Bull River. Channel stability in the lower reach has been adversely affected by extensive stream channelization and subsequent channel maintenance. Factors affecting fish habitat included stream channelization, riparian alteration, channel clearing, and the high gradient nature of the drainage. The lower reach upstream of the confluence with Bull River is subject to seasonally intermittent flows. Copper Gulch may be used for bull trout mitigation.

Flower Creek

Flower Creek flows 13 miles to Kootenai River and has a drainage area of 11.2 square miles. Its entire length is rated as outstanding (Class 1) for fisheries habitat by the FWP (FWP 2012). Headwater tributaries begin in a series of small lakes at an elevation of about 6,200 feet. The lower portion flows through the city of Libby, Montana. Two man-made dams are present in the lower half of Flower Creek. The lower dam is used as a diversion point for a water intake that feeds by gravity to Libby's water treatment plant. The upper Flower Creek Dam is operated by Libby as part of their water supply storage system. Flower Creek may be used for bull trout mitigation.

3.11.3.2.2 Streamflow

Instantaneous and Continuous Streamflow Measurements

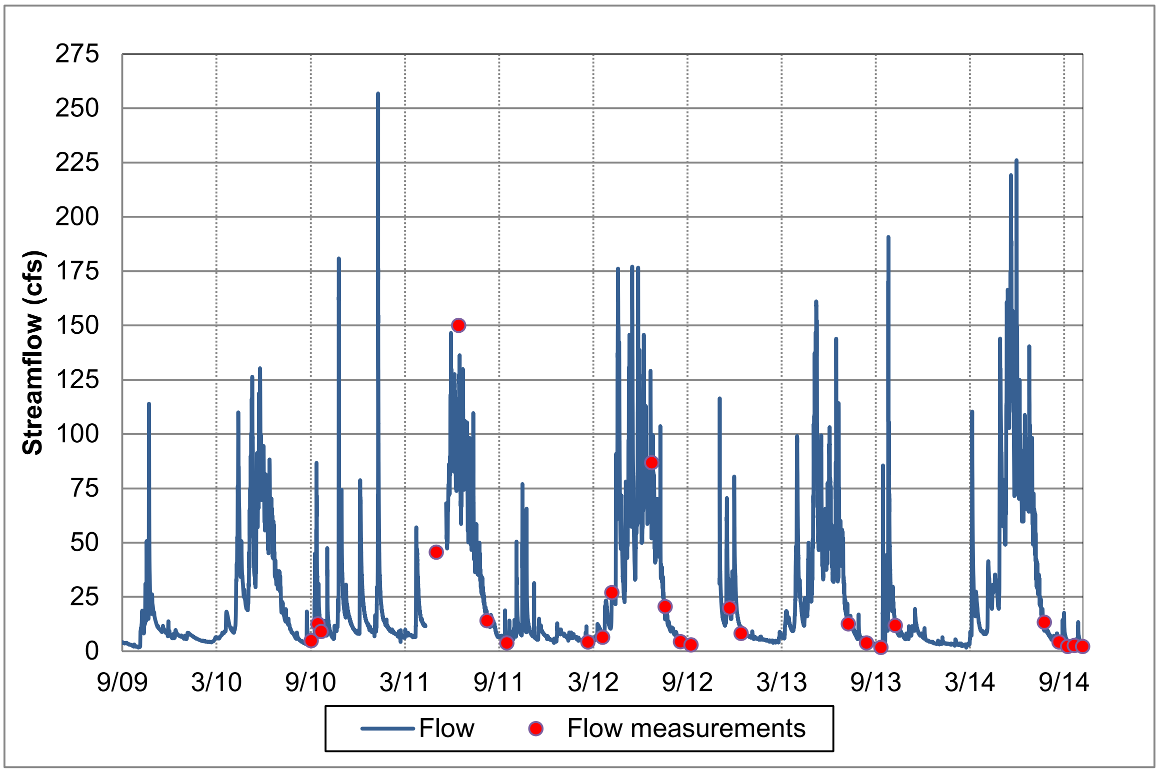
Instantaneous and continuous streamflow in the analysis area has been collected using a flow meter at measured stream cross-sections, mostly at lower elevations and outside of the CMW. None of the streams within the analysis area have been continuously gaged on a long-term basis; without such data, hydrographs cannot be developed to determine baseflow, average low flow, or peak flow.

In all of the streams measured (Libby Creek, Ramsey Creek, Poorman Creek, Little Cherry Creek, Bear Creek, Miller Creek, West Fisher Creek, Rock Creek, and the East Fork Bull River), the highest annual flows typically occur between April and June, with the highest flows most often occurring in May, then secondly in April. There are typically smaller, short-term increases in streamflow in October through March due to precipitation and snowmelt events. Lowest flow occurs most often from mid-August to mid-September and may occur for up to 2 months during late summer to early fall and also may occur during November through March. Streamflow in the analysis area was often not measured during November through February. Other streamflow peaks occurred in the spring and early summer of 2010 as a result of both precipitation and snowmelt runoff. Highest and lowest measured flows are provided for each stream in Table 105. Some of the lowest measured flows were close to or lower than the lower range of estimated $7Q_{10}$ flow shown in Table 87 in section 3.8.3.

The analysis area is sometimes subjected to strong warm-frontal storms between November and mid-April that bring heavy rain, warm temperatures, and strong winds. Rain-on-snow events occur about every 6 years east of the Cabinet Mountain divide (Wegner, pers. comm. 2006c) and every year on the west side of the Cabinet Mountains (Neesvig 2010). Depending on storm intensity and soil and snowpack moisture conditions, these storms can produce very high streamflow. For example, a major rain-on-snow event occurred in December 2004. The KNF measured a flow of 560 cubic feet per second (cfs) at the West Fisher Creek site and a flow of 549 cfs in Libby Creek at US 2 (Wegner, pers. comm. 2006d). In addition to causing high streamflow, channel migration, and the movement of large materials within the stream channels, the high rate of water to the soil can generate unstable conditions on hill slopes. During such high flows, landslides can occur and stream channels may be altered by bank erosion, down cutting, and redistribution of sediment and large woody debris. These events caused extensive damage to road drainage and stream crossing structures throughout the KNF. Channel alterations caused by ice flows associated with these events occurred to most stream systems in the analysis area and resulted in streambed scouring. The rain-on-snow event that occurred in February 1996 resulted in down cutting of most perennial channels by about 2 to 3 inches.

Beginning in September 2009, MMC began continuously measuring stage in Libby Creek at LB-200, upstream of the Libby Adit. The stage readings were used to develop a stage-discharge relationship at LB-200; the resulting streamflows are provided in Chart 18. At LB-200, large precipitation events in October 2009, November 2010, January 2011, and September 2013 increased streamflow significantly during a typically low-flow period. The estimated $7Q_{10}$ flow at LB-200 using the USGS method is 2.35 cfs, with an estimated range of 1.11 cfs to 5.05 cfs. The lowest 7-day average flow was 1.8 cfs in mid-October 2009. Based on the Poorman SNOTEL site, 2009 was the driest year in the past 10 years and 2012 was the wettest in the analysis area (Natural Resources Conservation Service 2015).

Chart 18. Streamflow at LB-200, September 2009 to October 2014.



Source: MMC 2015b.

Based on numerous streamflow measurements collected at LB-2000, flows during all months were very variable, with low flows of 2 cfs or less occurring every month, average monthly flows ranging from 4 cfs in September to 80 cfs in May, and maximum monthly flows ranging from 23 cfs in September to nearly 420 cfs in June. Flows exceeding 200 cfs occurred infrequently; seven measurements greater than 200 cfs occurred in April through June, and one occurred in February.

In September 2012, MMC measured flow in Ramsey Creek 500 feet above the CMW boundary (RC-10) and 4,000 feet downstream of the boundary (RC-20). Flow was 1.15 cfs at the upper location and 1.59 cfs at the lower location. In 2013, MMC measured flow at RC-10 in August, September, and October; flows ranged from 1.40 cfs in September to 4.02 cfs in October (MMC 2014d).

Table 105. Measured High and Low Flows in Analysis Area Streams.

Stream	Station	Sampling Period	Minimum Measured Streamflow (cfs)	Maximum Measured Streamflow (cfs)	Number of Measure-ments
Libby Creek	LB-100	4/88 to 10/13	0.77	50.7	32
	LB-200†	4/88 to 10/14	0.77	262	Numerous
	LB-300*	9/89 to 7/12	1.6	148	80
	LB-500	4/88 to 7/12	0.47	173	81
	LB-800	4/88 to 8/07	2.9	250	37
	LB-1000	2/91 to 4/12	2.9	122	34
	LB-2000	9/88 to 4/12	0.1	418	Numerous
	LB-3000§	4/88 to 4/12	10.6	319	Numerous
	US 2‡	3/99 to 9/09	4.0	1,076	53
Ramsey Creek	RA-100	4/88 to 10/93	0	60.9	18
	RA-200	4/88 to 10/93	0.5	62.8	24
	RA-600	4/88 to 10/09	1.2	119.5	41
Poorman Creek	PM-500	4/88 to 10/93	0.5	85.4	24
	PM-1000	4/88 to 4/12	0.7	62	50
Little Cherry Creek	LC-100	4/63 to 9/65; 4/88 to 10/07	0.1	15	64
	LC-600	4/88 to 6/05	0.2	13.2	12
	LC-800	4/91 to 4/10	0.2	11.9	24
Bear Creek	BC-100	4/88 to 10/88	1.8	98.1	9
	BC-500	4/91 to 4/12	2.8	110	25
East Fork Rock Creek	EFRC-50	7/12 to 9/13	<0.01	10.4	5
	EFRC-100 (Rock Lake inflow)	10/98 to 10/13	0.01	10.4	9
	EFRC-200 (Rock Lake outflow)	10/98 to 10/13	<0.01	27.3	20
	EFRC-300	9/88 to 10/88	0.4	6.5	2
Rock Creek	RC-2000	1984-1993, 2011-2013	<1	782	Numerous
East Fork Bull River	EF Bull River above confluence with Bull River	1974-2000, 2009-2013	4.6	820	Numerous
Miller Creek	Miller Creek	5/78 to 4/82	10.6	63.5	3
West Fisher Creek	West Fisher Creek	10/01 to 8/08	8.6	669	34

†LB-200 water level stage measured continuously by MMC beginning September 2009.
*LB-300 flow includes discharge from the Libby Adit between 1990 to 1998 and 2008 to present. Flow at other Libby Creek sites downstream of LB-300 also may have been influenced by discharge from the adit during the same time periods.
§LB-3000 flow measured with a continuous recorder in 1988 and 1989.
‡The KNF measured flow at the US 2 bridge until September 2009. The monitoring station was moved about 2 miles downstream due to safety concerns. The new station is outside of the analysis area.
Station locations are shown on Figure 76.
cfs = cubic feet per second; < = less than.
Source: NewFields 2013a; MMC 2008, 2009b, 2010, 2011b, 2012g, 2013; Neesvig, pers. comm. 2006, 2010 and 2011; Wegner, pers. comm. 2006d; Boyd, pers. comm. 2010.

In July to October 2013, MMC measured flow in the upper East Fork Bull River at EFBR-50 monthly measured stage continuously using a pressure transducer (MMC 2014d). The flow ranged from 0.02 cfs in mid-September to 0.22 cfs in mid-October. The transducer data showed a drop in stream stage from July through early September, with a couple of short increases during that period due to precipitation events. The stream stage was lowest in early September, and remained fairly steady for about two weeks, so the flow of 0.02 cfs may represent baseflow conditions. In mid-September, stream stage increased due to fall precipitation. MMC measured a flow of 0.05 cfs in August 2013 at EFBR-10, located at an elevation of 5,400 feet upstream of EFBR-50 where flow was observed to begin in that channel. MMC also measured flow in three of the four other channels that flow into St. Paul Lake in September 2013. Flow in SPL-1, SPL-4, and SPL-11 ranged from 0.01 to 0.03 cfs; these flows may represent baseflow conditions.

MMC installed a pressure transducer in the East Fork Rock Creek at EFRC-100 (inflow to Rock Lake) in August 2013. The continuous stage measurements were fairly steady through mid-September, which may represent baseflow conditions, which was measured in mid-September 2013 as 0.05 cfs. Stream stage increased in mid-September due to fall precipitation.

MMC measured the flow at the outlet of benchmark lake Wanless Lake to Swamp Creek (in Sanders County) in July, August, and September 2013. The site (WL-2) is a benchmark monitoring site (outside the range of influence of expected mine or adit inflows) comparable to EFRC-200, the outlet of Rock Lake. The flow at EFRC-200 was measured within 1 to 2 days of flow measurements collected at WL-2, and were similar. Highest flows (5.3 cfs at EFRC-200 and 5.7 cfs at WL-2) were measured in mid-July 2013, and lowest flows (0.3 cfs at EFRC-200 and 0.4 cfs at WL-2) were measured in mid-September 2013.

MMC also measured flow in Swamp Creek (in Lincoln County) at the proposed wetland mitigation site adjacent to US 2. Flow measurements collected at three locations at the site between May and September 2011 and June and August 2012 ranged from 1.37 in September to 31.8 cfs in May. Flow in a tributary channel from a spring (#2) ranged from 6.19 cfs in May 2011 to 1.01 cfs in August 2012 (NewFields 2013a).

Synoptic Streamflow Measurements

MMC completed synoptic streamflow measurements in late August 2005 at selected locations along Ramsey Creek, Poorman Creek, Little Cherry Creek, and Libby Creek (Table 106). These data indicate that the three tributaries to Libby Creek along nearly all of their reaches are gaining streams with inflow from groundwater. Some of the flow in Libby Creek between stations LB-500 and LB-800 apparently infiltrates into the alluvium, because the increase in flow from 1.6 to 2.8 cfs does not account for the 2.8 cfs coming in from Ramsey Creek (RA-600) and unknown flow from Howard Creek. Libby Creek below LB-800 apparently gains some flow from groundwater.

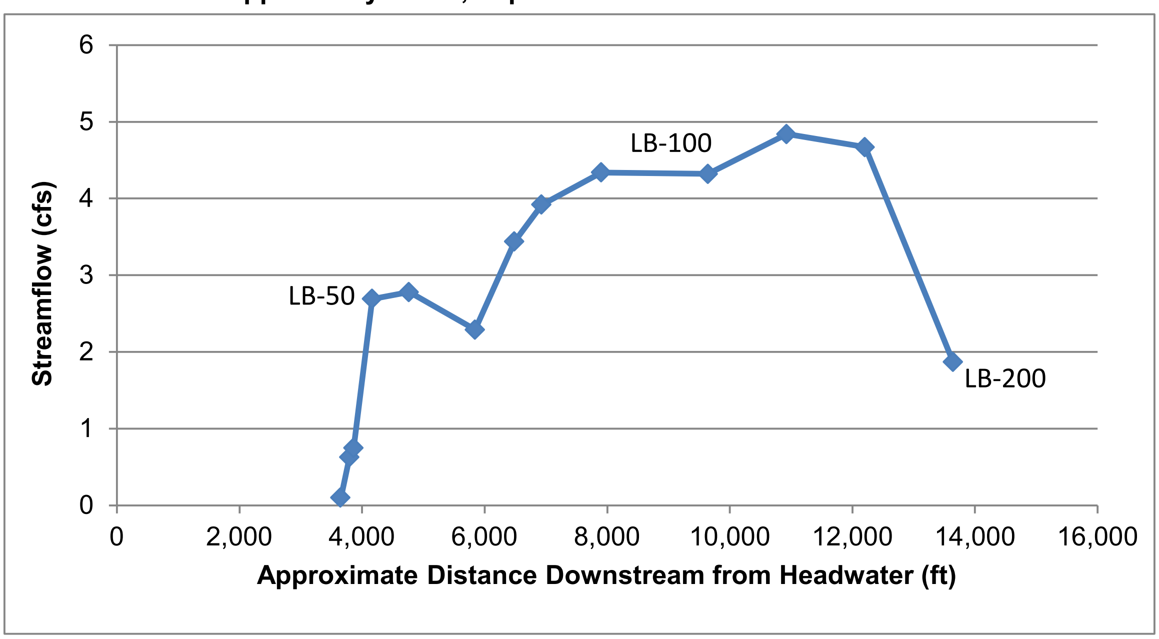
Table 106. August 2005 Synoptic Streamflow Measurements.

Ramsey Creek	Poorman Creek	Little Cherry Creek	Lower Libby Creek
RA-1 = 1.79	PM-500 = 1.07	LC-100 = 0.16	LB-500 = 1.55
RA-2 = 1.93	PM-1 = 0.76	LC-1 = 0.17	LB-800 = 2.82
RA-3 = 2.26	PM-2 = 1.03		LB-2000 = 8.86
RA-4 = 2.34	PM-3 = 1.5	LC-100 = 0.11*	
RA-600 = 2.79	PM-4 = 0.91	LC-1 = 0.33*	
	PM-1000 = 0.77	LC-800 = 1.82*	
	PM-5 = 1.93		
		LC-1 = 0.37**	
		LC-800 = 0.31**	

All flows are in cubic feet per second.
Measurements made August 24-26, 2005, except data with (*) measured June 25-26, 2005 or data with (**) measured July 30-31, 2005.
Source: Geomatrix 2006b.

On September 3, 2010, MMC completed synoptic flow measurements along Libby Creek from the top of the main channel where the uppermost channel from the west joins the uppermost channel from the south, about 1 mile upstream of the CMW boundary to LB-200 (Chart 19). MMC also completed synoptic flow measurements in this same area in September and October 2012, and extended the measurements up to the top of the highest, most westerly channel up to an elevation of 5,880 feet (Figure 76). MMC completed synoptic flow measurements from LB-40 to LB-100 in July through October 2013 and 2014. The 2012, 2013, and 2014 synoptic flow measurements are provided in Table 107. This entire section of the Libby Creek channel is narrow, with numerous steep side channels on both sides of the creek. At 5,880 feet, in an area of

Chart 19. Flow in Upper Libby Creek, September 2010.



Source: Geomatrix 2010b.

Table 107. 2012, 2013, and 2014 Synoptic Streamflow Measurements in Upper Libby Creek.

Measurement Date	Libby Creek Tributaries		Libby Creek Main Stem				
	LB-30	LB-20	LB-40	LB-50	LB-70	LB-80	LB-100
9/13/12	0.54	0.30	0.18	1.67	1.37	1.40	3.87
9/27/12	0.29	1.66	0.14	1.87	1.08	1.77	2.33
10/10-14/12	0.37	0.25	0.02	0.85	0.15	0.61	1.92
7/10/13	5.52	1.55	3.34	10.88	13.16	10.53	19.70
7/24/13	3.45	1.31	1.96	5.13	NM	6.63	12.88
8/7/13	2.05	0.87	1.39	4.83	4.31	3.19	7.40
8/19/13	1.18	0.65	0.67	3.59	4.15	4.51	4.72
9/4/13	0.73	0.57	0.33	2.67	2.00	1.24	2.39
9/19/13	4.40	0.57	2.36	9.91	10.41	10.50	19.74
10/4/13	3.27	1.21	1.86	6.67	12.12	13.46	25.90
7/14/14	6.20	1.43	11.32	18.57	21.98	29.00	28.55
7/26/14	2.33	0.38	1.61	5.58	6.49	9.17	10.89
8/15/14	1.37	0.30	1.00	3.51	4.48	5.58	5.19
8/29/14	1.10	0.21	0.36	1.83	2.35	2.86	3.66
9/11/14	0.60	0.20	0.25	1.57	1.61	2.38	2.30
9/26/14	1.07	0.18	0.55	2.81	3.13	3.94	4.13
10/10/14	0.86	0.29	0.28	1.66	1.74	2.09	1.83

All flows are in cubic feet per second. LB-20 and LB-30 are tributaries to the mainstem of Libby Creek between LB-40 and LB-50.
NM = No measurement.
Source: MMC 2014d; Klepfer Mining Services 2015a.

extensive colluvium and rock talus, the flow in the channel was measured at 0.02 cfs in September 2012. Perennial flow in Libby Creek originates slightly above LB-50 where a fault of the Snowshoe thrust cuts across the valley (Fillipone and Yin 1994). At most locations measured in the mainstem, the creek showed flow gains except at the last location at LB-200. The creek for the most part gains flow from above LB-50 to LB-100, then loses flow between LB-100 and LB-200. Measurements indicate that some water is lost to alluvial deposits between LB-100 and LB-200, and that the alluvium is limited in the volume of water it can carry.

Downstream of LB-200, at least five steep side channels enter the main channel of Libby Creek between LB-200 and LB-300. The Libby Creek channel does not begin to widen and become flatter until the Libby Adit site just above LB-300. Historical flow data (1989-2013) for LB-200 and LB-300 collected on the same date show that during low flows (defined for this purpose as flow of less than 4.73 cfs, the estimated $7Q_2$ flow at LB-300), the stream gained an average 36 percent in flow between LB-200 and LB-300. Based on these data, upper Libby Creek to LB-300 is largely a gaining stream, with inflow from groundwater (either directly to the mainstem or via the numerous side channels), and a temporary loss to alluvium of limited thickness within the narrow channel above LB-200. This water appears to return to the creek between LB-200 and LB-300.

3.11.3.3 Spring Flows

Numerous springs occur in the analysis area and are discussed in section 3.10, *Groundwater Hydrology*.

3.11.3.4 Stream Channel Characteristics of Impoundment Sites

3.11.3.4.1 Little Cherry Creek Tailings Impoundment Site

At the Little Cherry Creek Tailings Impoundment Site, the Little Cherry Creek channel substrate material is predominantly gravel. The average bankfull width of upper Little Cherry Creek is 8 feet and 14 feet in the lower creek. The maximum bankfull depth is 0.7 to 1.2 feet. The floodplain width ranges from 30 to more than 100 feet. The channel gradient ranges from 7 percent near the confluence with Libby Creek to 2 percent in the upper part of the watershed (Kline Environmental Research 2005a). The channel is stable, and the stream contains pools and riffles. Bedrock outcrops in the channel downstream of the Seepage Collection Dam Site. The range of measured Little Cherry Creek flows is provided in Table 105.

3.11.3.4.2 Poorman Tailings Impoundment Site

Surface water in four drainages in the Poorman Tailings Impoundment Site (Drainages 3, 5, 10 and 14) flows east toward Libby Creek (Figure 87). The four drainages comprise a small, 1,025-acre watershed within the Libby Creek watershed. Libby Creek is a third-order stream. The area upstream of and including the watershed of the four unnamed drainages is 23,245 acres. Major tributaries of Libby Creek upstream of the Poorman Tailings Impoundment Site are Poorman Creek, Ramsey Creek, Howard Creek, and Midas Creek. The four drainages were characterized by Kline Environmental Research (2012) and NewFields (2014a). The descriptions below apply to observations made in 2011. From north to south, the drainages are 10, 5, 3, and 14 (Figure 87).

Drainage 10

Drainage 10 has a drainage area of about 213 acres and an estimated length of 8,120 feet. Drainage 10 was largely unchannelized. Flow in Drainage 10 originated at springs 29, 33, 34, and 35. The lower portion of the drainage dropped steeply through a narrow, v-shaped valley, forming step pools, step riffles, and cascades, followed by a riffle-dominated final reach. The drainage became unchannelized across a flat area leading to two culverts under NFS road #1408. The flow dispersed and infiltrated in this flat area and did not always reach the culverts. It was assumed that Drainage 10 connected to Libby Creek downgradient of the culvert (Kline Environmental Research 2012). In May 2011, the maximum measured flow in Drainage 10 was 126 gpm.

Drainage 5

Drainage 5 originates from two branches (Figure 87). It has a drainage area of 72 acres and an estimated length of 3,209 feet. Flow in one of the branches is entirely unchannelized and intermittent. Flow was observed to begin upstream of Spring 31, flowed through a wetland (WUS-36), drained through a culvert (NFS road #6212H), and continued through dense alder before merging with a second branch. The second branch had perennial flow that began at Spring 36, flowed through channel habitat, and then became unchannelized. The second branch was joined by flow from Spring 30 and entered wetland WUS-4. This wetland had standing water in May and September 2011. Flow through the culvert at NFS road #6212H ceased in October. Below the culvert, flow became somewhat dispersed through a dense stand of alder, where it joined with the other branch.

After the two branches combined, the maximum measured flow rate in 2011 was 18 gpm (0.04 cfs), and the channel became entrenched and crossed a low-gradient, bushy area before cascading down a steep bank in a narrow v-shaped valley. It then flattened out and ended abruptly at a pool near the edge of the proposed Seepage Collection Pond in Alternative 3. Flow to the terminal pond appeared to be perennial. From the terminal pool, there was no evidence of surface flow connecting Drainage 5 to Libby Creek.

Drainage 3

Drainage 3 originated from two main branches (Figure 87). It has a drainage area of 382 acres and an estimated length of 9,494 feet. The flow path from a wetland and a spring (SP-28) and a spring slightly downgradient in one of the branches had minor flow when measured in May 2011. Some of the flow path was unchannelized and some was channelized. The second main branch also originated in a wetland. From the wetland, the flow path was mainly unchannelized, with short reaches where it was channelized, with a transition to a mainly persistent flow near the confluence with the other main branch. The combined flows in the second branch created a channel with persistent flow for most of the distance to Libby Creek. Of the four drainages, Drainage 3 had the highest measured discharge (202 gpm) to Libby Creek when measured in May 2011. An area below spring SP-37 has perennial flow for about 8 feet before reaching the northern branch. In general, flow in the two channels is intermittent, with flow observed from April to July, and no flow observed in the two branches from August to October. Where the two branches join, flows up to 70 gpm (0.16 cfs) were measured in April to July, and less than 10 gpm (0.02 cfs) were measured in August to October. Near Libby Creek, flow in Drainage 3 in late summer and fall is often is only below the ground surface due to the coarse alluvial material along Libby Creek.

Drainage 14

Drainage 14 has a drainage area of 358 acres and an estimated length of 12,736 linear feet. All of the perennially flowing reaches of Drainage 14 were in the upper part of the drainage due to several springs (38, 39, and 41). Another spring (26) is located at the head of a large wetland area. Intermittent flow through the large wetland area is in both defined and undefined channels. Segments of channelized and intermittent flow were scattered throughout the drainage. Several reaches of Drainage 14 below the upper reaches were only identifiable during spring runoff. The lowest reach of Drainage 14 within the disturbance area boundary was channelized in a well-defined valley. Surface flow at the downstream disturbance area boundary was assumed to reach Libby Creek either as surface flow or subsurface flow in the coarse alluvial material along Libby Creek. In May 2011, the measured flow in Drainage 14 was 108 gpm (0.23 cfs).

3.11.3.5 Climate Change

The USDA Forest Service issued the KIPZ Climate Change Report in 2010 (USDA Forest Service 2010a). The Department of the Interior, Bureau of Reclamation issued three reports on climate change in 2011 (Reclamation 2011a, 2011b, 2011c), discussed in section 3.3.1, *Climate Change* and in section 3.10.3.4, *Climate Change* in the *Groundwater Hydrology* section. For the Columbia River Basin in general, warming is expected to diminish the accumulation of snow during the cool season (*i.e.*, late autumn through spring) and the availability of snowmelt to sustain runoff during the warm season (*i.e.*, late spring through early autumn). Increased rainfall in December through March is expected to increase runoff during those months. Decreased snowpack volume could result in decreased groundwater infiltration, decreased spring/summer runoff, increased rain-on-snow events, and ultimately decreased contribution to baseflow in streams (USDA Forest Service 2010a; Reclamation 2011c).

3.11.4 Environmental Consequences

3.11.4.1 Alternative 1 – No Mine

Under this alternative, MMC would not develop the Montanore Mine. Any existing exploration-related or baseline collection disturbances by MMC would be reclaimed in accordance with existing laws and permits. Streamflow monitoring devices installed by MMC would be removed. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Reduction of streamflow in Libby Creek above the Libby Adit from the partial dewatering of the Libby Adit would continue until groundwater levels recovered after the Libby Adit was plugged. Streamflow in Libby Creek below the Libby Adit and in other nearby streams would not be affected.

3.11.4.2 Effects Analysis of the Action Alternatives

Mine facilities and activities in Alternatives 2, 3 and 4 would affect streamflow and the volume and level of Rock Lake. All mine alternatives would reduce groundwater discharge to area streams and Rock Lake due to mine and adit inflows and lowering of the potentiometric surface during all five mine phases (Evaluation, Construction, Operations, Closure, and Post-Closure). When the potentiometric surface reached steady state conditions after mining ceased, the effect would vary by drainage and without or with mitigation. Without mitigation, the effect on streamflow in the East Fork Rock Creek and East Fork Bull River and on the volume and level of Rock Lake would be the same in all mine alternatives. The effects on aquatic life and habitat due to streamflow changes are described in section 3.6, *Aquatic Life and Fisheries*. The indirect effects due to streamflow changes on riparian vegetation are described in section 3.22, *Vegetation* and on wetland vegetation are described in section 3.23, *Wetlands and Other Waters of the U.S.* Various mitigations of effects on surface water may be used and are described in section 2.5.4.3.2, 3.10.4.3.3, or 3.11.4:

- Mitigation modeled by MMC in the 3D model, which is the grouting of the side of the mine blocks which are adjacent to the Rock Lake Fault This grouting would occur on the three uppermost mine blocks and corresponding access ramps during operations
- Maintaining one or more barrier pillars, if necessary, in the mine during operations and constructing bulkheads at the access openings at mine closure
- Increasing the buffer zones near Rock Lake and the Rock Lake Fault
- Additional grouting along the Rock Lake Fault
- Mitigation of effects on senior water rights in the Libby Creek watershed during the Construction, Operations, Closure, and Post-closure Phases

3.11.4.3 Alternative 2 – MMC Proposed Mine

In MMC's proposal, the mill and production adits would be located in the upper Ramsey Creek drainage, about 0.5 mile east of the CMW boundary. An additional adit on MMC's private land in the Libby Creek drainage and a ventilation adit on MMC's private land east of Rock Lake would be used for ventilation. A tailings impoundment would be constructed in the Little Cherry Creek drainage, and would require the diversion of Little Cherry Creek. Two LAD Areas between Poorman Creek and Ramsey Creek are proposed to allow for wastewater discharge using sprinklers during the growing season. A portion of the waste rock produced by driving the adits may be stored temporarily at LAD Area 1, and at the Libby Adit Site, before use in construction.

3.11.4.3.1 Evaluation and Construction Phases (Years 1 through 5)

Streamflow—West Side Streams

Low Flow

Stream baseflow is predicted to change during the Evaluation and Construction Phases (Geomatrix 2011a). At the end of the Evaluation and Construction Phases, baseflow reductions would be 3 percent or less in the East Fork Rock Creek and East Fork Bull River. Effects to baseflow due to mine dewatering are described in greater detail in section 3.10.4.3.1, *Groundwater*. Effects of Alternative 2 would be the same as Alternative 3 without mitigation.

Streamflow—East Side Streams

Low Flow

Libby, Ramsey, and Poorman Creeks. In Alternative 2, MMC proposes to use slow rate land application for primary treatment of wastewater (Geomatrix 2007b; MMC 2008). Land application is the uniform application (usually with sprinklers) of wastewater to a vegetated soil surface, with no surface runoff. The discharged water can receive significant treatment as it flows through the plant root/soil matrix (EPA 2006b). Water discharged to the LAD Areas would either evapotranspire or percolate to groundwater. Water that percolated to groundwater would flow downgradient to the nearest stream. Land application would occur only during the 6-month growing season; during the rest of the year, wastewater would be stored in the tailings impoundment or treated at the Water Treatment Plant and discharged to Libby Creek. The application rate would be adjusted to meet MPDES permitted effluent limits set for discharges at the LAD Areas and to prevent the development of springs in or downgradient of the LAD sites. The discharges to streams from the LAD Areas would be small (32 gpm or 0.07 cfs); the flow of water initially through groundwater would dampen any sudden increases in streamflow due to the additional water. When land application was used in Alternative 2, increases in flow due to treated water discharges would be less than in Alternative 3 because much of the water discharged at the LAD Areas would evaporate or be used by plants.

Effects of mine inflows on the low flows of east side streams would be similar to Alternative 3. Construction Phase effects for Alternative 3 are shown in Table 109. In Alternative 2, the adits would be in two drainages (Libby and Ramsey creeks), and total water inflow into the adits would be greater in Alternative 2 than Alternatives 3 and 4. Compared to Alternatives 3 and 4, effects on streamflow in Libby Creek above LB-300 would be slightly less and would be slightly greater on Ramsey Creek. Discharges during both phases would increase low flow below LB-300. Discharges from the LAD Areas reaching Ramsey, Libby and Poorman creeks would partially offset streamflow effects from mine dewatering.

MMC did not propose in Alternative 2 to discharge water whenever flow at LB-2000 was less than 40 cfs to avoid adversely affecting senior water rights. When water was stored for mill startup during the Construction Phase, low flow at and downstream of LB-300 would be substantially less in Alternative 2 than Alternatives 3 or 4.

Little Cherry Creek. Little Cherry Creek would not be affected during the Evaluation Phase. After the Diversion Dam was constructed during the Construction Phase, water in Little Cherry Creek above the tailings impoundment would be diverted around the tailings impoundment down to Libby Creek via a 10,800-foot-long Diversion Channel. The channel would be sized to divert large flood flows safely around the tailings impoundment. The Diversion Channel would consist of an upper channel, and two existing natural drainages. Two natural drainages would be used to convey water from the upper channel to Libby Creek. The northern drainage (Drainage 10) is currently a 9,000-foot long intermittent drainage that is primarily unchannelized in the upper part and has perennial channelized segments interspersed with unchannelized wet and dry segments in the lower part. The southern drainage (Drainage 5) is about 3,000 feet long with similar characteristics to Drainage 10. Flow in Drainage 5 does not appear to reach Libby Creek (Kline Environmental Research 2012). During the Construction Phase, the flow in Drainages 5 and 10 would increase.

Surface water within the catchment area of the Seepage Collection Dam and within the tailings impoundment area would be captured and returned to the mill for ore processing. Below the Seepage Collection Dam, the source of water to the former Little Cherry Creek channel would be surface water runoff from the catchment area and groundwater discharge below the Seepage Collection Dam.

Bear Creek. Low flow in Bear Creek would not be affected during the Evaluation or Construction Phases.

Peak and Average Annual Flow

The peak flow analysis indicates timber clearing for the mine facilities in Ramsey Creek may measurably increase the peak flow of the creek (Appendix H). The increase in Ramsey Creek peak flow is estimated to be 8 percent. When coupled with the MMC's proposed transmission line alternative (Alternative B), mine-related water yield increase would reach a measurable level in Ramsey and Poorman creeks. According to Grant *et al.* (2008), changes in peak flow that fall in a range of ±10 percent are within the error of peak flow measurement and cannot be ascribed as an effect. Based on an analysis of streamflow data from streams with gaging stations located at the periphery of the analysis area on the KNF, the average variability in low flow values is 20 percent (Wegner 2007). Increased peak flows as a result of timber clearing in other streams in Alternative 2 and in combined Mine-Transmission Line Alternative 2B would be less than 10 percent. Discharges of mine and adit inflows would slightly increase peak flow (less than 1 percent) and average annual flow (about 5 percent) at LB-300. The percent increase in average annual flow below LB-300 would be less as flow increases downstream.

Rock Lake

The effect on Rock Lake volume and levels would be the same as Alternative 3 without mitigation.

Stream and Floodplain Crossings

Alternative 2 would require three new road crossings across perennial streams and one new road crossing across a non-perennial stream (Table 108). The Ramsey Plant Site would affect less than 0.1 acre of FEMA-designated 100-year floodplain on Ramsey Creek. During construction, disturbances within the FEMA-designated 100-year floodplain would be minimized using Best Management Practices (BMPs), as required by FW-GDL-WTR-03 of the 2015 KFP. New bridges are proposed over Ramsey and Poorman creeks and a culvert would be installed in Little Cherry Creek above the Diversion Dam. For all alternatives, no new roads would cross designated 100-year floodplains. The Ramsey Creek bridge would be designed for a 50-year flow, the Poorman Creek bridge for a 100-year flow event, and the culvert would be constructed in compliance with INFS standards and guidelines and Forest Service guidance (USDA Forest Service 2008a, 2015b). After construction was completed, the bridges and culvert would not affect natural streamflow except during very large flow events.

Table 108. Comparison of Stream and Floodplain Crossings Required for Mine Alternatives.

Mine Alternative	Number of Stream Crossings by New Roads		Disturbance Area within a FEMA-Designated 100-year Floodplain (acre)
	Perennial Stream	Other Streams	
2	3	1	<1
3	1	1	9
4	2	1	3

< = less than.
Source: GIS analysis by ERO Resources Corp. using KNF data.

An estimated 12,600 feet of the Little Cherry Creek floodplain would be inundated by construction of the tailings impoundment and seepage collection pond. A new floodplain would be created along the diverted Little Cherry Creek channel and the floodplain of Drainage 10 may widen with increased flows. The net floodplain loss would be 9,510 feet in the Little Cherry Creek watershed.

3.11.4.3.2 Operations Phase (Years 6 through 25)

Streamflow—West Side Streams

Low Flow

The effect on west side streams would be greater than during the Construction Phase, and the greatest effect during the Operations Phase would be at the end of mining operations. The effect would be the same as Alternative 3 without mitigation (Table 111). For the two west side aquatic life sites (RC-3 and EFBR-2), the effect would be the same as Alternative 3 without mitigation (Table 110).

Streamflow—East Side Streams

Low Flow

Libby, Ramsey, and Poorman Creeks. The effect of mine inflows on east side streams would be greater than during the Construction Phase, and the greatest effect during the Operations Phase would be at the end of mining operations. MMC did not propose in Alternative 2 to discharge water during operations whenever flow at LB-2000 was less than 40 cfs to avoid adversely affecting senior water rights. The water balance for Alternative 2 indicates that up to 159 gpm of additional water on an annualized basis would be required during the Operations Phase to meet mill needs (Table 14 in Chapter 2). Flow at and downstream of LB-300 would be less in Alternative 2 than Alternatives 3 or 4. The effect on Ramsey Creek would be slightly greater in

Alternative 2 because the adits in Ramsey Creek drainage would affect streamflow in Ramsey Creek and less in upper Libby Creek (Table 111). The effect on Poorman Creek would be only from mine inflows (a loss of 0.01 cfs without mitigation and no effect with MMC's modeled mitigation). The pumpback wells and impoundment diversions would not affect Poorman Creek in Alternative 2.

Little Cherry Creek. The agencies completed an analysis of the effect of Alternative 2 to the Little Cherry Creek watershed area and the resulting change in the flow of area streams (ERO Resources Corp. 2010a in Appendix H). Precipitation and runoff captured by the tailings impoundment and the Seepage Collection Dam would no longer flow to either the diverted or former Little Cherry Creek. During operations, 13 percent of the Little Cherry Creek watershed would continue to contribute flow to the former Little Cherry Creek channel downstream of the Seepage Collection Dam; the estimated average annual flow would be 0.77 cfs. The flow in Drainage 10 would be about 60 percent of the flow of the original Little Cherry Creek. The estimated $7Q_{10}$ flow of the water diverted to Drainages 5 and 10 would be 0.16 cfs. Diversions, combined with the pumpback well system would likely eliminate the $7Q_{10}$ flow in the diverted Little Cherry Creek and substantially reduce the $7Q_2$ flow. Flow below the Seepage Collection Dam in the former Little Cherry Creek channel would also be substantially reduced. The flow in Drainages 5 and 10 (the diverted Little Cherry Creek) would increase. Some of the flow would be intercepted by the pumpback well system.

Bear Creek. Low flow in Bear Creek would be reduced during the Operations Phase by diversions and a pumpback well system at the Little Cherry Creek impoundment. The effect was not quantified.

Peak and Average Annual Flow

The effect on peak flow in Ramsey Creek from timber harvesting for mine facilities would continue during the Operations Phase. Other than Ramsey Creek, the effect on peak and average annual flows in the Libby Creek watershed would be negligible. Appropriation of water for mill use would be taken when the flow of Libby Creek was equal to or greater than the average annual low flow of the creek at a rate of up to 159 gpm (0.35 cfs), which would reduce peak flow and average annual flow in Libby Creek at the point of diversion (about LB-2000).

Rock Lake and Rock Creek Meadows

The effect on Rock Lake volume and levels and the effect on Rock Creek Meadows would be the same as Alternative 3 without mitigation.

3.11.4.3.3 Closure Phase (Years 26 to 30)

Streamflow—West Side Streams

The effects during the Closure Phase would be the same as Alternative 3 without mitigation.

Streamflow—East Side Streams

Low Flow

Libby, Ramsey, and Poorman Creeks. After the adits were plugged at the surface as proposed in Alternative 2, reduction in low flow above the Libby Adit Site (LB-300) and above lower Ramsey Creek (RA-600) would be slightly greater than predicted during the Operations Phase, with the greatest reductions occurring immediately after the adits were plugged. The effect was not quantified. Compared to Alternative 3, effects above LB-300 would be slightly less and above RA-600 would be slightly greater. Discharges during both phases would increase streamflow downstream of the LAD Areas and Water Treatment Plant discharge. Discharges would partially offset streamflow effects from mine dewatering during low flows. Overall streamflow increases due to discharges would be less than in Alternative 3 because some water would evaporate at the LAD areas. The effect on flows in Poorman Creek during this phase would be negligible.

Little Cherry Creek and Bear Creek. The effect on Little Cherry Creek and Bear Creek would be the same as during the Operations Phase.

Peak and Average Annual Flow

After site reclamation, the increase in peak flow in Ramsey Creek would be less than during operations as disturbed areas became revegetated. The effect of discharges and vegetation clearing on other streams would be the same as during the Construction Phase. MMC did not propose any diversions from Libby Creek except as needed during the Operations Phase.

Rock Lake and Rock Creek Meadows

The effect on Rock Lake volume and levels and on Rock Creek Meadows would be greater than during the Operations Phase. The effect during the Closure Phase was not quantified and would be the same as Alternative 3 without mitigation.

3.11.4.3.4 Post-Closure Phase (Years 31+)

Streamflow—West Side Streams

Low Flow

The effect on west side streams would increase from the Operations and Closure Phases and would be the greatest during the Post-Closure Phase after the end of mining operations in the East Fork Rock Creek, Rock Lake, and the East Fork Bull River. The effects would be the same as described for Alternative 3 (Table 113 and Table 114).

Streamflow—East Side Streams

Low Flow

Libby, Ramsey, and Poorman Creeks. The effect would be the same as Alternative 3 without mitigation except that the effect on Ramsey Creek would be slightly greater (Table 113 and Table 114).

Little Cherry Creek and Bear Creek. After the impoundment was reclaimed and runoff was no longer subject to ELGs and applicable water quality standards, runoff from the reclaimed tailings impoundment surface and the watershed west of the impoundment would be routed toward Bear Creek. Because the impoundment would be reclaimed, runoff would be stormwater not mixed with any mine drainage or process water. The Bear Creek watershed area where runoff would meet the creek would increase by 560 acres, an 8 percent increase (ERO Resources Corp. 2010a). Watershed area and mean annual precipitation were the location-specific variables in the equations developed by the USGS to estimate both $7Q_2$ and $7Q_{10}$ flow in the region that includes the analysis area (Hortness 2006). Assuming no change in annual precipitation, the Hortness method would predict that an 8 percent increase in watershed area would increase $7Q_2$ and $7Q_{10}$ flow by about 8 percent. At mine closure, the reclaimed impoundment surface would drain toward Bear Creek and the reclaimed impoundment would be in a watershed adjacent to the original watershed (Little Cherry Creek). Some of the precipitation that would infiltrate into the reclaimed impoundment would be intercepted by the impoundment's underdrain system and routed toward Little Cherry Creek, the original watershed. Consequently, the Hortness method overestimates $7Q_2$ and $7Q_{10}$ flow in watersheds containing the reclaimed impoundment. Both $7Q_2$ and $7Q_{10}$ flow likely occur during late summer or early fall during periods of little or no precipitation. The amount of baseflow that would flow during these period toward Bear Creek would be negligible. The agencies anticipate little or no increase in $7Q_2$ and $7Q_{10}$ flow in Bear Creek. Any increased flow would partially offset the flow reduction caused by the pumpback well system as long as it operated. The effect of the pumpback well system on Bear Creek was not quantified.

Low flows in the diverted Little Cherry Creek and Drainage 10 would likely be substantially reduced as long as the pumpback well system operated. When the impoundment was reclaimed and the pumpback well system no longer operated, the watershed of the former Little Cherry Creek would be 220 acres larger than during the Operations Phase, but would remain 74 percent smaller than the existing creek. The effect of a smaller watershed would be less than the Hortness method would predict based on watershed size because some of the water intercepted by the impoundment's underdrain system would flow to the former Little Cherry Creek. The diverted creek's watershed (Drainage 10) would be 45 percent smaller than the existing Little Cherry Creek's watershed.

Peak and Average Annual Flow

During the Post-Closure Phase, peak flow in Ramsey Creek would gradually return to pre-mine conditions as disturbed areas became revegetated. The agencies estimate the Ramsey Creek watershed would take 25 years after completion of the Closure Phase to recover to existing peak flow conditions. The average annual flow in Bear Creek would be an estimated 8 percent higher over the long term. The watershed of diverted Little Cherry Creek would be 915 acres, or 54 percent smaller than the original Little Cherry Creek. Average annual flows of diverted Little Cherry Creek are estimated to be about half of the original creek flows. The former Little Cherry Creek channel below the impoundment dam would have a watershed of 445 acres (ERO Resources Corp. 2010a in Appendix H), providing some flow to the channel. In addition, Klohn Crippen (2005) estimated at steady state 50 to 100 gpm from the impoundment's underdrain system would flow toward the former Little Cherry Creek. Following cessation of the pumpback wells and recovery of groundwater levels, springs and seeps outside of the impoundment footprint that were affected by the pumpback wells would likely return to pre-mine conditions and also may contribute to baseflow. The effect of discharges and vegetation clearing on other streams would be the same as during the Construction Phase. After discharges ceased, peak flow and average annual flow would return to pre-mine conditions.

Rock Lake and Rock Creek Meadows

The effect on Rock Lake volume and levels and on Rock Creek Meadows would be the same as Alternative 3 without mitigation and is discussed in section 3.11.4.4.4 *Post-Closure Phase.*

3.11.4.3.5 Climate Change

The combined impacts of Alternative 3 and climate change were not quantified because of the possible range in effects of climate change on water resources. It is difficult to predict how the hydrologic systems in the Montanore Project analysis area would respond to the forecasted regional effects of climate change. Uncertainty is discussed in section 3.10.4.2.3, *Climate Change*. Quantifying the combined effects would not improve the proposed designs and mitigation in light of climate change over the designs already incorporated into the agencies' alternatives. The effects of the reduced low flows on water resources combined with the effects of climate change may be greater than those estimated to occur in Alternative 3 alone. In Alternative 3, collection of data at benchmark sites unaffected by mining and before any mine construction or activity would provide comparative data to evaluate whether any changes detected in aquatic assemblages were related to impacts from mine activities.

The Forest Service (2010a) and the Bureau of Reclamation (2011c) predicted that more precipitation may fall as rain in December through March, resulting in more runoff in the winter, and reduce the accumulation of snow in the winter. Climate change may also reduce summer and fall runoff, and reduce baseflow in streams in the Columbia River Basin. Decreased groundwater infiltration could reduce the project's mine and adit inflows, but because baseflow to streams would also decrease, the percentage change to baseflow may remain the same. If mine and adit inflows decreased, discharges to Libby Creek would be less and makeup water requirements would increase. If climate change did not reduce infiltration enough to change mine and adit inflows from those projected without climate change, any increase in winter streamflows due to climate change may moderate the effect of mine inflows during the winter low flow periods, and any decrease in fall flows may magnify the effect of mine inflows during the fall low flow periods. As described in Appendix C, MMC would monitor streamflows at potential impact area sites and benchmark sites (similar to analysis area sites, but outside the area of potential mine impacts) to evaluate trends due to mining compared to trends due to non-mining effects such as climate change.

3.11.4.4 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

In Alternative 3, mine facilities would be located in alternate locations. MMC would develop an impoundment site north of Poorman Creek for tailings disposal, use a plant site between Libby and Ramsey creeks, and construct two additional adits in the upper Libby Creek drainage. LAD Areas would not be used. All excess mine and adit water not used for mine operations would be treated at the Libby Adit Water Treatment Plant and discharged to Libby Creek. Treated discharge water would be subject to MPDES permitted effluent limits.

The Libby Plant Site would be built with fill material from a large cut on the west side of the plant site. Based on preliminary analysis, the cut and fill materials would balance, and waste rock would not be used in plant site construction. Avoiding the use of waste rock in plant site construction would minimize the potential for stormwater runoff from the plant site to adversely affect the quality of nearby water resources.

The effects on aquatic life and aquatic habitat due to streamflow changes are described in section 3.6, *Aquatic Life and Fisheries.* The indirect effects due to streamflow changes on riparian vegetation are described in section 3.22, *Vegetation*, and on wetland vegetation are described in section 3.23, *Wetlands and Other Waters of the U.S.* Various mitigations of effects on surface water may be used and are described in sections 2.5.4.3.2, 3.10.4.3.3, or 3.11.4.

3.11.4.4.1 Evaluation and Construction Phases (Years 1 through 5)

The effect on west side streams during the Evaluation and Construction Phases during low flow periods would be small. A decrease of 0.01 cfs (2 percent reduction of the estimated $7Q_{10}$ flow) at EFRC-200 during the Evaluation Phase is predicted. Estimated changes in lake levels and lake surface area would be below what can be accurately calculated. In east side streams, predicted changes during the Evaluation Phase are small decreases (0.02 cfs) between the CMW boundary and the Libby Adit in Libby Creek. The current adit dewatering has likely resulted in a reduction in Libby Creek baseflow, but the effect is not detected because either the reduction is very small and/or there are insufficient baseline data (before the adit was constructed) for comparison to current conditions. Below the Water Treatment Plant at the Libby Adit, predicted discharges of up to 263 gpm would increase flow at LB-300 in Libby Creek by 12 percent of the estimated $7Q_2$ flow and 19 percent of the estimated baseflow. A decrease of 0.01 cfs (2 percent reduction of the estimated $7Q_{10}$ flow) at the CMW boundary at Rock Lake is also predicted. The remainder of this section discusses flow changes during the Construction Phase (Table 109).

Streamflow—West Side Streams

Low Flow

The effect on west side streams during the Construction Phase during low flow periods would be small (up to a 3 percent loss of baseflow at EFRC-200), but slightly greater than the Evaluation Phase (Table 109). The effects on aquatic life sites RC-3 and EFBR-2 in the Evaluation and Construction Phases were not estimated, but would be smaller than shown for the Operations Phase (Table 110).

Streamflow—East Side Streams

Low Flow

Low flow in Ramsey, Poorman, and Little Cherry creeks would not be affected during the Evaluation Phase. The effect during the Construction Phase on low flow in Ramsey, Poorman, and Little Cherry creeks would be small (-1 to +3 percent). If baseflow changes in Ramsey Creek adversely affected a senior water right on Ramsey Creek during any mining phase, MMC would develop a plan during final design to convey treated water from the Water Treatment Plant to a location upstream of the right's point of diversion. Discharge to Ramsey Creek would equal MMC's Ramsey Creek baseflow changes whenever the flow at RA-300 was less than 1 cfs. Baseflow in Libby Creek at LB-100 (near the CMW boundary) is predicted not to change during the Evaluation Phase, and is predicted to decrease by up to 9 percent during the Construction Phase. Flow in Libby Creek at and below LB-300 would increase due to discharges from the Water Treatment Plant, which would reach a maximum of 1.11 cfs during the Construction Phase. At LB-300, flow would increase by 0.96 cfs, which would be a 79 percent increase above the estimated baseflow (Table 109). At LB-2000, the increase in $7Q_{10}$ flow is estimated to be 0.67 cfs, a 7 percent increase. The low flow in Bear Creek would not be affected. The effects on aquatic life site LB-2 for the Evaluation and Construction Phases were not estimated, but would be smaller than shown for the Operations Phase (Table 110).

Table 109. Estimated Changes during $7Q_2$ and $7Q_{10}$ Flows, Construction Phase, Alternative 3.

Activity	East Fork Rock Creek EFRC-200†	Rock Creek RC-2000	East Fork Bull River EFBR-500	Ramsey Creek RA-600	Poorman Creek PM-1200	Little Cherry Creek LC-800	Libby Creek LB-300†	Libby Creek LB-2000
	(cfs except % change)							
Modeled baseflow change (without mitigation)	-0.01	-0.02	0.00	-0.02	0.00	0.00	-0.13	-0.17
Potable water	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02
Pumpback wells	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	-0.01	-0.02	0.00	-0.02	0.00	0.00	-0.15	-0.19
Stormwater diversion at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.08	0.01	0.00	0.00
Impoundment precipitation captured at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.38
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	1.11	1.11
Change at 7Q2 flow	**-0.01**	**-0.02**	**0.00**	**-0.02**	**+0.08**	**+0.01**	**+0.96**	**+0.54**
Estimated $7Q_2$ flow	0.92	13.53	5.77	3.26	2.46	0.32	4.73	13.85
Percent Change in $7Q_2$ Flow	**-1%**	**<-1%**	**0%**	**-1%**	**+3%**	**+3%**	**+20%**	**+4%**
Stormwater diversion at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.00
Impoundment precipitation captured at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Change at $7Q_{10}$ flow	**-0.01**	**-0.02**	**0.00**	**-0.02**	**+0.05**	**+0.01**	**+0.96**	**+0.67**
Estimated $7Q_{10}$ flow	0.29	8.80	3.71	2.07	1.55	0.19	1.22	8.99
Percent Change in $7Q_{10}$ Flow	**-3%**	**<-1%**	**0%**	**-1%**	**+3%**	**+3%**	**+79%**	**+7%**

†Modeled baseflow values used rather than estimated $7Q_{10}$ flow for EFRC-200 and LB-300 (see section 3.8.3).
Effects shown do not include mitigation measures such as grouting during operations or maintaining barriers in the mine void, or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase. Effects shown do include discharges to Libby Creek and (but not Ramsey Creek) during all phases to avoid adversely affecting senior water rights.
cfs = cubic feet per second; < = less than.
Note: Values shown for modeled baseflow change include 2 years of mining.
Groundwater models were used to predict effects from mine dewatering and the pumpback wells. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.

The primary long-term source of water in the perennial reaches of the four tributaries in the impoundment site is one or more springs located within the footprint of the tailings impoundment. After the springs were filled during the Construction Phase, flow in the perennial reaches downgradient of the impoundment would likely be reduced, at least during baseflow conditions. Perennial flow would change to intermittent or ephemeral flows in some segments.

Table 110. Predicted Changes in Baseflows and Wetted Perimeters at LB-2, RC-3, and EFBR-2 during Operations and Post-Closure, All Mine Alternatives.

Site and Description	LB-2 (Libby Creek above Little Cherry Creek)	RC-3 (East Fork Rock Creek above Confluence with West Fork Rock Creek)	EFBR-2 (East Fork Bull River at Confluence with Isabella Creek)
Existing Conditions and No Action Alternative			
Estimated $7Q_{10}$ Flow (cfs)	8.62	5.70	2.93
Estimated Wetted Perimeter at $7Q_{10}$ Flow (ft^2)	7.38	26.62	1.31
During Operations (Year 22)			
Effect on $7Q_{10}$ Flow (cfs)	+0.82	-0.06	-0.07
% Change in $7Q_{10}$ Flow (cfs)	+10%	-1%	-2%
Effect on Wetted Perimeter (ft^2)	+2.54	-0.28	-0.09
% Change in Wetted Perimeter	+34%	-1%	-7%
During Post-Closure (Year 38)			
Effect on Flow (cfs)	0.00	-0.51	-0.31
% Change in $7Q_{10}$ Flow (cfs)	0%	-9%	-11
Effect on Wetted Perimeter (ft^2)	0.00	-2.52	-0.35
% Change in Wetted Perimeter	0%	-9%	-26%

Effects shown do not include mitigation measures such as grouting during operations or maintaining barriers in the mine void, or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase. Effects shown do include discharges to Libby Creek during all phases to avoid adversely affecting senior water rights.
Source: ERO 2012a.

The current locations and periods of intermittent and ephemeral flow are expected to be similar after construction of the impoundment, but the magnitude of flow would be reduced due to significant reductions in drainage area from the tailings impoundment. The four tributaries have a low capacity to convey water to Libby Creek, and their combined flow of up to 0.7 cfs is much less than the flow of Libby Creek near the impoundment site. The effects on Libby Creek would minor during high flow conditions and negligible or nonexistent for the majority of the year. Appendix L discusses the effects of changes to the four tributaries and Libby Creek due to the tailings impoundment in greater detail.

Peak and Average Annual Flow

During the Construction Phase, less than a 1 percent increase in peak flow from timber clearing for the mine facilities is estimated in all east side streams. All transmission line alternatives combined with Alternative 3 would have estimated increases in peak flow of less than 10 percent. The Poorman Tailings Impoundment would be located in the watersheds of four small drainage channels. This alternative would not require the diversion of Little Cherry Creek or Poorman Creek. Any flow within the watershed above the impoundment would be routed to Poorman Creek or Little Cherry Creek. Water from above the Poorman Tailings Impoundment and Plant

Access Road would be diverted either toward Poorman Creek or Little Cherry Creek, increasing the watershed of both creeks by about 3 percent (ERO Resources Corp. 2010a). ERO Resources' analysis indicated the watershed above the impoundment and access road was 230 acres; NewFields analysis (NewFields 2014b) indicated the area was 270 acres. The difference in effect would be negligible. Average annual flow in both creeks would increase by about 3 percent. Discharges of mine and adit inflows would slightly increase peak flow (less than 1 percent) and average annual flow (about 5 percent) at LB-300. The percent increase in average annual flow below LB-300 would be less as flow increases downstream.

Rock Lake and Rock Creek Meadows

Groundwater discharge into Rock Lake would decrease beginning in the Evaluation Phase and continuing through the Construction Phase. The 3D model predicted very small decreases during the Evaluation (3 acre-feet per year) and Construction Phases (9 acre-feet per year). The effect on the estimated lake volume of 1,302 acre-feet would be negligible. The effect on lake volume, lake level, and surface area during the 2-month late summer/early fall period would be very small, less than can be calculated accurately (Table 115).

The 3D model predicted a decrease of 0.01 cfs in East Fork Rock Creek where it enters Rock Creek Meadows. Observations made during an agency field review in a very dry period (September 2007) indicated that a high water table supported the wetlands. Baseflow in East Fork Rock Creek where it enters Rock Creek Meadows was estimated at 2 cfs. A reduction of 0.01 cfs from an estimated baseflow of 2 cfs in the East Fork Rock Creek at the Meadows would result in a less than 1 percent flow reduction. As discussed in section 3.11.4.4.2, *Operations Phase,* other sources of water to the Meadows would not be affected by mining. The watershed area for Rock Creek Meadows is about 1,070 acres for the East Fork Rock Creek and 2,970 acres for the other tributaries to Rock Creek Meadows that would not be affected by mining. Based on watershed size and the fact that watershed characteristics are similar to the East Fork Rock Creek watershed, the surface inflow to Rock Creek Meadows from the other tributaries is likely to be about three times greater than that from the East Fork Rock Creek. The hydrology support for the wetland vegetation in Rock Creek Meadows is not expected to be affected.

Stream and Floodplain Crossings

Alternative 3 would require one new road crossing across a major and minor stream (Table 108). The Seepage Collection Pond and infiltration gallery for Libby Creek appropriations would affect 9 acres of the designated 100-year floodplain of Libby Creek. During final design, MMC would avoid or minimize, to the extent practicable, locating facilities, such as the Seepage Collection Pond, in a floodplain. The agencies' monitoring and mitigation plans include the construction of some minor facilities in the Libby Creek floodplain, such as an infiltration gallery for makeup water in Libby Creek, and streamflow measurement devices. No alternative exists to avoid locating these facilities in the Libby Creek floodplain. If locating mine facilities in a floodplain could not be avoided during final design, MMC would submit a floodplain permit application to the DNRC that provides details on the obstruction or use of a floodway/floodplain before construction. DNRC's permit issuance is based on the danger to life and property downstream, availability of alternate locations, possible mitigation to reduce the danger, and the permanence of the obstruction or use (76-5-405, MCA).

3.11.4.4.2 Operations Phase (Years 6 through 25)

Streamflow—West Side Streams

The predicted effect on west side streams during the Operations Phase during low flow periods without mitigation would be a reduction of 0.06 to 0.07 cfs in all west side streams (Table 111). The predicted reduction in low flow would be most pronounced in the East Fork Rock Creek at the CMW boundary (EFRC-200). The 3D model predicted that with MMC's modeled mitigation, the reduction would be 0.05 cfs at EFRC-200, or 0.01 cfs less than shown in Table 111. The flow reduction at EFRC-200 would be 21 percent of the baseflow without mitigation and 17 percent with MMC's modeled mitigation. The effects on aquatic life sites RC-3 and EFBR-2 during Operations (Year 22) and Post-Closure (Year 38) are provided in Table 110. During the Operations Phase, the wetted perimeter at RC-3 would be reduced by 1 percent and at EFBR-2 by 7 percent.

Streamflow—East Side Streams

Low Flow

During the Operations Phase, low flow in Libby Creek above LB-300 and its downstream tributaries would be reduced by mine activities. The predicted reductions of the estimated $7Q_{10}$ flow in lower Poorman Creek (PM-1200), without mitigation, would be 12 percent and 19 percent in Little Cherry Creek (LC-800) (Table 111). The *Groundwater Hydrology* section discusses the geology of the impoundment sites. A low permeability bedrock ridge separates groundwater flow between the watershed of Little Cherry Creek and those of Drainages 5 and 10 in the Poorman Impoundment Site. NewFields (2014a) concluded that the bedrock ridge would limit drawdown in the Little Cherry Creek watershed, but drawdown could still extend between watersheds unless the bedrock ridge provided a complete barrier to cross-boundary groundwater flow. Additional subsurface data from this area would be collected during the final design process of the Poorman Impoundment to assess the separation of groundwater flow between the Little Cherry Creek and Poorman Impoundment Site watersheds and the 3D model would be rerun with the new data to evaluate the site conditions.

The 3D model predicted that with mitigation, reductions at RA-600 and PM-1200 would be 0.01 cfs less than shown in Table 111. Low flow in Bear Creek would not be affected. If MMC's Ramsey Creek water appropriation adversely affected a senior water right on Ramsey Creek during any mining phase, MMC would develop a plan during final design to convey treated water from the Water Treatment Plant to a location upstream of the right's point of diversion. Discharge to Ramsey Creek would equal MMC's Ramsey Creek appropriation whenever the flow at RA-300 was less than 1 cfs.

At LB-100 in upper Libby Creek, baseflow is predicted to decrease by up to 22 percent during the Operations Phase. Because of Water Treatment Plant discharges, flow is estimated to increase by 138 percent of the modeled baseflow at LB-300 and by 38 percent of the estimated $7Q_2$ flow. At LB-2000 and aquatic site LB-2, the estimated $7Q_{10}$ flow would increase by 9 percent and $7Q_2$ flow increase by 6 percent. The wetted perimeter at LB-2 would increase by an estimated 34 percent.

Table 111. Estimated Changes during $7Q_2$ and $7Q_{10}$ Flows, Operations Phase, Alternative 3.

Activity	East Fork Rock Creek EFRC-200†	Rock Creek RC-2000	East Fork Bull River EFBR-500	Ramsey Creek RA-600	Poorman Creek PM-1200	Little Cherry Creek LC-800	Libby Creek LB-300†	Libby Creek LB-2000
	(cfs except % change)							
Modeled baseflow change (without mitigation)	-0.06	-0.06	-0.07	-0.04	-0.01	0.00	-0.20	-0.27
Potable water	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02
Pumpback wells	0.00	0.00	0.00	0.00	-0.18	-0.04	0.00	-0.55
Subtotal	-0.06	-0.06	-0.07	-0.04	-0.19	-0.04	-0.22	-0.84
Stormwater diversion at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impoundment precipitation captured at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.38
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	2.04	2.04
Change at $7Q_2$ flow	**-0.06**	**-0.06**	**-0.07**	**-0.04**	**-0.19**	**-0.04**	**+1.82**	**+0.82**
Estimated $7Q_2$ flow	0.92	13.53	5.77	3.26	2.46	0.32	4.73	13.85
Percent Change in $7Q_2$ Flow	**-7%**	**<-1%**	**-1%**	**-1%**	**-8%**	**-11%**	**+38%**	**+6%**
Stormwater diversion at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impoundment precipitation captured at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	1.91	1.91
Change at $7Q_{10}$ flow	**-0.06**	**-0.06**	**-0.07**	**-0.04**	**-0.19**	**-0.04**	**+1.69**	**+0.82**
Estimated $7Q_{10}$ flow	0.29	8.80	3.71	2.07	1.55	0.19	1.22	8.99
Percent Change in $7Q_{10}$ Flow	**-21%**	**-1%**	**-2%**	**-2%**	**-12%**	**-19%**	**+137%**	**+9%**

†Modeled baseflow values used rather than estimated $7Q_{10}$ flow for EFRC-200 and LB-300 (see section 3.8.3).
cfs = cubic feet per second; < = less than.
Effects shown do not include mitigation measures such as grouting during operations or maintaining barriers in the mine void, or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase. Effects shown do include discharges to Libby Creek and possibly Ramsey Creek during all phases to avoid adversely affecting senior water rights.
Groundwater models were used to predict effects from mine dewatering and the pumpback wells. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.

Springs located in the four drainages and 9,787 linear feet of streams would be permanently filled, which would reduce flow in the drainages downstream of the tailings impoundment. An additional 2,136 linear feet of streams between the impoundment and the Seepage Collection Pond would be used to convey intercepted tailings seepage and stormwater runoff from the impoundment to the Seepage Collection Pond. The effect on the 2,136 linear feet of streams would remain until the Seepage Collection Pond was reclaimed, which may be decades or more. Operation of the pumpback wells would further reduce flows in the drainages downgradient of the Seepage Collection Pond, and in the case of Drainage 14, downgradient of the impoundment. As a result of the reduction in drainage area and the elimination of year-round flow from springs in the tailings impoundment area, effects to the drainages downstream of the Poorman Tailings Impoundment and Seepage Collection Pond would be reduced flow rates, shorter flow duration, and shorter flowing lengths in the drainages. Streamflow would be less during runoff events, and flow at some locations would change from perennial to intermittent. Appendix L (Table 3) and NewFields (2014b) describe the direct and indirect effects on the four drainages in the Poorman Impoundment Site in greater detail.

The agencies' mitigation plans (section 2.5.7.2 in Chapter 2) describe mitigation that would replace the functions of the channels directly or indirectly affected by the Poorman Tailings Impoundment. The Corps would be responsible for developing final mitigation requirements for jurisdictional waters of the U.S. including wetlands, depending on the functions and services of the affected wetlands and streams. In Alternatives 3 and 4, reconstruct three existing channels and removing culverts at the Swamp Creek site to add meanders and to raise the channel bottom, adding 6,500 linear feet of stream. The following stream mitigation would be implemented (analyzed under section 3.23.4.10.2, *Stream Mitigation*):

- Replace a culvert on Little Cherry Creek with a bottomless, arched culvert
- Replace a culvert on Poorman Creek with a bottomless arched culvert
- Remove a bridge across Poorman Creek and re-establish floodplain
- Stabilize 400 feet of eroding area on NFS road #6212
- Remove 21 culverts and restore riparian habitat on land acquired for grizzly bear mitigation
- Implement BMPs such as installing, replacing, or upgrading culverts on Libby Creek to bring the proposed access roads (NFS roads #231 and #2316) up to INFS standards

Peak and Average Annual Flow

Due to Water Treatment Plant discharges, peak flow would increase slightly (less than 1 percent) and average annual flow by about 5 percent at LB-300, with a smaller percent increase down to LB-2000. Peak flow and average annual flow at and downstream of LB-2000 in Alternative 3 during the Operations Phase would be less than during the Construction Phase due to all of MMC's appropriations, primarily of up to 2.5 cfs during April through July.

Water from above the Poorman Tailings Impoundment and Plant Access Road would continue to be diverted either toward Poorman Creek or Little Cherry Creek, increasing the watershed and average annual flow of both creeks by about 3 percent (ERO Resources Corp. 2010a). The watersheds of the drainages in the Poorman Impoundment Site would be reduced by 48 percent (Drainage 14) up to 86 percent (Drainage 5) during the Operations Phase, which would reduce peak and average annual flows in the drainages.

Rock Lake and Rock Creek Meadows

The 3D model predicted, for an average precipitation year, a decrease of 47 acre-feet per year of groundwater flowing into Rock Lake without mitigation (36 acre-feet with mitigation). The effect on the estimated lake volume of 1,302 acre-feet would be negligible. The effect on lake volume, levels and surface area during the 2-month late summer/early fall period would be very small, less than can be calculated accurately (Table 115). The 3D model predicted a decrease of 0.06 cfs in East Fork Rock Creek where it enters Rock Creek Meadows. It is uncertain whether the effect of mine inflows on Rock Lake during the late summer/early fall period would be greater or less during a multi-year dry or multi-year wet period because these scenarios have not been modeled. The watershed of Rock Lake receives a large amount of precipitation, primarily during the winter and spring, and during a rainy period in late fall. There is enough water even in a very dry year to refill the lake many times during both the snowmelt runoff period and the fall rainy period after drawdown periods when outflows exceed inflows. The water level in Rock Lake would "reset" to full capacity each spring and each fall even during a very dry period (ERO Resources Corp. 2012c).

The groundwater level at the Meadows or other surface flows to Rock Creek Meadows would not be reduced because Rock Creek Meadows and the tributaries that flow into Rock Creek Meadows are outside of the model-predicted drawdown due to mine inflows. MMC completed an annual average water balance for Rock Creek Meadows (MMC 2012f), but did not evaluate the water balance during low flow periods. Observations made during an agency field review in a very dry period (September 2007) indicated that a high water table supported the wetlands. Baseflow in East Fork Rock Creek where it enters Rock Creek Meadows was estimated at 2 cfs. A reduction of 0.06 cfs from an estimated baseflow of 2 cfs in the East Fork Rock Creek at the Meadows would result in a 3 percent flow reduction, and the other sources of water to the Meadows would not be affected by mining. As discussed previously, the surface inflow from the other tributaries that flow directly into the Meadows is likely to be about three times greater than that from the East Fork Rock Creek. The hydrology support for the wetland vegetation in Rock Creek Meadows is not expected to be affected.

3.11.4.4.3 Closure Phase (Years 26 to 30)

Streamflow—West Side Streams

The effect on west side streams would be greater in the Closure Phase than in the Operations Phase. Table 112 provides the unmitigated effects. Low flow would be 0.01 to 0.03 cfs greater than shown in Table 112 with mitigation. The agencies' proposed mitigation and its effectiveness are discussed in section 3.10.4.3.6, *Effectiveness of Agencies' Proposed Monitoring and Mitigation*.

Streamflow—East Side Streams

Low Flow

Libby, Ramsey, Poorman, and Little Cherry Creeks. The following discussion is based the results of the 3D model that did not consider multiple adit plugging for water rights mitigation at mine closure. The effects during the Closure Phase without MMC's modeled mitigation or multiple adit plugs would be less than in the Operations Phase (Table 112). Low flow would be 0 to 0.01 cfs greater than shown in Table 112 with MMC's modeled mitigation.

To mitigate effects on senior water rights on Libby Creek and Ramsey creeks, MMC would install plugs at the base of each adit soon after mining operations ceased. Reductions in streamflow due to adit inflows would continue in Libby Creek above LB-300 in Libby Creek, and in Ramsey Creek above RA-300 whenever flow at RA-300 was less than 1 cfs. At LB-100 in upper Libby Creek, baseflow would decrease by up to 19 percent during the Closure Phase. Streamflow reductions would continue and would cease within an estimated one to two decades after all initial adit plugs were in place. The effect would be reduced to a few years if MMC used water diverted from Libby Creek during high flows to fill the adits during the Closure Phase. Below these locations, discharges to mitigate senior water rights would increase flow.

The effect on flow in Little Cherry Creek would be similar to the Operations Phase (Table 112). The role of a bedrock ridge was discussed under the Operations Phase effects.

Peak and Average Annual Flow

The effect during the Closure Phase on peak flow in all east side streams would be small. Due to Water Treatment Plant discharges, peak flow would increase slightly (less than 1 percent) and average annual flow would increase by about 5 percent at LB-300 and by a smaller percent below LB-300 down to LB-2000. MMC's water appropriations, particularly those during April through July if they continued throughout the Closure Phase, would slightly reduce peak and annual flows in Libby Creek at and downstream of LB-2000. Water from above the Poorman Tailings Impoundment and Plant Access Road would continue to be diverted either toward Poorman Creek or Little Cherry Creek, increasing the watershed and average annual flow of both creeks by about 3 percent (ERO Resources Corp. 2010a).

Rock Lake and Rock Creek Meadows

The effect on Rock Lake would be slightly greater than described in the Operations Phase. The decrease in the flow in East Fork Rock Creek where it enters Rock Creek Meadows would be slightly greater than described in the Operations Phase. Baseflow in East Fork Rock Creek where it enters Rock Creek Meadows was estimated at 2 cfs. A reduction of 0.18 cfs from an estimated baseflow of 2 cfs in the East Fork Rock Creek at the Meadows would result in a 9 percent flow reduction, and the other sources of water to the Meadows would not be affected by mining. As discussed previously, the surface inflow from the other tributaries that flow directly into the Meadows is likely to be about three times greater than that from the East Fork Rock Creek. The hydrology support for the wetland vegetation in Rock Creek Meadows is not expected to be affected.

Table 112. Estimated Changes during $7Q_2$ and $7Q_{10}$ Flows, Closure Phase, Alternative 3.

Activity	East Fork Rock Creek EFRC-200†	Rock Creek RC-2000	East Fork Bull River EFBR-500	Ramsey Creek RA-600	Poorman Creek PM-1200	Little Cherry Creek LC-800	Libby Creek LB-300†	Libby Creek LB-2000
	(cfs except % change)							
Modeled baseflow change	-0.18	-0.19	-0.16	-0.03	0.00	0.00	-0.19	-0.25
Potable water	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02
Pumpback wells	0.00	0.00	0.00	0.00	-0.18	-0.04	0.00	-0.55
Subtotal	-0.18	-0.19	-0.16	-0.03	-0.18	-0.04	-0.21	-0.82
Stormwater diversion at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impoundment precipitation captured at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.38
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	1.20	1.20
Change at $7Q_2$ flow	**-0.18**	**-0.19**	**-0.16**	**-0.03**	**-0.18**	**-0.04**	**0.99**	**0.00**
Estimated $7Q_2$ flow	0.92	13.53	5.77	3.26	2.46	0.32	4.73	13.85
Percent Change in $7Q_2$ Flow	**-20%**	**-1%**	**-3%**	**-1%**	**-7%**	**-13%**	**+21%**	**0%**
Stormwater diversion at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impoundment precipitation captured at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	1.07	1.07
Change at $7Q_{10}$ flow	**-0.18**	**-0.19**	**-0.16**	**-0.03**	**-0.18**	**-0.04**	**0.86**	**0.00**
Estimated $7Q_{10}$ flow	0.29	8.8	3.71	2.07	1.55	0.19	1.22	8.99
Percent Change in $7Q_{10}$ Flow	**-62%**	**-2%**	**-4%**	**-1%**	**-12%**	**-21%**	**+71%**	**0%**

†Modeled baseflow values used rather than estimated $7Q_{10}$ flow for EFRC-200 and LB-300 (see section 3.8.3).
Effects shown do not include mitigation measures such as grouting during operations or maintaining barriers in the mine void, or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase. Effects shown include discharges to Libby Creek (but not Ramsey Creek) during all phases to avoid adversely affecting senior water rights.
Groundwater models were used to predict effects from mine dewatering and the pumpback wells. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.

3.11.4.4.4 Post-Closure Phase (Years 31+)

The Post-Closure Phase would begin after all active reclamation activities were completed. The mine void and adits would continue to fill with water and groundwater levels would continue to decline. After reaching a maximum drawdown and maximum reductions in baseflow in the Rock Creek and East Fork Bull River drainages early in the Post-Closure Phase, the 3D model predicted groundwater levels would begin to recover and would reach equilibrium or steady state in 1,172 years without MMC's modeled mitigation to 1,322 years with MMC's modeled mitigation. Multiple adit plugs, which are a component of the agencies' mitigation that were not simulated in the model, would also increase the time to reach steady state conditions over the mine void because adit inflows would not fill the void. The actual time to recover to steady state would be re-evaluated using the 3D model after additional data were collected during the Evaluation Phase. Once the potentiometric surface stabilized, without MMC's modeled mitigation, groundwater flow to Rock Lake and the baseflow component of streamflow at some stream locations would be reduced.

Streamflow—West Side Streams

The modeled effect on west side streams would be greater than during the Operations and Closure Phases. In Rock Creek and the East Fork Rock Creek, without MMC's modeled mitigation, streamflow is predicted to decrease by a maximum 0.29 cfs at the CMW boundary (EFRC-200) and by 0.65 cfs at the mouth of Rock Creek (RC-2000) (Table 113). The modeled reduction would consist of the entire baseflow at EFRC-200 and 7 percent of the estimated $7Q_{10}$ flow at RC-2000. Rock Creek at the mouth is often dry during low flow periods and the reduction may not be measurable in the channel. When the channel was dry, the modeled effect would be to reduce subsurface flow. The modeled reduction in flow in the East Fork Bull River at the CMW boundary (EFBR-500) would be 0.4 cfs, or 11 percent of the estimated $7Q_{10}$ flow and 7 percent of the estimated $7Q_2$ flow. For the Bull River at the mouth, streamflow is predicted to decrease by a maximum of 0.39 cfs without mitigation, or 1 percent of the estimated baseflow of 40 cfs (Geomatrix 2012).

With mitigation, streamflow is predicted by the 3D model to decrease by 0.17 cfs at EFRC-200 (a 59 percent decrease in baseflow), by 0.15 cfs at RC-2000 (a 2 percent decrease in the estimated $7Q_{10}$ flow), and by 0.39 cfs at EFBR-500 (an 11 percent decrease in the estimated $7Q_{10}$ flow and 7 percent of the estimated $7Q_2$ flow).

The unmitigated modeled effects on aquatic life sites RC-3 and EFBR-2 are provided in Table 110. The predicted wetted perimeter decreases are 9 percent for RC-3 and 26 percent for EFBR-2.

As the mine void filled and groundwater levels over the mine and adits reached steady state conditions, the effects on streamflow would decrease (Table 114). Without mitigation, permanent flow reductions of about 10 percent of the baseflow at EFRC-200 and less than 1 percent of the estimated $7Q_{10}$ flow at RC-2000 are predicted to occur. A permanent decrease of 0.01 cfs is predicted at EFBR-500, and a flow increase of 0.05 cfs is predicted at the mouth of the East Fork Bull River. The uncertainty of the location where streamflow would increase in the East Fork Bull River is discussed in section 3.10.4.3.4, *Post-Closure Phase* in the *Groundwater Hydrology* section.

At EFRC-200, modeled baseflow is estimated to be reduced by 10 percent without MMC's modeled mitigation (Table 114). Without MMC's modeled mitigation, there is the potential for groundwater to permanently flow from the East Fork Rock Creek watershed to the East Fork Bull River watershed via the mine void because of the very high permeability void that would connect the watersheds. With MMC's modeled mitigation, the flow at EFRC-200 is predicted to return to pre-mining conditions and, the loss of water from the mine void to the East Fork Bull River may be minimized. The flow in East Fork Bull River would permanently decrease by 0.02 cfs in the CMW and 0.01 cfs below the CMW boundary (the same as without mitigation), and the flow of the East Fork Bull River at the mouth would decrease by 0.01 cfs. The agencies' proposed mitigation and its effectiveness in minimizing effects on baseflow are discussed in section 3.10.4.3.6, *Effectiveness of Agencies' Proposed Monitoring and Mitigation* in the *Groundwater Hydrology* section.

Streamflow—East Side Streams

Low Flow

The effects on streamflows shown in Table 113 assume the impoundment was reclaimed, the adits were not plugged near the mine void, the pumpback wells at the tailings impoundment were operating at the same rate as during the Closure Phase (0.55 cfs), and the Water Treatment Plant was used to treat discharged water, some of which would be used to avoid adversely affecting senior water rights. When discharge occurred at the Water Treatment Plant, flow would increase by 0.54 cfs at LB-300 (Table 113). Low flow at LB-2000 would not change. As long as the pumpback well system operated, the low flow in Poorman Creek would be reduced by 0.18 cfs. The reduction at PM-1200 would be 12 percent of the estimated $7Q_{10}$ flow and 7 percent of the estimated $7Q_2$ flow. Low flow in Bear Creek would not be affected. The length of time seepage interception and water treatment would be necessary is unknown, and may be decades or more after mine operations ceased. If seepage interception and water treatment were not necessary at the time when maximum baseflow reductions occurred, streamflow in Poorman Creek would not be affected, and streamflow in Libby Creek above LB-300 would be affected only by baseflow reductions from mine inflows. At LB-100 in upper Libby Creek, baseflow would decrease by up to 12 percent during the Post-Closure Phase. Low flow in Libby, Ramsey and Poorman creeks would return to pre-mining conditions with or without mitigation when groundwater levels reach steady state conditions (Table 114).

After the surface of the impoundment was reclaimed and runoff was no longer subject to ELGs and applicable water quality standards were met, a channel would be excavated through the tailings and Saddle Dam abutment to route runoff from the site toward a tributary of Little Cherry Creek. The runoff channel would be routed at no greater than 1 percent slope and along an alignment requiring the shallowest depth of tailings to be excavated down to the channel grade. The side slopes would be designed to be stable and would be covered with coarse rock to prevent erosion. The Little Cherry Creek watershed area where runoff would meet the creek would increase by 633 acres, potentially increasing the flow in Little Creek by an estimated 67 percent (ERO Resources Corp. 2010a). At the mouth of Little Cherry Creek, the watershed would be 644 acres larger, a 44 percent increase. The Hortness method overestimates $7Q_2$ and $7Q_{10}$ flow in watersheds containing the reclaimed impoundment, as discussed previously under Alternative 2. Both $7Q_2$ and $7Q_{10}$ flow likely occur during late summer or early fall during periods of little or no precipitation. The amount of baseflow that would flow during these periods toward Little Cherry Creek would be negligible. The agencies anticipate little or no increase in $7Q_2$ and $7Q_{10}$ flow in Little Cherry Creek. Any increased flow would be partially offset by flow reduction due to the pumpback well system as long as it operated. As discussed in the Operations Phase, the pumpback wells may not affect flow in Little Cherry Creek.

Low flow at LB-2 would not be affected (Table 110) because MMC would discharge water to Libby Creek and possibly Ramsey Creek from water stored in the adits to the extent necessary to avoid adversely affecting senior water rights.

Table 113. Estimated Changes during $7Q_2$ and $7Q_{10}$ Flows, Post-Closure Phase, Alternative 3.

Activity	East Fork Rock Creek EFRC-200[†]	Rock Creek RC-2000	East Fork Bull River EFBR-500	Ramsey Creek RA-600	Poorman Creek PM-1200	Little Cherry Creek LC-800[§]	Libby Creek LB-300[†]	Libby Creek LB-2000
	(cfs except % change)							
Without MMC's Modeled Mitigation								
Modeled baseflow change[‡]	-0.29	-0.65	-0.40	-0.02	0.00	0.00	-0.12	-0.11
Potable water	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Pumpback wells[§]	0.00	0.00	0.00	0.00	-0.18	-0.04	0.00	-0.55
Stormwater diversion at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impoundment precipitation captured at $7Q_2$ flow[§]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.67
Change in $7Q_2$ flow	**-0.29**	**-0.65**	**-0.40**	**-0.02**	**-0.18**	**-0.04**	**0.54**	**0.00**
Estimated $7Q_2$ flow	0.92	13.53	5.77	3.26	2.46	0.32	4.73	13.85
Percent Change in $7Q_2$ Flow	**-32%**	**-5%**	**-7%**	**<-1%**	**-7%**	**-13%**	**+11%**	**0%**
Stormwater diversion at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in $7Q_{10}$ flow	**-0.29**	**-0.65**	**-0.40**	**-0.02**	**-0.18**	**-0.04**	**+0.54**	**0.00**
Estimated $7Q_{10}$ flow	0.29	8.80	3.71	2.07	1.55	0.19	1.22	8.99
Percent Change in $7Q_{10}$ Flow	**-100%**	**-7%**	**-11%**	**-1%**	**-12%**	**-21%**	**+44%**	**0%**
With MMC's Modeled Mitigation								
Modeled baseflow change	-0.17	-0.15	-0.39	-0.02	0.00	0.00	-0.12	-0.10
Potable water	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Pumpback wells[§]	0.00	0.00	0.00	0.00	-0.18	-0.04	0.00	-0.55
Stormwater diversion at $7Q_2$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impoundment precipitation captured at $7Q_2$ flow[§]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water treatment plant discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.66
Change in $7Q_2$ flow	**-0.17**	**-0.15**	**-0.39**	**-0.02**	**-0.18**	**-0.04**	**+0.53**	**0.00**
Estimated $7Q_2$ flow	0.92	13.53	5.77	3.26	2.46	0.32	4.73	13.85
Percent Change in $7Q_2$ Flow	**-18%**	**-1%**	**-7%**	**<-1%**	**-7%**	**-13%**	**+11%**	**0%**
Stormwater diversion at $7Q_{10}$ flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in $7Q_{10}$ flow	**-0.17**	**-0.15**	**-0.39**	**-0.02**	**-0.18**	**-0.04**	**+0.53**	**0.00**
Estimated $7Q_{10}$ flow	0.29	8.80	3.71	2.07	1.55	0.19	1.22	8.99
Percent Change in $7Q_{10}$ Flow	**-59%**	**-2%**	**-11%**	**-1%**	**-12%**	**-21%**	**+43%**	**0%**

[†]Modeled baseflow values used rather than $7Q_{10}$ flow for EFRC-200 and LB-300 (see section 3.8.3).
[§]Assumes impoundment was reclaimed and pumpback well system was operating.
Maximum model predicted baseflow reductions occur at Year 38 for the Rock Creek drainage and Year 52 for the East Fork Bull River drainage. Baseflow changes for east slope watersheds in this table are for Year 38.
cfs = cubic feet per second; < = less than.
Effects shown do not include mitigation measures not provided in MMC's 3D model report such as increasing buffer zones or using multiple plugs in the adits during closure. Such mitigation would be evaluated after additional data were collected during the Evaluation Phase. Effects shown do include discharges to Libby Creek (but not Ramsey Creek) during all phases to avoid adversely affecting senior water rights.
Groundwater models were used to predict effects from mine dewatering and the pumpback wells. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.

Table 114. Estimated Changes during $7Q_2$ and $7Q_{10}$ Flows, Steady State Conditions Post-Closure, Alternative 3.

Activity	East Fork Rock Creek EFRC-200†	Rock Creek RC-2000	East Fork Bull River EFBR-500	East Fork Bull River at Mouth	Ramsey Creek RA-600	Poorman Creek PM-1200	Little Cherry Creek LC-800	Libby Creek LB-300†	Libby Creek LB-2000
Effects at Estimated $7Q_2$ Flow									
Estimated $7Q_2$ flow	0.92	13.53	5.77	12.27	3.26	2.46	0.32	4.73	13.85
Change at $7Q_2$ flow without MMC's modeled mitigation	-0.03	-0.03	-0.01	0.05	0.00	0.00	0.00	0.00	0.00
Percent Change in $7Q_2$ Flow without MMC's modeled mitigation	-3%	<-1%	<-1%	1%	0%	0%	0%	0%	0%
Change at $7Q_2$ flow with MMC's modeled mitigation	0.00	0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
Percent Change in $7Q_2$ flow with MMC's modeled mitigation	0%	<+1%	<-1%	<-1%	0%	0%	0%	0%	0%
Effects at Estimated $7Q_{10}$ Flow									
Estimated $7Q_{10}$ flow	0.29	8.80	3.71	7.97	2.07	1.55	0.19	1.22	8.99
Change at $7Q_{10}$ flow without MMC's modeled mitigation	-0.03	-0.03	-0.01	0.05	0.00	0.00	0.00	0.00	0.00
Percent Change in $7Q_{10}$ flow without MMC's modeled mitigation	-10%	<-1%	<-1%	<1%	0%	0%	0%	0%	0%
Change at $7Q_{10}$ flow with MMC's modeled mitigation	0.00	0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
Percent Change in $7Q_{10}$ flow with MMC's modeled mitigation	0%	<+1%	<-1%	<-1%	0%	0%	0%	0%	0%

†Modeled baseflow values used rather than estimated $7Q_{10}$ flow for EFRC-200 and LB-300 (see section 3.8.3).
All units are cfs except % change; cfs = cubic feet per second; < = less than.
Groundwater models were used to predict effects from mine dewatering and the pumpback wells. With the data currently available, the model results provide a potential range of dewatering and pumping rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.

Peak and Average Annual Flow

Reductions in peak and annual flow in east side streams would continue in the Post-Closure Phase. Peak and annual flow in Poorman Creek and Ramsey Creek would return to pre-mine conditions after the tailings impoundment was reclaimed, the adits were completed plugged, and the pumpback well system ceased operating. Peak and annual flow in the four unnamed drainages below the Poorman Impoundment would be substantially less than pre-mine conditions because stormwater from the reclaimed impoundment surface would be diverted to Little Cherry Creek, reducing the watershed of Drainage 10 by 66 percent and the watersheds of the other three drainages by 74 percent (ERO Resources Corp. 2010a in Appendix H).

As long as the pumpback well system operated, flow in the four unnamed drainages at the impoundment area would be substantially reduced. After the impoundment was reclaimed and the pumpback ceased operation, flow in the four unnamed drainages at the impoundment area would be substantially reduced from pre-mine conditions, but slightly greater than in the Operations Phase. Compared to pre-mine size, the watershed of Drainage 10 would be 66 percent smaller and the watersheds of the other three drainages would be 74 percent smaller (ERO Resources Corp. 2010a in Appendix H). Peak flows would be reduced by similar percentages. The Hortness method overestimates $7Q_2$ and $7Q_{10}$ flow in watersheds containing reclaimed impoundments as discussed in Alternative 2. Klohn Crippen (2005) estimated a steady state flow from the underdrain system of 50 to 100 gpm for the Little Cherry Creek impoundment and the agencies anticipate conditions at the Poorman Impoundment Site would be similar. Springs outside of the impoundment footprint that were affected by the pumpback wells would likely return to pre-mine conditions and also may contribute baseflow to channels outside of the impoundment.

After the impoundment was reclaimed, surface water runoff that was diverted to Poorman Creek prior to closure would flow toward the reclaimed impoundment. The watershed and average annual flow in Poorman Creek would return to pre-mine conditions. The watershed area of Little Cherry Creek would increase by 644 acres, an increase of 44 percent (ERO Resources Corp. 2010a). It is expected that average annual flow in Little Cherry Creek would increase by a smaller percentage, as the larger watershed would not increase flow during low-flow periods. The larger watershed would increase runoff during storm events. Due to Water Treatment Plant discharges, peak flow would increase slightly (less than 1 percent) and average annual flow would increase by about 5 percent at LB-300 and by less than 5 percent below LB-300 down to Poorman Creek. The effect on average annual flow in Libby Creek between Poorman Creek and Little Cherry Creek would be offset as result of the diversion of runoff to Little Cherry Creek. Other segments of Libby Creek would return to pre-mine conditions after the tailings impoundment was reclaimed, the adits were completed plugged, and the pumpback well system ceased operating.

As part of the final closure plan, MMC would complete a hydraulic and hydrologic (H&H) analysis of the proposed runoff channel during final design, and submit it to the lead agencies and the Corps for approval. The H&H analysis would include a channel stability analysis and a sediment transport assessment. Based on the analysis, modifications to the final channel design would be made and minor modifications to the upper reaches of the tributary of Little Cherry Creek may be needed to minimize effects on channel stability in the tributary of Little Cherry Creek and to avoid allowing water to pond on the surface of the reclaimed tailings. Other drainage alternatives for the surface of the reclaimed tailings impoundment that protect against erosion but also provide aquatic habitat downstream of the impoundment may be developed with agency approval.

Rock Lake

Effects on Rock Lake during the Post-Closure Phase would be a reduction in groundwater flow to the lake and a reduction in water stored in the lake. The effects would depend on the time of year and whether the potential effects were mitigated. The following discussion is based on the results of the 3D model for an average precipitation year and an analysis of the Rock Lake water balance (ERO Resources Corp. 2012c). It is uncertain whether the effect of mine inflows to Rock Lake during the late summer/early fall period would be greater or less during a multi-year dry or multi-year wet period because these scenarios have not been modeled. The watershed of Rock Lake receives a large amount of precipitation, primarily during the winter and spring, and during a rainy period in late fall. There is enough water even in a very dry year to refill the lake many times during both the snowmelt runoff period and the fall rainy period after drawdown periods when outflows exceed inflows. The water level in Rock Lake would “reset” to full capacity each spring and each fall even during a very dry period (ERO Resources Corp. 2012c).

Without MMC’s Modeled Mitigation

Without MMC’s modeled mitigation, the potentiometric surface surrounding Rock Lake would continue to decline after mining ceased. When the potentiometric surface decreased below the lake surface, the groundwater flow direction would reverse. As a result, water would flow out of the lake toward the mine void, resulting in a loss of lake volume. The model predicted the loss would occur for about 130 years after mining ceased (Geomatrix 2011c).

The estimated reduction in lake volume, surface area, and lake level would be greatest 16 years after mining ceased and the adits were plugged, and would gradually decrease after that time. During the late summer/early fall period, the volume of the lake would be reduced by a maximum of about 4 percent, the surface area would be reduced by a maximum of about 3 percent, and the lake level would decline by 1.2 feet (Table 115). Littoral vegetation, if present in shallow areas of Rock Lake, may experience drier conditions late in the growing season. During the 7-month winter period, the lake volume would be reduced by an estimated 5 percent, the surface area by 4 percent, and the lake level would decline by about 1.5 feet (Table 116).

At steady state conditions, the model predicted that the potentiometric surface would not recover completely to pre-mining conditions, resulting in less groundwater flow into the lake. Total groundwater inflow to Rock Lake would be permanently reduced by 24 acre-feet per year, about 2 percent of the estimated full lake volume. During the late summer/early fall period, Rock Lake would have a volume and surface area reduction estimated to be less than 1 percent (Table 115). The volume, surface area, and level of the lake would not be affected during the 7-month winter period (Table 116). The permanent effect on the lake during the 7-month winter period would be a reduction in groundwater inflow to the lake of about 10 percent, which would result in 10 percent less outflow from the lake into the East Fork Rock Creek.

Without mitigation, the change to Rock Lake may be measurable as a long-term trend during periods when deep bedrock groundwater is the only source of supply to Rock Lake, but a trend may be difficult to observe or measure when the lake was ice-covered. The effects on Rock Lake would occur during these two periods, but the lake would refill each year during snowmelt runoff and during late fall precipitation that resulted in runoff to Rock Lake. An analysis of precipitation within the watershed above Rock Lake that considered possible losses before runoff reaching the lake showed that there is enough water even in a very dry year to refill Rock Lake many times during both the snowmelt runoff period and the fall rainy period (ERO Resources Corp. 2012c).

Table 115. Estimated Effects on Rock Lake during 2-Month Summer/Fall Period.

Phase	Total Mine Depletions During Period (acre-feet)	Initial Lake Volume (acre-feet)	Ending Lake Volume (acre-feet)	Volume Reduction (%)	Change in Lake Level (feet)	Change in Surface Area (acres)	Surface Area Reduction (%)
Construction (without mitigation)	1.5	1,302	1,300.5	<0.1	*	*	*
Operations (without mitigation)	7.8	1,302	1,294.2	0.6	*	*	*
Operations (with mitigation)	6.0	1,302	1,296.0	0.5	*	*	*
Post-Closure (maximum reduction, without mitigation)	53.0	1,302	1,249.0	4	-1.2	1.5	3
Post-Closure (maximum reduction, with mitigation)	20.5	1,302	1,281.5	2	-0.5	0.6	1
Post-Closure (steady state, without mitigation)	4.0	1,302	1,298.0	0.3	*	*	*
Post-Closure (steady state, with mitigation)	0.0	1,302	1,302.0	0.0	0.0	0.0	0

* Estimates of changes in lake levels and lake surface area would be very small and cannot be accurately calculated.
cfs = cubic feet per second; < = less than.
A groundwater model was used to predict effects from mine dewatering. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. The 3D groundwater flow model would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
Source: ERO Resources Corp. 2012c.

With MMC's Modeled Mitigation

With MMC's modeled mitigation, the 3D model predicted less of a reduction in the potentiometric surface at Rock Lake. During the Operations Phase, the effect on Rock Lake would be slightly less with MMC's modeled mitigation than without. The estimated reduction in lake volume, surface area, and lake level would be greatest 16 years after mining ceased and the adits were plugged. At that time during the 2-month summer/fall period, the volume of the lake would be reduced by an estimated 2 percent, the surface area would be reduced by an estimated 1 percent, and the lake level would decline by 0.5 foot (Table 116).

At steady state conditions, there would be slightly less baseflow (-0.01 cfs) at EFRC-50 upstream of Rock Lake. The 3D model predicted that low permeability barriers would increase groundwater flow toward the lake by 0.01 cfs. The net result would be no change in the lake volume, lake level, or surface area at steady state (Table 116). The agencies' mitigation, leaving barrier pillars with access openings that would be plugged at closure with bulkheads, would be designed, based on hydrologic data collected during mining, to minimize post-mining changes in East Fork Rock Creek and East Fork Bull River streamflow and water quality. The mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault, which was not modeled, may eliminate effects on Rock Lake during and after mining.

Table 116. Estimated Effects on Rock Lake during 7-Month Winter Period during Maximum Reduction in Potentiometric Surface and at Steady State Post-Closure.

Phase	Total Mine Depletions During Period (acre-feet)	Initial Lake Volume (acre-feet)	Ending Lake Volume (acre-feet)	Volume Reduction (%)	Change in Lake Level (feet)	Change in Surface Area (acres)	Surface Area Reduction (%)
Maximum Effect							
Post-Closure without mitigation	63.6	1,302	1,238.4	5	-1.5	1.8	4
Post-Closure with mitigation	0.0	1,302	1,302.0	0	0.0	0.0	0
Steady State Conditions							
Post-Closure without mitigation	0.0	1,302	1,302.0	0	0.0	0.0	0
Post-Closure with mitigation	0.0	1,302	1,302.0	0	0.0	0.0	0

A groundwater model was used to predict effects from mine dewatering. With the data currently available, the model results provide a potential range of dewatering rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. The 3D groundwater flow model would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
Source: ERO Resources Corp. 2012c.

Rock Creek Meadows

The 3D model-predicted effect on the East Fork Rock Creek where it enters Rock Creek Meadows would be greatest 16 years after mine closure, and is estimated to be 0.43 cfs (Klepfer Mining Service 2012). Observations made during an agency field review in a very dry period (September 2007) indicated a high water table supported the wetlands. Baseflow in East Fork Rock Creek at the Meadows was estimated to be 2 cfs (discussed in section 3.10.3.1.2 in the *Groundwater Hydrology* section). A reduction of 0.43 cfs would be about 20 percent of the estimated baseflow in East Fork Rock Creek. Groundwater levels at Rock Creek Meadows and other tributaries that flow into the East Fork Rock Creek at the Meadows are predicted not to be affected by mining. The hydrology support for the wetland vegetation in Rock Creek Meadows is not expected to be affected.

3.11.4.4.5 Climate Change

The effects of climate change in combination with Alternative 3 would be the same as in combination with Alternative 2.

3.11.4.4.6 Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities

The ability to measure streamflow accurately and precisely depends on a number of factors, reviewed by Harmel *et al*. (2006). Potential errors in streamflow measurement are introduced in the measurement of stream depth, velocity, and channel dimensions. Accuracy varies over the distribution of flows, ranging from a few percent for low flows measured with an accurately calibrated weir, to 10 to 15 percent or more for high flows measured by standard stage-to-discharge techniques and calibrated against periodic wading discharge measurements (Grant *et al*.

2008). In an analysis of effects of forest harvest activities on peak flows and channel morphology in the Pacific Northwest, Grant *et al.* (2008) identified a detection limit for changes in peak flow measurements of about ±10 percent; changes in peak flow that fall in this range are within the error of peak flow measurement and cannot be ascribed as an effect.

Harmel *et al.* (2006) reported measurement error in overall streamflow measurement for a “typical” scenario, a “best case” scenario, and a “worse case” scenario. The best case scenario represented measurement procedures used with a concentrated effort in quality assurance/quality control (QA/QC) unconstrained by financial and personnel resource limitations and in ideal hydrologic conditions. The typical scenario represented measurement procedures conducted with a moderate effort at QA/QC and under typical hydrologic conditions. For a typical scenario, estimated measurement error averaged 10 percent and ranged from 6 percent to 19 percent for a range of conditions. The estimated measurement error was 3 percent for the best case scenario, which included flow measurement under ideal hydrologic conditions, specifically a pre-calibrated flow control structure (stable bed and channel) and a stilling well for stage measurement. Measurement error reported by Harmel *et al.* (2006) is consistent with an earlier evaluation of measurement error by the USGS (Sauer and Meyer 1992). Sauer and Meyer reported most measurements will have standard errors ranging from about 3 percent to 6 percent, with a low of 2 percent under ideal conditions.

A recent improvement in streamflow measurement for streams that are at least a foot deep is the use of acoustic Doppler current profilers to measure streamflow. Under suitable conditions, the advantages are that this method is much faster and no less accurate than mechanical current meters, it allows measurements where mechanical current meters are inappropriate or unreliable, and it measures continuous profiles of water velocity, providing more accurate streamflow measurements (Hirsch and Costa 2004).

The natural variability in streamflow also influences the ability to detect a mining-induced change in streamflow. Based on an analysis of streamflow data from streams with gaging stations located at the periphery of the analysis area on the KNF, Wegner (2007) reported the average variability in low flow values is 20 percent. In stream reaches when and where the only source of water to streams is deep bedrock groundwater, it is expected that flow variability would be less. A sufficient number of streamflow measurements could be collected to determine whether the streamflow that may be affected by mining is statistically different from the streamflow that occurred pre-mining, regardless of variability. Although mining-induced streamflow changes would initially be small and gradually increase, a trend should be observable given adequate streamflow monitoring before mining began, during all mining phases, and after mining ceased.

3.11.4.4.7 Effectiveness of Agencies’ Proposed Monitoring and Mitigation

Monitoring

MMC would monitor lake levels in Rock Lake and Lower Libby Lake as one component of a comprehensive plan to monitor project effects. MMC began measuring lake level continuously in Rock Lake in 2009 and the KNF currently is monitoring the lake level in Lower Libby Lake. Continued monitoring of lake levels would be effective for subsequently detecting changes in lake levels due to possible dewatering effects of the project. During periods when runoff from precipitation or snowmelt is supplying water to the lake, it probably would not be possible to measure the effect of the project if the lake level changes are in the predicted range of 1 foot or less. Wanless Lake, 4 miles south of Rock Lake and outside of the area of influence of the

Montanore Project, would be used as a benchmark lake and would monitored in the same manner as Rock Lake (Appendix C). The monitoring would be effective in assisting MMC and the agencies in separating natural variability from the effects of the mine on Rock Lake.

Streamflow would also be measured at numerous locations during the various mine phases (see Appendix C) to monitor the effects of mine activities. Some sites would be monitored continuously, while others would be measured every other week, monthly or at quarterly intervals when streams were not frozen. For stream sites measured continuously, after adequate data were collected, stage/discharge relationships, daily flows, and yearly hydrographs would be developed and used to estimate baseflow, average, and peak flows. As discussed in the previous section, there are potential errors in streamflow measurement, particularly in rock-filled mountain streams, and during very low flows, but streamflow measurements would be effective for monitoring the effects of mine activities when the agencies' monitoring plans in Appendix C were implemented. Swamp Creek, which originates at the Wanless Lake outlet, would be used as a reference stream on the west side of the divide and Bear Creek would be used as a reference stream on the east side of the divide. These streams are located outside of the area of influence of Alternative 3, and monitoring would be effective in assisting MMC and the agencies in separating natural variability from the effects of the mine on analysis area streams.

Mitigation

Mitigation of effects on the baseflow of streams within the CMW and to Rock Lake, the effectiveness of the mitigations and the uncertainty associated with each mitigation are discussed in detail in section 3.10.4.3.5, *Groundwater Model Uncertainty* and section 3.10.4.3.6, *Effectiveness of Agencies' Proposed Monitoring and Mitigation* in the *Groundwater Hydrology* section. Mitigations would include:

- Buffers around the Rock Lake Fault and Rock Lake where mining would not occur to reduce the risk of high mine inflows and excessive impacts on surface flows and the level of Rock Lake. Based on the 3D model results, buffers would be highly effective in minimizing effects on surface water.

- Barrier pillars in the mine with bulkheads at access openings, if necessary, to minimize post-mining changes in streamflow in East Fork Rock Creek and East Fork Bull River and eliminate the loss of water from storage in Rock Lake. The 3D model results indicated that the concept of barriers in the mine void would be effective in reducing post-mining impacts on streams and in eliminating the loss of water from storage in Rock Lake. Barrier design would be based on an analysis of hydrologic data collected during mining to assess the need for barriers and to optimize their effectiveness.

- Grouting in the mine to reduce adit and mine inflows, which would reduce changes in baseflow in nearby watersheds. With the planned proper maintenance during the Construction and Operations Phases, grouting would be effective in reducing mine and adit inflows. The uncertainty of the effectiveness of grouting over the long term was considered in the agencies' analysis.

- Placing multiple, site-specifically designed adit plugs post-mining would be effective for separating the mine void from the adits, which would allow streamflows in the Libby Creek watershed to recover to pre-mining conditions more quickly.

Other activities that would reduce streamflow in Libby Creek (capture of precipitation and evaporation in the impoundment, and operation of the pumpback wells) would be effectively mitigated in Alternatives 3 and 4 by discharges of treated water from the Water Treatment Plant that would be equal to or greater than the flow reductions in Libby Creek. The use of thickened tailings in Alternative 3 would reduce the amount of water stored in the tailings by up to about 1 cfs, and reduce makeup water requirements from Libby Creek. Thickened tailings would be an effective mitigation because it would reduce MMC's appropriation at the Libby Creek infiltration gallery. The mitigation for effects on senior water rights in Libby and Ramsey creeks is discussed in section 2.5.4.3.2, *Water Rights* in Chapter 2 and section 3.12.4.3 under *Water Rights*.

The disturbance area of Alternatives 3 and 4 would be less than Alternative 2, which would effectively minimize peak flow increases in all area streams.

In Alternatives 3 and 4, runoff from the reclaimed tailings impoundment would be directed toward Little Cherry Creek instead of Bear Creek proposed in Alternative 2. As part of the final closure plan, MMC would complete a H&H analysis of the proposed runoff channel during final design that would include a channel stability analysis and a sediment transport assessment. The runoff channel design would effectively minimize effects on Little Cherry Creek. Other effects on streamflow in streams other than Libby Creek, such as Poorman and Little Cherry creeks, would be unavoidable.

The agencies' analysis indicates that various discharges or diversions in all mine alternatives may result in changes in the estimated $7Q_{10}$ flow of greater than 10 percent. Although not analyzed, various discharges or diversions also may change the mean monthly flow by more than 15 percent. The final MPDES permit will contain DEQ's final determination regarding the discharges and nondegradation review.

3.11.4.5 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would be similar to Alternative 3, but modified from MMC's proposed Little Cherry Creek Impoundment Site. All other modifications and mitigations described in Alternative 3, other than those associated with the Poorman Tailings Impoundment Site, would be part of Alternative 4. The amount of seepage collected by the Seepage Collection System, which includes seepage from the tailings impoundment, may be increased by optimizing the location of the Seepage Collection Dam where bedrock outcrops in the Little Cherry Creek drainage. Any tailings seepage not intercepted by the drains beneath the impoundment and dams would likely discharge to the former Little Cherry Creek watershed through the fractured bedrock aquifer. Consequently, siting the Seepage Collection Dam at or below the location where bedrock outcrops in the Little Cherry Creek drainage would increase the likelihood that the seepage would be collected by the dam. In Alternative 4, MMC would conduct additional geotechnical work near the Seepage Collection Dam during final design and site the dam lower in the drainage if technically feasible. Pumpback wells would intercept tailings impoundment seepage not intercepted by the underdrain system before it reached surface water.

Effects on west side streams, Rock Lake, and Ramsey Creek would be the same as those described in Alternative 3 during all phases of the project. Effects on Libby Creek would be slightly greater (3 percent) because the tailings impoundment would be 20 acres larger and would intercept more precipitation. Effects on Poorman, Little Cherry, and Bear creeks through the Operations Phase would be the same as Alternative 2 without mitigation; these effects were not quantified. Alternative 4 would require two new road crossings across a perennial stream and one new crossing of a non-perennial stream (Table 108).

During the Construction Phase, less than a 1 percent increase in peak flow from timber clearing for the mine facilities is estimated in all east side streams. All transmission line alternatives combined with Alternative 4 would have estimated increases in peak flow of less than 10 percent.

The agencies' monitoring and mitigation plans include the construction of minor facilities in the Libby Creek floodplain, such as streamflow measurement devices and an infiltration gallery for makeup water in Libby Creek. No alternative exists to avoid locating these facilities in the Libby Creek floodplain and the effect would be the same as Alternative 3.

The effect on the Little Cherry Creek floodplain would be less than that described for Alternative 2. In Alternative 4, a new floodplain would be created along the diverted Little Cherry Creek channel.

After the tailings impoundment surface and dams were reclaimed, the runoff would no longer be subject to ELGs. When it met applicable water quality standards, runoff from the reclaimed tailings impoundment surface would be routed via the permanent Diversion Channel and Drainage 10 to Libby Creek (as compared to Alternative 2, where runoff from the reclaimed tailings impoundment surface would flow toward Bear Creek). After the South Saddle Dam and the south Main Dam abutment were reclaimed, runoff would flow to the Diversion Channel. Consequently, the watershed of Drainage 10 would increase by about 500 acres post-mining, as compared to operational conditions. This additional area may require MMC to complete more channel stabilization work in Drainage 10 due to increased flow, plus follow-up monitoring. Average annual flow in the diverted Little Cherry Creek would be about five times the existing flow in Drainage 10 and about 10 percent less than the current flow of Little Cherry Creek (Appendix H).

Compared with the pre-mining watershed area, the post-mining watershed area contributing water to the former Little Cherry Creek channel would be 85 percent smaller directly below the tailings impoundment and 74 percent smaller at the confluence of former Little Cherry and Libby creeks. The Hortness method overestimates $7Q_2$ and $7Q_{10}$ flow in watersheds containing the reclaimed impoundment, as discussed in Alternative 2. Changes in the watershed areas contributing flow to Bear and Libby Creek would be 5 percent or less. Below Bear Creek, streamflow in Libby Creek would return to pre-mining conditions, less any reduced baseflow which would be less than 1 percent of the estimated $7Q_{10}$ flow at Libby Creek at US 2. Following cessation of the pumpback wells and recovery of groundwater levels, springs and seeps outside of the impoundment footprint that were affected by the pumpback wells would likely return to pre-mine conditions and may contribute to baseflow.

3.11.4.6 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation and loop line for the Montanore Project would not be built. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Possible impacts on streams due to construction, operation, and maintenance of a new transmission line, Sedlak Park Substation, and loop line would not occur.

Table 117. Comparison of Stream and Floodplain Crossings Required for Transmission Line Alternatives.

Trans-mission Line Alternative	Number of Stream Crossings by New Roads		Acres of New Roads within FEMA Designated 100-Year Floodplain	Crossings by Transmission Line		
				Miles of Flood-plain	Number of Streams	
	Perennial Stream	Other Stream			Perennial Stream	Other Stream
B	0	5	1.6	1.1	4	16
C-R	0	0	0.2	0.4	5	15
D-R	0	0	0.2	0.3	4	18
E-R	0	1	0.2	0.3	4	19

Source: GIS analysis by ERO Resources Corp. using KNF data.

3.11.4.7 Alternative B – MMC Proposed Transmission Line (North Miller Creek Alternative)

3.11.4.7.1 Construction Phase

Alternative B transmission line would have four perennial stream crossings: the Fisher River, Howard Creek, Libby Creek, and Ramsey Creek. The alignment also would have 16 new crossings over other streams. Five new road crossings over other streams would be required. The transmission line would cross 1.1 miles of floodplains and require 1.6 acres of new roads within a floodplain (Table 117). Eight structures would be located in a floodplain. Construction would be curtailed during heavy rains or high winds to prevent erosion to streams. MMC identified four possible methods of stream crossings: fords, culverts, arches, and bridges. Culverts would be the most commonly used crossing method. Because the construction time of the line would be short, MMC anticipates that no drainage would be provided for the temporary roads and would follow the agencies' guidance if installation of culverts were required. Culvert installations on perennial streams would meet BMP requirements. In all transmission line alternatives, the DEQ would require on-site inspections of perennial stream crossings associated with the 230-kV transmission line to determine the most suitable crossing methods and timing of construction that would minimize impacts on floodplains and streamflow (see Environmental Specifications in Appendix D). During construction, streams may be temporarily dammed or routed around construction activities. Damming the stream would reduce or eliminate flow below the dam for a short period of time. After construction was completed, the bridges and culvert would not affect natural streamflow except during very large flow events.

The proposed Sedlak Park Substation would be south of Sedlak Creek and the loop line would cross the creek. Sedlak Creek has a small drainage area and an undefined floodplain. The Sedlak Park Substation and loop line would not affect streamflow in Sedlak Creek.

During the Construction Phase, a 1 percent or less increase in peak flow from timber clearing for the transmission line is estimated in all east side streams. Based on the ECAC model results (Appendix H), the mine-related water yield increase with the combination of Alternative 2 and Alternative B would reach a measurable level in Ramsey and Poorman creeks, with an estimated peak flow increase in Ramsey Creek of 12 percent.

3.11.4.7.2 Operations Phase

The transmission line and associated road crossing culverts would not affect streamflow during operations.

3.11.4.7.3 Decommissioning Phase

As proposed, culverts would remain after the project was completed. The culverts would not affect natural streamflow except during very large flow events.

3.11.4.8 Transmission Line Alternatives C-R, D-R and E-R

3.11.4.8.1 Construction Phase

Five perennial streams would be crossed by the transmission line in Alternative C-R: Fisher River, West Fisher Creek, Miller Creek, Howard Creek, and Libby Creek. Preliminary design indicates all transmission line alternatives except Alternative B would span a bend in the creek; it may be possible to avoid spanning the creek during final design. The effect of the Sedlak Park Substation and loop line in all agency alternatives would be the same as Alternative B. The transmission line would cross an estimated 0.4 mile of floodplains and require 0.2 acre of new roads within a floodplain (Table 117). Two structures would be located in a floodplain. Alternative C-R would require no new road crossings over major or minor streams. Culverts would be installed, if needed, on roads used for maintenance access. Other aspects of stream crossings, such as compliance with the Environmental Specifications in Appendix D, would be the same as Alternative B (section 3.11.4.7, *Alternative B – MMC Proposed Transmission Line (North Miller Creek Alternative)*).

Four perennial streams would be crossed by the transmission line in Alternative D-R: Fisher River, West Fisher Creek, Howard Creek, and Libby Creek. The transmission line would cross an estimated 0.3 mile of floodplains and require 0.2 acre of new roads within a floodplain (Table 117). Two structures would be located in a floodplain. Alternative D-R would require no new road crossings over any stream.

Four perennial streams would be crossed by the transmission line in Alternative E-R: Fisher River, West Fisher Creek, Howard Creek, and Libby Creek. The transmission line would cross an estimated 0.3 mile of floodplains and require 0.2 acre of new roads within a floodplain (Table 117). Two structures would be located in a floodplain. The alternative would require no new road crossings over perennial streams, and one new crossing over a non-perennial stream. Road and culvert construction, maintenance and removal, and effects on peak flow would be the same as Alternative C-R.

During final design, MMC would avoid or minimize, to the extent practicable, locating structures and roads in a floodplain. If locating transmission line structures and roads in a floodplain could not be avoided during final design, MMC would submit a flood plain permit application to the DNRC that provides details on the obstruction or use of a floodway/floodplain before construction. DNRC's permit issuance is based on the danger to life and property downstream, availability of alternate locations, possible mitigation to reduce the danger, and the permanence of the obstruction or use (76-5-405, MCA).

In Alternatives C-R, D-R, and E-R, installation of culverts, bridges, or other structures at perennial stream crossings would be specified by the agencies following on-site inspections with DEQ, Forest Service, FWP, landowners, and local conservation districts. Installation of culverts or other structures in a water of the United States would be in accordance with the U.S. Army Corps of Engineers 404 and DEQ 318 authorization conditions. Work in streams within the transmission line corridor would be in accordance with MFSA certificate requirements. All culverts would be sized according to Revised Hydraulic Guide (KNF 1990) and Parrett and Johnson (2004). Where new culverts were installed, they would be installed so water velocities or positioning of culverts would not impair fish passage. Stream crossing structures would be able to pass the 100-year flow event without impedance.

Based on the KNF ECAC model results (Appendix H), timber clearing for access roads and the transmission line in Alternatives C-R, D-R, and E-R is not predicted to measurably increase the peak flow of any streams. All transmission line alternatives combined with Mine Alternatives 3 and 4 would have estimated increases in peak flow of less than 10 percent.

3.11.4.8.2 Operations Phase

The transmission line and associated road crossing culverts would not affect streamflow during mine operations.

3.11.4.8.3 Decommissioning Phase

After line installation was completed, access roads would be changed to intermittent stored service. Culverts would be removed by the KNF if determined to be high risk for blockage or failure. Streambanks would be laid back to allow streamflow to pass without scouring or ponding. Transmission line roads would be decommissioned after mine closure and removal of the transmission line. Culverts would be removed and fill areas sloped back and stabilized during road decommissioning.

3.11.4.9 Cumulative Effects

3.11.4.9.1 Rock Creek Project

The Montanore and Rock Creek Projects, assuming they occurred concurrently, would cumulatively reduce flow in the Rock Creek, East Fork Bull River, and Bull River watersheds. No other aspects of the two projects would have cumulative effects on surface water resources. MMC's 3D model simulated the concurrent operation of both mines, based on several assumptions regarding the Rock Creek Mine design. The maximum effects on Rock Creek and the East Fork Bull River would occur after both mines ceased operations (assumed to be operating and closing simultaneously). The effects on low flows at RC-2000 and EFBR-500 are provided in Table 118. Compared to direct effects, cumulative flow reductions would be 0.03 cfs greater in Rock Creek at the mouth and the East Fork Bull River at the mouth, and 0.08 cfs greater at EFBR-500 at the CMW boundary. The cumulative effect at EFBR-500 would be a 13 percent reduction in the estimated $7Q_{10}$ flow and an 8 percent reduction in the estimate $7Q_2$ flow. The cumulative reduction in the wetted perimeter of the stream would be 30 percent at EFBR-2, and 18 percent at RC-3. The 3D model predicted that streamflow in the Libby Creek watershed, and Rock Lake levels would not be affected by the Rock Creek mine.

For the Bull River at the mouth, the cumulative effect would be a maximum flow reduction due to mine inflows of 0.48 cfs, which is a 1 percent decrease in the estimated baseflow of 40 cfs at that location (Geomatrix 2011a). During periods of the year when streamflow is dominated by surface water runoff (snowmelt and storm events), the effects on streamflow of the two mine projects would be negligible.

At the mouth of Rock Creek, the predicted reductions in low flows may not be measurable in the stream because the creek is often dry during baseflow periods (the flow reduction would be to subsurface flow). With mitigation, the cumulative effect on the East Fork Rock Creek and Rock Creek would be the same as discussed under the Montanore alternatives.

As the mine void filled and groundwater levels above the mines and adits reached steady state conditions, the effects on streamflow would decrease. Cumulative effects at steady state conditions were not quantified.

RCR prepared a 3D numerical hydrogeological model of the Rock Creek mine area to assist in defining potential impacts on groundwater and surface water resources (Hydrometrics 2014). For the Rock Creek Mine Supplemental EIS, the predicted cumulative effects were estimated by adding the results from the Montanore and Rock Creek 3D models for the respective periods of greatest groundwater drawdown. RCR's model predicted effects were slightly greater than estimated by MMC's 3D model. Because the two models present results for slightly different scenarios, Table 118 includes results for only one bulk hydraulic conductivity (10^{-6} cm/sec) from the Rock Creek model. The Montanore 3D model was used simulate to both unmitigated and mitigated effects, whereas the Rock Creek model only simulated unmitigated effects.

3.11.4.9.2 Other Reasonably Foreseeable Actions

Cumulative effects in the analysis area on both the east and west slopes of the Cabinet Mountains include past and current actions that are likely to continue in the future and reasonably foreseeable actions that could affect streamflows, spring flows, and lake levels. Other area mining activities, particularly in-stream suction dredging and placer exploration, have in the past created physical substrate habitat alterations in area streams. Other activities that could affect surface water flows include timber harvesting, land clearing, home construction, road construction, septic field installation, water well drilling, livestock grazing, and stream channel and bank stabilization or restoration projects. These activities could either increase or reduce water sources to streams, springs, and lakes; other than the Montanore and Rock Creek Projects, cumulative effects would be minor. The cumulative peak flow increase in the Libby Creek and Fisher Creek watersheds would be less than 10 percent. For annual water yield, the cumulative annual flow increases would mostly be less than 1 percent, with the largest impact being a 4 percent increase. These increases would offset flow decreases predicted to occur due to mine inflows and water diversions (Table H-9, Appendix H). For example, in the Ramsey Creek watershed, the analysis predicted a cumulative increase in flow during baseflow periods of 0.2 cfs for Alternative 3. The maximum flow reduction to Ramsey Creek due to mine inflows would be 0.04 cfs. The effects on aquatic life and aquatic habitat due to streamflow changes are described in section 3.6, *Aquatic Life and Fisheries.* The indirect effects due to streamflow changes on riparian vegetation are described in section 3.22, *Vegetation* and on wetland vegetation are described in section 3.23, *Wetlands and Other Waters of the U.S.*

The proposed Wayup Mine in upper West Fisher Creek and the Libby Creek Ventures drilling plan adjacent to Upper Libby Creek Road would have negligible cumulative effects on streamflows.

Table 118. Estimated Cumulative Changes during $7Q_2$ and $7Q_{10}$ Flows, Maximum Baseflow Changes during Post-Closure.

Variable	Rock Creek RC-2000		East Fork Bull River EFBR-500		East Fork Bull River @ Mouth	
	Without Mitigation	With MMC's Modeled Mitigation†	Without Mitigation	With MMC's Modeled Mitigation†	Without Mitigation	With MMC's Modeled Mitigation†
MMC's Model Results						
Modeled baseflow change (cfs)	-0.68	-0.19	-0.48	-0.47	-0.36	-0.37
Estimated $7Q_2$ flow (cfs)	13.53	13.53	5.77	5.77	12.27	12.27
Percent Change in $7Q_2$ Flow	-5%	-1%	-8%	-8%	-3%	-3%
Estimated $7Q_{10}$ flow (cfs)	8.80	8.80	3.71	3.71	7.97	7.97
Percent Change in $7Q_{10}$ Flow	-8%	-2%	-13%	-13%	-5%	-5%
RCR's Model Results						
Modeled baseflow change (cfs)	-1.05	—	—	—	-0.80	—
Estimated $7Q_2$ flow (cfs)	13.53	—	—	—	12.27	—
Percent Change in $7Q_2$ Flow	-8%	—	—	—	-7%	—
Estimated $7Q_{10}$ flow (cfs)	8.80	—	—	—	7.97	—
Percent Change in $7Q_{10}$ Flow	-12%	—	—	—	-10%	—

Groundwater models were used to predict effects from mine dewatering and the pumpback wells. With the data currently available, the model results provide a potential range of dewatering and pumping rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. Both 3D groundwater flow models would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see Section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* for more discussion of model uncertainty.
†These are only for unmitigated conditions for the Rock Creek mine because Rock Creek model did not evaluate effects of mitigation.

3.11.4.10 Regulatory/Forest Plan Consistency

This section discusses compliance with applicable laws and regulations regarding surface water hydrology, specifically changes in streamflow and floodplains. Section 3.13.4.11, *Regulatory/*

Forest Plan Consistency in the subsequent *Water Quality* section (p. 785) discusses compliance with water quality laws and regulations.

3.11.4.10.1 Organic Administration Act and Forest Service Locatable Minerals Regulations

36 CFR 228.8 requires that mining operators minimize, where feasible, adverse environmental impacts on National Forest surface resources; comply with applicable state and federal water quality standards including the Clean Water Act; take all practicable measures to maintain and protect fisheries and wildlife habitat that may be affected by mine operations; and reclaim the surface disturbed in operations by taking such measures as preventing or controlling onsite and off-site damage to the environment and forest surface resources.

The reclamation plan in all mine and transmission line alternatives would ensure changes in streamflow would be minimized. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8. In these alternatives, MMC did not propose to implement feasible measures to minimize changes in streamflow and to protect fisheries habitat from changes in streamflow. The agencies' alternatives (Mine Alternatives 3 and 4 and Transmission Line Alternatives C-R, D-R, and E-R) would incorporate additional feasible and practicable measures to minimize adverse environmental impacts on National Forest surface resources and to maintain and protect fisheries habitat. The measures would include increasing mining buffer zones, installing multiple, site-specifically designed adit plugs at closure, grouting, and, if necessary, leaving mine void barriers. Using thickened tailings would reduce MMC's appropriation from the Libby Creek and minimize effects on Libby Creek streamflow. The agencies' alternatives expanded MMC's proposed monitoring plans and would include action levels on mine inflows and changes in surface water flow and lake levels that would trigger corrective measures to be implemented by MMC (see Appendix C).

Alternative 2 would have a disturbance area of 2,582 acres. The disturbance area of Alternative 4, which would have a tailings impoundment at the same location as Alternative 2, would be smaller than Alternative 2 by 658 acres by eliminating the LAD disturbance area and minimizing the disturbance area around the tailings impoundment. The disturbance area of Mine Alternative 3 would be the smallest. The smaller disturbance area of Alternatives 3 and 4 minimize peak flow increases in all area streams. Because the clearing width for Transmission Line Alternative B would be narrower than the agencies' transmission line alternatives, the maximum clearing width for Alternative B would be less than the agencies' alternatives. Clearing associated with the agencies' transmission line alternatives would be minimized through the development and implementation of a Vegetation Removal and Disposition Plan.

In Alternatives 3 and 4, runoff from the reclaimed tailings impoundment would be directed toward Little Cherry Creek instead of Bear Creek proposed in Alternative 2. As part of the final closure plan in Alternatives 3 and 4, MMC would complete a H&H analysis of the proposed runoff channel during final design that would include a channel stability analysis and a sediment transport assessment. The runoff channel would be designed to minimize adverse effects of increased streamflow on Little Cherry Creek. MMC's mitigation plans contained limited measures to protect fisheries habitat from changes in streamflow. The agencies' alternatives would create or secure genetic reserves through bull trout transplanting or habitat restoration; rectify factors that are limiting the potential of streams to support increased production of bull trout; and e eradicate non-native fish species, especially brook trout that are a hybridization threat to bull trout. Through these mitigations, the agencies' alternatives would comply with 36 CFR 228.8 to minimize adverse environmental impact.

3.11.4.10.2 Wilderness Act

All mine alternatives have the potential to indirectly affect wilderness qualities. Mitigation measures identified in Chapter 2 for Alternatives 3 and 4 and monitoring required for Alternatives 3 and 4 (Appendix C) would be implemented to minimize changes in wilderness character. Mitigation measures such as increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring coupled with final design criteria submitted for the agencies' approval, would reduce the risk of subsidence and measurable hydrological indirect effects to the surface within the wilderness.

Mitigation measures and monitoring requirements in Alternatives 3 and 4 are reasonable stipulations for protection of the wilderness character and are consistent with the use of the land for mineral development. Alternatives 3 and 4 would be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and to preserve the wilderness character consistent with the use of the land for mineral development and production in compliance with 36 CFR 228.15 and the Wilderness Act. The agencies' mine and transmission line alternatives would comply with the Wilderness Act. Alternatives 3 and 4 would minimize adverse environmental impacts on surface resources within the wilderness, and thereby comply with the regulations (36 CFR 228, Subpart A) for locatable mineral operations on National Forest System lands.

3.11.4.10.3 Clean Water Act and Montana Water Quality Act

The DEQ will discuss compliance with applicable water quality regulations addressing streamflow including nondegradation rules in the ROD, the renewed MPDES permit, and 401 Certification.36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations." DEQ's permit decision and associated conditions in the draft renewal MPDES permit or on any other state water quality permit would constitute compliance with Montana water quality requirements and Clean Water Act requirements regarding water quality.

3.11.4.10.4 Kootenai Forest Plan

Compliance with the 2015 KFP is described in the following sections.

GOAL-WTR-01: All mine and transmission line alternatives would maintain streamflow conditions that support ecological functions and beneficial uses. The DEQ will discuss compliance with applicable water quality regulations addressing streamflow including nondegradation rules in the ROD, the MPDES permit, and 401 Certification. DEQ's permit decision and associated conditions in the MPDES permit or on any other state water quality permit would constitute compliance with Montana water quality requirements and Clean Water Act requirements regarding water quality. Overall, at a forest-wide scale, the alternatives would be neutral with regard to progress toward this goal. The alternatives would affect water resources, but mitigation would be implemented to avoid or minimize adverse effects. At a forest-wide scale, the effects on water resources would be minor.

FW-DC-WTR-01: Watersheds and associated aquatic ecosystems would retain their inherent resilience to respond and adjust to disturbance without long-term, adverse changes to their physical or biological integrity in the agencies' mine and transmission line alternatives. The agencies' alternatives include appropriate mitigation for all reasonably foreseeable adverse streamflow effects on watersheds and associated aquatic ecosystems. The agencies' alternatives would be neutral with regard to progress toward this desired condition. MMC's mine alternative did not include appropriate mitigation for all reasonably foreseeable adverse streamflow effects on watersheds and associated aquatic ecosystems and would not make progress or be neutral with regard to progress toward this desired condition. The effect forestwide of MMC's alternatives would be negligible.

FW-DC-WTR-02. All mine and transmission line alternatives would meet applicable state water quality standards and fully support beneficial uses. The DEQ will discuss compliance with applicable water quality regulations addressing streamflow including nondegradation rules in the ROD, the MPDES permit, and the 401 certification. DEQ's permit decision and associated conditions in the MPDES permit or on any other state water quality permit would constitute compliance with Montana water quality requirements and Clean Water Act requirements regarding water quality. The agencies' alternatives would be neutral with regard to progress toward this desired condition. MMC's mine alternative did not include appropriate mitigation for all reasonably foreseeable adverse streamflow effects on wetlands and aquatic ecosystems in Little Cherry Creek and would not make progress or be neutral with regard to progress toward this desired condition. The effect forestwide of MMC's alternatives would be negligible.

FW-DC-WTR-03: None of the alternatives would affect channel dimensions. Based on conceptual designs presented in Chapter 2, all mine and transmission line alternatives would have some facilities located in a FEMA designated floodplain. Mine Alternative 2 would have the least amount of disturbance in a FEMA designated floodplain. Construction of the Seepage Collection Pond and an infiltration gallery for makeup water in Mine Alternative 3 would have 9 acres of construction in a floodplain and Mine Alternative 4 would have 3 acres. During final design, MMC would be required to avoid or minimize, to the extent practicable, locating facilities, such as the Seepage Collection Pond in Alternative 3, in a floodplain. If locating mine facilities in a floodplain could not be avoided, an application for a floodplain permit would be submitted to the DNRC that provides details on the obstruction or use of a floodway floodplain and a permit would be required before construction. DNRC's permit issuance is based on the danger to life and property downstream, availability of alternate locations, possible mitigation to reduce the danger, and the permanence of the obstruction or use (76-5-405, MCA). The alternatives would be neutral with regard to progress toward this desired condition.

FW-DC-WTR-06: All mine and transmission line alternatives would maintain and improve forestwide trends toward achieving the desired condition of cooperating with other parties to improve watershed conditions. The agencies' alternatives would improve watershed conditions on lands obtained by MMC for wetland and grizzly bear mitigation.

3.11.4.10.5 Executive Order 11988 and Montana Floodplain and Floodway Management Act

Transmission line facilities are not subject to the Montana Floodplain and Floodway Management Act. Based on conceptual designs presented in Chapter 2, all mine and transmission line alternatives would have some facilities located in a FEMA designated floodplain. Mine Alternative 2 would have the least amount of disturbance in a FEMA designated floodplain. Construction of the Seepage Collection Pond and an infiltration gallery for makeup water in Mine Alternative 3 would have 9 acres of construction in a floodplain and Mine Alternative 4 would have 3 acres. During final design, MMC would be required to avoid or minimize, to the extent practicable, locating facilities, such as the Seepage Collection Pond in Alternative 3, in a floodplain. If locating mine facilities in a floodplain could not be avoided, an application for a floodplain permit would be submitted to the DNRC that provides details on the obstruction or use of a floodway floodplain and a permit would be required before construction. DNRC's permit issuance is based on the danger to life and property downstream, availability of alternate locations, possible mitigation to reduce the danger, and the permanence of the obstruction or use (76-5-405, MCA). DNRC's permit decision and associated conditions on the floodplain permit for these facilities would constitute compliance with requirements of Executive Order 11988.

In addition to the facilities described above, the agencies' monitoring and mitigation plans associated with Alternatives 3 and 4 would require the construction of some minor facilities in the Libby Creek floodplain, including an infiltration gallery for makeup water and continuous flow measurement devices in the Libby Creek floodplain. In compliance with Executive Order 11988, the KNF finds that no alternative exists to avoid locating these minor facilities in the Libby Creek floodplain. DNRC's permit decision and associated conditions on the floodplain permit would constitute compliance with requirements of Executive Order 11988.

3.11.4.11 Irreversible and Irretrievable Commitments

During mine operations, use of mine and adit inflows and any water needed for mine operations would be an irretrievable commitment of resources. Any permanent change in stream or spring flow or lake levels due to mining would be an irretrievable and irreversible commitment of resources. Some water would be used consumptively by the project, reducing the total water yield in the region by that amount. Relative to the total yield of the affected watersheds, the consumptively used volume would be small. The reduction in yield would be an irretrievable commitment of resources.

The tailings impoundment in the Little Cherry Creek watershed in Alternatives 2 and 4 would permanently alter the flow in Little Cherry Creek, Bear Creek (Alternative 2 only), Libby Creek, and two unnamed drainages. Alternative 3 would alter the flow in the Little Cherry Creek, Poorman Creek, Libby Creek, and four unnamed drainages. These flow changes would be an irreversible commitment of surface water resources.

3.11.4.12 Short-Term Uses and Long-Term Productivity

The short-term use of surface water resources in the various alternatives would consist of diverting analysis area streams for mining, and using analysis area streams for discharge of treated water. Changes that may occur that would affect the long-term productivity of surface water resources include:

- Changes in flow in streams and springs that receive some of their water supply from bedrock groundwater, as well as changes in the levels of Rock Lake that may occur due to mine inflows
- Changes to watersheds and floodplains (and the streams and springs within them) that would be permanently covered by the tailings impoundment site
- Changes in streamflow that would occur due to permanent stream diversions around or from the tailings impoundment site

3.11.4.13 Unavoidable Adverse Environmental Effects

The consumptive use of groundwater by the project during mine operations would unavoidably reduce the total water yield from this portion of the Cabinet Mountains. The anticipated consumptive use is expected to be small relative to the total water yield of this area. Water yield would remain reduced until the project no longer consumptively used water, and then slowly return to the pre-mining yield as the mine void filled, which the 3D model predicted would require 490 years. Water levels overlying the mine are predicted by the model to reach steady state conditions 1,150 to 1,300 years after mining ended. The actual time to recover to steady state may be shorter or longer and would be re-evaluated using the 3D model after additional data were collected during the Evaluation Phase). Without mitigation, such as barrier pillars and bulkheads, water levels over the mine void nearest Rock Lake are predicted to remain about 200 feet below pre-mine conditions. Mitigation would reduce this effect. Mining of the ore body would unavoidably reduce streamflow and deep groundwater inflow to Rock Lake. Without mitigation, a change in deep groundwater inflow to Rock Lake would permanently reduce the volume and level of Rock Lake. With mitigation, the volume and level of Rock Lake would be affected until groundwater levels reached steady state conditions. If deep groundwater was a component of the inflow to St. Paul Lake, mine dewatering would unavoidably reduce this source of water to the lake, and the lake level may lower more quickly during dry years when the only source of water to the lake was bedrock groundwater.

3.12 Water Rights

3.12.1 Regulatory Framework

3.12.1.1 Montana Water Use Act

The Montana Water Use Act requires that any person, agency, or governmental entity intending to acquire new or additional water rights or change an existing water right in the state obtain a beneficial water use permit before commencing to construct a new or additional diversion, withdrawal, impoundment, or distribution works for appropriations of groundwater or surface water.

The Montana Water Rights Bureau, within the Water Resources Division of the DNRC, administers the Water Use Act and assists the Water Court with the adjudication of water rights. An Application for Beneficial Water Use Permit requires proof by a preponderance of evidence that there is water physically and legally available at the proposed point of diversion in the amount requested (ARM 36.12.1702 and 36.12.1705). Senior water rights have an earlier priority date and claimants who hold them have a higher priority to divert water from a stream or water body than those with more junior rights. If a senior water user would be adversely affected by a new use, the application must include a mitigation plan with specific conditions that the new water user is willing to accept to eliminate or mitigate potential adverse effects on senior water rights. For example, a new water user may need to divert or pump water only at certain times when adequate water is available for all users or may need to find water from another source to replace water appropriated by the new user.

Dewatering the adits or mine void during mining, or filling of the adits and mine void during the Closure and Post-Closure Phases is not a beneficial use of water and a beneficial water use permit would not be required. Although MMC would not be able to obtain a permit to secure an appropriation to dewater the adits or mine void or fill the mine void, the Water Use Act has a requirement that a person cannot waste water, use water unlawfully, or prevent water from moving to another person having a prior right to use the water. If dewatering the Libby Adit or filling of the mine void resulted in one of these, MMC would need a plan to regulate the controlling works of an appropriation as may be necessary to prevent the wasting or unlawful use of water and to ensure that a person having a prior senior right is not deprived of their lawful use of water (85-2-114(1), MCA).

Changes in an existing water right include a change in the point of diversion, place of use, the purpose of use, or the place of storage. A change in a water right can be made as long as there is no adverse impact on other appropriators. Before a change can be initiated, approval from the DNRC must be obtained. Increasing the amount of water consumed from a stream would be considered a new water right requiring an application for beneficial water use.

3.12.1.2 USDA Forest Service/State of Montana Reserved Water Rights Compact

Additional requirements for obtaining a new water rights permit come from the Forest Service/State of Montana Reserved Water Rights Compact (85-20-1401 Article IV B.1., MCA). The compact was entered into by the State of Montana and the United States of America to settle all claims to federal reserved water rights for National Forest System lands administered by the Forest Service. Article IV.B.1. of the compact provides that there will be sequencing of the permitting process for water appropriations under state law and the permitting for access and use of National Forest System lands in relation to water appropriations to avoid conflict between state and federal permitting. Under the compact, an applicant is required to show proof of federal authorization before the application for a new appropriation of water or a change of appropriation will be considered correct and complete when:

- A state permit is required prior to a new appropriation of water, including groundwater, or a change of appropriation, and
- A federal authorization is required to occupy, use, or traverse National Forest System lands for the purpose of diversion, impoundment, storage, transportation, withdrawal, use, or distribution of water for the appropriation or change of appropriation.

A state permit for a new appropriation will be subject to any terms, conditions, and limitations related to the use of water contained in the approved Plan of Operations. For the Montanore Project, the federal authorization for occupancy and use of National Forest System lands in relation to MMC's water appropriations would be the Forest Service's approved Plan of Operations for the project. Any new state permit(s) for water appropriations by MMC would be subject to the terms, conditions, and limitations in the Plan of Operations relating to the use of water.

3.12.1.3 Kootenai Forest Plan

The 2015 KFP direction considered in the analysis of water rights is:

> **FW-DC-WTR-05.** Water rights for consumptive and non-consumptive water uses obtained in the name of the Forest Service support instream flows that provide for channel maintenance, water quality, aquatic habitats, and riparian vegetation. Water quality and beneficial uses are fully protected under special use permits related to water uses.

3.12.2 Analysis Area and Methods

The water rights analysis area is slightly larger than described in section 3.11.2.1, *Analysis Area* and consisted of the Libby Creek watershed to the Kootenai River, the East Fork Bull River drainage, the Bull River below the confluence of the East Fork Bull River to the confluence with the Clark Fork River and East Fork Rock Creek and Rock Creek to the confluence with the Clark Fork River. The analysis area was larger than that used for the surface water hydrology analysis to assess the physical and legal availability of water and to ensure downstream water rights were not adversely affected by the project. Water rights in streams in the transmission line corridors would not be affected.

MMC assessed the physical and legal availability of water using methods required by the DNRC. The impact on groundwater rights from pumping the pumpback wells and from mine inflows was evaluated based on the location of the rights with respect to the 3D-modeled drawdown areas. The impact on a spring right located downgradient of MMC's proposed infiltration gallery to divert groundwater in the alluvium of Libby Creek was evaluated based on the possible source of water to the spring. Possible impacts on surface water rights due to changes in streamflow were evaluated by comparing requested water appropriations to measured streamflow in all potentially affected streams.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on water rights in the analysis area, and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.12.3 Affected Environment

Surface water in the analysis area is used for a variety of beneficial uses including domestic water supply, irrigation, mining, stock watering, fish habitat, and wildlife. The DNRC has 38 active water rights on record for surface water within the Libby Creek watershed, including diversions from Bear, Ramsey and Libby creeks, as well as unnamed tributaries to Libby Creek. Most of the surface water permits are for domestic, irrigation, fishery, and mining use. The total active surface water rights are for an average use of about 55 cfs, and maximum use of about 81 cfs. The 30 spring rights in the Libby Creek watershed are used for primarily for domestic, irrigation and livestock purposes. The livestock rights are for 30 gallons per day per animal unit. The total for the rights (not including stock rights with only animal unit limits) is a maximum flow of 4.93 cfs, and maximum volume of about 1,726 acre-feet. Nineteen groundwater rights are listed within the analysis area. Six of these rights are springs, and the rest are wells; the well depth range is 40 to 235 feet, with all but one well less than 100 feet deep. The total for the groundwater rights is a maximum flow of 1.1 cfs, and maximum volume of about 359 acre-feet. The permitted point of diversion for spring water right 76D 28349 00, a 15 gpm water right for placer mining with a May 1 to September 30 period of use, is on Libby Creek, 1.5 miles downstream of MMC’s proposed infiltration gallery. The KNF does not have an approved plan of operations for placer mining at the permitted place of use for spring water right 76D 28349 00.

MMC holds two 1902 surface water rights on Libby Creek, one for mining near the Libby Adit site in Section 15, Township 27N, Range 31W (with a maximum diversion of 44.9 gpm between April 1 and December 19, and maximum volume of 50.97 acre-feet), and one for domestic use in the same section (15 gpm year-round, and a maximum volume of 1.5 acre-feet). MMC also holds a 1989 groundwater right near the Libby Adit site in Section 15, Township 27N, Range 31W (with a total diversion of 40 gpm year-round).

The Forest Service has a year-round 40 cfs instream flow right with a 2007 priority date for a segment of Libby Creek that starts at Bear Creek and goes to above Hoodoo Creek. The use of the right is to provide adequate flows for bull trout to migrate from Libby Creek into Bear Creek and spawn. The Forest Service also has a 1949 right to divert 0.5 cfs for mining during May and June from Libby Creek above the confluence with Howard Creek at the Recreation Gold Panning Area, and a 1925 water right on Libby Creek above Ramsey Creek to divert 25 gpm for commercial purposes.

A private entity owns three 1925 surface water rights on Libby Creek for mining, domestic and stock use, and one 1900 water right on Ramsey Creek for mining use that have points of diversion upstream of MMC’s requested diversion points (Table 119). The rights shown in Table 119 are junior to MMC’s surface water rights, and senior to MMC’s groundwater right, all Forest Service rights on Libby and Ramsey creeks, and MMC’s requested rights from Libby Creek. Each of the water rights for mining is for a maximum diversion rate of 1 cfs and maximum volume of 521.6 acre-feet per year.

Table 119. Privately-Owned Water Rights with Diversion Points Upstream of MMC's Requested Diversion Points.

Source Name	Libby Creek	Libby Creek	Libby Creek	Ramsey Creek
Water Right No.	76D 141290 00	76D 141291 00	76D 141300 00	76D 141292 00
Priority Date (yyyymmdd)	19250509	19250509	19250509	19001217
Purpose	Domestic	Stock	Mining	Mining
Means of Diversion	Flowing	Livestock Direct From Source	Headgate	Headgate
Maximum Flow Rate (gpm)	30.00	NA	448.8	448.8
Maximum Flow Rate (cfs)	0.066	NA	1	1
Maximum Volume (ac-ft/yr)	1.50	30 gals/day/animal	521.6	521.6
Point of Diversion Legal Land Description	T28N R3lW Sec. 36 SW SW SE	T27N R31W Sec 1 E2 NW and SW	T27N R31W Sec 11 SW NW SE	T27N-R31W Sec. 3 NE SE SE
General Location	About 1,000 feet upstream of confluence with Ramsey Creek	About 1 mile upstream of confluence with Ramsey Creek	About 5,000 feet upstream of confluence with Howard Creek below Libby Adit	About 2 miles upstream of confluence with Libby Creek
Period of Use	Jan 1-Dec 31	May 15-Oct 19	April 1-Dec 19	April 1-Dec 19

Source: DNRC 2015.
NA = Not applicable

In Alternatives 3 and 4, MMC would acquire a parcel along US 2 through which Swamp Creek flows for wetland mitigation (see section 2.5.7.1, *Jurisdictional Wetlands and Other Waters of the U.S.*). The current owner of this parcel has a surface water right to flood irrigate 26 acres of hay meadow between May 1 and October 31, with a maximum diversion rate of 291.72 gpm, and maximum volume of 52 acre-feet per year.

No surface water rights exist on the East Fork Bull River and no groundwater rights are in the East Fork Bull River basin. There are three surface water rights on the Bull River downstream of the East Fork Bull River for domestic and irrigation purposes with a total maximum diversion rate of 0.21 cfs and maximum volume of 37 acre-feet per year. One domestic surface water right for 10 gpm and a shallow groundwater right for 20 gpm are held on Rock Creek about 2 miles downstream of the confluence of West Fork Rock Creek and East Fork Rock Creek.

3.12.4 Environmental Consequences

3.12.4.1 Alternative 1 – No Mine

In this alternative, MMC would not develop the Montanore Project. Any existing exploration-related or baseline collection disturbances by MMC would be reclaimed in accordance with existing laws and permits. Surface water and groundwater rights in the area would not be affected. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands.

3.12.4.2 Alternative 2 – MMC Proposed Mine

For all mine alternatives, MMC would have to acquire new surface water and groundwater appropriations from the DNRC to use water for mining and possibly wetland mitigation purposes. MMC did not apply for beneficial water use permits for Alternative 2. MMC estimated that a permit for 200 to 300 gpm would be adequate for mining purposes. The rate and points of diversion for Alternative 2 would vary slightly from those described in Alternative 3. MMC did not propose to discharge treated water to Libby Creek or Ramsey Creek to prevent adverse effects on senior water rights. Baseflow changes and appropriations by MMC from Libby Creek would adversely affect senior water rights. Baseflow changes also may affect senior water rights in Ramsey Creek.

The spring and groundwater well rights located in or near the analysis area are all located outside of the 3D-model predicted drawdown area for mine inflows. There is a water right for a developed spring located near the confluence of Bear Creek and Libby Creek that may be within the drawdown area for the pumpback wells for the Little Cherry Creek tailings impoundment and possibly within the area of influence of the make-up well near Libby Creek. This water right is 76D 28349 00, a 15 gpm water right for mining with a May 1 to September 30 period of use. The source of water for this spring is unknown. If it is alluvial groundwater in the Libby Creek channel, then the flow of the spring may be reduced due to pumping from the pumpback wells or the make-up well, but would be measurable only during low flow periods in Libby Creek. If the source of water for the spring water right is bedrock rather than alluvial water, then appropriation of water by MMC from the make-up well or pumping from the pumpback wells would not affect the flow of the spring.

3.12.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

3.12.4.3.1 Libby Creek

MMC applied for new surface water and groundwater beneficial water use permits using the project components of Alternative 3 (MMC 2012a). Section 2.5.4.3.2, *Water Rights* in Chapter 2 discusses the three water rights for which MMC submitted applications to the DNRC. MMC's water rights applications included an analysis on the physical and legal availability of water for such a diversion and concluded water was physically and legally available at the proposed point of diversion in the amounts requested for. The DNRC would determine the physical and legal availability of water of MMC's requested new rights.

The applications also included a mitigation plan to avoid adversely affecting senior water rights on the mainstem of Libby Creek during the Operations Phase. The DNRC will determine whether requested uses are permittable during the water rights permitting process. The agencies modified MMC's mitigation plan that was submitted to the DNRC. In addition to groundwater interception from pumpback wells, and interception of precipitation at the Poorman Impoundment Site, MMC would divert groundwater from an infiltration gallery near Libby Creek during high flows, estimated to be in April through July. The maximum diversion rate would be 1,125 gpm (2.5 cfs).

To mitigate effects on senior water rights during all mine phases, such as the Forest Service's 40 cfs right on Libby Creek, MMC would monitor the flow at LB-2000, and whenever flow was less than 40 cfs at LB-2000, would treat and discharge water from the Water Treatment Plant at a rate equal to all of its Libby Creek watershed appropriations. The agencies anticipate discharges typically would occur in January through March, and August through December, though discharges would be determined by real-time continuous streamflow monitoring at LB-2000 (see Appendix C). Make-up water during the Operations Phase would be diverted from Libby Creek during high flows (discussed in a subsequent paragraph).

Similar mitigation would occur during the Closure and Post-Closure Phases using water stored in the adits. The effect of filling the mine void with the adits plugged as proposed by the agencies on Libby Creek streamflow was not modeled. MMC would update the groundwater model in the final closure plan to predict the effect on Libby Creek streamflow of filling the mine void with the adits plugged. Based on this information, MMC would mitigate any effects to senior water rights, if needed, to avoid adversely affecting senior water rights. The agencies' mitigation required in Alternative 3, discussed in section 2.5.4.3.2, *Water Rights*, would ensure MMC's appropriations or baseflow changes would not injure senior water rights at mine closure as the adit or mine void filled. None of MMC's requested new surface water and groundwater beneficial water use permits would adversely affect the privately-owned water rights listed for Libby Creek in Table 119. MMC's discharges of treated mine and adit water would increase flow in Libby Creek from pre-mine conditions throughout the project until the adits were plugged (Table 109, Table 111, Table 112, and Table 113). The discharges would increase the physical availability of water for diversion for the senior water rights on Libby Creek listed in Table 119. Under the Montana Water Use Act, the DNRC can only issue MMC a new beneficial water use permit if MMC proves by a preponderance of evidence that water is physically and legally available (85-2-311(1), MCA). The DNRC will decide the physical and legal availability of water for MMC's requested new surface water and groundwater beneficial water use permits after it received from the KNF notification that MMC's Plan of Operation was approved. After the adits were plugged, the impoundment was reclaimed, and the pumpback well system ceased operation, the availability of water for diversion in Libby Creek would return to pre-mine conditions.

MMC would acquire a water right for the created wetlands if the DNRC determined water use for creating wetlands was a beneficial use. If water use for creating wetlands was not a beneficial use, MMC could use water for wetland creation without a beneficial water use permit protecting its right to do so. Water to create wetlands would come from precipitation on MMC and National Forest System lands and the legal availability of that water would not be at risk of appropriation by another user. Any water rights used for wetland mitigation would be conveyed to the Forest Service when the mitigation sites were conveyed.

3.12.4.3.2 Ramsey Creek

On Ramsey Creek, a senior water right holder has a 1 cfs water right for mining between RA-200 and RA-400 (Table 119). The baseflow is estimated to be about 0.38 cfs in Ramsey Creek at the CMW boundary, and may be about 1 cfs at this right's point of diversion on Ramsey Creek. The maximum predicted baseflow decrease due to mine inflows is 0.04 cfs at the CMW boundary and would be similar at the point of diversion. This reduction would adversely affect this water right whenever flow at the point of diversion was less than 1 cfs. MMC would monitor flow in Ramsey Creek at RA-300, above the point of diversion (see Appendix C, Section C.10). When the 3D model was updated after the Evaluation Phase, MMC would re-evaluate potential effects on Ramsey Creek. If the senior water right on Ramsey Creek would be adversely affected during any mining phase, MMC would develop a plan during final design to convey treated water from the

Water Treatment Plant to a location upstream of the right's point of diversion (RA-300). Discharge of treated water to Ramsey Creek would require a new outfall in MMC's MPDES permit.

3.12.4.3.3 Swamp Creek

In Alternatives 3 and 4, MMC would acquire a parcel along Swamp Creek for wetland mitigation and the water right associated with this parcel allows for flood irrigation of 26 acres of hay meadow. Rehabilitation of the site to improve its functions as a wetland would not require a water right. MMC would file for a change of use for this water right to an instream flow right.

3.12.4.3.4 Groundwater Rights in the Libby Creek Watershed

The permitted points of diversion of spring and groundwater well rights located in or near the analysis area are all outside of the 3D-modeled drawdown areas due to mine inflows and the pumpback wells. The permitted point of diversion for spring water right 76D 28349 00 is on Libby Creek, 1.5 miles downstream of MMC's proposed infiltration gallery. MMC would divert water from the Libby Creek alluvium at an average rate of 765 gpm and a maximum flow rate of 1,125 gpm from April through July (Table 25). Assuming that the source of water for the spring water right is alluvial water associated with Libby Creek, pumping from the infiltration gallery during high streamflow (40 cfs or greater) would not likely affect the ability of the spring water rights owner to divert 15 gpm from the spring. Pumping from the infiltration gallery would not affect spring flow if the source of water for the spring water right is bedrock rather than alluvial water. Spring water right 76D 28349 00 may no longer be in use; the KNF does not have an approved plan of operations for placer mining at the permitted place of use for the right.

3.12.4.3.5 East Fork Rock Creek, Rock Creek, East Fork Bull River, and Bull River

Water rights in the East Fork Bull River basin would not be affected because no existing water rights are in that basin. Water rights in the Bull River downstream of the East Fork Bull River would not be affected because the maximum predicted flow reduction would be less than 1 cfs, and the model-estimated baseflow of the Bull River at the confluence with the Clark Fork River is 40 cfs. The surface water right on Rock Creek for 10 gpm would not be affected by the predicted flow decrease due to mine inflows of between 0.5 and 0.65 cfs of the estimated baseflow, which is between 3 and 7 cfs at the point of diversion. The shallow groundwater right on Rock Creek for 20 gpm is outside of the area of expected drawdown due to mine inflows.

3.12.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

MMC did not apply for beneficial water use permits for Alternative 4. The rate and points of diversion for Alternative 4 would vary slightly from those described in Alternative 3. The effects on area surface water rights would be the same as described in Alternative 3 and on groundwater rights would be the same as described in Alternative 2.

3.12.4.5 Transmission Line Alternatives

In the transmission line alternatives, the small flow changes expected to occur as a result of water use for dust control or concrete mixing are not expected to adversely affect area water rights. Similarly, the construction and maintenance of the Sedlak Park Substation and the loop line would not affect water rights.

3.12.4.6 Cumulative Effects

Because any new MMC water right could not injure existing water rights, no water rights would be cumulatively affected.

3.12.4.7 Regulatory/Forest Plan Consistency

3.12.4.7.1 Montana Water Use Act or the Montana Reserved Water Rights Compact

Alternative 2 would not comply with the Montana Water Use Act or the Montana Reserved Water Rights Compact. MMC did not propose to discharge treated water to Libby Creek or Ramsey Creek to prevent adverse effects on senior water rights. Baseflow changes and appropriations by MMC from Libby Creek would adversely affect senior water rights.

Alternative 3 and 4 would comply with the Montana Water Use Act and the Montana Reserved Water Rights Compact. In Alternative 3 and 4, mine and adit inflows would not be used beneficially during any mine phase and treatment and discharge of all mine and adit inflows would not require a beneficial use permit. MMC would discharge treated water to Libby Creek and Ramsey Creek, as necessary, to prevent adverse effects on senior water rights. At mine closure, MMC would install two or more plugs in each of the three Libby Adits. As long as MMC appropriated or diverted water from Libby Creek whenever flow at LB-2000 was less than 40 cfs, MMC would treat, if necessary to meet MPDES permitted effluent limits, stored adit water and discharge it to Libby Creek at a rate equal to all of MMC’s Libby Creek appropriations or diversions occurring at that time. Discharges to Ramsey Creek also would be required if the modeling indicated adit inflows during the Closure Phase would adversely affect the senior water right on Ramsey Creek. Any new water right for water use issued pursuant to Montana law for water use in the selected alternatives would be consistent with the terms of an approved Plan of Operations. An approved Plan of Operations consistent with the selected alternatives would contain the stipulation that any water right acquired solely for the purposes of mineral development in an approved Plan of Operations will terminate when the Plan of Operations terminates. MMC must request and obtain prior written approval from the KNF for any change in beneficial use or place of use of water allowed under an approved Plan of Operations or the water use allowed under an approved Plan of Operations will terminate.

36 CFR 228.8(h) states that “certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations.” DNRC’s permit decision and associated conditions on any beneficial water use permit would constitute compliance with Montana water use requirements.

3.12.4.7.2 Kootenai Forest Plan

The agencies’ alternatives would be neutral with regard to progress toward the desired condition for water rights. In the agencies’ alternatives, any water right obtained for wetland and stream mitigation purposes would be conveyed to the Forest Service.

3.12.4.8 Irreversible and Irretrievable Commitments

Because the 3D predicted streamflow in the Libby Creek watershed eventually would return to pre-mining conditions, no irreversible or irretrievable commitment of resources would occur.

3.12.4.9 Short-Term Uses and Long-Term Productivity

This section is not applicable to water rights.

3.12.4.10 Unavoidable Adverse Environmental Effects

The issuance of new water rights would not adversely affect other water rights.

3.13 Water Quality

3.13.1 Regulatory Framework

3.13.1.1 Permits, Approvals and Authorizations Held by MMC

3.13.1.1.1 Board of Health and Environmental Sciences Order No 93-001-WQB

NMC submitted a "Petition for Change in Quality of Ambient Waters" in 1989 to the BHES requesting an increase in the allowable concentration of select constituents in surface water and groundwater above ambient water quality, as required by Montana's 1971 nondegradation statute. NMC submitted supplemental information to support the petition in 1992. In response to NMC's petition, the BHES issued an order in 1992, authorizing degradation and establishing limits in surface water and groundwater in the Libby Creek, Poorman Creek, and Ramsey Creek watersheds adjacent to the Montanore Project for discharges from the project (BHES 1992; Appendix A). The Order remains in effect for the operational life of the project and for as long as necessary thereafter. The Order established numeric limits for total dissolved solids, chromium, copper, iron, manganese, and zinc in both surface water and groundwater, nitrate+nitrite in groundwater only, and total inorganic nitrogen (nitrate+nitrite+ammonia) in surface water only (Table 120 and Table 121). Although the Order established a limit for copper of 0.003 mg/L, the chronic aquatic life standard of 0.00285 mg/L would be the limiting concentration.

The Order indicates that land treatment, as then proposed and currently proposed in Alternative 2, would satisfy the requirement in ARM 16.20.631(3) (now ARM 17.30.635(3)) to treat industrial wastes using technology that is the best practicable control technology available. In 1992, the DHES (now DEQ) determined that land treatment would provide adequate secondary treatment of nitrate (80 percent removal) and metals. The Order requires the DEQ to review design criteria and final engineering plans to determine that at least 80 percent removal of nitrogen would be achieved and the total inorganic nitrogen concentration in Libby, Ramsey, or Poorman creeks would not exceed 1 mg/L. The Order states "surface water and groundwater monitoring, including biological monitoring, as determined necessary by the Department [DEQ], will be required to ensure that the allowed levels are not exceeded and that beneficial uses are not impaired." The Order also adopted the modifications developed in Alternative 3, Option C, of the Final EIS (USDA Forest Service *et al.* 1992), addressing surface water and groundwater monitoring, fish tissue analysis, and instream biological monitoring.

3.13.1.1.2 MPDES Permit No MT0030279

The DEQ issued a MPDES permit to NMC in 1997 for Libby Adit discharge to the local groundwater or Libby Creek. Three outfalls were included in the permit: Outfall 001 – percolation pond discharging to groundwater; Outfall 002 – drainfield with three infiltration zones discharging to groundwater; and Outfall 003 – pipeline outlet to Libby Creek. The DEQ renewed the permit in 2006. A minor modification of the MPDES permit in 2008 reflected an owner/operator name change from NMC to MMC. In 2011, MMC applied to the DEQ to renew the existing MPDES permit and requested the inclusion of five new stormwater outfalls under the permit (Figure 28). In 2011, the DEQ determined the renewal application was complete and administratively extended the permit (ARM 17.30.1313(1)) until MMC received the renewed permit. The DEQ issued a draft renewal MPDES permit in July 2015 and held a public hearing on the draft permit in August 2015. The DEQ will issue a final renewal MPDES permit with its

ROD. MMC also held MPDES permit MTR104874 for stormwater discharges from the Libby Adit Site. These discharges were incorporated into the draft renewal MPDES permit.

Outfalls 001 and 002 are permitted as surface water discharges that incorporate a groundwater mixing zone. The percolation pond (Outfall 001) has an estimated capacity of 25 acre-feet. The drainfields (Outfall 002) are designed to accommodate discharge flows in excess of 200 gallons per minute (gpm). If the pond reaches full capacity, then an overflow pipe (Outfall 003) routes water directly into Libby Creek. MMC has not reported a discharge from Outfalls 002 and 003 during the term of the 2006-issued permit.

The five new stormwater outfalls are:

- Outfall 004—stormwater-only outfall for runoff from the Upper Libby Adit pad and access road discharging into Libby Creek
- Outfall 005—stormwater-only runoff from a 3.8-acre road segment between the Libby Adit Pad and the Libby Plant Site discharging into Libby Creek
- Outfall 006—stormwater-only runoff from a 6.2-acre road segment north of the Libby Plant Site discharging into Ramsey Creek
- Outfall 007—stormwater-only runoff from a 2.8-acre road segment south of the Poorman Tailings Impoundment Site discharging into Poorman Creek; this outfall is unlikely to be used because the access road alignment changed after MMC submitted its MPDES renewal permit application
- Outfall 008—stormwater-only runoff from a 2.9-acre road segment south of the Poorman Tailings Impoundment Site discharging into Poorman Creek

Precipitation and runoff from the Libby Adit Pad area would be collected and directed into Outfall 001. The drainage area for Outfall 005 is separate from the Libby Adit Pad area and does not include the drainage area for Outfall 001.

Table 120. Surface Water Limits Established by BHES Order for the Montanore Project and Montana Surface Water Quality Standards.

Parameter – Category[1]	BHES Order Limit (mg/L)	Human Health Standard (mg/L)	Aquatic Life Standard[2]	
			Acute (mg/L)	Chronic (mg/L)
Temperature (°F) – H	—	—	1ºF max increase for naturally occurring range of 32º to 66ºF, 67ºF max 0.5ºF max increase for naturally occurring 66.5ºF or greater 2ºF per hour max decrease for naturally occurring temperatures above 55ºF; 2ºF max decrease for naturally occurring range of 32º to 55ºF	
pH (s.u.)	—	—	6.5 – 8.5	
Dissolved Oxygen[3] – T	—	—	8.0 (early life) 4.0 (other life stages)	9.5 (7-day, early life) 6.5 (30-day, other life stages)
Total dissolved solids (TDS)	100	—	—	—
Total suspended solids (TSS)	—	—	30	20
Turbidity (NTU) – H A-1 waters (within CMW) B-1 waters (outside CMW)	 — —	 — —	 No increase above ambient 5 NTU maximum increase	
Total nitrogen, as N – H July 1 to September 30 October 1 to June 30	 — —	 — —	 0.275 No excessive amounts	
Total Inorganic Nitrogen (TIN), as N – H	1	—	—	
Nitrate + nitrite, as N – T	5.5	10	See total nitrogen standard	
Total phosphorus, as P – H July 1 to September 30 October 1 to June 30	 — —	 — —	 0.025 No excessive amounts	
Ammonia, as N – T	1.5	—	Calculated based on stream pH	Calculated based on stream pH and temperature
Aluminum[4] – T	—	—	0.75	0.087
Antimony[4]– T	—	0.0056	—	—
Arsenic[4] – C	—	0.01	0.34	0.15
Barium[4] – T	—	1.0	—	—
Beryllium[4] – C	—	0.004	—	—
Cadmium[4] – T	—	0.005	0.00052	0.000097
Chromium[4] – T	0.005	0.1	0.579/0.016[5]	0.0277/0.011[5]
Copper[4] – T	0.003	1.3	0.00379	0.00285
Iron[4] – H	0.1	—	—	1.0
Lead[4] – T	—	0.015	0.014	0.000545
Manganese[4]	0.05	—	—	—
Mercury[4] – T, BCF>300[6]	—	0.00005	0.0017	0.00091
Nickel[4] – T	—	0.1	0.145	0.0161
Selenium[4] – T	—	0.05	0.02	0.005
Silver[4] – T	—	0.1	0.000374	—
Zinc[4] – T	0.025	2	0.037	0.037

[1] T = toxic; C = carcinogen; H = harmful (aquatic life).
[2] Many metals standards are hardness dependent; for this table, values presented are based on a hardness of 25 mg/L.
[3] Dissolved oxygen standards are water column concentrations; see DEQ-7 for other notes.
[4] All metals standards, except aluminum, are based on total recoverable concentrations. Aluminum standards are based on dissolved aluminum concentrations and are valid only in pH range of 6.5 to 9.
[5] Aquatic life chromium standards are for trivalent/hexavalent forms.
[6] Mercury has a bioconcentration factor of greater than 300 (developed by EPA).
mg/L = milligrams/liter; "—" = No applicable standard.
Sources: BHES 1992; Circular DEQ-7, Montana Numeric Water Quality Standards, DEQ 2012a; DEQ 2014a; ARM 17.30.623; ARM 17.30.637 (1)(e).

Table 121. Groundwater Limits Established by BHES Order for the Montanore Project and Montana Groundwater Quality Standards.

Parameter	BHES Order Limit (mg/L)	Montana Groundwater Quality Standard (mg/L)
pH	—	6.5 – 8.5
Total dissolved solids	200	—
Nitrate + nitrite, as N	10	10
Dissolved Metals		
Antimony	—	0.006
Arsenic	—	0.01
Barium	—	1.0
Beryllium	—	0.004
Cadmium	—	0.005
Chromium	0.02	0.1
Copper	0.1	1.3
Iron	0.2	—
Lead	—	0.015
Manganese	0.05	—
Mercury	—	0.002
Nickel	—	0.1
Selenium	—	0.05
Silver	—	0.1
Zinc	0.1	2

"—" = No applicable concentration.
mg/L = milligrams per liter.
Source: BHES 1992; Circular DEQ-7, Montana Numeric Water Quality Standards, DEQ 2012a; ARM 17.30.623.

3.13.1.2 Applicable Regulations and Standards

3.13.1.2.1 Federal Requirements

Organic Administration Act

The Organic Administration Act authorizes the Forest Service to regulate the occupancy and use of National Forest System lands. The Forest Service's locatable minerals regulations are promulgated at 36 CFR 228, Subpart A. The regulations apply to operations conducted under the U.S. mining laws as they affect surface resources on National Forest System lands under the jurisdiction of the Secretary of Agriculture. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. 36 CFR 228.8 also requires that mining operators comply with applicable state and federal water quality standards including the Clean Water Act; comply with applicable Federal and State standards for the disposal and treatment of solid wastes; take all practicable measures to maintain and protect fisheries and wildlife habitat which may be affected by mine operations; construct and maintain all roads so as to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values; and reclaim the surface disturbed in operations by taking such measures as preventing or controlling onsite and off-site damage to the environment and forest surface resources. 36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations."

Clean Water Act

The Federal Water Pollution Control Act (Clean Water Act) is designed to protect and improve the quality of water resources and maintain their beneficial uses. Proposed mining activities on National Forest System lands are subject to compliance with Clean Water Act Sections 401, 402 and 404 as applicable. The DEQ, EPA, and the Corps all have regulatory, compliance and enforcement responsibilities under the Clean Water Act. The Clean Water Act requires states to establish water quality standards, including specifying appropriate water uses to be achieved and protected, adopting water quality criteria that protect the designated use, and developing and adopting a statewide antidegradation policy. In 1974, the EPA delegated to Montana authority to implement some Clean Water Act programs within the state. Under section 303(c) of the Act, the EPA is to review and to approve or disapprove State-adopted water quality standards. The EPA has reviewed and approved Montana's water quality standards. Because EPA delegated Montana authority to implement the provisions of the Clean Water Act applicable to surface water and the Montanore Project, applicable Clean Water Act requirements are discussed under the next section, *State Requirements.*

Pursuant to the Clean Water Act, MMC must obtain a 401 certification from the DEQ for proposed discharges of fill into navigable waters unless the DEQ waives its issuance (see section 1.6.2.1, *Montana Department of Environmental Quality*). A 401 certification from the DEQ certifies that the operator's proposed discharges of fill permitted under a Section 404 permit are in compliance with all applicable water quality requirements of the Clean Water Act. Unless the 401 certification is waived, a mining operator must give a copy of the 401 certification to the Forest Service before the KNF can allow the operator to commence any activity that requires a 404 permit.

Effluent guidelines are national standards for wastewater discharges to surface waters and publicly owned treatment works (sometimes called municipal sewage treatment plants). The EPA issues effluent guidelines for categories of existing sources and new sources under the Clean Water Act. For industrial sources, national effluent limitation guidelines (ELGs) have been developed for specific categories of industrial facilities and represent technology-based effluent limits. The Montanore Mine site is in an industrial category that is specifically identified and included in the ELGs at 40 CFR 440, Ore Mining and Dressing Point Source Category, Subpart J – Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores Subcategory.

The federal ELGs apply to mine drainage and process wastewater that discharge to surface water. Mine drainage is "any water pumped, drained, or siphoned from a mine" (40 CFR 440.132). Process wastewater is "any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product" (40 CFR 401.11). In terms of the ELG requirements for copper mines that use froth flotation for milling, tailings water is considered process wastewater. Process wastewater from copper mines that use froth flotation for milling may not be discharged to state surface waters except in areas of net precipitation (where precipitation and surface runoff within the impoundment area exceeds evaporation). Because precipitation and surface runoff within the impoundment area would not consistently exceed evaporation, the impoundment in all alternatives would be designed as a zero-discharge facility. The DEQ is responsible for ensuring compliance with the federal ELGs.

Under USDA Nonpoint Source Water Quality Policy Directive 9500-007, the Forest Service agreed to become a Designated Management Agency for National Forest System lands within all states, including Montana. The Forest Service strategy for control of nonpoint source pollution is to require mining operators to apply appropriate BMPs, evaluate BMP performance, and initiate corrective action where objectives are not met. The Forest Service's *National Best Management Practices for Water Quality Management on National Forest System Lands* (USDA Forest Service 2012a) are designed to achieve and document water resource protection on National Forest System lands.

A 2008 MOU between the Forest Service and the DEQ entitled "Fostering Collaboration and Efficiencies to Address Water Quality Impairment on National Forest System Lands in Montana" is a component of the national and Montana Nonpoint Source Program and identifies the process of cooperatively ensuring proper design and implementation of water protection management system on National Forest System lands in Montana.

Kootenai Forest Plan

The 2015 KFP direction considered in the analysis of water quality is:

> **GOAL-WTR-01.** Maintain or improve watershed conditions in order to provide water quality, water quantity, and stream channel conditions that support ecological functions and beneficial uses.
>
> **FW-DC-WTR-01.** Watersheds and associated aquatic ecosystems retain their inherent resilience to respond and adjust to disturbance without long-term, adverse changes to their physical or biological integrity.
>
> **FW-DC-WTR-02.** Water quality meets applicable state water quality standards and fully supports beneficial uses. Flow conditions in watersheds, streams, lakes, springs, wetlands, and groundwater aquifers fully support beneficial uses, and meet the ecological needs of native and desirable non-native aquatic species and maintain the physical integrity of their habitats.
>
> **FW-DC-WTR-04.** Municipal watersheds and public water systems (source water protection areas) meet water quality standards.
>
> **FW-STD-WTR-01.** Management activities shall maintain or improve water quality in public source water areas, and be consistent with applicable state source water protection requirements. Short-term effects (effects that occur during, or immediately following, implementation of activity) from activities in source water areas may be acceptable when those activities support long-term benefits (benefits that occur following completion of the activity) to aquatic resources.
>
> **FW-GDL-WTR-01.** Management activities in impaired watersheds (listed by the state under section 5 of the Integrated 303(d)/305(b) Report) with approved TMDLs are designed to comply with the TMDL. Management activities in watersheds with streams on the 303(d) list are designed to maintain or improve conditions relative to the cause for impairment and will not cause a decline in water quality or further impair beneficial uses. A short-term or incidental departure from state water quality standards may occur where there is no long-term threat or impairment to the beneficial uses.

FW-GDL-WTR-02. In order to avoid future risks to watershed condition, ensure hydrologic stability when decommissioning or storing roads or trails.

FW-GDL-WTR-03. Project-specific best management practices (BMPs) will be incorporated in all land use and project plans as a principle mechanism for controlling non-point pollution sources, meet soil and water goals, and protect beneficial uses. To the extent practicable, ditch and road surface runoff should be disconnected from streams and other water bodies.

GA-DC-WTR-LIB-02. Source water protection is provided in the Flower Creek watershed for the town of Libby.

3.13.1.2.2 State Requirements

The DEQ is responsible for administering several water quality statutes, including the Public Water Supply Act and the Montana Water Quality Act. The DEQ also administers several sections of the federal Clean Water Act pursuant to an agreement between the State of Montana and the U.S. EPA. The State of Montana, through the DEQ, has been delegated authority for administering nonpoint source pollution prevention programs, the National Pollutant Discharge Elimination System program, and water quality standards. The Water Quality Act provides a regulatory framework for protecting, maintaining, and improving the quality of water for beneficial uses. Pursuant to the Water Quality Act, the DEQ has developed water quality classifications and standards, a nondegradation policy, and a permit system to control discharges into state waters. Mining operations must comply with Montana's regulations and standards for surface water and groundwater.

MPDES permits are required for discharges of wastewater to state surface water. MPDES permits regulate discharges of wastewater by imposing, when applicable, technology-based effluent limits, which specify the minimum level of treatment or control for pollutants and water quality-based effluent limits that attain and maintain applicable numeric and narrative water quality standards. A MPDES permit may also include limits for discharges of stormwater and require the development of a Stormwater Pollution Prevention Plan (SWPPP). Montana Ground Water Pollution Control System permits are required for discharges of wastes to state groundwaters. Discharges to groundwater from mining operations subject to operating permits under the Metal Mine Reclamation Act are not subject to groundwater permit requirements (75-5-401(5), MCA).

Water Quality Standards

The DEQ classifies all surface water in the analysis area as either A-1 (within wilderness areas) or B-1. Water quality standards are nearly identical for A-1 and B-1 waterbodies. An A-1 classification has stricter protection requirements associated with allowable levels of impurities for drinking, culinary, and food-processing purposes, and stricter protection requirements associated with allowable levels of turbidity. The water quality of both A-1 and B-1 waterbodies must be suitable for bathing, swimming, and recreation, aquatic life, wildlife, and agricultural and industrial uses. Surface water in the wilderness is classified as A-1, where stricter allowable changes are defined to maintain the water quality classification.

Montana surface water quality standards for inorganic pollutants applicable to the project are provided in Table 120. The DEQ also has required reporting limits for pollutants. Both Montana's surface water and groundwater rules contain narrative standards (ARM 17.30.620 through 17.30.670 and ARM 17.30.1001 through 17.30.1045). The narrative standards cover a number of parameters, such as alkalinity, chloride, hardness, sediment, sulfate, and total dissolved solids (for surface water), for which sufficient information does not yet exist to develop specific numeric standards. These narrative standards are directly translated to protect beneficial uses from adverse effects, supplementing the existing numeric standards. The narrative standard for nutrients is that state surface waters must be free of substances that will create conditions that produce undesirable aquatic life (ARM 17.30.637).

In 2014, the Board of Environmental Review adopted numeric standards for total phosphorus and total nitrogen for wadeable streams in Montana Ecoregions (DEQ 2014a). Wadeable streams are perennial or intermittent streams in which most of the wetted channel is safely wadeable by a person during baseflow conditions; this includes all streams in the analysis area. The analysis area is in the Northern Rockies Ecoregion; all wadeable streams have a seasonal total phosphorus standard is 0.025 mg/L and a seasonal total nitrogen standard is 0.275 mg/L between July 1 to September 30. The narrative nutrient standard applies during October 1 to June 30. Because the numeric nutrient standards are stringent and may be difficult for MPDES permit holders to meet in the short term, Montana's Legislature adopted a law (75-5-313, MCA) allowing for the achievement of the standards over time via variance procedures found in Circular DEQ-12B (DEQ 2014b). A MPDES permit holder may apply for a general variance for either total phosphorus or total nitrogen, or both. The general variance may be established for a period not to exceed 20 years. In 2015, MMC requested that the general variance for both total nitrogen and total phosphorus be incorporated into the MPDES permit and indicated that the facility design flow is less than 1.0 million gallons per day (mgd). In the draft renewal MPDES permit, the DEQ preliminarily granted a variance for total nitrogen of 15 mg/L, and determined that a variance for total phosphorus was not necessary because the facility did not show reasonable potential to violate this nutrient standard. The DEQ would require the completion of an optimization study/nutrient reduction analysis to optimize nutrient reduction with existing infrastructure and analyze other cost-effective methods of nutrient load reductions. The total nitrogen variance would be reviewed every 3 years by DEQ and the variance concentration reduced if new, low cost nutrient removal technologies have become widely available (DEQ 2014b). The general variance for total nitrogen may not be in place more than 20 years, and the standard of 0.275 mg/L for total nitrogen must be reached at the end of the mixing zone when it is technologically and economically feasible to do so. The final MPDES permit will contain DEQ's final determination regarding the variance.

The DEQ classifies all groundwater in the analysis area as Class I, which are suitable with little or no treatment for public and private drinking water supplies, culinary, and food preparation purposes, irrigation, drinking water for livestock and wildlife, and commercial and industrial purposes. Montana groundwater quality standards for inorganic pollutants applicable to the project are shown in Table 121.

If authorized by the DEQ by a 318 authorization, the short-term water quality standards for total suspended solids and turbidity resulting from stream-related construction activities or stream enhancement projects are the narrative standards for total suspended solids. If a short-term narrative standard is authorized, the numeric standard for turbidity does not apply to the affected water body during the term of the narrative standard (75-5-318, MCA). During the review of a 318 authorization application, the DEQ reviews each application on a case-by-case basis to determine whether there are reasonable alternatives that preclude the need for a narrative standard. If the DEQ determines that the numeric standard for turbidity cannot be achieved during the term of the activity and that there are no reasonable alternatives to achieve the numeric standard, the DEQ may authorize the use of a narrative standard for a specified term. Any authorization would include conditions that minimize, to the extent practicable, the magnitude of any change in water quality and the length of time during which any change may occur. The authorization also would include site-specific conditions that ensure that the activity is not harmful, detrimental, or injurious to public health and the uses of state waters and that ensure that existing and designated beneficial uses of state water are protected and maintained upon completion of the activity. Conditions that require water quality or quantity monitoring and reporting may be included. The DEQ may not authorize short-term narrative standards for activities requiring a MPDES permit.

Nondegradation Rules

The Montana Water Quality Act requires the DEQ to protect high quality waters from degradation. The current rules were adopted in 1994 in response to amendments to Montana's nondegradation statute in 1993 and apply to any activity that is a new or increased source that may degrade high quality water. These rules do not apply to water quality parameters for which an authorization to degrade was obtained prior to the 1993 amendments to the statute. NMC, MMC's predecessor, obtained an authorization to degrade in 1992 for certain water quality parameters. For those parameters, the limits contained in the authorization to degrade apply. For those parameters not covered by the authorization to degrade, the applicable nonsignificance criteria established by the 1994 rules, and any subsequent amendments, apply (ARM 17.30.715), unless MMC obtained an authorization to degrade under the current statute.

The nondegradation rules (ARM 17.30.715(1)) state that changes in existing surface water quality resulting from the activities that meet the criteria listed below are nonsignificant, and are not required to undergo degradation review:

- Discharges containing carcinogenic parameters, such as arsenic or beryllium, or parameters with a bioconcentration factor greater than 300, such as mercury, at concentrations less than or equal to the concentrations of those parameters in the receiving water;
- Discharges containing toxic parameters, including ammonia, nitrate plus nitrite, nitrite, aluminum, antimony, barium, cadmium, chromium, copper, lead, nickel, selenium, silver, and zinc, which will not cause changes that equal or exceed the trigger values in Circular DEQ-7 (trigger values are used to determine if proposed activities will cause degradation). Whenever the change exceeds the trigger value, the change is not significant if the resulting concentration outside of a mixing zone designated by the DEQ does not exceed 15 percent of the lowest applicable standard;
- Discharges containing harmful parameters, such as iron, turbidity, total nitrogen, and total phosphorus, that do not cause changes outside the mixing zone greater than 10 percent of the applicable standard and where the existing concentration is less than 40 percent of the standard;
- Discharges causing changes in the quality of water for any parameter for which there are only narrative water quality standards if the changes do not have a measurable effect on any existing or anticipated use or cause measurable changes in aquatic life or ecological integrity;
- Changes in the concentration of nitrate in groundwater which will not cause degradation of surface water if the sum of the predicted concentrations of nitrate at the boundary of any applicable mixing zone will not exceed the following values:

(i) 7.5 mg/L for nitrate sources other than domestic sewage;

(ii) 5.0 mg/L for domestic sewage effluent discharged from a conventional septic system;

(iii) 7.5 mg/L for domestic sewage effluent discharged from a septic system using level two treatment, as defined in ARM 17.30.702; or

(iv) 7.5 mg/L for domestic sewage effluent discharged from a conventional septic system in areas where the ground water nitrate level exceeds 5.0 mg/L primarily from sources other than human waste.

For purposes of this subsection, the word “nitrate” means nitrate as nitrogen; and

- Changes in concentration of total inorganic phosphorus in groundwater if water quality protection practices approved by the DEQ have been fully implemented and if an evaluation of the phosphorus adsorptive capacity of the soils in the area of the activity indicates that phosphorus will be removed for a period of 50 years prior to a discharge to any surface waters.

Notwithstanding compliance with the nonsignificance criteria in ARM 17.30.715(1), the DEQ may determine under ARM 17.30.715(2) that a change in water quality is degradation based on the following criteria: a) cumulative impacts or synergistic effects; b) secondary byproducts of decomposition or chemical transformation; c) substantive information derived from public input; d) changes in flow; e) changes in the loading of parameters; f) new information regarding the effects of a parameter; or g) any other information deemed relevant by the DEQ and that relates to the criteria in ARM 17.30.715 (1). Under ARM 17.30.715(3), the DEQ may determine that a change in water quality is nonsignificant based on information submitted by an applicant that demonstrates conformance with the guidance found in 75-5-301(5)(c), MCA which is: i) potential for harm to human health, a beneficial use, or the environment; ii) strength and quantity of any pollutant; iii) length of time the degradation will occur; and iv) the character of the pollutant so that greater significance is associated with carcinogens and toxins that bioaccumulate or biomagnify and lesser significance is associated with substances that are less harmful or less persistent. Such a determination would be submitted for public comment before making a decision. Under the Montana Water Quality Act, no authorization to degrade may be obtained for outstanding resource waters, such as surface waters within a wilderness.

3.13.2 Analysis Area and Methods

3.13.2.1 Analysis Area

The groundwater quality analysis area is the same as groundwater hydrology and is described in section 3.10.2.1, *Analysis Area.* The surface water quality analysis area is the same as surface water hydrology and is described in section 3.11.2.1, *Analysis Area.* These analysis areas were used for direct, indirect, and cumulative effects. Streams located outside the analysis area, such as Libby Creek below US 2 may be affected by the project, but effects would be negligible.

3.13.2.2 Methods

3.13.2.2.1 Baseline Data Collection

NMC began surface water quality data collection in the analysis area in 1988 and MMC has continued data collection to the present time. In addition, the Forest Service has collected water quality data on some analysis area streams since 1960. Details of the surface water baseline data collection through 2009 are provided in the Data Collection section of the *Final Baseline Surface Water Quality Technical Report* (ERO Resources Corp. 2011c). The Forest Service is conducting a long-term air quality study that began in 1991 that includes lake chemistry monitoring of Upper and Lower Libby Lakes (Grenon and Story 2009, McMurray 2013). Gurrieri and Furniss (2004) reported results of chemical analyses at Rock Lake of bulk atmospheric deposition, lake water, surface inflow, and springs collected manually in 1999 at two- to four-week intervals during the ice-free period. Snow samples were collected in June 1999 at Rock Lake. Kline Environmental Research and NewFields (2012) reported water quality field parameters for drainages in the Poorman Impoundment Site, and in headwater tributaries in the mine area.

NMC collected groundwater data from monitoring wells in the Little Cherry Creek and Poorman Tailings Impoundment Sites, LAD Areas, and Libby Adit Site between 1988 and 1995 (Geomatrix 2006c). The sampling frequency varied from one to multiple times per year. Water samples were collected from wells in the Poorman Tailings Impoundment Site between 1988 and 1993 and analyzed for most major cations and anions and total dissolved solids. MMC collected quarterly groundwater quality data from two monitoring wells between 2005 and 2009, one between the Little Cherry Creek and Poorman Tailings Impoundment Sites (LCTM-8V), and one near the proposed LAD Areas (WDS-1V). MMC also collected monthly groundwater quality data from two monitoring wells at the Libby Adit Site (MW07-01 and MW07-02) beginning in 2007.

The preceding section summarizes the baseline information collected on water quality and the affected environment, and the following sections describe the approaches used by the lead agencies in analyzing potential effects. The KNF and the DEQ determined that the baseline data and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on water quality in the analysis area, and to enable the decision makers to make a reasoned choice among alternatives. Section 3.10.2.4, *Additional Data Collection* and Appendix C describe the additional water quality data that would be collected during all phases of the project, including the Evaluation Phase and for final design. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.13.2.2.2 Impact Analysis

Mass Balance Analysis

A mass balance approach was used to predict potential surface water quality changes resulting from mine wastewater discharge. For Alternatives 3 and 4, mass balance calculations were completed for Libby Creek at LB-300 where discharges from the Water Treatment Plant would be made. For Alternative 2, the agencies completed mass balance calculations for three streams near where discharges from the Water Treatment Plant or from the LAD areas would occur: Libby, Poorman, and Ramsey creeks. Locations analyzed on Poorman and Ramsey creeks for the Alternative 2 LAD areas were PM-1200, RA-400 and RA-600 downgradient of the two proposed LAD areas (data used for PM-1200 were collected at PM-1000, and data used for RA-600 were collected at RA-500, RA-550, and RA-600). In all alternatives, mass balance calculations were completed at locations on Libby Creek at LB-1000 and LB-2000, downgradient of the discharges. In the calculations, a representative wastewater quality at an estimated flow rate was mixed with a representative surface water quality at an estimated flow rate to estimate a final surface water concentration. With the exception of the Operations and Closure Phases in Alternative 3, the effluent discharge rates for the mine phases are from the water balance tables (Table 14 and Table 24) in Chapter 2. Water would be discharged from the Water Treatment Plant for water rights mitigation purposes (as described in section 2.5.4.3.2, *Water Rights*) during the Alternative 3 Operations Phase. An effluent discharge rate of 921 gpm was used, which includes the discharge of a maximum of 541 gpm during a dry year for mitigation, and the discharge of 380 gpm of mine and adit inflows. Although discharges would be higher during average and wet years, streamflow also would be higher and MPDES permitted effluent limits are set based on very low flows. During the Alternative 3 Closure phase, a discharge rate of 540 gpm was used, which includes the treatment of 405 gpm from the tailings impoundment and 135 gpm for mitigation. The mass balance calculations presented in Appendix G provide predicted concentrations, after mixing, of total dissolved solids, ammonia, nitrate, total inorganic nitrogen (which was treated in the calculations as the sum of ammonia + nitrate), total nitrogen, total phosphorus, aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc. Data were also collected for thallium, but thallium was not detected in surface water, groundwater, or adit and mine water, and it is not discussed further.

Because nitrate would be the dominant nitrogen form, the analysis assumed that the BHES Order limit of 1 mg/L for TIN would be the applicable limit for nondegradation purposes. The DEQ completed a nondegradation review and set effluent limits during the MPDES permitting process. In the draft renewal permit, DEQ preliminarily granted a variance for total nitrogen of 15 mg/L; a variance for total phosphorus was determined not necessary because the facility did not show reasonable potential to exceed this nutrient standard. In the mass balance analysis, the standard of 0.275 mg/L for total nitrogen was used to determine the effluent concentration that would be required by DEQ when it is technologically and economically feasible to meet that standard outside of the mixing zone in Libby Creek. The nitrogen and phosphorus limits for ambient surface waters could be modified in the MPDES permit issued by DEQ at any time if nuisance algal growth caused by MMC's discharge was observed.

For discharges to groundwater at the LAD Areas and tailings impoundment sites, dissolved metal concentrations were used. For MMC's proposed discharges to LAD Areas, some of which would also reach surface water, dissolved metal concentrations were used for the representative wastewater quality because discharges would flow through unconsolidated materials and reach groundwater before reaching surface water.

Potential changes in groundwater quality were assessed by developing representative wastewater quality that would be discharged to groundwater, such as seepage from the tailings impoundment in all mine alternatives and water applied to the LAD Areas in Alternative 2. The agencies completed mass balance calculations for discharges at the impoundment sites and LAD Areas. Representative wastewater quality at an estimated flow rate was mixed with representative ambient groundwater at an estimated groundwater flux to estimate a final groundwater concentration. The uncertainties associated with the mass balance calculations are discussed in section 3.13.4.5, *Uncertainties Associated with the Water Quality Assessment*. The agencies' approach to developing representative concentrations is discussed in subsequent sections.

Streamflows used for the calculations were estimated $7Q_{10}$ flow less any pre-discharge depletions (see next section), except for LB-300, where the modeled baseflow less any pre-discharge depletion due to mine inflow was used (see section 3.8.3). Discharge rates used in the mass balance calculations are provided in Appendix G.

Stormwater runoff events associated with storms exceeding the 10-year/24-hour storm (the design capacity of the Alternative 2 stormwater retention ponds) were not analyzed. The water quality of both the storm runoff and the storm flows of the receiving streams are unknown. A qualitative analysis of possible changes in stream water quality during storm runoff events was completed. Streamflow would be very high during such an event, with discharges to Poorman and Ramsey creeks likely less than 5 percent of the high flows. Any discharges from stormwater retention ponds would be sampled and regulated.

Surface water quality changes to streams, springs, and lakes due to reduced contributions from deeper bedrock groundwater were evaluated qualitatively. Available data on the relative contribution of direct surface runoff, shallow groundwater, and deeper bedrock groundwater, and the water quality of each source to surface water at specific locations are not adequate for a quantitative analysis.

The following subsections describe the streamflow rates, groundwater flux, receiving quality values, and wastewater quality values used in the mass balance calculations.

Streamflow Rates Used in Mass Balance Analyses

The DEQ's standard surface water mixing zone rules (ARM 17.30.516) require the use of the $7Q_{10}$ flow to assess effects of discharges that may affect surface water. The $7Q_{10}$ flow is the lowest 7-day average flow that occurs on average once every 10 years. The USGS (Hortness 2006) developed the method used by the agencies to estimate $7Q_{10}$ flow (Appendix G). The estimated $7Q_{10}$ flow for analysis area monitoring locations is:

- 2.06 cfs (925 gpm) for Ramsey Creek at RA-400
- 2.07 cfs (929 gpm) for Ramsey Creek at RA-600
- 1.55 cfs (696 gpm) for Poorman Creek at PM-1200
- 3.03 cfs (1,361 gpm) for Libby Creek at LB-300
- 8.59 cfs (3,855 gpm) for Libby Creek at LB-1000
- 8.99 cfs (4,035 gpm) for Libby Creek at LB-2000

For LB-300, the flow used in the mass balance analyses was 1.22 cfs, which was the baseflow for LB-300 estimated in the 3D groundwater model. The reason for using the modeled baseflow rather than the estimated $7Q_{10}$ flow at LB-300 is explained in section 3.8.3. This baseflow was the flow estimated by the 3D model for average climate conditions; it is possible that the flow at LB-300 might be lower than 1.22 cfs when climate conditions were drier and/or hotter than average.

For the mass balance analyses, the flow reductions estimated by the 3D model were subtracted from the estimated $7Q_{10}$ flow (or from the modeled baseflow at LB-300), potable water use (9 gpm) was subtracted from the Libby Creek flows, and water diverted from Libby Creek by the impoundment and pumpback wells (up to 247 gpm) was subtracted from the Libby Creek flows in the pumpback well area of influence (at LB-2000 for Alternatives 2 and 4 and LB-1000 and 2000 for Alternative 3). The resulting flows were used in the mass balance calculations.

Groundwater Flux Used in Mass Balance Analyses

Section 3.10.4.2.1, *LAD Areas* provides the agencies' analysis of the maximum possible application rate of wastewater that could occur to the LAD Areas based on guidance documents from the Corps and EPA (Corps 1982; EPA 2006b) and limitations due to the hydrologic characteristics of subsurface unconsolidated materials. The maximum application rate to the LAD Areas that the agencies estimated would be 130 gpm. The application rate was used in the agencies' analysis of effects for Alternative 2; application rate would vary and would be based on BHES Order limits and MPDES permitted effluent limits. Applied water that was not evapotranspired would percolate to and then mix with groundwater and then flow to adjacent streams. For Alternatives 3 and 4, the agencies assumed that all water treated and released from the Water Treatment Plant to Libby Creek, and, if necessary for water right concerns, to Ramsey Creek, would meet BHES Order limits or applicable nondegradation criteria at the end of a mixing zone in accordance with the MPDES permit.

The KNF determined that the Poorman site and the Little Cherry Creek site were sufficiently similar in geologic character and origin that the hydrogeologic properties and conditions at the Little Cherry Creek site could be used in an environmental analysis of the Poorman Impoundment Site. Tailings seepage at the Little Cherry Creek Impoundment Site was estimated with groundwater modeling conducted of the Little Cherry Creek Impoundment Site for MMC (Klohn Crippen 2005) and independently verified by the lead agencies (USDA Forest Service 2008). Seepage not collected by the underdrain seepage collection system is expected to flow to groundwater at a rate of about 25 gpm and, after the impoundment was reclaimed, slowly decrease to 5 gpm (Klohn Crippen 2005). The agencies used the same estimates for the Poorman Impoundment Site because of the similarity in the geologic conditions observed from the drill log data collected from the Little Cherry Creek Impoundment Site and the Poorman Impoundment Site (Morrison-Knudsen Engineers, Inc. 1989a, Morrison-Knudsen Engineers, Inc. 1989b). In addition, the proposed underdrain system at both sites would be similar. The rate of seepage not collected by the underdrain seepage collection system is likely more influenced by the effectiveness of the underdrain seepage collection system than the underlying geologic materials. A SEEP/W analysis of the Poorman site would be completed during final design. For the mass balance analysis to estimate effects on groundwater quality, the groundwater flux (volume per unit time) beneath the Little Cherry Creek impoundment was estimated to be about 35 gpm (Geomatrix 2007b) and the agencies estimated a groundwater flux of 41 gpm under the Poorman Tailings Impoundment. Downgradient of the tailings impoundment, such water would be captured by a pumpback well system before reaching surface water and returned to the tailings impoundment.

Receiving Water Quality Used in Mass Balance Analysis

Receiving water quality includes both surface water and groundwater. For the mass balance analyses, estimates of the representative water quality of the streams that would receive wastewater discharges were derived from surface water monitoring data collected from 1988 to 2012 (ERO Resources Corp. 2011c; MMC 2008, 2009b, 2010, 2011b, 2012g, 2013). Representative surface water concentrations are provided in Appendix K-1. For the analyses for the Alternative 2 LAD Areas and the tailings impoundment for all alternatives, estimates of the ambient groundwater quality were derived from groundwater data collected from 2005 to 2009 (MMC 2008, 2009b, 2010). Water quality in a well (LCTM-8V) between the Little Cherry Creek and Poorman Impoundment Sites was used to represent ambient concentrations at both impoundment sites. Well LCTM-8V was used as representative because the well was within the footprint of the Little Cherry Creek Impoundment and 850 feet north of the footprint of the Poorman Impoundment; was sampled quarterly between 2005 and 2009; and represented the best available data. Additional site-specific water quality data would be collected prior to construction. Representative concentrations for each parameter in groundwater are provided in Appendix K-4.

Representative values were determined after removing data outliers. For water quality parameters with no below detection limit values, the representative value is the median concentration. For parameters with some below detection limit values (less than or equal to 70 percent), the representative value is the Kaplan Meier mean concentration. For parameters with greater than 70 percent below detection limit values, the representative concentration is the median concentration with the detection limit substituted for below detection limit results. The *Final Baseline Surface Water Quality Technical Report* (ERO Resources Corp. 2011c) discusses the methods used in determining representative concentrations in ambient surface waters along with details concerning data reduction methods and outlier identification. The same methods were applied in determining the representative groundwater concentrations. The data outliers removed along with a discussion of the data reduction methods are provided in Appendix K-11. The agencies reviewed and summarized available water quality data collected through 2012. Any data collected after 2012 has not been reviewed as part of this EIS evaluation.

Wastewater Quality

Consistent with the recommendations of the Global Acid Rock Drainage guide (International Network for Acid Prevention 2010) for mine planning, feasibility and design stage projects, potential water quality impacts were predicted for material types based on geological descriptions and mineral deposit models. Changes in the chemistry of water interacting with rock exposed in underground mine workings, backfilled waste rock, surface facilities constructed with waste rock, and tailings were evaluated using available metal mobility and kinetic analyses of rock from the Montanore, Rock Creek, and Troy deposits (see section 3.9.4, *Environmental Geochemistry*). Estimates of wastewater quality (Table 122) relied on monitored water quality from the Libby Adit, the waste rock stockpiled at the Libby Adit, and the Troy Mine underground workings, waste rock, tailings impoundment, and decant pond (Appendix K). Because no organic nitrogen data were available for the mine and tailings water from the Troy Mine, total nitrogen concentrations provided in Table 122 for mine and tailings water are only for the total of nitrate, nitrite and ammonia concentrations. A *Final Baseline Surface Water Quality Technical Report* (ERO Resources Corp. 2011c) provides the methods used in reducing the data, identifying outliers, and determining representative concentrations in wastewater. Representative wastewater concentrations were updated using available water quality data collected through 2012. A discussion of the geochemistry information used in developing wastewater quality is in section 3.13.3.3, *Geochemistry of Exposed Materials*. Section 3.13.4.5, *Uncertainties Associated with the Water Quality Assessment* discusses the uncertainties of the concentrations provided in Appendix K.

Three aspects of water management at Montanore in Alternatives 3 and 4 would likely result in lower concentrations of total dissolved solids, metals, and nutrients in tailings water quality than found at the Troy Mine. 1) Mine and adit water would not be used for ore processing, but would be treated year-round and discharged from the Water Treatment Plant. 2) Pumpback wells at the impoundment would pump groundwater mixed with tailings seepage back into the impoundment. The estimated seepage at full capacity is 25 gpm and the estimated pumping rate of all pumpback wells is 250 gpm. Groundwater at both impoundment sites would have lower concentrations of all parameters than tailings water. 3) MMC would divert water from Libby Creek during high flows for mill use. MMC estimates 125 million gallons of water would be needed during an average precipitation year. The makeup water would be stored in the impoundment, the Seepage Collection Pond, or the mine/yard pond at the Libby Plant Site. Libby Creek surface water would have lower concentrations of all parameters than tailings water.

Underground workings would expose zones of ore and waste rock to groundwater, with relatively low reactive surface area. Most sulfide and metal-bearing minerals are encapsulated within silica in the Revett Formation and water quality impacts would likely be minimal. Waste rock backfilled into underground workings would be variably reactive; the extent of sulfide oxidation and metal release would depend on the surface area of the backfill, as well as the relative conditions of saturation and oxygen availability. For this assessment, water interacting with ore and waste rock exposed in underground workings was estimated using the water chemistry measured in the Troy Mine adit, where comparable zones of in-place ore and waste, and backfill deposits, are exposed to groundwater. Underground workings in ore would be minimal during the Evaluation Phase. Any ore that was stockpiled early in mine life would be stockpiled in the tailings impoundment, placed on a liner at the waste rock stockpile area in the tailings impoundment, or stored at the stockpile area. Any seepage water from the ore would be collected and re-used in the mine or treated. Unsaturated conditions expected to exist underground during the Construction and Operations Phases are represented with operational monitoring data from the Troy Mine (Table 122; Appendix K-8). The conditions expected at closure are represented with water quality data collected at the Troy Mine during a period of interim closure between 1993 and 2004 when dewatering occurred during most of the period and the majority of the underground workings remained unsaturated. The results of laboratory kinetic tests generally agree with the monitoring data, although some differences in metal concentrations (relative magnitude, dissolved vs. total, etc.) were observed that would be addressed during Evaluation Phase testing. Future geochemical analyses of metal release potential for waste rock (see Appendix C) would be used, together with monitoring of underground water quality during the Operations Phase, to address uncertainty about the contribution from backfilled waste rock and refine long-term predictions of water quality for underground workings.

Table 122. Estimated Adit, Mine, and Tailings Wastewaters and Water Treatment Plant Treated Water Quality for Alternatives 2, 3, and 4.

Parameter	Construction Adit Water	Post-Construction Adit Water	Mine Water Operations	Mine Water Post-Operations	Tailings Water	Water Treatment Plant Discharge†
Total dissolved solids	122	114	121	108	266	110
Ammonia, as N	<0.65	<0.050	<1.6	<0.16	4.4	0.70
Nitrate, as N	<37	<0.12	**3.1**	**0.76**	**13**	0.60
Total Nitrogen	<38.1	<0.13	**<4.7**	**<0.92**	**17.4**	0.155
Total Phosphorus	<0.026	<0.0073	0.096	<0.10	0.086	0.007
Aluminum	<0.014	<0.011	0.075	**<0.050**	<0.13	0.090
Antimony	<0.00069	<0.00032	<0.0088	<0.0094	0.023	0.0010
Arsenic	<0.0057	<0.0011	<0.018	<0.0031	<0.0017	0.00010
Barium	0.014	0.012	0.068	**0.043**	<0.11	0.20
Beryllium	<0.00080	<0.00080	**<0.0010**	**<0.0010**	<0.0010	0.00020
Cadmium	<0.000080	<0.000080	0.0015	**0.00040**	0.00097	0.000010
Chromium	<0.00047	<0.00054	<0.0010	**<0.0010**	<0.0010	0.0060
Copper	<0.0012	<0.0010	0.042	0.065	0.026	0.0035
Iron	<0.017	<0.017	<0.15	<0.020	0.050	0.13
Lead	<0.00010	<0.00017	0.0080	**0.0060**	<0.0044	0.00035
Manganese	<0.0050	<0.0050	0.21	0.067	0.51	0.070
Mercury	<0.000022	<0.000017	<0.0000050	**0.00059**	<0.0000050	0.000010
Nickel	<0.00075	<0.00055	<0.010	**<0.010**	<0.010	0.0030
Selenium	<0.0010	<0.0010	0.0020	**<0.0010**	<0.0013	0.0015
Silver	<0.00020	<0.00025	**0.075**	**0.0040**	**0.0017**	0.00040
Zinc	<0.010	<0.012	<0.012	<0.013	<0.010	0.030

All concentrations are in mg/L. All metal concentrations are dissolved metals unless otherwise noted.
Bolded nitrate concentrations indicate analyses were for nitrate plus nitrite.
Bolded total nitrogen concentrations do not include organic nitrogen because organic nitrogen data were not collected at the Troy Mine for mine and tailings water.
Bolded metal concentrations are total results due to either lack of dissolved data or dissolved data that were below the laboratory detection limit with the detection limit being greater than the lowest water quality standard.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
†Concentrations shown are for EIS analysis purposes only and would vary from MPDES permit limits. It is not known if the Water Treatment Plant effluent concentrations shown are technologically or economically achievable.
Source: Appendices G and K.

Waste rock would be used for tailings dam construction in all mine alternatives and for plant site construction in Alternative 2. Any rock with a potential for acid generation or trace metal release would be placed as backfill. As kinetic and metal mobility test data are limited for waste rock weathering in the surface environment, the best available data are from the water sump for Prichard and Burke waste rock deposited on a liner at the Libby Adit Site. Data from water in the sump at the Libby Adit waste rock stockpile (Appendix K-10) were used to represent changes in water quality related to waste rock to be used at the impoundment site.

The tailings would have a low residual sulfide content after ore removal, and low potential for acid generation under either saturated (during the Operations Phase) or unsaturated conditions (Post-closure Phase), but due to its relatively high surface area would release trace quantities of metals into solution. This conclusion is consistent with monitoring data from the Troy tailings impoundment, as well as kinetic and metal mobility tests of Montanore tailings conducted before

1992, and with the results of the tailings analysis from Rock Creek. Due to the scale effects of surface area and water flux on metal concentrations predicted for the tailings impoundment, the best available data for the assessment are the field-scale water quality monitoring results from the Troy impoundment (Appendix K-9). The specific identity and concentrations of metals would be re-evaluated when a bulk composite sample of ore could be collected during the Evaluation Phase and tested metallurgically to produce tailings for further testing (see Appendix C). This would allow consideration of any changes in water quality that could result from dewatering at post-closure.

Nitrate concentrations are less affected by the primary mineralogy of the rock than by the blasting practices used in mining. Increased nitrate concentrations are expected in water intercepted near blasted zones. Nitrate and ammonia concentrations of the wastewater from the mine and adits are not known. Data from the Libby Adit during the construction by NMC, from nitrate waste rock blasting tests completed by MMC, and from the nearby Troy Mine show a wide range of nitrate and ammonia concentrations. For water pumped from adits during construction, the nitrate concentration range is 0.0096 to 687 mg/L, with a representative concentration of <37 mg/L, and the ammonia concentration range is 0.010 to 21.9 mg/L, with a representative concentration of <0.65 mg/L (Appendix K-5). Additional data on nitrate and ammonia concentrations would be collected during the Evaluation Phase. The agencies used the Libby Adit water quality data collected by NMC after adit construction ceased and nitrate and ammonia concentrations were not affected by blasting to develop an estimate of nitrate and ammonia concentrations in wastewater from post-construction adits. From the post-construction adits, the representative nitrate concentration is estimated to be <0.12 mg/L and the representative ammonia concentration is <0.050 mg/L in wastewater (Appendix K-6).

Stream Temperature

Quantitative and qualitative approaches were used to analyze potential surface water temperature changes resulting from mine and transmission line activities. The project may affect stream temperatures by discharge of treated water from the Water Treatment Plant, vegetation clearing, decreased streamflow due to direct diversions, and changes in groundwater discharge to area streams. MMC submitted synoptic temperature data to the DEQ during the MPDES permitting process (DEQ 2015b Appendix 6). The data covered measured 2014-2015 temperatures in Water Treatment Plant effluent and in Libby Creek at LB-200, upstream of the Water Treatment Plant outfalls, and at LB-300, downstream of the outfalls. The difference between the temperatures of the two Libby Creek sites during Water Treatment Plant discharges was used as a surrogate for the potential effect of discharges on stream temperatures. Stream temperature differences between LB-200 and LB-300 may not be solely attributable to discharges; other factors, such as groundwater/ surface interactions, stream depth, and canopy coverage, affect stream temperatures at adjacent stream segments. For other mine and transmission line activities besides Water Treatment Plant discharges, a qualitative approach was used due to the numerous factors affecting stream temperatures and the constantly changing stream temperature regime that occurs, making it difficult to quantitatively predict how the project may alter stream temperature, or to what extent stream temperatures may change. It may not be possible to separate indirect effects of the mine alternatives on stream temperature from other natural effects. The agencies' water resources and aquatic biology monitoring includes temperature monitoring (Appendix C).

Erosion and Sedimentation

WEPP Forest Road Erosion Predictor Model

The agencies analyzed the potential effects of facility construction and diversions on erosion and sedimentation both qualitatively and quantitatively. The effects of facility construction were qualitatively analyzed. In all mine alternatives, the proposed Rock Lake Ventilation Adit would be on a steep, rocky slope about 800 feet east of and 600 feet higher than Rock Lake. Because the total disturbance area for this adit would be small (about 1 acre), any effects would be minor and are not discussed further.

All mine and transmission line alternatives would require the construction of new roads, and the use of closed roads. Road construction and reconstruction is often considered the largest source of sediment in mining and timber harvest areas due to the removal of vegetation and construction of cut and fill slopes that expose large areas subject to erosion (Belt *et al.* 1992).

The agencies used the WEPP:Road Batch interface for the Forest Service Water Erosion Prediction Project model (FS WEPP) (USDA Forest Service 2015e) to quantitatively evaluate erosion and sediment delivery from forest roads that would be used for the mine alternatives and transmission line alternative D-R. FS WEPP is a physically based model that has been adapted to forestlands and forest management activities including road construction, timber harvest disturbances, and forest fires. The FS WEPP model predicts average annual erosion only, and does not predict the probability of a given amount or erosion occurring in any given daily event, month, or year.

The WEPP:Road Batch interface is one of several interfaces of the FS WEPP model. The WEPP:Road Batch model uses soil texture, rock fragment content in the soil cover, road design, road surface, road gradient, road width and length, traffic level, fillslope and buffer gradients, fillslope and buffer lengths, vegetation cover, and climate data to determine erosion rates and sediment yields from a road through a fillslope and buffer (if there are fillslopes and buffers). It is designed to predict runoff and potential sediment yield from forest roads, compacted landings, compacted skid trails, and compacted foot, cattle, or off-road vehicle trails (USDA Forest Service 1999a). The FS WEPP:Road model was developed by the Forest Service’s Rocky Mountain Research Station, based on a WEPP model developed by a team of government scientists from the Agricultural Research Service, Forest Service, Natural Resource Conservation Service, Bureau of Land Management, U.S. Geological Survey, and university cooperators. The DEQ and the EPA (2014) used WEPP to estimate sediment loads from unpaved roads in developing TMDLs and a water quality improvement plan for the Kootenai River-Fisher River Project Area, which included the Libby Creek watershed.

To assist in the road erosion analysis (ERO Resources Corp. 2015b), the KNF in 2015 collected site-specific road sediment source information on the main access roads and transmission line roads on National Forest System lands. The road sediment source inventory focused on locations where a road crossed or intercepted a RHCA. Some roads on National Forest land were not inventoried because they are located far from an RHCA. A literature review associated with the development of the INFS concluded that non-channelized sediment flow rarely travels more than 300 feet, and that 200- to 300-foot riparian buffers are generally effective at protecting streams by preventing sediment from reaching streams via non-channelized overland flow (Belt *et al.* 1992). Most inventoried locations were culverts or bridges. There are five groups of transmission line road crossings. One group of crossings were not inventoried because they were near the top of the drainage and only carry water during a brief portion of the spring. One representative location in each of the remaining four groups was inventoried. The inventory of transmission line roads was limited to National Forest System roads because access to private roads was not available. Data collected were road design, road surface type, road gradient, road length and width, fill gradient and width, buffer gradient and width, and percent coarse rock fragment. The agencies used a 50-year simulation period to assess effects, and assumed that the soil type at all locations was a silt loam soil (ERO Resources Corp. 2015b).

For roads outside the mine permit area boundary, the agencies' analysis of sediment erosion from access roads and their buffer areas to streams compared existing conditions to the action alternatives. The Bear Creek Road (NFS road #278) would be completely paved and the road widened to 20 to 29 feet in Alternative 2 and 26 feet in Alternatives 3 and 4. For modeling purposes, a road with of 26 feet was used for all three alternatives. For Alternatives 3 and 4, the Libby Creek Road (NFS road #231) would not be widened or paved, but the road length contributing to the nearest RHCA would be reduced to 150 feet. In Alternative 2, the Libby Creek Road would not be improved. The Bear Creek Road and Libby Creek Road are currently high use roads and were modeled as such for existing conditions. The use of the Libby Creek Road would increase during the Evaluation Phase and first year of the Construction Phase, then traffic would return to existing levels. The use of the Bear Creek Road would also increase beginning in the Construction Phase. Because the WEPP: Road Batch model can only use high, low, or no traffic levels, all of the modeled scenarios of access road use used a high traffic level.

The agencies used the model to estimate the average annual sediment that would leave the existing Alternative D-R transmission line roads under existing conditions and with the contributing road length reduced to 150 feet. The agencies also modeled five new transmission line roads that would be constructed for Alternative D-R with contributing road lengths of 150 feet and a width of 12 feet. During the 2-year construction and 2-year decommissioning period for the transmission line, traffic would be high. Each individual road would have high traffic for 1 to 3 months during each period. During mine operations and after decommissioning, use of the three roads would return to existing conditions.

The WEPP:Road Batch model provides estimates of average annual sediment leaving the road and the buffer. The model assumes that:

- The ground cover of fillslopes is 50 percent; consequently, fillslopes are potentially erodible in the model
- Buffers have 100 percent ground cover equal to that of a 20-year old forest, and are potentially erodible
- Paving a road increases runoff from the road, which can cause increased erosion on fillslopes and flow paths leading from the road into drainages

To mitigate for project access effects on grizzly bears, some roads that are currently open would be closed, most before the Evaluation Phase and all before the Construction Phase. Other roads would be closed at the end of mine operations. The grizzly bear mitigation roads would be placed in intermittent stored service or decommissioned. Roads placed in intermittent stored service or decommissioned are discussed in section 2.9.4.2, *Access Road Construction and Use*. The WEPP:Road Batch model was used to estimate the average annual sediment that would leave the road buffers for six currently open grizzly bear mitigation roads located near RHCAs that would be barriered with an earthen berm and traffic eliminated (NFS roads #6205D, #4776A, #4776B, #4778, #4778C, and #14458).

The WEPP:Road Batch model provides estimates of average annual sediment leaving roads and buffers, considering the possible variables that can be manipulated in the model. The results can be used to compare the effects of these variables, such as graveling versus paving, changes in traffic levels, road length and width, or buffer length. Reducing the contributing road length by using drain dips, surface water deflectors, or open top box culverts to route the water off the road away from drainages or wetlands is shown by the model to be very effective in reducing sediment loads from roads and buffers. In the agencies' alternatives, the BMPs that cannot be modeled using the WEPP:Road Batch model to minimize the movement of sediment from all new and reconstructed roads would be developed in accordance with the Forest Service's *National Best Management Practices for Water Quality Management on National Forest System Lands* (USDA Forest Service 2012) and the BMP requirements in the MPDES permit. BMPs may include reducing erosion on fillslopes, stabilizing disturbed areas with vegetative cover, replacing buried or damaged culverts, or adding additional gravel to roads.

WEPP Road Model and Modeling Limitations

The WEPP:Road Batch model is best used as a comparative tool between different road designs. Any predictions of runoff or erosion by any model will at best be within only ±50 percent of the true value. Actual sediment delivery rates to streams would be highly variable spatially and temporally due to large variations in local topography, climate, soil properties, and vegetation properties; predicted rates are only an estimate of a highly variable process (USDA Forest Service 1999a). The WEPP:Road Batch model estimates sediment yield on an average annual basis in units of pounds, but cannot be used to model seasonal sediment yield or specific precipitation events. High erosion rates typically occur during the first years of vegetation establishment after disturbance (Megahan and Kidd 1972, Grace 2007). Other limitations include:

- Soil type is one of the critical factors in forest road erosion; the WEPP:Road Batch model has only four soil textures: clay loam, silt loam, sandy loam, or loam
- The agencies' modeling assumed a silt loam soil texture for all roads, which may be different than at the modeled locations
- Average annual sediment yield values likely will be greater than erosion that occurs in most years because sediment delivery is dominated by a few very large events every decade
- The model's range of traffic levels consists of three levels: none, low, and high and does not account increases in high traffic levels
- The model does not incorporate road armoring processes; roads with low or no traffic may become armored, which reduces erosion rates by 70 to 80 percent
- The rate of infiltration of precipitation into the road surface depends in part on the timing of road maintenance and prior wetting and drying cycles, neither of which are incorporated in the model
- The WEPP:Road Batch model inaccurately models the effect of road paving because it over-predicts erosion from paved roads and the model may not have adequate mechanisms for accurately evaluating the degree to which road designs that include drainage and dissipation structures may dissipate and infiltrate road runoff from a paved road (Breibart *et al*. 2007)

- The model does not account for BMPs that MMC would implement on roads, examples of which are discussed in section 3.11.4.3.5.

3.13.3 Affected Environment

3.13.3.1 Surface Water

3.13.3.1.1 Streams

The representative quality of the mine area streams is summarized in Appendix K-1. The surface waters in the analysis area are a calcium-bicarbonate water. Total suspended solids, total dissolved solids, turbidity, major ions, and nutrient concentrations are all low, frequently at or below analytical detection limits. Metal concentrations are generally low with a high percentage of below detection limit values (exceptions include aluminum and barium). Analysis area streams are poorly buffered due to low alkalinities. Consequently, surface waters tend to be slightly acidic, with most pH values slightly below 7. The acidity has two likely natural sources: organic acids originating from surrounding coniferous forests and dissolved carbon dioxide in surface water and groundwater draining into the area streams. Median water hardness in area streams are typically less than 35 mg/L, with upper stream reaches having median hardness values typically less than 10 mg/L. Surface water in the Poorman Impoundment Site, some of which originates from bedrock springs, had pH values ranging from 7.2 to 8.2 and higher ion concentrations than other surface water in the analysis area (Kline Environmental Research 2012).

Water temperature data were collected continuously at LB-200 from September 2009 to August 2013 (MMC 2014d). Warmest temperatures of up to 55°F were recorded in early August, and coldest temperatures of about 33°F were recorded in December through April. Temperature data collected in 2005 through 2007 in Libby Creek ranged from 32°F to 70°F, with maximum 7-day average maximum temperatures ranging from 50°F at a site on Libby Creek upstream of the Howard Creek confluence to 68°F at a site on Libby Creek downstream of the Crazyman Creek confluence. Single temperature readings were also collected from multiple reaches in the headwaters of Libby Creek and Ramsey Creek in September 2012, with data at some sites in Libby Creek also collected in September 2010 and 2011 (Kline Environmental Research and NewFields 2012). Temperatures were often warmer at the more downstream sites, and ranged from 43°F to 50°F. Temperature data also were collected in 1994, 2002, and in May 2009 through September 2011 in the East Fork Bull River. Temperatures averaged 50°F, 37°F, 38°F, and 43°F in the summer, fall, winter, and spring of 1994, with maximum temperatures of 62°F and 59°F occurring in 1994 and 2002, respectively (Washington Water Power Company 1996; Liermann and Tholl 2003). Daily mean temperatures ranged from 32°F to 57°F in 2009 through 2011, and peaked in August of each year (USDA Forest Service 2011h, 2011i, 2011j). Temperatures were monitored in Rock Creek in 1994, 2008, and 2011. In 1994, stream temperatures averaged 51°F in the summer, 43°F in the fall, 38°F in the winter, and 44°F in the spring, with a maximum temperature of 54°F (Washington Water Power Company 1996). Temperature data from various sources in 2008, 2011, and 2012 indicated that the maximum temperature reached was 64°F in August 2011 (Moran *et al*. 2009; Salmon Environmental Services 2012; Kline Environmental Research and NewFields 2012).

3.13.3.1.2 Springs

The representative quality of the mine area springs is summarized in Appendix K-2. Springs from all areas are mostly calcium bicarbonate water, but some are sodium bicarbonate water. Springs with higher total dissolved solids and metal concentrations (*e.g.*, SP-14 and SP-30 shown on Figure 70) are a result of longer subsurface flow paths than other springs. For example, a spring located directly above Rock Lake (SP-1R) appears to receive mostly shallow groundwater, whereas a spring below Rock Lake (SP-3R) appears to receive a combination of shallow and deeper groundwater; both springs are shown on Figure 68.

3.13.3.1.3 Lakes

The representative quality of the mine area lakes is summarized in Appendix K-3. Lakes located in or near the CMW are quite dilute; the primary source of dissolved solids and nutrients is bedrock groundwater (Gurrieri and Furniss 2004). Groundwater entering the lakes can be the major source of nutrients for phytoplankton in the lakes. An investigation of Rock Lake completed in 1999 (Gurrieri and Furniss 2004) found that during the ice-free season, groundwater contributed 71 percent of the minerals to the lake, surface water contributed 25 percent, and rainfall contributed 4 percent. Seasonal variations in the water quality of Rock Lake indicate that the volume of inflow from various sources (snowmelt, rainfall, shallow and deep groundwater) varies proportionally during the year. Because the watershed above Rock Lake consists of highly resistant bedrock with little vegetation and soil cover, snowmelt and surface water entering the lake are very dilute (very low dissolved solids). Because the Libby Lakes are extremely dilute and very vulnerable to atmospheric acid deposition, and possible indicators of climate change, they were monitored beginning in 1991 (Grenon and Story 2009; McMurray 2013).

In July through September 2013, MMC measured specific conductance, pH, temperature, dissolved oxygen, and turbidity in the outlets from Rock Creek and Wanless Lake, the latter a benchmark monitoring location outside of the range of influence of expected mine or adit inflows. The water quality results were similar. Specific conductance was slightly higher in water at the Wanless Lake outlet (ranging from 3 to 4.5 µS/cm higher in the Wanless Lake outlet). MMC also measured specific conductance, pH, temperature, and dissolved oxygen in Wanless Lake. All of the specific conductance measurements for Rock and Wanless lakes were less than 25 µS/cm, indicating quite dilute lakes.

3.13.3.1.4 Impaired Streams

Section 303(d) of the federal Clean Water Act requires states to assess the condition of state waters to determine where water quality is impaired (does not fully support uses identified in the stream classification or does not meet all water quality standards) or threatened (is likely to become impaired in the near future). The result of this review is the compilation of impaired surface waters, which states must submit to the EPA biannually. Section 303 also requires states to prioritize and target water bodies on their list for development of water quality improvement strategies (*i.e.*, TMDLs), and to develop such strategies for impaired and threatened waters. A TMDL is the maximum amount of a pollutant a river, stream, or lake can receive and still support all designated uses. Five streams in the analysis area are listed on the most current Montana list of impaired streams (DEQ 2014c). These streams are two segments of Libby Creek, Big Cherry Creek, the Fisher River, and Rock Creek.

Libby Creek is separated into two segments on the 2014 list of impaired surface waters. The upper segment is from 1 mile above Howard Creek to the US 2 bridge. This segment is listed as not supporting drinking water use and partially supporting its fishery and aquatic life. Agricultural and industrial beneficial uses are fully supported. Contact recreation has not been assessed. Probable causes of impairment listed in 2014 were alteration in stream-side vegetative cover and physical substrate habitat alterations. Probable sources of impairment were impacts from abandoned mine lands and historical placer mining. The lower segment begins at the US 2 bridge and is impaired for physical substrate habitat alterations and sedimentation/siltation. Although both segments may be affected by proposed activities in all mine alternatives, the lower impaired segment is outside of the analysis area because the effects would be negligible. In 2014, the DEQ and the EPA issued TMDLs and a water quality improvement plan for the Kootenai River-Fisher River project area, which includes Libby Creek. The DEQ performed updated assessments on Libby Creek for metals impairment and did not identify metals impairment conditions in Libby Creek in the reassessment (DEQ and EPA 2014). The remaining impairments for this section, alteration in stream-side vegetative cover and physical substrate habitat alterations, are not pollutants and did not require development of a TMDL (DEQ and EPA 2014). The DEQ and EPA established as a TMDL an average annual sediment load of 4,234 tons for Libby Creek from the US 2 bridge to the confluence with the Kootenai River (DEQ and EPA 2014). As part of this TMDL, the Montanore facility was assigned a sediment wasteload allocation of 24 tons/year. The wasteload allocation would be met by adhering to the MPDES permit requirements. The DEQ and the EPA established water quality restoration goals for sediment in Libby Creek on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available instream habitat as it relates to the effects of sediment, and the stability of streambanks. Meeting the TMDL, of which Montanore's wasteload allocation of 24 tons per year is a part, will satisfy the water quality restoration goals. The DEQ believes that once the water quality restoration goals are met, all beneficial uses currently affected by sediment will be restored (DEQ and EPA 2014).

The DEQ and the EPA quantified watershed sediment loads from four sources: streambank erosion, hillslope erosion (upland sediment sources), unpaved roads, and permitted point sources. The DEQ and the EPA estimated that streambank erosion was the largest contributing load of the four sediment sources. During development of the TMDLs and water quality improvement plan for the Kootenai River-Fisher River Project Area, the DEQ and EPA assessed sediment and habitat conditions at 15 stream reach sites. The two monitoring sites on Libby Creek, downstream of the analysis area, had the highest sediment load per mile from streambank erosion of the 15 monitored sites. For all of Libby Creek, including the section impaired for sedimentation/siltation downstream of the analysis area, the DEQ and the EPA estimated a sediment load of nearly 4,900 tons/year due to streambank erosion. Of the six streams required to be assessed for sediment loads in the Kootenai-Fisher TMDL project area, the mainstem of Libby Creek had the highest rate of streambank erosion per mile of stream (116 tons/mile of stream) of the six streams assessed by the DEQ and the EPA (2014).

The estimated existing sediment load described in DEQ and EPA (2014) was for the entire Libby Creek watershed. None of the sediment generated by the Montanore Project would be in the lower Libby Creek watershed and most of the sediment generated by the project would be in the upper Libby Creek watershed. The agencies used the same approach described in and data from DEQ and EPA (2014) to estimate sediment loads in the upper Libby Creek and Big Cherry Creek watersheds. The uncertainty discussion in DEQ and EPA (2014), including appendices, is incorporated by reference.

DEQ's and EPA's estimates of streambank erosion were developed using two approaches: 1) an aerial assessment and stratification of stream reaches and development of a sediment load factor based on sediment and habitat assessments at 15 field monitoring sites (assessed streams) and 2) extrapolating sediment loads for unassessed stream based on the aerial assessments. Thirteen segments totally 10.57 miles in upper Libby Creek from downstream of the Libby Adit to the downstream boundary of the upper Libby Creek watershed were included in the DEQ's and EPA's aerial assessment. The agencies estimated total sediment load from streambank erosion in the assessed reaches of upper Libby Creek is estimated to be 895.5 tons/year (ERO Resources Corp. 2015b). Three and one half miles of upper Libby Creek and 53 miles of other streams were not assessed in the upper Libby Creek watershed. For unassessed tributaries to the listed stream segments, a sediment load of 1.41 tons/year/1,000 feet (7.42 tons/year/mile) was applied (DEQ and EPA 2014). The total estimated load from unassessed streams is 419.2 tons per year, for a total load from streambank erosion in the upper Libby Creek watershed estimated to be 1,314.7 tons/year. The agencies' estimate of existing sediment load in the upper Libby Creek watershed without the Montanore Project is 1,621 tons/year (Table 123).

The agencies estimated future sediment load from upland sediment sources, unpaved roads, and point sources using data from DEQ and EPA (2014). The estimated future sediment load from streambank erosion was based on an assumed 35 percent reduction with the use of BMPs (DEQ and EPA 2014). The reduction is based on following permit conditions for point sources and implementing all reasonable land, soil, and water conservation practices for nonpoint sources. The agencies' estimate of future sediment load in the upper Libby Creek watershed without the Montanore Project after the sediment TMDL is achieved is 1,102 tons/year (Table 123).

Table 123. Estimated Sediment Load in Upper Libby Creek and Big Cherry Creek Watersheds.

Sediment Sources	Estimated Current Load (Tons/Year)	Estimated Future Load Without Montanore (Tons/Year)
Upper Libby Creek Watershed		
Streambank Erosion	1,314.7	854.9
Upland Sediment Sources	303.9	245.7
Unpaved Roads	2.7	1.3
Total Sediment Load	**1,621.4**	**1,101.9**
Big Cherry Creek Watershed		
Streambank Erosion	638.2	414.8
Upland Sediment Sources	128.3	103.3
Unpaved Roads	1.0	0.5
Total Sediment Load	767.5	518.6

Sources: DEQ and EPA 2014, ERO Resources Corp. 2015b.

A short segment of Big Cherry Creek where it parallels the Bear Creek Road is in the analysis area. Big Cherry Creek from Snowshoe Creek to the mouth is impaired due to alteration in stream-side vegetative cover, cadmium, lead, zinc, and physical substrate habitat alterations. Probable sources of impairment are forest road construction and use, mine tailings, impacts from abandoned mine lands, and habitat modification. This section of Big Cherry Creek is listed as fully supporting drinking water use and not supporting aquatic life. A TMDL for cadmium, lead, and zinc was established in Big Cherry Creek; alteration in stream-side vegetative cover and physical substrate habitat alterations are not pollutants and did not require a TMDL (DEQ and EPA 2014). Big Cherry Creek was not included in the aerial assessment completed by the DEQ and the EPA (2014). The agencies' total estimated load from unassessed streams in the Big Cherry Creek watershed is 638.2 tons/year (Table 123). The agencies estimate the current sediment load in the Big Cherry Creek watershed to be 768 tons/year and future sediment load after the TMDLs are achieved to be 519 tons/year (Table 123).

The Fisher River from the Silver Butte/Pleasant Valley junction to the Kootenai River is impaired, with aquatic life support and cold-water fishery uses only partially supported. Probable causes for the Fisher River impairment were listed in 2014 as a high flow regime, with probable sources listed as channelization and streambank modification and destabilization. In 2014, the DEQ and EPA issued draft and a water quality improvement plan for the Kootenai River-Fisher River project area, which included the Fisher River. The DEQ performed updated assessments on the Fisher River for metals impairment and did not identify metals impairment conditions in the Fisher River in the reassessment (DEQ and EPA 2014). The remaining impairments, high flow regime and streambank modification and destabilization, are not pollutants and do not require development of a TMDL (DEQ and EPA 2014).

Rock Creek is impaired from the headwaters to the mouth at the Clark Fork River, with aquatic life support and cold-water fishery uses only partially supported. Probable causes for the Rock Creek impairment were listed in 2014 as other anthropogenic substrate alterations, with probable sources of these impairments listed as silvicultural activities. In 2010, the DEQ issued sediment TMDLs and a framework for water quality restoration for lower Clark Fork River tributaries. The DEQ concluded Rock Creek's impairment is not a pollutant and did not require a TMDL (DEQ 2010a).

3.13.3.2 Groundwater

Several monitoring wells installed adjacent to the Libby Adit Site, near the LAD Areas or at the proposed location of the Alternative 2 and 4 tailings impoundment are screened in the unconsolidated glacial or fluvial sands and gravels (Figure 68 and Figure 70). Water samples from the Libby Adit represent the quality of water in fractured deep bedrock. The sources of the adit water were generally more than 1,000 feet below the ground surface and seasonal trends in water quality were not observed in the data, as might be expected in shallow groundwater influenced by surface water infiltration. Appendix K-4 summarizes the quality of shallow groundwater at the Libby Adit Site, LAD Areas, Little Cherry Creek Impoundment Site, and deep bedrock groundwater from the Libby Adit Site. For purposes of analysis, it is assumed that the groundwater quality under the Poorman Tailings Impoundment Site is the same as under the Little Cherry Creek Tailings Impoundment Site because the two locations are adjacent to each other and are geologically similar.

Groundwater samples from monitoring wells in the Libby Adit, Little Cherry Creek tailings impoundment, and LAD Area sites show that existing groundwater in the unconsolidated sediments is a calcium-bicarbonate or calcium-magnesium bicarbonate type with low total dissolved solids concentrations, low nutrient concentrations, and dissolved metal concentrations that are typically below detection limits. Barium and manganese were the only metals consistently detected in groundwater samples. The Libby Adit wells appear to be influenced by seasonal infiltration of surface water because they have seasonal fluctuations in ion concentrations (generally low in May through July, and higher in the fall through winter months). The Little Cherry Creek tailings impoundment and LAD Area wells have consistently low ion concentrations that do not appear to fluctuate seasonally. The pH of groundwater is slightly acidic in the various facility areas (Appendix K-4). Bedrock groundwater has higher ion concentrations, especially sodium and bicarbonate. The pH is somewhat alkaline, and the water is harder.

3.13.3.3 Geochemistry of Exposed Materials

3.13.3.3.1 Ore

Because there has been no historical development of ore within the Montanore deposit, the proposed action would modify the existing underground environment. Low concentrations of dissolved copper, manganese, and zinc are predicted for release when ore and waste rock in the adit walls are exposed to air and water. The sulfides contained in the ore are predominantly non-acid generating, although some potentially reactive sulfides may be present in altered waste zones (Enviromin 2013b). The massive nature of the quartzite that hosts Revett-style ore would limit the surface area exposure of potentially reactive sulfides and substantially reduce the potential for acid generation by exposed ore. The small percentage of sulfides that would be exposed is expected to oxidize to form secondary copper oxide and sulfate minerals with variable solubilities. These secondary minerals would have potential to release metals into groundwater at a near-neutral pH. Results reported for dissolved metal concentrations in Troy Adit mine water, which are believed to result from this process, are consistent with the metal release concentrations reported in metal mobility and kinetic tests of rock from Montanore. Higher total recoverable metal concentrations are expected in groundwater samples that contain sediment, which reflects the importance of metal transport by sediment. For these reasons, any water from underground workings would be treated before discharge in Alternatives 3 and 4 to meet MPDES permitted effluent limits.

3.13.3.3.2 Tailings

During the Operations Phase, ore would be shipped to the mill for processing, where 90 percent of the sulfides would be removed. Following grinding, pH adjustment, and removal of sulfide during processing, the homogenous tailings would have an elevated pH of 9 or greater, with a low sulfide content of less than 0.1 percent. Due to the elevated pH and low sulfide content, acid generation from tailings would be unlikely. Tests of metal mobility in tailings, and operational monitoring at the analogous Troy Mine, suggest that some metals would be mobile in tailings effluent at a near-neutral pH, particularly during operations when suspended sediments may transport adsorbed metals. These metals include aluminum, cadmium, copper, iron, lead, manganese, and silver. Nitrate and ammonia concentrations also would be elevated. Only dissolved constituents would have the potential to move beyond the impoundment and potentially affect groundwater and surface water quality, and it is likely that mobile concentrations would decrease when suspended solids were diminished at closure. Tailings would be placed in the impoundment during operations, under saturated conditions, and remain exposed to weathering processes in the tailings impoundment under unsaturated conditions at closure. The specific concentrations of metals would be re-evaluated in tests conducted during the Evaluation Phase (see Appendix C) when a bulk composite sample of ore would be collected from the Evaluation adit and metallurgically processed to produce tailings for further kinetic leach testing (see Appendix C). This testing would allow consideration of any changes in water quality that could result from dewatering of tailings post-closure.

3.13.3.3.3 Waste Rock

Waste rock to be mined at Montanore has a low risk of acid generation, but may release low concentrations of metals. A relatively low tonnage of reactive waste rock would be produced, which would be placed as backfill in underground workings and stored under saturated, anaerobic conditions. The same volume of each lithology would be produced under each alternative, and waste rock would be used for tailings dam construction in all mine alternatives and for Plant Site construction in Alternative 2.

The environmental geochemistry data indicate that a portion of the lower Revett Formation has the potential to generate acid, while other portions of the formation do not. Kinetic data support the potential for weak acid generation from the lower Revett altered waste zones, particularly the barren lead zone that separates the two ore zones (Zones 1 and 2) (Figure 11 in Chapter 2). This zone has the potential to reduce the pH in water to 6 and release low concentrations of barium, copper, lead, manganese, and zinc. The risk to water quality would be mitigated by limiting the mining of rock within the barren lead zone. Additional characterization as development advanced through the lower Revett altered waste zones would be important for selection of waste rock for use in tailings dam construction, and would also be of value in understanding potential changes in mine water chemistry resulting from backfilling of reactive waste rock. Rock in the lower Revett would be exposed in workings during the Evaluation, Construction, and Operations Phases of the project.

Comparison of the static results with kinetic test data indicates that static test data overestimate the potential for acid formation from the Prichard Formation waste rock, a conclusion that is supported by the neutral pH of mine drainage observed in the exposed section of Prichard Formation in the Libby Adit and from the rock stockpiled at the Libby Adit Site. In spite of a neutral pH, Prichard Formation rock has the potential to release low quantities of arsenic, iron, manganese, and zinc. Metal release information would also be important for final Water Treatment Plant design. The majority of the exposure of rock from the Prichard and Burke formations would occur during adit construction, through operations, and into closure. Waste mined from the Burke Formation appears unlikely to generate acid, although additional data would be collected to confirm this.

3.13.3.4 Climate Change

Section 3.10.3.4, *Climate Change* in the *Groundwater Hydrology* section discusses projected climate trends for the Columbia River Basin in general. Several variables potentially affected by climate change, such as water temperature, flow, runoff rate and timing, and the physical characteristics of the watershed, affect water quality (Lettenmaier *et al*. 2008). While it is likely that climate change will affect the capacity of surface water ecosystems to remove pollutants and improve water quality, the timing, magnitude, and consequences of these impacts are not well understood (Lettenmaier *et al*. 2008).

3.13.4 Environmental Consequences

This section describes the anticipated changes in surface water and groundwater quality for each alternative. This includes analysis area streams, lakes, springs, and aquifers underlying the mine facilities. Potential direct and indirect effects of the project are described, as are potential cumulative effects that may occur as a result of the mine and transmission line alternatives and identified reasonably foreseeable actions.

3.13.4.1 Alternative 1 – No Mine

In this alternative, MMC would not develop the Montanore Project. Any existing exploration-related or baseline data collection disturbances by MMC would be reclaimed in accordance with existing laws and permits. The DEQ’s approval of the mine, as permitted by DEQ Operating

Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Discharges from the Water Treatment Plant would continue until the adit was plugged. Monitoring wells and other devices installed for monitoring would be removed and the area reclaimed. Disturbances on private land at the Libby Adit Site would remain until reclaimed in accordance with existing permits and approvals.

3.13.4.2 Alternative 2 – MMC Proposed Mine

Development of the Montanore Project would require construction of project facilities, such as a mill, tailings impoundment, adits, and access roads. In MMC's proposal, the mill and mine production adits would be located in the upper Ramsey Creek drainage, about 0.5 miles from the CMW boundary. An additional adit on MMC's private land in the Libby Creek drainage and a ventilation adit on MMC's private land east of Rock Lake would be used for exploration and ventilation. A tailings impoundment proposed in the Little Cherry Creek drainage would require the diversion of Little Cherry Creek. MMC anticipates and the agencies concur that proper management of explosives and use of emulsions would reduce nitrate concentrations from those detected during the initial Libby Adit construction. Adit and mine water would be treated, if needed, before discharging to LAD Areas for secondary treatment. Two LAD Areas between Poorman Creek and Ramsey Creek are proposed to allow for discharge of excess mine water using sprinkler irrigation of water on the land surface. A portion of the waste rock resulting from adit development may be stored temporarily on an unlined surface at LAD Area 1, and at the Libby Adit Site. The total area of disturbance for Alternative 2 would be 2,582 acres.

Effects on stream temperature would be similar in all mine alternatives and are discussed in section 3.13.4.3.4, *Stream Temperature*. MMC did not propose to discharge water from the Water Treatment Plant during the Operations Phase and the potential effects and monitoring described for Alternative 3 would not occur during the Operations Phase.

Fisheries mitigation proposed for Alternative 2 is described in section 2.4.6.2. The mitigation would be for the fisheries impacts associated with the Little Cherry Creek diversion and the riprapped tailings impoundment overflow channel to Bear Creek. Where channel stabilization and habitat rehabilitation occurred in Libby Creek, Ramsey Creek, the Howard Lake outlet, Snowshoe Creek, and Kilbrennan Creek, there would be brief increases in turbidity and sediment concentrations in the creeks during construction. For activities not covered by a MPDES or general permit, MMC may request and the DEQ may approve a 318 authorization for short-term increases in turbidity and total suspended solids discussed on p. 705. Longer-term effects to stream water quality would be beneficial because the improved channel stability would result in decreased instream sediment concentrations.

Sanitary waste would be collected and shipped off-site for treatment and disposal. Handling sanitary waste in this manner would not be feasible because the City of Libby would not accept sanitary waste produced at the operation and no other feasible off-site option was available.

3.13.4.2.1 Evaluation and Construction Phases (Years 1-5)

Groundwater

Mine Area

During the Evaluation and Construction Phases, groundwater would flow toward the adit and mine openings, and the quality of groundwater surrounding the adits and mine would not be adversely affected by the mine. In the streams whose baseflow would be reduced as a result of mining, water quality changes may occur. Deeper bedrock groundwater is likely to have higher total dissolved solids concentrations than shallow groundwater or direct runoff to streams, so a decrease in the deeper bedrock groundwater contribution to streamflow may result in lower total dissolved solids concentrations in streams.

The Libby Lakes are located at an elevation of about 7,000 feet, and are perched above the potentiometric surface. The lakes lie on a series of faults and vertically oriented bedding planes, but there are no observations, data, or numerical model results to indicate that the lakes are hydraulically connected to the deep bedrock potentiometric surface. It is unlikely that the Libby Lakes would be affected by mining activities during these phases. Because deep bedrock groundwater is a contributor to Rock Lake throughout the year (Gurrieri 2001), mining may affect the water quality of Rock Lake. There are subtle differences in the quality of shallow and deeper groundwater, both of which are source waters for Rock Lake, as is surface water runoff (Gurrieri 2001). Baseline water quality data for Rock Lake are provided in Appendix K-3. It may be difficult to differentiate changes in water quality from pre-mining water quality variability. If less groundwater were contributed to Rock Lake, total dissolved solids, silica (needed by diatoms), and nutrient concentrations may decrease in the lake.

Depending on the ratio between shallow and deep groundwater contribution to area springs, water quality changes may be slight and not detectable. In the case of springs that receive a large portion of their flow from deep groundwater, total dissolved solids concentrations may decrease as the shallow groundwater accounts for a larger proportion of the total flow. The only springs whose water quality may be adversely affected by the mine would be those in the analysis area located below an elevation of about 5,000 to 5,600 feet (see section 3.10.4.3.1, *Seeps and Springs* of the *Groundwater Hydrology* section).

Libby Adit Area

Mine and adit water treated at the Water Treatment Plant at the Libby Adit Site (up to 500 gpm in Alternative 2) may be discharged to groundwater via a percolation pond or a drainfield located in the Libby Adit pad adjacent to Libby Creek or, when the percolation pond reached capacity, to Libby Creek. The pH of the discharge of mine and adit water is expected to be about 8, slightly greater than instream pH values of between 6.5 and 7.5 in Libby Creek. Water discharged from the Water Treatment Plant, if discharged to the percolation pond or infiltration gallery next to Libby Creek, would mix with groundwater with a pH of about 6.5 in an approved groundwater mixing zone. Mixing would also occur within an approved surface water mixing zone in Libby Creek. After mixing, the expected quality of the treated water would be below BHES Order limits and applicable nondegradation criteria in surface water and groundwater.

Tailings Impoundment Area

No water would be stored at the tailings impoundment site during the Evaluation Phase. Groundwater quality in the area would not be affected. The Starter Dam would be constructed partially with waste rock. Limited testing of waste rock excavated from the Libby Adit indicated waste rock leachate contained elevated nutrient concentrations (Table 95). Nitrate concentrations may increase beneath the Starter Dam. MMC committed to implementing seepage control measures, such as pumpback recovery wells, if required to comply with applicable standards. Seepage pumpback wells could be installed along the downstream toe of the tailings dam. Given the heterogeneity of the foundation soils, additional wells could be required to ensure that all flow paths were intercepted. The wells may require active pumping, depending on the artesian pressures within the wells (Klohn Crippen 2005).

After the Starter and Seepage Collection Pond dams were constructed, precipitation and runoff would be captured behind the dams. Some of the area behind the Starter Dam would be lined. Some seepage not collected by the Seepage Collection System would reach groundwater. Water stored behind the Starter Dam would be of generally good quality because it would be mostly precipitation and surface water runoff. Water stored in the impoundment would not affected groundwater quality.

LAD Areas

When mine and adit water was discharged to the LAD Areas, it would mix with precipitation, and much of it would evapotranspire. The quality of the water before chemical and biological treatment within the plant root/soil matrix would change as a result of dilution by rain water, then concentration of about 90 percent (on average, depending on the season of discharge, weather conditions, soil moisture levels, etc.) of this water could be lost to the atmosphere via evapotranspiration. Resultant nutrient and metal concentrations were calculated and used for the mass balance analysis (Appendix G). The water would then be treated within the plant root/soil matrix.

Land application can substantially reduce suspended sediment, nitrogen, phosphorus, and metal concentrations in the applied water. Nitrogen removal occurs through vegetation uptake, biological reduction through nitrification/denitrification in the soil, and ammonia volatilization. The main concern associated with land application is the potential for nitrate to be transported to groundwater (EPA 2006b). Nitrate removal is site- and effluent-specific; removal depends on application rate, soil physiochemical properties, soil hydraulics, soil moisture, soil organic content vegetation types, slope, and temperature. Ammonia removal is by volatilization, uptake by vegetation, and adsorption by clay minerals in the soil; its removal depends on temperature, pH, soil characteristics, and soil water content. Phosphorus removal is accomplished through plant uptake and by fixation in the soil matrix. Metals are removed by adsorption, precipitation, ion exchange, biogeochemical reactions, uptake by plants and microorganisms, and complexation (EPA 2006b). Metal removal is site- and effluent-specific and depends on vegetation type, soil characteristics, pH, and temperature.

Due to the many variables that have not been specifically defined for the LAD Areas, the agencies could not determine specific treatment rates for nitrate, nitrite, ammonia, total nitrogen, total phosphorus and metals. The BHES Order requires the DEQ to review design criteria and final engineering plans to determine that at least 80 percent removal of nitrogen would be achieved by LAD treatment. Removal rates for ammonia, nitrate, and nitrite cannot be determined until LAD Area final engineering plans, design criteria, and soil studies were submitted and monitoring commenced. Treatment rates for nitrogen compounds appear to vary widely, ranging from 50 to 90 percent for total nitrogen (EPA 2002). Maximum nitrogen removal occurs when nitrogen is applied in the ammonia or organic form rather than the nitrate form (Georgia

Department of Natural Resources 2006; EPA 2006b). Ammonia represents the reduced (less oxidized) form of nitrogen, while nitrate represents the oxidized form. Ammonia is expected to be present in wastewater used on the LAD Areas. Nitrates are more readily taken up by plants, while ammonia is more readily adsorbed by soils. Phosphorus removal by land application has shown a wide range of removal rates ranging from 20 to 100 percent (EPA 1974), and is a function of residence time and travel distance involving complex physical, biochemical, and chemical interactions, soil type and vegetation type.

In the agencies' analysis, land application treatment rates were assumed to be 50 percent for nitrate, ammonia, total nitrogen, total phosphorus, and some metals. If needed, primary treatment of nitrate would occur before land application disposal. For zinc, aluminum, barium, and manganese, a 10 percent removal was assumed, and for copper and nickel a 90 percent removal was assumed. A report prepared for NMC (Camp Dresser and McKee, Inc. 1991) on soil attenuation in the analysis area showed high copper attenuation in the analysis area soils. Zinc may be taken up by vegetation, but does not, in general, sorb readily on soils. Manganese also does not sorb readily on all soil types. In the agencies' analysis, it was assumed that 90 percent of the zinc and manganese percolated to groundwater.

The predicted concentrations in groundwater after mixing beneath the LAD Areas for each mine phase, when an estimated rate of 130 gpm of water was sent to the LAD Areas for treatment (see section 3.10.4.2.1, *LAD Areas* of the *Groundwater Hydrology* section), are provided in Table 124. Predicted concentrations in groundwater would be slightly better during the Post-Closure Phase than those shown for the Closure Phase. If land application of excess water resulted in BHES Order limit or nondegradation criteria exceedances, MMC would treat the additional water at the Water Treatment Plant instead of discharging it to the LAD Areas. No natural attenuation or removal mechanisms for total dissolved solids in groundwater are expected; dissolved solids concentrations in groundwater may increase based on residence time. No natural attenuation or removal is expected for nitrate in groundwater. Analyses of the Troy Mine decant pond disposal system by Hydrometrics (2010), Land and Water Consulting (2004), and Camp, Dresser and McKee (2010), indicated natural attenuation or removal of metals from tailings impoundment seepage would occur, including antimony, arsenic, copper, and mercury. Schafer developed a paste tailings seepage model (Schafer 2014) for the tailings facility proposed for the Rock Creek Project. These investigations and analyses are described under the Operations Phase. Based on these findings, the predicted antimony, arsenic, copper, and mercury concentrations in groundwater (Table 124) may be higher than would actually occur during the Evaluation, Construction, Closure, and Post-Closure Phases. Oxygenation of the mine and adit water from the use of sprinklers at the LAD Areas may result in the precipitation of iron oxide and manganese oxide on the land surface. As a result, the predicted iron and manganese groundwater concentrations shown in Table 124 may be higher than would actually occur. The ambient manganese concentration in groundwater at the LAD Areas exceeds the BHES Order limit. Iron and manganese oxides are relatively insoluble, and if precipitated on the ground surface at the LAD Areas, would not dissolve. Although large runoff events may loosen the material and erode it downhill, the material would not reach surface water as most runoff would be captured by sediment ponds designed for a 10-year/24-hour storm. A larger storm event may result in iron and manganese precipitates eroding downhill to surface water.

Table 124. Predicted Concentrations in Groundwater after Mixing beneath the LAD Areas, Alternative 2.

Parameter	Ambient Concen-tration	Construc-tion Phase	Closure Phase	BHES Order Limit[1]	Applicable Nonsignificance Criteria Outside of a Mixing Zone		
					Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]
Total dissolved solids	63	**283**	**580**	200			
Nitrate	0.060	**<38**	**13**	10			
Antimony-T	<0.0030	<0.0022	**<0.025**			0.0004	0.0009
Arsenic-C	<0.0030	**<0.0076**	**<0.0033**		<0.0030		
Barium-T	<0.0067	<0.029	**<0.21**			0.002	0.15
Beryllium-C	<0.0010	<0.0007	<0.0007		<0.0010		
Cadmium-T	<0.00010	<0.00013	**<0.0011**			0.0001	0.000075
Chromium-T	<0.0010	<0.0010	<0.0015	0.02			
Copper-T	<0.0010	<0.00074	<0.0061	0.1			
Iron-H	<0.052	<0.043	<0.076	0.2			
Lead-T	<0.00034	<0.00019	<0.0011			0.0001	0.0023
Manganese	<0.081	<0.049	**<1.0**	0.05			
Mercury-T	<0.000020	**<0.000033**	<0.000015		<0.000020		
Nickel-T	<0.010	<0.0051	<0.0070			0.0005	0.015
Selenium-T	<0.0010	<0.00151	<0.0018			0.0006	0.0075
Silver-T	<0.00050	<0.00045	<0.0020			0.0002	0.015
Zinc-T	<0.010	<0.024	<0.024	0.1			

All concentrations are mg/L. All metal concentrations are for dissolved metals.
Method used to derive representative ambient water quality concentrations described in ERO 2011c. Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
No discharges to LAD Areas are projected to occur during the Operations Phase.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria without additional primary treatment before land application are shown in **bold**.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic, beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for antimony, barium, cadmium, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (antimony, barium, cadmium, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value. The DEQ typically does not authorize mixing zones for LAD Areas.
Source: Appendix G.

MMC requested a source-specific groundwater mixing zone for the LAD Areas in Alternative 2 (Geomatrix 2007b). A mixing zone is a limited area of a surface water body or a portion of an aquifer, where initial dilution of a discharge takes place and water quality changes may occur, and where certain water quality standards may be exceeded (ARM 17.30.502(6)). During the MPDES permitting process, the DEQ would determine if a mixing zone beneath and downgradient of the LAD Areas would be authorized in accordance with ARM 17.30.518 and, if so, would determine its size, configuration, and location. If DEQ authorized a mixing zone, water quality changes might occur, but BHES Order limits could not be exceeded outside the mixing zone, and for other water quality parameters, nondegradation criteria could not occur outside the mixing zone unless authorized by DEQ. The DEQ typically does not authorize mixing zones for LAD Areas. The DEQ also would determine where compliance with applicable standards would be measured.

Surface Water

West Side Streams, Lakes, and Springs

During the Evaluation and Construction Phases, water quality in streams, lakes, and springs on the west side of the divide may be affected by reductions due to mine inflows in groundwater discharge to streams and Rock Lake. Because bedrock groundwater has higher dissolved solids concentrations, a reduction in groundwater discharge may result in surface water having lower dissolved solids concentrations. The change in groundwater discharge would be very small during these phases and it is unlikely that changes in water quality would be detectable.

East Side Streams, Lakes, and Springs

Effects of Mine Inflows and Discharges. Reductions in groundwater discharge to springs and streams east of the divide due to mine inflows would be small during the Evaluation and Construction Phases; changes in water quality would not likely be detectable. No lakes in the Libby Creek watershed would be affected by mine dewatering. Effects on the spring located close to the LAD Areas (such as SP-21 shown on Figure 70), assuming that shallow groundwater was a source of supply to such springs, would be similar to the effects on groundwater beneath the LAD Areas (Table 124). An assessment of the effect of Water Treatment Plant discharge on Libby Creek flow completed to evaluate stream stability is described in section 3.13.4.3.2, *Effects of Discharges*. The flow increase would have insignificant effects on streambank erosion, would not alter the physical substrate habitat, and would not affect sediment transport, aggradation, or degradation.

Predicted concentrations after mixing at RA-600 (Ramsey Creek), PM-1200 (Poorman Creek), and LB-1000 (Libby Creek) following discharge at the Water Treatment Plant and the LAD Areas during Construction and Closure Phases are provided in Table 125, Table 126, and Table 127, respectively. The predicted concentrations for sites in Libby, Poorman, and Ramsey creeks were compared to the BHES Order limits, where applicable, or were evaluated based on the criteria for determining nonsignificant changes in water quality for parameters not listed in the BHES Order. Instream water quality concentrations during the Evaluation Phase would be similar to the Construction Phase. Predicted concentrations for all mine phases at numerous monitoring locations are presented in Appendix G.

Table 125. Predicted Concentrations with Land Application Treatment after Mixing at RA-600, Alternative 2.

Parameter	Ambient Concen-tration	Construction Phase	Closure Phase	BHES Order Limit[1]	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
					Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]	10%/40% of Lowest Standard[5]
Total dissolved solids	<13	<22	<33	100				
Ammonia, as N	<0.052	<0.079	<0.22	TIN=1				
Nitrate, as N	<0.081	<1.4	<0.58	TIN=1				
Total inorganic nitrogen	<0.13	**<1.5**	<0.80	1				
Total nitrogen	<0.25	**<1.63**	**<0.92**					0.0275/0.11
Total phosphorus	<0.0096	**<0.011**	**<0.013**					0.0025/0.01
Aluminum - T	0.013	<0.014	<0.022			0.03	0.013	
Antimony-T	<0.0030	<0.0030	**<0.0038**			0.0004	0.00084	
Arsenic-C	<0.0020	**<0.0022**	<0.0020		<0.0020			
Barium-T	<0.0040	<0.0052	<0.012			0.002	0.15	
Beryllium-C	<0.0010	<0.00099	<0.00099		<0.0010			
Cadmium-T	<0.000017	<0.000024	<0.000055			0.0001	0.000015	
Chromium-T	<0.0010	<0.0010	<0.0010	0.005				
Copper-T	<0.0010	<0.0010	<0.0012	0.003				
Iron-H	<0.050	<0.050	<0.051	0.1				
Lead-T	<0.00010	<0.00010	<0.00013			0.0001	0.000082	
Manganese	<0.0023	<0.0036	<0.039	0.05				
Mercury-T	<0.000020	<0.000020	<0.000020		<0.000020			
Nickel-T	<0.0051	<0.0050	<0.0051			0.0005	0.0024	
Selenium-T	<0.0010	<0.0010	<0.0010			0.0006	0.00075	
Silver-T	<0.00020	**<0.00041**	<0.00026			0.0002	0.000056	
Zinc-T	<0.0038	<0.0044	<0.0044	0.025				

All concentrations are mg/L. All metal concentrations are for total recoverable metals except aluminum, which is dissolved.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
No discharges to LAD Areas are projected to occur during the Operations Phase.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria without additional primary treatment before land application are shown in **bold**.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for aluminum, antimony, barium, cadmium, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
[5] 10% and 40% of lowest standard applies to degradation determination review for total nitrogen and total phosphorus.
Source: Appendix G.

Table 126. Predicted Concentrations with Land Application Treatment after Mixing at PM-1200, Alternative 2.

Parameter	Ambient Concentration	Construction Phase	Closure Phase	BHES Order Limit[1]	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
					Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]	10%/40% of Lowest Standard[5]
Total dissolved solids	<23	<29	<36	100				
Ammonia, as N	<0.050	<0.068	<0.16	TIN=1				
Nitrate, as N	<0.053	<0.95	<0.38	TIN=1				
Total inorganic nitrogen	<0.10	<1.0	<0.54	1				
Total nitrogen	<0.22	**<1.1**	**<0.66**					0.0275/0.11
Total phosphorus	<0.0099	<0.011	**<0.012**					0.0025/0.01
Aluminum - T	<0.010	<0.011	<0.016			0.03	0.013	
Antimony-T	<0.00050	<0.00053	**<0.0011**			0.0004	0.00084	
Arsenic-C	<0.00050	**<0.00067**	<0.00050		<0.00050			
Barium-T	<0.0064	<0.0071	<0.011			0.002	0.15	
Beryllium-C	<0.00020	<0.00020	<0.00020		<0.00020			
Cadmium-T	<0.000040	<0.000044	<0.000065			0.0001	0.0000145	
Chromium-T	<0.0010	<0.0010	<0.0010	0.005				
Copper-T	<0.0010	<0.0010	<0.0011	0.003				
Iron-H	<0.050	<0.050	<0.051	0.1				
Lead-T	<0.000045	<0.000048	<0.000068			0.0001	0.000082	
Manganese	<0.00089	<0.0018	<0.025	0.05				
Mercury-T	<0.000020	<0.000020	<0.0000020		<0.000020			
Nickel-T	<0.00050	<0.00050	<0.00055			0.0005	0.0024	
Selenium-T	<0.0010	<0.0010	<0.0010			0.0006	0.00075	
Silver-T	<0.00020	<0.00034	<0.00024			0.0002	0.000056	
Zinc-T	<0.0031	<0.0035	<0.0035	0.025				

All concentrations are mg/L. All metal concentrations are for total recoverable metals except aluminum, which is dissolved.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
No discharges to LAD Areas are projected to occur during the Operations Phase.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria without additional primary treatment before land application are shown in **bold**.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for aluminum, antimony, barium, cadmium, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
[5] 10% and 40% of lowest standard applies to degradation determination review for total nitrogen and total phosphorus.
Source: Appendix G.

Table 127. Predicted Concentrations with Land Application Treatment after Mixing at LB-1000, Alternative 2.

Parameter	Ambient Concen-tration	Construction Phase	Closure Phase	BHES Order Limit[1]	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
					Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]	10%/40% of Lowest Standard[5]
Total dissolved solids	<33	<43	<50	100				
Ammonia, as N	<0.030	<0.10	<0.17	TIN=1				
Nitrate, as N	<0.034	0.62	0.29	TIN=1				
Total inorganic nitrogen	<0.064	<0.72	<0.46	1				
Total nitrogen	<0.11	**<0.66**	**<0.37**					0.0275/0.11
Total phosphorus	<0.0070	<0.0074	**<0.0082**					0.0025/0.01
Aluminum - T	<0.017	<0.024	<0.029			0.03	0.013	
Antimony-T	<0.00050	<0.00056	<0.00090			0.0004	0.00084	
Arsenic-C	<0.00020	**<0.00030**	**<0.00022**		<0.00020			
Barium-T	0.0066	<0.024	<0.032			0.002	0.15	
Beryllium-C	<0.00020	<0.00020	<0.00020		<0.00020			
Cadmium-T	<0.000060	<0.000058	<0.000069			0.0001	0.000015	
Chromium-T	<0.0010	<0.0014	<0.0016	0.005				
Copper-T	<0.00046	<0.00074	<0.00089	0.003				
Iron-H	<0.017	<0.027	<0.031	0.1				
Lead-T	<0.000054	<0.000082	<0.00010			0.0001	0.000082	
Manganese	<0.00099	<0.0076	<0.023	0.05				
Mercury-T	<0.000020	<0.000019	<0.000019		<0.0000020			
Nickel-T	<0.00050	<0.00072	<0.00082			0.0005	0.0024	
Selenium-T	<0.0010	<0.0011	<0.0011			0.0006	0.00075	
Silver-T	<0.00020	<0.00030	<0.00025			0.0002	0.000056	
Zinc-T	<0.0044	<0.0069	<0.0076	0.025				

All concentrations are mg/L. All metal concentrations are for total recoverable metals except aluminum, which is dissolved.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
No discharges to LAD Areas are projected to occur during the Operations Phase.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria without additional primary treatment before land application are shown in **bold**.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for aluminum, antimony, barium, cadmium, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
[5] 10% and 40% of lowest standard applies to degradation determination review for total nitrogen and total phosphorus. For total nitrogen, the variance of 15 mg/L in the draft renewal permit would apply.
Source: Appendix G.

Nitrate and ammonia concentrations were added together to evaluate compliance with the BHES Order limit for total inorganic nitrogen (TIN). The BHES Order TIN limit (1 mg/L) during the Evaluation and Construction Phases at RA-400 and RA-600 are predicted to be exceeded without nitrogen pre-treatment. The mass balance analysis also predicted exceedances of BHES Order limits or applicable nondegradation criteria for antimony, arsenic, total nitrogen, total phosphorus, and silver at RA-400. The mass balance analysis predicted exceedances of BHES Order limits or applicable nonsignificance criteria for antimony, arsenic, total nitrogen, total phosphorus and silver at RA-600 and PM-1200, and arsenic, total nitrogen, and total phosphorus at LB-1000. If land application of excess water resulted in BHES Order limit or nonsignificance criteria exceedances, MMC would treat the additional water at the Water Treatment Plant instead of discharging it to the LAD Areas.

In the draft renewal MPDES permit, the DEQ preliminarily determined the size, configuration, and location of the mixing zones in Libby Creek for Outfalls 001, 002, and 003. The chronic groundwater mixing zone for Outfalls 001 and 002 authorized in the 1997-issued MPDES permit and continued in the 2006-issued MPDES permit was retained in the draft renewal MPDES permit. The mixing zone for Outfalls 001 and 002 extends from their point of discharge to Libby Creek downgradient to monitoring station LB-300 for these parameters: nitrate + nitrite, total inorganic nitrogen, chromium, copper, iron, lead, manganese, and zinc. For Outfalls 001, 002, and 003, the DEQ preliminarily authorized a chronic mixing zone, at 25 percent of the $7Q_{10}$, from the point of discharge two stream widths for the following parameters: nitrate + nitrite, total inorganic nitrogen, chromium, copper, iron, lead, manganese, and zinc. For Outfalls 001, 002, and 003, the DEQ also preliminarily authorized a nutrient mixing zone, at 100 percent of the 14-day, 5-year low flow ($14Q_5$), from the point of discharge two stream widths for the following parameters: total nitrogen, and total phosphorus. MMC did not request a mixing zone for any discharges from Outfalls 004 through 008; any applicable effluent limitations must be met at the end-of-pipe discharge. The DEQ did not authorize a mixing zone for any parameters discharged from Outfalls 004 through 008 in the draft renewal permit. The draft renewal permit (DEQ 2015b) contains the water quality assessment required before the DEQ could authorize a mixing zone. The final MPDES permit will contain DEQ's final determination regarding mixing zones.

The Water Treatment Plant uses ultrafiltration to remove metals sorbed onto particulates suspended in the influent, which removes suspended sediments. Outfall 001 is a percolation pond, which allows for solids to settle and flows to groundwater and Outfall 002 is a drainfield with three infiltration zones discharging into groundwater. Discharges to Outfalls 001 and 002 would have no effect on sediment concentrations in Libby Creek or fine sediment levels in the Libby Creek substrate.

MMC has not reported a discharge from Outfalls 002 and 003 during the term of the 2006-issued permit. Outfall 003 for direct discharge to Libby Creek is included in the existing and draft renewal MPDES permit. The median total suspended solids concentration from samples collected quarterly from Libby Creek at LB-300 between 2006 and 2010 (141 samples) as part of the existing MPDES permit requirements is less than 1 mg/L (Appendix K). In the Kootenai-Fisher TMDL development, the DEQ and the EPA (2014) used a total suspended solids concentration of 1 mg/L for Water Treatment Plant discharges directly to Libby Creek from Outfall 003. Assuming an average total suspended solids concentration of 1 mg/L and a year-long discharge rate of 500 gpm (the Water Treatment Plant's capacity), the estimated maximum sediment load from the Water Treatment Plant would be 1.1 tons/year. The average annual discharge during the Evaluation Phase is estimated to be 260 gpm (Table 14); the average annual sediment load from the discharges would be proportionally less (0.6 ton/year). For the reasons described under Alternative 3 in section 3.13.4.3.2, *Effects of Discharges*, it is expected that discharges from the Water Treatment Plant to Outfall 003, if they were to occur, would not increase suspended sediment concentrations in Libby Creek or fine sediment levels in the Libby Creek substrate.

Effects of Stormwater Runoff, Erosion, and Sedimentation. MMC would request an amendment to its MPDES permit for Alternative 2. Within the mine permit area boundary, all stormwater runoff from roads and mine facilities would be captured by ditches and sediment ponds designed for the 10-year/24-hour storm and directed to MPDES-permitted outfalls. Precipitation and runoff from the Libby Adit pad area would be collected and directed to Outfall 001. Stormwater from the impoundment site would be more likely discharged in Alternative 2 than the other alternatives because MMC would use mine and adit water in the mill and would have less need for make-up water from the impoundment site. In Alternative 2, MMC indicated that below the tailings impoundment, ditches containing runoff would be directed, where possible, toward the Seepage Collection Pond; otherwise, appropriate BMPs would be used to handle stormwater that was not classified as mine drainage water or process water. Discharges from the outfalls to Libby, Ramsey Poorman, and diverted Little Cherry creeks would be monitored, and would be required to meet applicable effluent limits.

MMC would implement a SWPPP to minimize erosion and sedimentation from disturbed areas during the Construction and Operations Phases. The plan would address stormwater runoff from mine-related facilities for soil stockpiles, access/haul roads, adit pads, and parking lots. The plan would describe the potential sources of stormwater pollution, pollution prevention practices, sediment and erosion control measures, runoff management, inspections, and reporting. BMPs would include ditches, sediment traps, and sediment retention ponds.

All clearing before construction at the LAD Areas would be located 300 feet or more from Libby, Poorman, and Ramsey creeks. MMC would shut off sprinklers during periods of stormwater runoff, snowmelt, or saturated ground conditions, and MMC would not operate the LAD Areas in a manner that produced runoff or increased spring flow. With these measures in place, increases in sediment directly to Libby, Poorman, or Ramsey creeks from tree thinning or use of the LAD Areas are not expected.

A Diversion Dam in Little Cherry Creek would be constructed to divert flow above the dam around the tailings impoundment. After the Diversion Dam was constructed during the Construction Phase, water in Little Cherry Creek above the tailings impoundment would be diverted to Libby Creek via a 10,800-foot long Diversion Channel to ensure that it would not contact any mine wastewater, waste rock, or tailings. The channel would be sized to divert large flood flows safely around the tailings impoundment. The Diversion Channel would consist of an upper channel, and two existing natural drainage channels that flow toward Libby Creek. Two natural drainages would be used to convey water from the upper channel to Libby Creek. The northern drainage (Drainage 10) is currently a 9,000-foot long intermittent drainage that is primarily unchannelized in the upper part and has perennial channelized segments interspersed with unchannelized wet and dry segments in the lower part. The southern drainage (Drainage 5) is about 3,000 feet long with similar characteristics to Drainage 10. Flow in Drainage 5 does not reach Libby Creek (Kline Environmental Research 2012).

During the Construction Phase, the flow in Drainages 5 and 10 would increase and would change to perennial flow. Because the tributaries are not large enough to handle the expected flow volumes, downcutting, and increased sediment delivery to Libby Creek is expected to occur as the channel stabilized. In the event of heavy precipitation during construction of the channel, substantial erosion and brief increases in sedimentation to the lower drainage and Libby Creek would occur. Where possible, MMC would construct some bioengineered and structural features in the two drainages to reduce flow velocities, stabilize the channels, and create fish habitat. An energy dissipater would be constructed at the outlet section of both drainages to reduce flow velocity of water entering Libby Creek. Short sections of these two drainages are steep, and it may be difficult to access such sections to complete any channel stabilization work. In addition, some sections of these two drainages have thick vegetation that may require clearing before starting channel stabilization, which may temporarily create erosion and increase sediment delivery to the drainages.

For roads outside the mine permit area boundary, the agencies' analysis of sediment erosion from access roads and their buffer areas to streams compared existing conditions to the action alternatives (Table 132). In Alternative 2, the Bear Creek Road (NFS road #278) would be completely paved and the road widened to 20 to 29 feet. High erosion rates typically occur during the first years of vegetation establishment after disturbance (Megahan and Kidd 1972, Grace 2007). The movement of sediment from Alternative 2 roads to RHCAs would be minimized through the use of BMPs to reduce road sediment erosion and flow velocities (MMC 2008). Because the BMPs were not specified, they cannot be modeled using the WEPP:Road Batch model, but they would further reduce sediment leaving the roads and buffers. The WEPP:Road Batch model predicted that paving and widening all of the Bear Creek Road would increase the amount of sediment leaving the buffer. Other users of the model have found it over-predicts erosion from paved roads (Breibart *et al.* 2007), and research indicates that paved roads generate the least sediment and typically have the shortest distance of sediment transport away from a road bed compared to gravel or unimproved roads (Riedel *et al.* 2007).

MMC did not propose improvements to the Libby Creek Road during the Evaluation Phase and first year of the Construction Phase, so existing sediment yield from the Libby Creek Road would not change. A road-by-road summary of predicted erosion from roads at stream crossings is provided in a technical memorandum (ERO Resources Corp. 2015b). The WEPP:Road Batch model is not an exact numeric predictor of sediment delivery and is best used as a comparative tool between different road designs.

The two road closures proposed in Alternative 2 for grizzly bear mitigation would not reduce sediment reaching streams because they are not available for closure. One road proposed for closure, NFS road #4784 (upper Bear Creek Road) would be closed for mitigation of the Rock Creek Project and would only be closed for the Montanore Project if it was not already closed before Forest Service approval to initiate the Evaluation Phase. The other road proposed for closure, NFS road #4724 (South Fork Miller Creek), would be used in constructing transmission line Alternatives D-R and E-R. Upgrades to NFS road #278 (Bear Creek Road), part of which is adjacent to the impaired section of Big Cherry Creek, are discussed in section 3.13.4.3.5, *Effect on Impaired Streams*. Effects of the transmission line alternatives on the impaired sections of Libby Creek and the Fisher River are discussed in sections 3.13.4.8, *Alternative B – MMC Proposed Transmission Line (North Miller Creek Alternative)*.

The movement of sediment from Alternative 2 roads to RHCAs would be minimized through the use of BMPs to reduce road sediment erosion and flow velocities (MMC 2008). Because the BMPs were not specified, they cannot be modeled using the WEPP:Road Batch model, but they would further reduce sediment leaving the roads and buffers. Surface water monitoring would include regular sampling for total suspended solids and turbidity.

As part of its proposed Fisheries Mitigation Plan, MMC may conduct a sediment-source inventory in the watershed, and stabilize, recontour, and revegetate priority sediment-source areas, which are typically roadcuts in the watersheds of Libby, Hoodoo, Poorman, Midas, and Crazyman creeks. MMC's proposed mitigation is not reflected in the sediment rates shown in Table 132. Implementation of this measure would reduce the sediment delivery to area streams. MMC also may rehabilitate habitat upstream from the mouth of Howard Creek through creation of pool and hiding cover habitat, stabilization of old mining spoils, and channel narrowing. The installation of grade control structures in streams to improve aquatic habitat may increase sediment concentrations in streams temporarily. After the activities were completed, and the improvements stabilized, sediment delivery to area streams would decrease below existing levels.

3.13.4.2.2 Operations Phase (Years 6 through 25)

Groundwater

Mine Area

Groundwater in the vicinity of the adit and mine would flow toward the mine and adit voids, so groundwater quality surrounding the adits and mine would not be affected by the mine. Adit, mine, and tailings impoundment water would be collected and used for milling purposes.

Libby Adit Area

No mine or adit water would be treated at the Water Treatment Plant and discharged during operations because all water would be used in the mill. If no water were treated and discharged, groundwater quality below the Libby Adit percolation pond or infiltration gallery would return to pre-mine conditions soon after discharges to the percolation pond or infiltration gallery during the Construction Phase ceased.

Tailings Impoundment Area

During the Operations Phase, it is estimated that a maximum of 25 gpm of water would seep to groundwater under the tailings impoundment (Klohn Crippen 2005). The existing groundwater quality would be altered because tailings seepage would have higher concentrations of nutrients, some metals, and total dissolved solids than existing groundwater.

Using the DEQ's approach for determining a standard mixing zone (ARM 17.30.517), MMC estimated a groundwater flux of 10 gpm. An additional 25 gpm was added to the estimated flux to account for flow in the buried alluvial channel (Geomatrix 2007b). The hydrologic and geologic conditions of the Little Cherry Creek Tailings Impoundment Site are complex. The agencies used a groundwater flux of 35 gpm in the agencies' mass balance calculations for Alternative 2 as a reasonable estimate of flux beneath the impoundment site. Results of the mass balance analysis are provided in Table 128. The predicted groundwater concentrations were compared to the BHES Order limits, where applicable, or applicable nondegradation criteria.

Table 128. Predicted Concentrations in Groundwater after Mixing beneath the Tailings Impoundment without Attenuation, Alternatives 2 and 4.

Parameter	Ambient Concen-tration	Opera-tions Phase	Post-Closure at Stabilized Flow Conditions	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
				BHES Order Limit[1]	Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]
Total dissolved solids	60	146	86	100			
Nitrate, as N	<0.10	5.5	1.7	TIN=1			
Antimony-T	<0.0030	**<0.011**	**<0.0055**			0.0004	0.0009
Arsenic-C	<0.0030	<0.0025	<0.0028		<0.0030		
Barium-T	<0.040	<0.069	<0.049			0.002	0.15
Beryllium-C	<0.0010	<0.0010	<0.0010		<0.0010		
Cadmium-T	<0.00010	<0.00046	<0.00021			0.0001	0.000075
Chromium-T	<0.00074	<0.00085	<0.00077	0.005			
Copper-T	<0.0012	<0.012	<0.0043	0.003			
Iron-H	<0.010	<0.027	<0.015	0.1			
Lead-T	<0.00028	<0.0020	<0.00080			0.0001	0.0023
Manganese	<0.077	**<0.26**	**<0.13**	0.05			
Mercury-T	<0.000030	<0.000020	<0.000027		<0.000030		
Nickel-T	<0.010	<0.010	<0.010			0.0005	0.015
Selenium-T	<0.0010	<0.0011	<0.001			0.0006	0.0075
Silver-T	<0.00050	<0.0010	<0.00064			0.0002	0.015
Zinc-T	<0.0064	<0.0079	<0.0069	0.025			

All concentrations are mg/L. All metal concentrations are for dissolved metals.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria are shown in **bold**.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for antimony, barium, cadmium, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
Source: Appendix G.

During operations, elevated antimony and manganese concentrations are predicted to occur in groundwater beneath and downgradient of the tailings impoundment. The manganese exceedance of the BHES Order limit is due in part to the ambient groundwater manganese concentration exceeding the BHES Order limit. Based on analyses of the Troy Mine decant pond disposal system by Land and Water Consulting (2004), Hydrometrics (2010) and Camp, Dresser and McKee (2010), the agencies anticipate natural attenuation and removal of metals in the tailings water infiltrated at the tailings impoundment. Assuming that geochemical conditions would be similar at Montanore as at the Troy Mine, groundwater metal concentrations beneath the impoundment area are expected to be less than those predicted by the mass balance calculations (Table 128). Nitrate would not be attenuated or removed as mine water infiltrated to groundwater.

In a 2004 study, Land and Water Consulting (2004) evaluated the fate and movement of copper beneath the Troy Mine decant ponds. Geologic material beneath the decant ponds was analyzed for total copper to identify the composition of copper minerals and to identify which mineral phases contain the most copper. Study results indicated that copper was attenuated within the upper foot of soil primarily through the precipitation of secondary copper minerals (carbonates, silicates, and oxides) and through the secondary adsorption of copper onto organic matter. Precipitation is the formation of a solid (mineral) from dissolved constituents in groundwater, and adsorption is a process where dissolved metal adheres to the surface of organic particles (USDA Forest Service and DEQ 2012).

The geochemical conditions at the Troy Mine tailings impoundment conducive to metals attenuation and removal included neutral to alkaline pH, oxidizing conditions, the presence of moderate amounts of dissolved silica, bicarbonate, and low to moderate amounts of organic material (Hydrometrics 2010). The metals that were attenuated or reduced at the Troy Mine tailings impoundment area included antimony, arsenic, copper, and lead. Comparing decant pond water concentrations to those collected in the adjacent downgradient groundwater at the Troy Mine, Hydrometrics (2010) reported a 50 percent reduction in antimony concentrations, an order of magnitude (10 times) reduction in copper concentrations, and reduction to undetectable concentrations for arsenic. Cadmium, mercury, and silver were not detected in either the Troy Mine decant pond water or the underlying shallow groundwater. Based on scientific literature, Hydrometrics (2010) concluded that if higher concentrations of cadmium, mercury, or silver occurred in the decant pond water, the necessary geochemical conditions existed to attenuate and remove these metals.

Camp Dresser and McKee (2010) completed a study of the Troy Mine decant ponds for the DEQ designed to evaluate whether other attenuation or removal mechanisms of metals that would occur in the event that the initial mechanisms, such as precipitation, became less effective. These secondary attenuation processes would occur when oxygen-rich mine water from the decant ponds mixed with groundwater. When oxygen-poor groundwater contains iron, dissolved iron precipitates from solution as iron hydroxide (a solid mineral). When the iron hydroxide precipitates, it facilitates removal of other metals from water by co-precipitation. Specifically, the 2010 Camp, Dresser and McKee study evaluated the following: whether dissolved iron in groundwater would precipitate as iron hydroxide; whether dissolved iron that precipitates would help remove copper and other metals (co-precipitation) from mine waters; and the quantity of other metals that would be removed with the iron. The evaluation consisted of computer geochemical modeling based on the quality of mine water and the groundwater under the tailings impoundment; and bench-scale jar testing using varying proportions of mine water and groundwater. The computer modeling showed that between 98 and 100 percent of the iron would precipitate in response to mixing of the waters, while the laboratory tests showed that precipitation of the iron resulted in the removal of 73 to 98 percent of the copper and 11 to 59 percent of the antimony (Camp Dresser and McKee 2010).

Schafer developed a paste tailings seepage model (Schafer 2014) for the tailings facility proposed for the Rock Creek Project. In general, chemical loading in groundwater beneath the paste facility would increase throughout the Operations Phase as the tailings footprint expanded, reaching a peak near the end of operations. Nitrate would have the largest relative increases in concentration.

Other parameters for which concentrations would increase are sodium, potassium, chloride, sulfate, ammonia, and aluminum. The model predicted virtually no changes in ambient groundwater concentrations of arsenic, antimony, cadmium, copper, lead, and silver beneath the paste facility due to the significant sorption capacity for these parameters in the glaciolacustrine materials beneath the proposed Rock Creek Project tailings facility. Similar glaciolacustrine materials underlie the center and eastern portion of the both Montanore impoundment sites (Figure 65). Although site differences preclude a direct comparison between the tailings facility at the Troy Mine and the Rock Creek Project, studies at both sites suggest attenuation may significantly reduce some metal concentrations in groundwater at the Little Cherry Creek and Poorman Impoundment Sites.

Based on the mass balance calculations, seepage of impoundment water is predicted to increase the manganese concentration in groundwater under the tailings impoundment. Oxygenation of the water stored as surface water in the impoundment would cause the precipitation of manganese oxide and a decrease in the dissolved manganese concentration in the impounded water. Therefore, the predicted manganese groundwater concentration based on the mass balance calculation may be higher than would actually occur. The predicted manganese concentration exceeds the BHES Order limit. Although the manganese concentration may exceed the BHES Order limit beneath the impoundment, all groundwater containing elevated concentrations would be intercepted by the pumpback wells and returned to the mill or treated and discharged. The pumpback well system would minimize the effect to groundwater quality and prevent the movement of the tailings seepage water to any surface water.

In all mine alternatives, a MPDES permitted outfall would not be required for the tailings impoundment seepage because seepage reaching groundwater would be collected by the pumpback system and not discharged to surface water. The discharge to groundwater beneath the impoundment would be authorized by a DEQ Operating Permit and a seepage recovery zone would encompass the impoundment footprint and extend to the pumpback wells, if installed. MMC requested a source-specific groundwater mixing zone for the tailings impoundment in Alternative 2 (Geomatrix 2007b). The DEQ would make the same determinations regarding a mixing zone as it would for discharges at the LAD Areas.

LAD Areas

Groundwater quality beneath the LAD Areas would not be affected because discharge to the LAD Areas would not occur during operations.

Surface Water

West Side Streams, Lakes, and Springs

Mine dewatering and the resulting drawdown of bedrock groundwater may subtly change the water quality of various water bodies, such as the East Fork Rock Creek, Rock Lake, East Fork Bull River, and springs and seeps. Reducing the source of deeper groundwater may reduce the concentration of some anions and cations in surface water, such as sodium, calcium, potassium, bicarbonate, magnesium, chloride, and sulfate. If such a water quality change occurred, it would be detectable only during low flow periods when bedrock groundwater is the major source of supply to surface water. Even at low flows, the changes in water quality may be difficult to measure.

Maximum modeled nitrogen emissions from the exhaust adit at the Libby Adit Site during operations in Alternative 2 are predicted to exceed deposition analysis thresholds at Upper Libby Lake, Lower Libby Lake, and Rock Lake. Maximum sulfur deposition impacts were less than the deposition analysis thresholds at Lower Libby Lake and Rock Lake and greater than the deposition thresholds at Upper Libby Lake (see Table 55, p. 307). Upper Libby Lake with very low ANC values would be at risk of becoming more acidic in Alternative 2. Deposition of sulfate to sensitive watersheds may result in leaching of base cations, soil acidification, and surface-water acidification. In some soils, sulfate adsorption may result in delayed acidification of surface waters. Deposition of excess nitrogen species (nitrate and ammonium) to both terrestrial and aquatic systems can result in acidifying streams, lakes, and soils. Increased nitrogen deposition can cause phytoplankton species that use nitrogen more efficiently to eventually dominate a lake (USDA Forest Service *et al.* 2010).

East Side Streams, Lakes, and Springs

Mine Dewatering and Discharges. The effects on streams, springs, and seeps due to mine dewatering would be the same as described for west side surface water. No lakes in the Libby Creek watershed would be affected by mine dewatering. Discharges of mine, adit and tailings impoundment water from the LAD Areas and the Water Treatment Plant during operations were not proposed because the water would be used for milling purposes. If sustained inflows higher than those predicted by the 3D model occurred during the Operations Phase, MMC would implement excess water contingency actions, such as increased grouting, increased sprinkler evaporation at the impoundment, increased storage in the impoundment, or, if necessary, treatment and discharge at the Water Treatment Plant. Discharges would likely be less than the rates during the Construction, Closure, and Post-Closure Phases, and water quality effects would be less than predicted for those phases. If no water were treated and discharged during operations, Water Treatment Plant discharges in Alternative 2 would not affect suspended sediment concentrations in Libby Creek or fine sediment levels in the Libby Creek substrate.

The pumpback wells downslope of the Little Cherry Creek tailings impoundment would reduce streamflow in Libby, Little Cherry and likely Bear creeks. The pumpback well system would likely eliminate the $7Q_{10}$ flow in the diverted Little Cherry Creek and substantially reduce the $7Q_2$ flow. Flow below the Seepage Collection Dam in the former Little Cherry Creek channel would also be substantially reduced. Shallow groundwater at the impoundment site has higher total dissolved solids, nitrate, and metal concentrations than Libby Creek. The flow reduction in Libby Creek and Bear Creek would be less than 10 percent of the estimated $7Q_{10}$ flow. It is likely that changes in the water quality of Libby Creek and Bear Creek during operation of the pumpback wells would not be detectable.

Effects of Runoff from Roads. Sediment delivery from access roads to analysis area streams would be the same as discussed for the Construction Phase. BMPs and monitoring would be implemented to minimize sediment reaching streams. Road closures proposed in Alternative 2 would not reduce sediment reaching streams.

As part of MMC's Fisheries Mitigation Plan (see section 2.4.6.2, *Fisheries*), MMC may conduct a sediment-source inventory in the watershed, and stabilize, recontour, and revegetate priority source areas, which are typically roadcuts in Libby, Hoodoo, Poorman, Midas, and Crazyman creeks. If selected as part of the Fisheries Mitigation Plan, these measures would reduce sediment to area streams.

Risks of Impoundment Failure during Construction, Operations, and Closure. The agencies evaluated the risks associated with impoundment failure during the Construction, Operations, and Closure Phases using a failure modes effects analysis (Klohn Crippen Berger 2009). The analysis identified potential failure modes of all project components. For each failure mode, the agencies estimated the likelihood of occurrence and likely consequences to determine an overall risk level. The risk level integrated likelihood and consequences. The analysis included a discussion of risk management plans.

The assessment evaluated the main dam, the impoundment and associated facilities, tailings and water transport, and closure. Most of the risks associated with impoundment construction, operations, and closure were low or inconsequential. The assessment identified three failure modes for the Little Cherry Creek impoundment with moderately low risks that had the potential to cause water quality effects. The effect of these failure modes would adversely affect groundwater quality beneath the impoundment or surface water in former Little Cherry Creek or Libby Creek.

The failure mode with the highest consequence was failure of the tailings dam due to the liquefaction of the loose glacial outwash layer beneath the tailings impoundment under seismic loading (result of an earthquake). The likelihood of liquefaction of the glacial outwash layer is discussed in section 3.14.3 of the *Geotechnical* section. Should such a failure occur, sediment, tailings, and impoundment water would be uncontrollably released to the environment. The volume of material released and the effect of the release on the environment cannot be predicted, and would depend on many factors, including the type of failure, size of the tailings impoundment at the time of failure, volume of water associated with the failure, and the initial volume and character of the sediments, and the character of concurrent releases from other sources. Under the worst-case scenario, tailings impoundment water containing dissolved metals and reagent residues, and large masses of tailings and sediment would flow into the Libby Creek stream channel. Some of the material would probably remain in the channel for an undefined period of time following failure, while the liquid and remaining solids would be carried downstream. Water quality would be substantially affected. Subsequent to any such failure, seasonal high flows would continue to wash most of the remaining material downstream. Most of the fine sediment from any such catastrophic failure would probably persist in the Libby Creek watershed for many years.

Another potential risk is the release of tailings from a tailings pipeline leak. For example, at the Troy Mine, a recent failure released about 45 tons of tailings into a nearby creek. Suspended sediments were briefly observed for more than 14 miles downstream to the Kootenai River. The failure was caused by a 2-centimeter hole in tailings pipeline. This section of pipe now is equipped with a secondary containment structure. The Troy Mine pipeline is polymer lined single-walled pipe buried over much of its length, with a pressure-sensitive leak detection system. The line has some secondary containment at its midpoint, and some secondary containment at stream crossings. In Montanore, the greatest risk would be at the crossings of Ramsey Creek and Poorman Creek. The pipelines would not be buried at the Ramsey Creek or Poorman Creek crossings, but would be in a lined, covered trestle adjacent to the bridge. The creek crossings would have secondary containment built into the crossings besides the double-walled pipe. The containment would be covered and drain toward a designed sump or tank system. Valves would be installed on either side of the crossings to minimize the quantity of tailings that would reach the creek. Should the tailings reach a creek, water quality would be substantially affected. Subsequent to any such failure, seasonal high flows would wash most of the remaining material downstream. Most of the fine sediment from any such failure would probably persist in the Libby Creek watershed for many years.

Risk of Water Collection and Treatment System Failure. The agencies analyzed the risk and potential effects of water collection and treatment system failure (ERO Resources Corp. 2015c). In Alternative 2, MMC committed to implementing seepage control measures, such as pumpback recovery wells, if required to comply with applicable standards. The pumpback well system could fail to operate as designed because of a power failure or pump failure. Backup generators at the Libby Adit would be available for pumping should the transmission line be unable to provide power. Individual pump failure would be managed by maintaining an inventory of spare pumps. Groundwater pumping would create a large cone of depression downgradient of the impoundment. Should the pumpback well system completely fail, water levels would slowly rise and tailings seepage mixed with groundwater would flow toward the monitoring wells, where increased concentrations may be detected. Groundwater would then flow toward former Little Cherry Creek and Libby Creek in Alternative 2. In the Little Cherry Creek Tailings Impoundment Site, the hydraulic conductivity of the glaciofluvial deposits ranges 0.0028 to 5.3 ft/day (Geomatrix 2006c). The former Little Cherry Creek channel would be 1,200 feet from the toe of the impoundment or 900 to 1,100 feet from the pumpback wells. A prolonged power outage or equipment failure would be necessary before groundwater levels recovered sufficiently to allow tailings seepage to reach surface water.

The effect on metal concentrations in Alternative 2 would not be detectable if metals were attenuated as suggested by the Rock Creek Project seepage model or Troy Mine monitoring. The extent of attenuation at either impoundment site may be less than modeled at the Rock Creek Project site. If no metal attenuation occurred, predicted concentrations of cadmium, copper, and lead in the former Little Cherry Creek would exceed chronic aquatic life standards; the acute aquatic life standard for copper in former Little Cherry Creek is also predicted to be exceeded. Nitrogen and phosphorus compounds would not be expected to be attenuated and total nitrogen and total phosphorus standards in former Little Cherry Creek are predicted to be exceeded. No exceedances of aquatic life standards are predicted for Libby Creek in Alternative 2.

MMC would use the Water Treatment Plant at the Libby Adit Site or install a new water treatment facility at the Ramsey Plant Site if necessary to meet MPDES permitted effluent limits. The Water Treatment Plant would not be used during the Operations Phase in Alternative 2. The agencies concluded that two scenarios—discharge of untreated mine, adit, or tailings water because of a loss of all power and discharge of untreated mine, adit, or tailings water because of inadequate capacity—are not supported by credible scientific evidence (ERO Resources Corp. 2015c). The only plausible water treatment plant failure scenario for which credible scientific evidence exists is a brief failure of the water treatment plant to operate as designed. MMC would likely cease discharges if the plant failed, and store the water until the plant was repaired and the discharge water quality met effluent limits. The draft renewal MPDES permit (DEQ 2015b) requires weekly sampling and analysis of some parameters and monthly sampling and analysis for metals, so any exceedances of the effluent limits would not last longer than about a month.

During plant malfunction, chronic aquatic life standards for total nitrogen, total phosphorus, cadmium, copper, and lead are predicted to be exceeded in Libby Creek at and below LB-300 in all alternatives. Exceedances of chronic aquatic life standards for total phosphorus, cadmium, copper, and lead would extend to LB-2000. Chronic aquatic life standards are based on a 96-hour exposure and can only be exceeded, on average, once in a 3-year period (DEQ 2012a). No acute aquatic life standards are predicted to be exceeded.

The draft renewal MPDES permit requires MMC to notify the DEQ as soon as possible, but no later than 24 hours from the time MMC first became aware of the circumstances of any serious incident of noncompliance with the MPDES effluent limits. Serious incidents include any noncompliance which may seriously endanger health or the environment; any unanticipated bypass which exceeds any effluent limitation in the permit; or any upset which exceeds any effluent limitation in the permit. In all alternatives, the Water Treatment Plant operator would have a Montana Water and Wastewater Operator Certification. The operator would oversee the daily operation of the plant. The MPDES permit conditions and required certification would reduce the potential for exceedances of water quality standards from a Water Treatment Plant malfunction.

Risk of Accidental Spills and Ruptures. In all alternatives, MMC would use non-hazardous and small amounts of hazardous materials in its operations, including reagents during milling (potassium amyl xanthate, methyl isobutyl carbinol, and polyacrylamide), lubricants, fuel, and blasting agents. Material safety data sheets for the proposed reagents are presented in MMC's Plan of Operations (MMI 2005a, MMC 2008).

The agencies evaluated the risk associated with several possible accidental spill failure modes, such as loss of fuel at the plant site from equipment failure or operator error, spills of materials along access roads from accidents or operator error, and spills of concentrate between the plant site and Libby Loadout (Klohn Crippen Berger 2009). A spill or release may result in short-term water quality degradation of area streams. The effect would depend on the response time for cleanup, the toxicity of the material spilled, the size of the spill, how much entered the creek, and how much dilution occurred within the stream. The risk level for the evaluated accidental spill failure modes was low or inconsequential (Klohn Crippen Berger 2009). MMC would implement an Emergency Spill Response Plan in the event of any spill or release.

A rupture or break in either the proposed tailings slurry or return water pipelines may result in short-term water quality degradation. All pipelines would be encased in larger pipes at stream crossings, and emergency storage areas would be provided in critical reaches along the utility corridor. Slurry lines would be continuously operated and monitored at the ore concentrator at the mill. In the event that pipeline leakage occurred, the system would be shut down and immediately repaired. Impacts for major ruptures would depend on the location of the rupture and the response time for cleanup. The agencies evaluated the risk associated with tailings slurry or return water pipelines. Based on the proposed pipeline design, the risk level associated with failure of tailings slurry or return water pipelines leading to the Little Cherry Creek impoundment was low (Klohn Crippen Berger 2009).

3.13.4.2.3 Closure and Post-Closure Phases (Years 25+)

Groundwater

Mine Area

During the Closure Phase in Alternative 2, the adits would be plugged at the surface, and groundwater would begin to fill the mine and adit void. The 3D model predicted that the mine void and adits would require about 490 years to fill. Groundwater in the vicinity of the mine would continue to flow toward the mine void until the regional potentiometric surface recovered to near pre-mining conditions after a predicted 1,150 to 1,300 years after mining ended. The actual time to recover to steady state may be shorter or longer based on actual adit and mine inflow rates and adit plug locations, and would be re-evaluated using the 3D model after additional data were collected during the Evaluation Phase. Groundwater quality would not be affected during the Closure Phase.

For adits from which water may discharge after mine closure, a water-retaining plug would be installed in competent bedrock. Design of the water-retaining plug would be determined by hydrologic and geotechnical data. Because water-retaining plugs can be located deeper into the adit than a dry plug, the adits from the portal to the plug would be backfilled. Final plugging design for "wet" openings would be prepared for the agencies' approval before cessation of operations.

The agencies anticipate the quality of the post-closure mine water would be similar to the Troy Mine water quality when it was not operating (Appendix K-8). The potentiometric surface would begin to recover, but water would continue to flow toward the mine void for hundreds of years. Eventually, water may begin to flow out of the mine void, mix with groundwater in saturated fractures, react with iron oxide and clay minerals along an estimated 0.5-mile or greater flow path, undergo changes in chemistry due to sorption of trace elements and mineral precipitation, and, without mitigation, and flow at a predicted rate of 0.07 cfs (32 gpm) as baseflow to the East Fork Bull River. Using all available hydrologic data collected during mining, mitigation (low permeability barriers in the mine) would be designed to minimize post-mining streamflow changes in the East Fork Rock Creek and East Fork Bull River.

Tailings Impoundment Area

During the Closure Phase, the tailings would continue to consolidate and MMC would begin reclamation of the impoundment. MMC estimates it would take up to 20 years for settling and consolidation at the tailings impoundment to stop and to completely reclaim the tailings impoundment surface. MMC would continue to operate the seepage collection system and pumpback wells until BHES Order limits or applicable nondegradation criteria were met without treatment. As adjacent compliance wells met applicable standards, individual pumpback wells may be shut down and adjacent compliance wells would continue to be monitored. As a result, long-term water treatment and surface water and groundwater quality monitoring may be required. The Water Treatment Plant and LAD Areas would continue to be used for treatment of water collected by the seepage collection and pumpback well systems. Effects on groundwater quality would be similar to the Operations Phase.

Seepage from the tailings impoundment reaching groundwater is estimated to decrease from 25 gpm to 17 gpm about 10 years after closure, stabilizing at 5 gpm at steady state conditions (Klohn Crippen 2005). The effect on groundwater quality under the tailings impoundment at a seepage rate of 25 gpm during the Operations Phase and 5 gpm when the seepage rate is estimated to stabilize is provided in Table 128. Water quality effects during the Closure and Post-Closure Phases when the seepage rate would be decreasing, before stabilizing at 5 gpm, would be less than shown for operations and greater than shown for steady state conditions. The analysis predicted that the water quality standard for antimony and the BHES Order limit for manganese would be exceeded at both the 25 gpm and 5 gpm seepage rates. The manganese exceedance of the BHES Order limit is due in part to the ambient groundwater manganese concentration exceeding the BHES limit. As discussed under the Operations Phase, the predicted antimony and manganese groundwater concentrations based on the mass balance calculation may be higher than would actually occur because of attenuation. Water quality beneath the impoundment would improve slowly over time as infiltrated precipitation mixed with water retained in the impoundment, and water quality concentrations in groundwater after mixing beneath the tailings impoundment would be less than shown in Table 128. MMC would maintain and operate the necessary seepage collection facilities (underdrain system and pumpback wells) until BHES Order limits or applicable nondegradation criteria were met, without treatment, in all receiving waters. MMC also would continue water monitoring as long as the MPDES permit was in effect. As long as post-closure water treatment was required, the agencies would require a bond for the operation and maintenance of the water treatment facilities. The length of time these closure activities would occur is not known and may be decades or more.

LAD Areas

The projected effects on groundwater under the LAD Areas after mill operations ceased are provided in Table 124. Total dissolved solids, nitrate, and dissolved antimony, arsenic, barium, beryllium, cadmium, and manganese concentrations are predicted to exceed one of the applicable criteria. The manganese exceedance of the BHES Order limit is due in part to the ambient groundwater manganese concentration exceeding the BHES Order limit. The predicted dissolved metal concentrations may be higher than would actually occur because they may be attenuated or removed. As infiltrated precipitation mixed with water in the tailings impoundment, the quality of collected tailings seepage water sent to the LAD areas would improve, and the concentrations beneath the LAD Areas would be less than those shown in Table 125, Table 126, and Table 127. The length of time tailings water may be discharged at the LAD Areas is not known and may be decades or more. Water quality beneath the LAD Areas would return to pre-mine conditions soon after discharges to the areas ceased.

Libby Adit Area

Water treated at the Water Treatment Plant (up to 500 gpm in Alternative 2) may be discharged to groundwater via a percolation pond or infiltration gallery located in the alluvial adjacent to Libby Creek. The expected quality of the treated water would be below groundwater BHES Order limits and nondegradation criteria. The length of time water may be discharged from the Water Treatment Plant is not known and may be decades or more. Groundwater quality would return to pre-mine conditions soon after discharges to the percolation pond or infiltration gallery ceased.

Surface Water

West Side Streams, Lakes, and Springs

Effects on west side streams, lakes, and springs would persist through the Closure and Post-Closure Phases as mine dewatering would continue to reduce the potentiometric surface. Without mitigation, the largest reductions in deep bedrock groundwater discharge to springs, the East Fork Rock Creek, Rock Lake, and East Fork Bull River would occur about 16 years after mine closure. After that time, groundwater discharges to surface would begin to increase as the potentiometric surface was recovering. Reduced bedrock groundwater entering surface water may reduce the concentration of some anions and cations in surface water, such as sodium, calcium, potassium, bicarbonate, magnesium, chloride, and sulfate. Whether water quality changes would be detectable or could be separated from natural variability is unknown. Based on previous studies of Rock Lake (Gurrieri 2001, Gurrieri and Furniss 2004), the water quality in Rock Lake may change due to the reduction in deep bedrock groundwater, and may be detectable if mitigation to reduce effects on Rock Lake were not implemented. The lake could become somewhat more acidic, could lose some of its buffering capacity, and the loads of nutrients (especially nitrate), sulfate, calcium, magnesium, sodium, and silicon dioxide could be reduced. These changes could reduce nutrient availability to phytoplankton in Rock Lake.

If mine void water flowed to the East Fork Bull River after mine closure, it is not likely that changes in water quality in the river would be detectable. The effect cannot be accurately quantified without additional information from the underground mine. To develop a quantitative estimate of the actual effect, MMC would monitor the chemistry within the underground workings, evaluate downgradient groundwater flow and chemistry within bedrock fracture systems, and monitor baseflow in the East Fork Bull River (see Appendix C, *Water Resources Monitoring*).

Nitrogen and sulfur emissions from the mine's exhaust adit at the Libby Adit Site would substantially decrease when underground mining ceased and would end when all underground mobile equipment ceased operating.

East Side Streams, Lakes, and Springs

Water Quality. Without mitigation, the largest reductions in deep bedrock groundwater discharge to springs and streams in the Libby Creek watershed would occur about 3 years after mine closure. Reduced bedrock groundwater entering surface water may reduce the concentration of some anions and cations in surface water, such as sodium, calcium, potassium, bicarbonate, magnesium, chloride, and sulfate. Whether water quality changes in Libby Creek above the Water Treatment Plant discharge point or in Ramsey Creek would be detectable or could be separated from natural variability is unknown. After mine closure and plugging of the adits near the surface, groundwater contributions to surface water would begin to increase as the potentiometric surface was recovering. After the adit filled, baseflow conditions would return to pre-mining conditions, and stream water quality is not expected to be affected. No lakes in the Libby Creek watershed would be affected by mine dewatering or changes in the potentiometric surface after mining.

The quality and rate of Water Treatment Plan discharges in the Closure Phase would be similar to the Construction Phase. For the reasons described under Alternative 3 in section 3.13.4.3.2, *Effects of Discharges,* it is expected that discharges from the Water Treatment Plant directly to Libby Creek at Outfall 003, if they were to occur, would not increase suspended sediment concentrations in Libby Creek or fine sediment levels in the Libby Creek substrate. Discharges to Outfalls 001 and 002 would have no effect on sediment concentrations in Libby Creek or fine sediment levels in the Libby Creek substrate.

Discharges from the LAD Areas are predicted to exceed BHES Order limits or applicable nondegradation criteria for six metals in Ramsey Creek, five metals in Poorman Creek, and three metals in Libby Creek (Table 125, Table 126, and Table 127).

After the impoundment was reclaimed and runoff met BHES Order limits or applicable nondegradation criteria, runoff from the reclaimed tailings impoundment surface and the watershed west of the impoundment would be routed toward Bear Creek. The water quality of Bear Creek would not be degraded by the runoff. MMC would design a riprapped channel to Bear Creek. The design would incorporate features that provide for stability of a transition zone so that sediment delivery to streams was not increased. A small, rock-filled check dam would be located just beyond the northwest end of the reclaimed impoundment. The check dam would be designed for the 100-year storm event. Sediment would be removed from behind the dam, if necessary. These measures would minimize the amount of sediment reaching Bear Creek. Increased sedimentation to Libby Creek within the upper and lower impaired segments would likely not occur.

3.13.4.2.4 Climate Change

The effects of climate change in combination with Alternative 2 would be the same as in combination with Alternative 3 (see section 3.11.4.4.5, *Climate Change*).

3.13.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Alternative 3 would incorporate modifications and mitigating measures proposed by the agencies that would reduce water quality impacts on area streams and springs. The LAD Areas would not be used in Alternative 3. Any excess water would be treated at the Water Treatment Plant at the Libby Adit Site and discharged at existing permitted outfalls. The tailings impoundment would be at the Poorman Impoundment Site, which would not require diversion of Little Cherry Creek. Seepage from the Poorman Tailings Impoundment Site would be intercepted by pumpback well system during the Operations, Closure, and Post-Closure Phases. Power backup would ensure that the pumpback wells would be continuously operated to protect surface water and groundwater quality. During system maintenance, individual pumps would be shut off for only short periods of time to maintain complete capture around the tailings impoundment. Tailings and reclaimed water pipelines would be buried, which, along with a leak detection system, would reduce the risk of affecting surface water resources. Sanitary waste would be treated on-site and pumped to the tailings impoundment during operations. MMC would comply with Forest Service policies when disposing of demolition debris during mine closure. The total disturbance area for Alternative 3 would be 1,565 acres. The following sections discuss only those effects that would be different from Alternative 2.

3.13.4.3.1 Effects of Mine Inflows and Pumpback Wells

The effects from mine inflows on surface water and groundwater quality during the Evaluation through Operations Phases would be the same as described for Alternative 2. The effect on water quality in streams, springs, and lakes during the Closure and Post-Closure Phases would be less than Alternative 2 due to implementing mitigation measures to reduce effects on water quality. Depending on the relative contribution of surface water, shallow groundwater, and deep groundwater to each surface water and groundwater body, water quality changes may be slight and not detectable, or may be greater and detectable. Because the Ramsey Adits would not be constructed, Ramsey Creek would be affected less than in Alternative 2 because there would be less drawdown in the Ramsey Creek watershed due to mine inflows. Three adits in the Libby Creek drainage would reduce streamflow in Libby Creek slightly more than Alternative 2, so water quality effects on upper Libby Creek (above the Water Treatment Plant point of discharge) may be slightly greater than in Alternative 2.

The pumpback wells, located downgradient of the tailings impoundment (Figure 25), would reduce streamflow in Poorman and Libby creeks. The modeled flow reduction in Poorman Creek would be up to 9 percent of the estimated $7Q_{10}$ flow. Shallow groundwater at the impoundment site has higher total dissolved solids, nitrate, and metal concentrations than Poorman and Libby creeks. During low flows, reducing shallow groundwater contribution to the creek may result in slight detectable changes in the water quality of Poorman Creek. It may not be possible to separate such changes from natural variability. In Libby Creek, the flow reduction due to pumping from the pumpback wells would be less than 10 percent of the estimated $7Q_{10}$ flow; it is likely that changes in the water quality of Libby Creek during operation of the pumpback wells would not be detectable.

3.13.4.3.2 Effects of Discharges

Sediments, Metals and Nutrients in Surface Water

MMC owns and operates a Water Treatment Plant the Libby Adit Site with three permitted outfalls. Three outfalls are included in the existing and renewal MDPES permit: Outfall 001 – percolation pond; Outfall 002 – drainfield with three infiltration zones discharging to groundwater; and Outfall 003 – pipeline outlet to Libby Creek. The percolation pond has an estimated capacity of 25 acre-feet (8.1 million gallons). If the pond reaches capacity, an overflow pipe routes water to a direct discharge to Libby Creek (Outfall 003). It is not known if the pipeline to Libby Creek is still functional. MMC has not reported a discharge from Outfalls 002 and 003 during the term of the 2006-issued permit. The Water Treatment Plant would be used during all phases of the project to treat and discharge mine and adit water. During all phases except the Evaluation Phase, it would also be used to treat and discharge water diverted from Libby Creek, stored primarily in the impoundment, and sent to the Water Treatment Plant as mitigation water to prevent adverse effects on the Forest Service's senior water right. The Water Treatment Plant uses ultrafiltration to remove metals sorbed onto particulates suspended in the influent, thereby reducing suspended sediment and metals.

Based on sample data collected between 2008 and 2010 from the Water Treatment Plant, the average total suspended solids concentration in the Water Treatment Plant effluent is anticipated to be 1 mg/L, which the DEQ and EPA (2014) determined to be a reasonable estimate for the outfall effluent total suspended solids concentration. The median total suspended solids concentration from samples collected quarterly from Libby Creek at LB-300 between 2006 and 2010 (141 samples) as part of the existing MPDES permit requirements is less than 1 mg/L (Appendix K).

Using an estimated maximum discharge from the Water Treatment Plant of 765 gpm, the calculated maximum sediment load from the outfall, assuming a total suspended solids concentration of 1 mg/L, is 1.6 tons/year. Because of ultrafiltration, it is expected that discharges from the Water Treatment Plant to Libby Creek at Outfall 003, should they occur, would not increase suspended sediment concentrations in Libby Creek or fine sediment levels in the Libby Creek substrate. The agencies' monitoring plan (Appendix C) would require MMC to follow DEQ methods for assessing sediment impairment (DEQ 2013) at all aquatic life monitoring stations. Beginning on the effective date of the MPDES permit, MMC would monitor all discharges to surface water for sediment, and report sediment concentrations to DEQ monthly (see Appendix C). Any failures of the sediment BMPs would require MMC to implement corrective measures in accordance with the MPDES permit.

An assessment of the effect of Water Treatment Plant discharge on Libby Creek flow was completed to evaluate stream stability using existing stream flow data, and information on channel substrate, habitat, and bank characteristics (Kline Environmental Research 2015). The agencies independently reviewed and concurred with the assessment. The increase in flow from the Water Treatment Plant would be negligible during high flows, and is predicted to increase low flow by more than 100 percent of the modeled baseflow at LB-300 during operations (from 1.2 to 3.1 cfs). The total flow below the Water Treatment Plant outfalls would not exceed the existing natural range of flow in Libby Creek. Stream channel processes that naturally occur would continue, but at a slightly elevated rate. The rate of bedload transport would increase slightly (Kline Environmental Research 2015). The increase during bankfull or channel-forming flows would be less than 1 percent. The flow increase would have insignificant effects on streambank erosion, would not alter the physical substrate habitat, and would not affect sediment transport, aggradation, or degradation.

During all mine phases in Alternative 3, excess water would be treated at the Water Treatment Plant and discharged to an outfall at the Libby Adit Site. The existing treatment plant would be modified as necessary to treat parameters such as nutrients or metals to meet MPDES permitted effluent limits, and its capacity increased. An additional outfall may be needed in Ramsey Creek to avoid adversely affecting senior water rights. The pH of the discharge of mine and adit water is expected to be about 8, slightly greater than in-stream pH values of between 6.5 and 7.5 in Libby Creek. Water discharged from the Water Treatment Plant, if discharged to the percolation pond or infiltration gallery next to Libby Creek, would mix with groundwater with a pH of about 6.5 in an approved groundwater mixing zone. Mixing would also occur within a surface water mixing zone in Libby Creek. After mixing, water treated and discharged from the Water Treatment Plant would be below BHES Order limits and applicable nondegradation criteria in surface water and groundwater. Groundwater and surface water quality would not be adversely affected.

The mass balance analysis, using $7Q_{10}$ flow less any predicted mine inflow or pumpback well streamflow reductions, was completed for all alternatives assuming certain treated total dissolved solids, nitrogen and metal concentrations at the Water Treatment Plant outfalls needed to meet applicable BHES Order limits or prevent significant changes in water quality for nutrients and toxic, carcinogenic or bioconcentrating parameters not listed in the BHES Order at all locations downstream of the Water Treatment Plant discharge mixing zone (currently LB-300). The expected water quality of the mine wastewater, adit wastewater during construction and post-construction, tailings wastewater post-operations, and Water Treatment Plant treated water quality are provided in Table 122. The discharges to Libby Creek may increase concentrations of total dissolved solids, nitrogen, phosphorus, and some metal concentrations in Libby Creek below LB-300 above ambient concentrations. Table 129 provides the results after mixing at LB-300 and Table 130 provides the results after mixing at LB-1000; results for LB-2000 are provided in Appendix G. Predicted concentrations during the Post-Closure Phase would be slightly better than those shown in the Closure Phase at LB-300 and LB-1000. Although concentrations of some parameters are predicted to increase, BHES Order limits or applicable nondegradation criteria would not be exceeded during all mine phases at either location. Poorman Creek would not be affected by discharges. Discharges would not occur to Ramsey Creek unless required for water rights mitigation; if needed, the discharged water would meet BHES Order limits and applicable nonsignificance criteria. During the permitting process, the DEQ would make the same determinations regarding a mixing zone at the tailings impoundment for seepage reaching groundwater in Alternative 3 that were discussed in Alternative 2.

Table 129. Predicted Concentrations after Mixing at LB-300, Alternative 3.

Parameter	Ambient Concentration	Construction Phase	Operations Phase	Closure Phase	BHES Order Limit[1]	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
						Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]	10%/40% of Lowest Standard[5]
Total dissolved solids	<25	<68	<82	<71	100				
Ammonia, as N	<0.050	<0.38	<0.49	<0.40	TIN=1				
Nitrate, as N	<0.13	<0.37	<0.45	<0.38	TIN=1				
Total inorganic nitrogen	<0.18	<0.75	<0.94	<0.78	1				
Total nitrogen	<0.26	<0.21	<0.19	<0.20					0.0275/0.11
Total phosphorus	<0.0064	<0.0067	<0.0068	<0.0067					0.0025/0.01
Aluminum - T	<0.012	<0.052	<0.064	<0.054			0.03	0.013	
Antimony-T	<0.00050	<0.00075	<0.00084	<0.00077			0.0004	0.00084	
Arsenic-C	<0.00035	<0.00022	<0.00018	<0.00022		<0.00035			
Barium-T	<0.0026	<0.10	<0.14	<0.11			0.002	0.15	
Beryllium-C	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020			
Cadmium-T	<0.0000088	<0.0000094	<0.000010	<0.0000094			0.0001	0.000078	
Chromium-T	<0.0010	<0.0035	<0.0044	<0.0037	0.005				
Copper-T	<0.0010	<0.0023	<0.0027	<0.0024	0.003				
Iron-H	<0.024	<0.078	<0.10	<0.081	0.1				
Lead-T	<0.00025	<0.00030	<0.00032	<0.00030			0.0001	0.000082	
Manganese	<0.0019	<0.037	<0.048	<0.039	0.05				
Mercury-T	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010			
Nickel-T	<0.00050	<0.0018	<0.0022	<0.0019			0.0005	0.0024	
Selenium-T	<0.0010	<0.0013	<0.0013	<0.0013			0.0006	0.00075	
Silver-T	<0.00020	<0.00030	<0.00033	<0.00031			0.0002	0.000056	
Zinc-T	<0.0080	<0.019	<0.023	<0.020	0.025				

Assumed quality of Water Treatment Plant effluent discharge is provided in Table 122.
All concentrations are mg/L. All metal concentrations are for total recoverable metals except aluminum, which is dissolved.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limits used in calculating representative values when reported concentrations were below the detection limit.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria are shown in **bold**; no exceedances of BHES Order limits or nonsignificance criteria during any mine phase were predicted.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic, beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
[5] 10% and 40% of lowest standard applies to degradation determination review for total nitrogen and total phosphorus apply.
Source: Appendix G.

Table 130. Predicted Concentrations after Mixing at LB-1000, Alternative 3.

Parameter	Ambient Concen-tration	Construction Phase	Operations Phase	Closure Phase	BHES Order Limit[1]	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
						Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]	10%/40% of Lowest Standard[5]
Total dissolved solids	<33	<42	<49	<43	100				
Ammonia, as N	<0.030	<0.11	<0.17	<0.12	TIN=1				
Nitrate, as N	<0.034	0.10	<0.15	<0.11	TIN=1				
Total inorganic nitrogen	<0.064	<0.21	<0.32	<0.23	1				
Total nitrogen	<0.11	<0.11	<0.12	<0.11					0.0275/0.11
Total phosphorus	<0.007	<0.0070	<0.0070	<0.0070					0.0025/0.01
Aluminum - T	<0.017	<0.025	<0.032	<0.026			0.03	0.013	
Antimony-T	<0.00050	<0.00056	<0.00060	<0.00056			0.0004	0.00084	
Arsenic-C	<0.00020	<0.00019	<0.00018	<0.00019		<0.00020			
Barium-T	0.0066	<0.029	<0.046	<0.032			0.002	0.15	
Beryllium-C	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020			
Cadmium-T	<0.000060	<0.000054	<0.000050	<0.000054			0.0001	0.000078	
Chromium-T	<0.0010	<0.0016	<0.0020	<0.0016	0.005				
Copper-T	<0.00046	<0.00082	<0.0011	<0.00085	0.003				
Iron-H	<0.017	<0.030	<0.040	<0.032	0.1				
Lead-T	<0.000054	<0.000089	<0.00011	<0.000092			0.0001	0.000082	
Manganese	<0.00099	<0.0091	<0.015	<0.010	0.05				
Mercury-T	<0.000020	<0.000019	<0.000018	<0.000019		<0.000020			
Nickel-T	<0.00050	<0.00079	<0.0010	<0.00082			0.0005	0.0024	
Selenium-T	<0.0010	<0.0011	<0.0011	<0.0011			0.0006	0.00075	
Silver-T	<0.00020	<0.00022	<0.00024	<0.00023			0.0002	0.000056	
Zinc-T	<0.0044	<0.0074	<0.010	<0.0077	0.025				

Assumed quality of Water Treatment Plant effluent discharge is provided in Table 122.
All concentrations are mg/L. All metal concentrations are for total recoverable metals except for aluminum, which is dissolved.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limits used in calculating representative values when reported concentration were below the detection limit.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria are shown in **bold**; no exceedances of BHES Order limits or nonsignificance criteria during any mine phase were predicted.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic, beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (aluminum, antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
[5] 10% and 40% of lowest standard applies to degradation determination review for total nitrogen and total phosphorus.
Source: Appendix G.

Assuming that the water treatment plant effluent would meet the total nitrogen concentration at the end of the mixing zone, total nitrogen concentrations are predicted to decrease at LB-300, increase to 0.12 mg/L from an ambient concentration of 0.11 mg/L at LB-1000, and stay the same as the ambient concentration at LB-2000, all below the total nitrogen standard of 0.275 mg/L. Predicted increased total phosphorus concentrations would remain below the total phosphorus standard. While a variance for total nitrogen remained in place, increases in total nitrogen concentrations may result in increased levels of filamentous algae in Libby Creek below the Water Treatment Plant discharge point. This may result in decreases in dissolved oxygen concentrations to below the standard during low flow periods in early fall, and may also result in higher pH levels in the creek. It is uncertain whether the pH standard would be exceeded due other factors that affect pH, such as chemical buffering or re-aeration rates in Libby Creek (Suplee, pers. comm. 2014).

Metals and Nutrients in Groundwater at Impoundment Site

Metals, nitrogen and total dissolved solids concentrations in groundwater after mixing beneath the Poorman Tailings Impoundment Site would be similar to Alternative 2 (Table 128), but the estimated groundwater flux under the Alternative 3 impoundment is slightly greater (41 gpm), resulting in slightly lower projected final mixing concentrations in groundwater under the tailings impoundment (Table 131). As discussed in Alternative 2, groundwater metal concentrations beneath the impoundment area during the Operations Phase may be less than those predicted by the mass balance calculations. Because water quality beneath the impoundment would improve slowly over time as infiltrated precipitation mixed with water retained in the impoundment, water quality concentrations post-closure when the seepage rate stabilized would be less than shown in Table 131.

The risk associated with ore in underground workings and waste rock and ore stockpiles in Alternative 3 would be the same as in Alternative 2. Alternative 3 might have some difference in the potential for acid rock drainage or trace element release from the construction of adits in Libby Creek instead of Ramsey Creek, as compared to Alternative 2. Minor differences in the relative volumes of waste rock lithologies intercepted in the alternative adit locations that would be developed under Alternative 3 may alter the overall potential for changes in water quality, depending upon the relative volume of Prichard and Revett formation altered waste zones to be mined. Any change would likely be minor. Characteristics and suitability of waste rock would be identified through sampling and analysis during the Evaluation Phase. The chemistry of tailings and waste rock used for impoundment construction would not change as a result of constructing impoundments in alternative locations.

The volume of waste rock to be mined from each altered waste zone, and the area of the underground workings that would expose the altered waste zone, are not yet fully defined because final mine plans would depend upon results of the proposed Evaluation Phase work. As noted above, the potential for trace metal release from waste rock used in construction or placed in stockpiles would primarily be a function of how much waste rock was mined from the reactive portions of the lower Revett Formation altered waste zones and the Prichard Formation, and how much metal those rock types would release. The zonation patterns do not indicate a higher potential for acid generation and metal leaching at the Montanore Project than that observed at the Troy Mine, but suggest the need for sampling at a level sufficient to represent the observed variability. These relationships would be further defined during the Evaluation Phase, when waste rock in these zones would be sampled more comprehensively, and would be used to support the need for further testing. Ore collected during the Evaluation Phase would be used to conduct further metallurgical testing with a goal of obtaining tailings reject for kinetic and metal mobility test work using a comprehensive suite of elements. Additional testing would be needed to support the results of a single kinetic test of tailings reported to date, and to provide a more comprehensive suite of metal mobility data for evaluating tailings impoundment performance.

Table 131. Predicted Concentrations in Groundwater after Mixing beneath the Tailings Impoundment without Attenuation, Alternative 3.

Parameter	Ambient Concen-tration	Opera-tions Phase	Post-Closure at Stabilized Seepage Rate	Applicable Nonsignificance Criteria Outside of a Mixing Zone			
				BHES Order Limit[1]	Ambient Concen-tration[2]	Trigger Value[3]	15% of Lowest Standard[4]
Total dissolved solids	60	138	82	100			
Nitrate, as N	<0.10	5.0	1.5	TIN=1			
Antimony-T	<0.0030	**<0.011**	**<0.0052**			0.0004	0.0009
Arsenic-C	<0.0030	<0.0025	<0.0029		<0.0030		
Barium-T	<0.040	<0.066	<0.048			0.002	0.15
Beryllium-C	<0.0010	<0.001	<0.001		<0.0010		
Cadmium-T	<0.00010	<0.00043	<0.00019			0.0001	0.000075
Chromium-T	<0.00074	<0.00084	<0.00077	0.005			
Copper-T	<0.0012	<0.011	<0.0039	0.003			
Iron-H	<0.010	<0.025	<0.014	0.1			
Lead-T	<0.00028	<0.0018	<0.00073			0.0001	0.0023
Manganese	<0.077	**<0.24**	**<0.12**	0.05			
Mercury-T	<0.000030	<0.000021	<0.000027		<0.000030		
Nickel-T	<0.010	<0.010	<0.010			0.0005	0.015
Selenium-T	<0.0010	<0.0011	<0.0010			0.0006	0.0075
Silver-T	<0.00050	<0.00095	<0.00063			0.0002	0.015
Zinc-T	<0.0064	<0.0078	<0.0068	0.025			

All concentrations are mg/L. All metal concentrations are for dissolved metals.
Method used to derive representative ambient water quality concentrations described in ERO 2011c.
Concentrations presented with a < symbol had at least one sample with a reported concentration less than the detection limit used in calculating representative values; detection limit used in calculating representative value when reported concentration was below the detection limit.
Predicted concentrations greater than BHES Order limits or applicable nondegradation criteria are shown in **bold**.
[1] BHES Order limits apply to only to those parameters for which limits were set in 1992: total dissolved solids, nitrate, chromium, copper, iron, manganese, and zinc.
[2] No increase in ambient concentrations outside of a mixing zone designated by the DEQ applies to degradation determination in nondegradation review for arsenic beryllium, and mercury.
[3] Trigger values apply to degradation determination in nondegradation review for antimony, barium, cadmium, lead, nickel, selenium, and silver.
[4] 15% of lowest standard only applies to degradation determination for concentrations of toxins (antimony, barium, cadmium, copper, lead, nickel, selenium, and silver) outside of a mixing zone designated by the DEQ if the change in water quality exceeds the trigger value.
Source: Appendix G.

3.13.4.3.3 Sanitary Waste Management

MMC's proposal in Alternative 2 to collect and ship sanitary waste off-site for treatment and disposal was not feasible. In Alternatives 3 and 4 during the Evaluation, Construction, Closure, and Post-Closure Phases, MMC would use a septic system consisting of septic tanks for primary treatment, followed by discharge to a leach field at the Libby Adit. Expected discharge is 585 gallons per day (Geomatrix 2010a). Using Montana DEQ guidelines for performing a nitrate sensitivity analysis for the septic system (DEQ 2010b), the resultant nitrate concentration calculated at the end of a groundwater mixing zone is 0.75 mg/L. The DEQ guidelines were also used for assessing compliance with nondegradation using a surface water dilution analysis (trigger value calculation) for nitrate and phosphorus. Using the proposed treatment system, the calculated increase in the concentration of nitrate (0.0099 mg/L) and phosphorus (0.0007 mg/L) did not exceed the trigger values of 0.01 mg/L for nitrate and 0.001 mg/L for phosphorus (Geomatrix 2010a). The nonsignificance criteria do not apply for nitrate in groundwater or for TIN in surface water for the Montanore Project because the BHES Order set limits of 10 mg/L for nitrate in groundwater and 1 mg/L for TIN in surface water. The assessment results showed that the BHES Order limits would not be exceeded for nitrate in groundwater or TIN in nearby Libby Creek.

During the Operations Phase, MMC would use a similar system consisting of septic tanks for primary treatment, followed by discharge to the tailings impoundment for final disposal. Disinfection of effluent from the septic tanks would occur before pumping to the impoundment, and would be accomplished by chlorination, ozonation, or ultraviolet light. Disinfection would reduce the number of microorganisms and eliminate potential hazards due to human exposure to the water in the impoundment. About 6,100 gallons per day or a rate of 5 gpm of sanitary wastewater is estimated to be produced through employee use; a rate of 7,000 gallons per day was used for design purposes (Geomatrix 2010a). The estimate is based on 30 office workers (12 gallons per day) and 230 miners/mill workers (25 gallons per day). Sending treated sanitary wastes to the tailings impoundment would not have a detectable effect on surface water or groundwater quality.

3.13.4.3.4 Stream Temperature

Stream temperature is an important criterion for aquatic life and Montana has surface water aquatic life standards for temperature that restrict temperature changes. For bull trout, cold water temperatures play an important role in determining habitat, as this species is primarily found in colder streams below 59°F and spawning habitats are generally characterized by temperatures that are below 48°F in the fall (USFWS 2014c). Constant temperatures greater than 60°F have been shown to be intolerable for bull trout (Maret *et al*. 2005). Direct solar radiation is the primary contributor to daily fluctuations in stream temperature, but stream temperature is influenced by many factors: air temperature, topography, weather, shade, streambed substrate (bedrock versus gravel or sandy bottoms), stream morphology, the amount of subsurface streamflow, and groundwater inflows (USDA Pacific Northwest Research Station 2005). The project may affect stream temperatures by discharge of treated water from the Water Treatment Plant, vegetation clearing, decreased streamflow due to direct diversions, and changes in groundwater discharge to area streams.

The temperature of the discharge of mine and adit water is expected to be between 51° and 60°F based on measured temperatures of the Water Treatment Plant effluent from February 2014 to May 2015 (DEQ 2015b). The temperature of the tailings water discharge during the Closure and

Post-Closure Phases is expected to be close to ambient temperature at the time of discharge from the Water Treatment Plant, except during the winter months, when it may be warmer. Discharges during operations would be a mixture of mine and adit water, and water stored in the tailings impoundment. Water discharged from the Water Treatment Plant, if discharged to the percolation pond or a drainfield next to Libby Creek, would cool as it flowed via the subsurface to the creek. Heat is not added as part of the facility’s wastewater treatment process. Discharges to groundwater (Outfalls 001 and 002) are expected to attenuate any thermal effects. Synoptic temperature data collected in 2014 and 2015 generally indicate less than 1 degree change between monitoring locations LB-200 and LB-300. A direct discharge to Libby Creek has not occurred since the MPDES permit was first issued in 1997. Direct discharges to Libby Creek from the percolation pond, if they were to occur, would be infrequent when the pond reached its full capacity. During final design, MMC would evaluate the size of the percolation pond at the Libby Adit, and enlarge it, if necessary, to accommodate higher discharge rates during operations. Temperatures upstream and downstream of the Water Treatment Plant outfalls would be monitored during water resources and aquatic biology monitoring (see Appendix C).

Vegetation clearing in all mine alternatives would occur along the Bear Creek Road, the main access road, and other access roads between the plant site and the tailings impoundment site. Widening of roads to access the plant site would require vegetation clearing at crossings of Bear Creek, Little Cherry Creek, Poorman Creek, and Ramsey Creek in all mine alternatives. The Bear Creek Road has an existing width of 14 feet; the existing width of other access roads is similar. The main access road would be widened to 26 feet; the right-of-way width would also increase by about 12 feet. Right-of-way clearing for new main access roads, such as the Little Cherry Creek crossing in Alternative 4, would be up to 100 feet wide. In British Columbia, stream temperature increases during the spring and summer months of about 1°F on average were found at a downstream monitoring site below a 100-foot wide road right-of-way. Increases were on average less than 0.5°F below a 65-foot wide road right-of-way. Stream temperatures in the winter months below the road right-of-ways showed no change or declined slightly. The authors speculated that the stream temperature increases may not have been solely attributed to clearing. Groundwater inflow at the stream crossings decreased because culverts prevented groundwater inflow to the streams at the crossings (Herunter *et al*. 2003). Clearing would increase direct solar radiation to streams and may increase stream temperature slightly at and for a short distance below the stream crossings along new roads on warm to hot days. The pumpback wells and any other diversions (such as make-up wells) would reduce streamflow. For example, at PM-1200 in Poorman Creek, the estimated $7Q_{10}$ flow is predicted to be reduced by up to 12 percent. It is possible that reduced streamflow might increase the stream temperature during low flows, but forest shading and flow in the gravel streambed substrate, as well as groundwater supply to the stream, may prevent or minimize such a temperature change.

The reduction in bedrock groundwater inflows to analysis area streams due to mine inflows may increase stream temperatures where and when bedrock groundwater is the major component of baseflow, such as in the upper streams in the mine area where alluvial and colluvial deposits are thin or absent. Bedrock groundwater flow to streams is fracture controlled and does not occur uniformly along any stream reach. It is difficult to predict how, when and where reduced bedrock inflows may affect stream temperatures, or if such changes would be measureable.

Due to the numerous factors affecting stream temperatures and the constantly changing stream temperature regime that occurs, it is difficult to predict how effects other than water treatment plant discharges in Alternative 3 may indirectly affect stream temperature, or to what extent stream temperatures may be changed. It may not be possible to separate indirect effects of the mine alternatives on stream temperature from other natural effects. The agencies' water resources and aquatic biology monitoring for Alternative 3 includes temperature monitoring (Appendix C).

3.13.4.3.5 Stormwater Runoff and Erosion

Evaluation, Construction, and Operations Phases

The following sections disclose the potential effect on sediment in analysis area streams from activities during the Evaluation, Construction, and Operations Phases. Each mine facility is discussed following a discussion of initially planning and implementation. Potential effects of proposed mitigation on sediment in analysis area streams also are described.

Stormwater Control Planning and Implementation

MMC would submit a final Stormwater Pollution Prevention Plan (SWPPP) for the agencies' approval no later than the 28th of the following month 60 days after the effective date of the MPDES permit. The SWPPP would describe the facility, BMPs, control measures, and monitoring procedures that would ensure compliance with the terms and conditions of their MPDES permit. The SWPPP would address stormwater runoff from mine-related facilities including topsoil stockpiles, access/haul roads, adit pads, and parking lots. The plan also would address stormwater runoff from transmission-related facilities. Sediment and runoff from all disturbed areas would be minimized through the use of BMPs developed in accordance with the Forest Service's *National Best Management Practices for Water Quality Management on National Forest System Lands* (USDA Forest Service 2012a) and the BMP requirements in the MPDES permit. After the activities were completed, and the roads became stabilized, sediment delivery to area streams would decrease below existing levels. As discussed under Alternative 2, for activities not covered by a MPDES or general stormwater permit, MMC may request and the DEQ may approve a 318 authorization for short-term increases in turbidity and total suspended solids discussed on p. 705.

All point source discharges containing sediment from the Montanore Project via stormwater outfalls or the Water Treatment Plant would be monitored and sediment concentrations reported to DEQ, and Outfall 003 would be subject to daily and monthly sediment limits. The DEQ and EPA established as a TMDL an average annual sediment load of 4,234 tons for Libby Creek from the US 2 bridge to the confluence with the Kootenai River (DEQ and EPA 2014). A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. As part of this TMDL, the Montanore facility was assigned a sediment wasteload allocation of 24 tons/year. MMC's discharges would be small in comparison to the estimated existing sediment load of 1,621 tons/year and the estimated future sediment load of 1,102 tons/year in the upper Libby Creek watershed (Table 123).

The following sections describe anticipated discharges containing sediment from each mine facility, roads, and mitigation activities. Stormwater discharges would be infrequent from all areas within the mine operating permit area because stormwater would be contained by sediment ponds sized for the 10-year/24-hour storm. A 10-year storm has an annual occurrence probability of 10 percent. Because of the natural variability of storm events, it is not possible to predict the frequency, duration, or suspended sediment concentration of the discharge. Ponds within the mine operating permit area could discharge during storm events greater than the 10-year/24-hour storm when sediment delivery to streams would already be naturally elevated. Distinguishing the additional sediment load from any discharges that occurred from existing conditions may not be feasible. Sediment from such discharges would be deposited into floodplains or low gradient stream reaches, or would be carried to the Kootenai River. Discharges from stormwater ponds may increase suspended sediment concentrations in Ramsey, Poorman, or Libby Creek or fine sediment levels in these streams' substrates, but it is expected that any increases would be minimal due to implementation of the SWPPP. Beginning on the effective date of the MPDES permit, MMC would monitor all discharges to surface water for sediment, and report sediment concentrations to DEQ monthly (see Appendix C). Any failures of the sediment BMPs would require MMC to implement corrective measures in accordance with the MPDES permit. Stormwater monitoring would be required at all stormwater outfalls whenever a measurable discharge occurred. Both grab and flow-weighted composite samples would be collected. Grab samples would be collected within the first 30 minutes of the stormwater discharge. Unless a grab sample was specified, a flow weighted composite sample would be taken for either the entire discharge or for the first 3 hours of the discharge. The flow-weighted composite sample for a stormwater discharge may be taken with a continuous sampler or as a combination of a minimum of three aliquots (with each aliquot separated by a minimum period of 15 minutes) taken in each hour of the discharge over the course of either the entire discharge or over the first 3 hours of the discharge. Sample type and parameters to be analyzed for each stormwater outfall are provided in Table C-15 of Appendix C.

The DEQ and EPA (2014) anticipate achievement of the allocated sediment loads in the water quality improvement plan for lower Libby Creek, including the 24 tons/year allocated to the Montanore Project, will allow Libby Creek to support and maintain its state-designated beneficial uses (DEQ and EPA 2014).

Plant Site

The Libby Plant Site would be constructed between Libby and Ramsey creeks. The plant would be more than 500 feet from Libby Creek, minimizing the potential for non-channelized overland flow to reach Libby Creek (Belt *et al.* 1992). During the Construction Phase, surface water runoff from the Plant Site area would be directed along ditches to lined sediment ponds sized for the 10-year/24-hour storm. MMC would request amendment to its MPDES permit to include stormwater runoff from the plant site during construction for Outfalls 005 and 006. Based on preliminary design, the Libby Plant Site would not be built with waste rock. MMC would request amendment to its MPDES permit to include stormwater runoff from the plant site during construction for Outfalls 005 and 006.

During the Operations Phase, surface water runoff from the Plant Site area would be directed along ditches to lined sediment ponds sized for the 10-year/24-hour storm. Water from the ponds would be pumped to the plant for makeup needs. An ore stockpile at the Plant Site would be covered so that precipitation water would not contact this material. No waste rock would be placed at the Plant Site. Stormwater discharges from the Libby Plant Site would not occur during operations and sediment in Libby and Ramsey creeks would not be affected.

Tailings Impoundment

The tailings impoundment would be constructed between Little Cherry and Poorman creeks, and above Libby Creek. MMC would request an amendment to its MPDES permit for stormwater discharges during the Construction Phase at the Poorman Impoundment Site. During construction, ditches and sediment ponds containing stormwater runoff from the area would be sized to either the 100-year/24-hour or the 10-year/24-hour storm (see below). Infrequent discharges from the sediment ponds would flow and be monitored at one or more MPDES permitted outfalls, and would be required to meet effluent limits.

Waste rock excavated extending the Upper Libby Adit and the new Libby Adit would be hauled to a temporary waste rock stockpile within the Poorman Tailings Impoundment footprint, the location of which would be determined during final design. Before the KNF or the DEQ would allow MMC to create a temporary waste rock stockpile within the Poorman Tailings Impoundment footprint, MMC would submit data regarding the concentrations of potential pollutants in runoff and seepage from waste rock to the DEQ. The DEQ would use a reasonable potential analysis to determine whether a discharge, alone or in combination with other sources of pollutants to a water body, could lead to an excursion above an applicable water quality standard. The DEQ would establish effluent limits during the MPDES permitting process if runoff from the waste rock stockpile was not sent to the Water Treatment Plant (Outfalls 001 through 003) for treatment.

Stormwater from undisturbed lands above the tailings facility would be diverted around the impoundment site toward the Poorman Creek and Little Cherry Creek drainages during mine operations, unless water was needed for mill operations. The small amount of water diverted around the Poorman Tailings Impoundment Site from the small watershed above the impoundment would not measurably affect the water quality of Little Cherry or Poorman creeks. The quality of the water is expected to be similar to the receiving water quality.

All runoff from the tailings impoundment dam and disturbed areas within the tailings impoundment permit area boundary would be directed to the Seepage Collection Pond or to lined containment ponds. Stormwater from the impoundment site would be less likely discharged in Alternative 3 than Alternative 2 because MMC would not use mine and adit water in the mill and would have a greater need for make-up water from the impoundment site. Ditches and sediment ponds containing process water or mine drainage would be designed for the 100-year/24-hour storm to minimize potential overflow to nearby streams. Water from the ponds would be returned to the Seepage Collection Pond or impoundment and then the mill for reuse. Alternative water management techniques may be identified during final design and the MPDES permitting process. Stormwater discharges from the tailings impoundment would not occur during operations and sediment in Libby, Poorman and Little Cherry creeks would not be affected.

Depending on final design, a stormwater outfall may be needed for stormwater from the soil stockpile upgradient of the tailings impoundment. Ditches and the sediment pond containing stormwater would be designed for the 10-year/24-hour storm. Infrequent discharges from the sediment pond would flow and be monitored at a MPDES permitted outfall at a Little Cherry Creek tributary, and would be required to meet applicable effluent limits.

Adit Sites

The Libby Adit Site is already constructed and slopes adjacent to Libby Creek revegetated. A lined stormwater holding pond also was constructed near the Libby Adit to collect runoff from the portal area. Two new lined waste rock piles also would be located on the main portal pad site. Stormwater from these rock piles would collect in lined ditches and sumps located downgradient of each waste rock pile. This water would be pumped to the Water Treatment Plant, treated, and discharged to Outfalls 001, 002, or 003. Precipitation and runoff from other locations at the Libby Adit pad area would be collected and directed to Outfall 001.

The Upper Libby Adit would be constructed from underground, and waste rock hauled out of the Libby Adit Site, and not the Upper Libby Adit site. The adit portal pad would be constructed of on-site soil and rock materials with no waste rock used. Ditches and a sediment pond designed for the 100-year/24-hour storm also would be constructed at this site, with infrequent discharges of stormwater from the pad being discharged to Outfall 004 at Libby Creek.

Libby Loadout

The Libby Loadout would be constructed near Libby Creek. The loadout would be more than 250 feet from the creek, minimizing the potential for non-channelized overland flow to reach the creek (Belt *et al.* 1992). During the Construction Phase, if the Libby Loadout construction was considered a construction activity, surface water runoff from the area would be discharged to Libby Creek from an MPDES-permitted outfall. During the Operations Phase, all transfer operations and storage areas at the Libby Loadout would be completely enclosed, so no runoff from the loadout would occur. The potential accumulation of concentrate along the haul truck turn-around, at the concentrate storage area, and along the railroad tracks would be limited, and would be managed by regular clean-up with sweepers, so runoff from any concentrate at these locations would be minimal.

Access Road Use and Improvements

Within the mine permit area boundary, all stormwater runoff from roads would be captured by ditches and sediment ponds sized to contain the 10-year/24 hour storm. Any discharges from the ponds would be routed toward MPDES permitted Outfalls 004, 005, 006, 007, or 008. Discharges from the outfalls to Libby, Ramsey, and Poorman creeks would be monitored, and would be required to meet effluent limits (DEQ 2015b).

For the Libby Creek and Bear Creek access roads located outside of the mine permit area boundary, Table 132 provides the results of the sediment modeling. A road-by-road summary of predicted erosion from roads at stream crossings is provided in a technical memorandum (ERO Resources Corp. 2015b). In Alternatives 3 and 4, the Libby Creek Road (NFS road #231) would not be widened or paved, but the road length contributing to the nearest RHCA would be reduced to 150 feet by adding drain dips, surface water deflectors, or open top box culverts that would route the water off the road away from drainages or wetlands. Reducing the contributing road

Table 132. Estimated Sediment Delivery from Access Roads to Analysis Area Streams.

	Libby Creek Road	Bear Creek Road
Existing Conditions		
Average annual sediment leaving road buffer (lbs.)	128	264
Road paved and widened to 26 feet (All mine alternatives)		
Predicted average annual sediment leaving road buffer (lbs.)	NA	297
Change with project (lbs.)	NA	+33
Contributing road length reduced to 150 feet (Alternatives 3 and 4)		
Predicted average annual sediment leaving road buffer (lbs.)	87	NA
Change with project (lbs.)	-41	NA

Source: ERO Resources Corp. 2015b.

length to 150 feet on the Libby Creek Road would reduce the average annual sediment leaving the road buffer and entering RHCAs by about one-third. Reducing the contributing road length to less than 150 feet would reduce sediment delivery further; the WEPP:Road Batch model assumes a linear relationship between contributing road length and the amount of sediment leaving a road and buffer. The agencies' WEPP-predicted sediment reduction from BMPs is consistent with that reported by the DEQ and the EPA (2014), which estimated a reduction of 51 percent through BMPs in the assessment of sediment load from unpaved roads in the Libby Creek and Big Cherry Creek watersheds. The estimated decreases would be small in comparison to the estimated existing sediment load of 1,621 tons/year and the estimated future sediment load of 1,102 tons/year in the upper Libby Creek watershed, but would assist in achieving the Libby Creek TMDL.

In Alternative 3, the Bear Creek Road (NFS road #278) would be completely paved and the road widened to 26 feet. High erosion rates typically occur during the first years of vegetation establishment after disturbance (Megahan and Kidd 1972, Grace 2007). The BMPs and SWPPP discussed previously and below would minimize sediment reaching streams.

The WEPP:Road Batch model predicted that paving and widening all of the Bear Creek Road would increase the amount of sediment leaving the buffer. Most of the sediment increase (40 pounds per year) is predicted to occur at one crossing of an unnamed tributary of Big Cherry Creek. The crossing would be 600 feet from Big Cherry Creek. Forty pounds of sediment is 0.24 cubic feet; this small volume may not reach Big Cherry Creek, but remain in the channel of the unnamed tributary. Other crossings at which sediment increases were predicted, including a bridge at Bear Creek and a culvert at Little Cherry Creek, had increases of less than 10 pounds per year. The estimated increase would be small in comparison to the estimated existing sediment load of 1,621 tons/year and the estimated future sediment load of 1,102 tons/year in the upper Libby Creek watershed, and may not assist in achieving the Libby Creek TMDL. (Table 123). BMPs in addition to paving at these crossings would be evaluated during final design. The model assumes that paving a road increases runoff from the road, which can cause increased erosion on fillslopes (assumed to be erodible in the model) and flow paths leading from the road into drainages. Other users of the model have found it over-predicts erosion from paved roads (Breibart *et al.* 2007). Research indicates that paved roads generate the least sediment and typically have the shortest distance of sediment transport away from a road bed compared to gravel or unimproved roads (Riedel *et al.* 2007).

The movement of sediment from Alternative 3 roads to RHCAs would be minimized through the use of BMPs. Some of these BMPs cannot be modeled using the WEPP:Road Batch model, but they would further reduce sediment leaving the roads and buffers. Various studies have shown that BMPs implemented to reduce sediment movement from roads, cutslopes and fillslopes to drainages are effective in reducing sediment by 70 to 100 percent (Burroughs and King 1989, Gucinski *et al.* 2001, Kennedy 1997, Riedel *et al.* 2007). Appropriate BMPs would be determined on a site-specific basis and would be monitored to determine their effectiveness. Appropriate BMPs (Burroughs and King 1989, Furniss *et al*. 1991, Kennedy 1997, Riedel *et al*. 2007) may include:

- Locating outlets for road drain dips, surface water deflectors, and open top box culverts in non-erosive buffer areas
- Stabilizing disturbed areas with vegetative cover

- Erosion control treatment on fillslopes and cutslopes such as erosion control mats, rocks, hydromulching, and sodding
- Placement of filter windrows (such as logging slash) on or just below fillslopes
- Capture of road runoff in settling ponds
- Prevention of ruts in roadways that channel runoff
- Regular road maintenance
- Addition of at least 6 inches of good aggregate to roads (if not paving)
- Dust control on roads
- Prevention of erosion from roadside ditches using riprap, mats or paving
- Aligning culverts with the natural course and gradient of a stream
- Controlling scouring at culvert outlets
- Replacing buried or damaged culverts
- Replacing culverts or bridges with larger structure to prevent road flooding and channel and bank scouring
- Monitoring and maintaining culverts to prevent clogging and flooding of roads

Changes in Road Access, Stream Crossings, and Other Sediment Reduction Mitigation

In Alternatives 3 and 4, MMC would implement or fund yearlong access changes on 26 roads totaling 48.1 miles, some of which would be completed before the Evaluation Phase and some before the Construction Phase (Table 28 and Table 29 in Chapter 2). Other roads would be closed at the end of the Operations Phase. The roads with access changes would be covered by a Road Management Plan. The plan would describe requirements for pre-, during-, and post-storm inspections and maintenance; implementation and effectiveness monitoring plans for road stability, drainage, and erosion control; and mitigation plans for road failures.

Seven grizzly bear roads, which are currently open and assumed to have low traffic use, would be barriered with an earthen berm and traffic use eliminated. Six of these roads were assessed using the WEPP model. Changing traffic use on the six roads from low use to no use would reduce sediment leaving the road buffers by 160 pounds per year (Table 133). The estimated decreases would be small in comparison to the estimated existing sediment load of 1,621 tons/year and the estimated future sediment load of 1,102 tons/year in the upper Libby Creek watershed, but would assist in achieving the Libby Creek TMDL.

Table 133. Estimated Sediment Delivery from Closed Grizzly Bear Roads to Analysis Area Streams, Alternatives 3 and 4.

Condition	Average Annual Sediment Leaving Road Buffer (lbs.)					
	4776A	4776B	4778	4778C	6205D	14458
Existing—Low Traffic Use	32	53	36	19	55	211
With Project—No Traffic Use	30	18	22	11	24	141
Change	-2	-35	-14	-8	-31	-70
Receiving Stream	Tributary to Libby Creek				Tributary to Big Cherry Creek	Midas Creek

Source: ERO Resources Corp. 2015b.

Six roads totaling 14.9 miles with access changes may be decommissioned and converted to trails (Table 28 and Table 29). Decommissioned roads would be monitored for stability, drainage, and erosion control. In accordance with 2015 KFP guideline FW-GDL-WTR-02, hydrologic stability would be ensured before decommissioning roads. To minimize sediment movement from decommissioned roads to RHCAs, MMC may decompact the road surface, move any unstable road fill to a more stable location, re-establish natural surface drainage patterns (such as by removing culverts and reshaping stream banks), recontour and revegetate the former road area. An analysis of decommissioning treatments on forest roads in northern Montana and Idaho showed a reduction in fine sediment delivery to streams of 97 percent (Cissel *et al.* 2011).

Intermittent stored service roads (some grizzly bear mitigation roads and transmission line roads) would be closed to motorized traffic and would be treated and maintained to minimize sediment movement to nearby streams. In accordance with 2015 KFP guideline FW-GDL-WTR-02, hydrologic stability would be ensured before storing roads. The treatment would include:

- Removing culverts determined by the KNF to be high risk for blockage or failure and laying back stream banks to allow flows to pass without scouring or ponding so that revegetation would have a strong chance of success
- Installing drain dips, surface water deflectors, or open top box culverts that would route the water off the road away from drainages or wetlands
- Removing and placing unstable materials to a stable location where stored materials would not present a risk to drainages or wetlands
- Replacing salvaged soil and revegetate with grasses in disturbed areas and unstable road segments to reduce erosion potential

The proposed stream mitigation in Alternatives 3 and 4 would include instream activity in Swamp Creek near US 2, Little Cherry Creek, Poorman Creek, and at 21 stream crossings on land acquired for grizzly bear mitigation. The proposed mitigation is section 2.5.7.1.2, *Jurisdictional Waters (Streams).* Brief effects (2 days or less) of these mitigations would be increased turbidity and sediment concentrations downstream of the culvert removals, bridge removal, and channel reconstruction and stabilization during construction. Placing straw bales in the stream below the construction area would significantly reduce sediment concentrations in the stream below the bales (Foltz *et al.* 2008). An effective way to prevent brief turbidity and sediment concentration increases, if practicable, would be to route stream water around the construction area until completion (Wegner 1999). When completing instream work within a 0.25-mile of a bull trout occupied stream, MMC would place straw bales in the stream where practicable, minimize the duration of instream work to the extent practicable, and conduct all instream work between July 15 to September 1. Work could be completed outside of that time period if it could be implemented in a dry portion of the stream channel and all other potential impacts were fully mitigated. Longer-term effects to the streams would be beneficial. Fine sediment in streams below mitigation sites has been shown to decrease, spawning areas increased, and monitoring of instream aquatic macroinvertebrate communities for several years after culvert removals showed increases in their populations and number of species (Wegner 1999).

Proposed instream activities would be subject to three permitting processes: a 310 permit, a 318 authorization, and a 404 permit. Installation of culverts, bridges, or other structures at perennial stream crossings would be specified in accordance with a 310 permit following on-site inspections with DEQ, Forest Service, FWP, landowners, and the local conservation district. Installation or removal of culverts or other structures in a water of the State would be in accordance with DEQ 318 authorization conditions. All installation or removal of culverts or other structures in a water of the United States if they resulted in a discharge of fill would be in accordance with the Corps' 404 permit conditions. MMC may request and the DEQ may approve a 318 authorization for short-term increases in turbidity and total suspended solids discussed on p. 705.

Instream Fisheries Mitigation

Fisheries mitigation proposed for Alternative 3 may include the instream activity in Copper Gulch, Libby Creek, and Flower Creek described in section 2.5.7.3.2, *Conceptual Mitigation Actions* for bull trout mitigation. Before implementation, MMC would complete and an interagency committee would review feasibility assessments on each project. Possible instream mitigation would include installing large wood structures in the floodplain and riparian zone of a short segment Libby Creek upstream of Libby Creek Falls and constructing a selective withdrawal mechanism in the Flower Creek dam or a stream water by-pass system through the reservoir. Mitigation implemented in Flower Creek would be a contingency to failed mitigation in Upper Libby Creek. Brief effects (2 days or less) of these mitigations would be increased turbidity and sediment concentrations downstream of the activity during construction. Appropriate BMPs would be identified during final design and implemented with each project. Longer-term effects to stream water quality would be beneficial because of improved channel stability and decreased downstream sediment concentrations.

Other Mitigation

To control dust on mine access roads and at other work areas, MMC would use either a chemical stabilization that does not attract wildlife or groundwater appropriated using its existing water right. This mitigation would reduce the potential for adversely affecting water quality.

Closure and Post-Closure Phases

When the impoundment was no longer needed to store water from the seepage collection and pumpback well systems during the Closure or Post-Closure Phase, a channel would be excavated through the tailings and Saddle Dam abutment at the Poorman Impoundment to route runoff from the site toward a tributary of Little Cherry Creek. The runoff channel would be routed at no greater than 1 percent slope and along an alignment requiring the shallowest depth of tailings to be excavated down to the channel grade. The side slopes would be designed to a stable slope and covered with coarse rock to prevent erosion. As part of the final closure plan, MMC would complete a hydraulic and hydrologic (H&H) analysis of the proposed runoff channel during final design, and submit it to the lead agencies and the Army Corps of Engineers for approval. The H&H analysis would include a channel stability analysis and a sediment transport assessment. Based on the analysis, modifications to the final channel design would be made and minor modifications to the upper reaches of the tributary of Little Cherry Creek may be needed to minimize effects on channel stability in the tributary of Little Cherry Creek. These measures would minimize erosion and sedimentation of Little Cherry Creek. The reclaimed impoundment would be designed to retain peak flows in the impoundment and allow dissipation of runoff from extreme storm events at a rate of about 2 cfs, which is 5 percent or less of the peak flows. Little Cherry Creek has a mean annual discharge of 3 to 5 cfs, a low flow of about 1 to 2 cfs (Kline Environmental Research 2015). Runoff from the reclaimed impoundment would increase mean monthly flows by less than 1 percent during April, May, and June, and would not increase mean monthly discharge for the remainder of the year. The influence of the increased flow to Little Cherry Creek on channel stability was assessed using information on stream habitat and bank characteristics (Kline Environmental Research 2015). It is expected that given the low occurrence of unstable banks in Little Cherry Creek and the small increases in stream flow, changes to bedload transport and streambank erosion would be insignificant in Little Cherry Creek.

Effect on Impaired Streams

In the first 2 years of the Construction Phase, MMC would upgrade NFS road #278 (Bear Creek Road), part of which is adjacent to the impaired section of Big Cherry Creek. The road would be widened on its existing alignment to 26 feet wide and chip-and-seal paved. Road reconstruction and paving would not increase cadmium, lead, and zinc concentrations in Big Cherry Creek. Stream-side vegetative cover and physical substrate habitat would not be further altered because none of the road changes would be adjacent to or would cross the Big Cherry Creek channel.

Libby Creek from 1 mile above Howard Creek to the US 2 bridge is listed as impaired for aquatic life use due to alteration in stream-side vegetative cover and alterations in physical substrate habitat. The lower segment begins at the US 2 bridge and is impaired for physical substrate habitat alterations and sedimentation/siltation. Effect to Libby Creek flow from the Water Treatment Plant discharge is discussed in section 3.13.4.3.2, *Effects of Discharge*. The DEQ and the EPA established water quality restoration goals for sediment in Libby Creek on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available instream habitat as it relates to the effects of sediment, and the stability of streambanks. Meeting the TMDL, of which Montanore's wasteload allocation of 24 tons per year is a part, will satisfy the water quality restoration goals. The DEQ believes that once the water quality restoration goals are met, all beneficial uses currently affected by sediment will be restored (DEQ and EPA 2014).

Rock Creek and the East Fork Rock Creek are listed by the DEQ as impaired due to anthropogenic substrate alterations, with the probable source of impairment listed as silvicultural activities. It is unlikely that the predicted flow decreases in the East Fork Rock Creek (up to 0.29 cfs at EFRC-200) and Rock Creek (up to 0.65 cfs at RC-2000), which are small compared to channel-forming flows, would affect the substrate, including sediment transport, aggradation, or degradation, in East Fork Rock Creek or Rock Creek.

3.13.4.3.6 Effect of Nitrogen and Sulfur Emissions on Area Lakes

Maximum modeled nitrogen and sulfur emissions from the exhaust adit at the Libby Adit Site during the Operations Phase in Alternative 3 are predicted to be less than deposition analysis thresholds at Upper Libby Lake, Lower Libby Lake, and Rock Lake (see Table 60, p. 311). Modeled rates were highest at Rock Lake, at 0.0011 kilograms/hectare/year, below the deposition analysis threshold of 0.005 kilograms/hectare/year. The agencies' mitigation, such as limiting generator use at the mill after power was available from a transmission line to 16 hours during any rolling 12-month time period and using Tier 4 engines, if available on underground mobile equipment and generators and ultra-low diesel fuel in underground mobile equipment and in generator engines, during all mine phases would substantially reduce emissions compared to Alternative 2. Nitrogen and sulfur emissions from the mine would substantially decrease when underground mining ceased and would end after the adits were plugged.

In Alternatives 3 and 4, MMC would monitor nitrogen and sulfur emissions at the Libby Adit for a minimum of 2 years. Using the monitoring data, MMC would update the nitrogen and sulfur deposition analysis and compare it the updated model results to the current FLM deposition analysis thresholds. If modeled results using the Libby Adit monitoring data were greater than current FLM deposition analysis thresholds, MMC would develop and implement available control technologies to reduce pollutant emissions.

3.13.4.3.7 Risk of Impoundment Failure

The agencies evaluated the risks associated with impoundment construction, operations, and closure using the same failure modes effects analysis used in Alternative 2 (Klohn Crippen Berger 2009). The Poorman Impoundment had a similar risk profile as the Little Cherry Creek impoundment. Three failure modes that potentially could affect water quality had risk levels slightly higher than the Little Cherry Creek impoundment. These three failure modes had a moderately low risk level. The increased risk was associated with use of more complex technology, and the closer proximity to Libby Creek and private land (Klohn Crippen Berger 2009). The likelihood of failure is discussed in section 3.14.3 of the *Geotechnical* section.

3.13.4.3.8 Risk of Water Collection and Treatment System Failure

The agencies analyzed the risk and potential effects of water collection and treatment system failure (ERO Resources Corp. 2015c). In Alternative 3, MMC would operate a pumpback well system designed to capture tailings seepage that reached groundwater beneath the impoundment. Groundwater pumping would create a large cone of depression downgradient of the impoundment. Should the pumpback well system completely fail, water levels would slowly rise and tailings seepage mixed with groundwater would flow toward the monitoring wells, where increased concentrations may be detected. Groundwater would then flow toward Libby Creek in Alternative 3. In the Poorman Tailings Impoundment Site, the hydraulic conductivity of the glaciofluvial deposits ranges from 0.37 to 19.4 ft/day and averages 7.35 ft/day, based on six aquifer tests reported by Chen-Northern (1989). Libby Creek is between 1,300 and 2,700 feet from the toe of the Poorman Impoundment or about 1,000 to 2,400 feet from the pumpback wells. A prolonged power outage or equipment failure would be necessary before groundwater levels recovered sufficiently to allow tailings seepage to reach surface water. In the event of a prolonged power outage or equipment, the predicted concentrations of all metals in Libby Creek would be below acute and chronic aquatic life standards. Total nitrogen and phosphorus standards in Libby Creek are also not predicted to be exceeded (ERO Resources Corp. 2015c).

The pumpback well system could fail to operate as designed because of a power failure or pump failure. Backup generators at the Libby Adit would be available for pumping should the transmission line be unable to provide power. Individual pump failure would be managed by maintaining an inventory of spare pumps.

MMC would use the Water Treatment Plant at the Libby Adit Site to treat all wastewater discharges. The agencies concluded that two scenarios—discharge of untreated mine, adit, or tailings water because of a loss of all power and discharge of untreated mine, adit, or tailings water because of inadequate capacity—are not supported by credible scientific evidence (ERO Resources Corp. 2015c). The only plausible water treatment plant failure scenario for which credible scientific evidence exists is a brief failure of the water treatment plant to operate as designed. MMC would likely cease discharges if the plant failed, and store the water until the plant was repaired and the discharge water quality met effluent limits. The draft renewal MPDES permit (DEQ 2015b) requires weekly sampling and analysis of some parameters and monthly sampling and analysis for metals, so any exceedances of the effluent limits would not last longer than about a month.

During plant malfunction, chronic aquatic life standards for total nitrogen, total phosphorus, cadmium, copper, and lead are predicted to be exceeded in Libby Creek at and below LB-300 in all alternatives. Exceedances of total phosphorus, cadmium, copper, and lead would extend to LB-2000. Chronic aquatic life standards are based on a 96-hour exposure and can only be exceeded, on average, once in a 3-year period (DEQ 2012a). No acute aquatic life standards are predicted to be exceeded. The draft renewal MPDES permit requires MMC to notify the DEQ as soon as possible, but no later than 24 hours from the time MMC first became aware of the circumstances of any serious incident of noncompliance with the MPDES effluent limits. Serious incidents include any noncompliance which may seriously endanger health or the environment; any unanticipated bypass which exceeds any effluent limitation in the permit; or any upset which exceeds any effluent limitation in the permit. In all alternatives, the Water Treatment Plant operator would have a Montana Water and Wastewater Operator Certification. The operator would oversee the daily operation of the plant. The MPDES permit conditions and required certification would reduce the potential for exceedances of water quality standards from a Water Treatment Plant malfunction.

3.13.4.3.9 Climate Change

It is difficult to predict how the hydrologic systems in the analysis area would respond to the forecasted regional effects of climate change. Decreased groundwater contribution to baseflow in streams and groundwater flow to wilderness lakes could change the chemistry of the streams and lakes, as could a seasonally altered runoff pattern. If climate change reduced groundwater infiltration enough to reduce mine and adit inflows, less water would contact exposed mineralized rock, which could reduce metal mobility and the potential for metal leaching in the mine. Discharges of treated water to Libby Creek would be less if mine and adit inflows decreased. Any effect on water quality from the project, combined with the effects of climate change, may be different than those estimated to occur with the Montanore Project alone. As described in Appendix C, MMC would monitor streamflows and water temperatures at potential impact area sites and benchmark sites (similar to analysis area sites, but outside the area of potential mine impacts) to evaluate trends due to mining compared to trends due to non-mining effects such as climate change. For all discharges, the DEQ would determine effluent limits for each outfall that were protective of aquatic life during the MPDES permitting.

3.13.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would be similar to Alternative 3, including the same mitigations to protect surface water, but would have modifications to MMC's proposed Little Cherry Creek Tailings Impoundment as part of the alternative. Fisheries mitigation proposed for Alternative 3 would be the same for Alternative 4. The total disturbance area for Alternative 4 would be 1,924 acres. The following sections discuss only those effects that would be different than Alternatives 2 or 3. The effects of discharges and nitrogen and sulfur emissions from the exhaust adit at the Libby Adit Site would be the same as Alternative 3.

3.13.4.4.1 Effects of Mine Inflows and Discharges

The effects on surface water and groundwater quality would be the same as Alternative 3, except for effects at the tailings impoundment site. Groundwater quality after mixing with seepage beneath the Little Cherry Creek Impoundment Site would be the same as Alternative 2 (Table 128). As discussed in Alternative 2, groundwater metal concentrations beneath the impoundment area may be less than those predicted by the mass balance calculations. The discussion in Alternative 2 of mixing zones in surface water (at LB-300 in Alternative 4) and groundwater at the tailings impoundment site would apply to Alternative 4. During the MPDES permitting process, the DEQ would make the same determinations regarding a mixing zone for discharges in Alternative 4 that were discussed in Alternative 2.

3.13.4.4.2 Stormwater Runoff, Erosion, and Sediment Control

Stormwater flow at all facilities and roads would be managed in the same manner as Alternative 3. The effects from the Libby Plant Site and the elimination of LAD Areas as a potential source of erosion would be the same as Alternative 3. Ditches and sediment ponds containing process water or mine drainage would be designed for the 100-year/24-hour storm to minimize potential overflow to nearby streams. The use and inspection of BMPs would be the same as Alternative 3.

At the tailings impoundment, the Diversion Channel would consist of two main sections: an upper engineered channel and a constructed lower channel to Libby Creek using Drainage 10 as proposed in Alternative 2. The engineered channel would be the same as the engineered channel in Alternative 2 and would be designed for the 6-hour probable maximum flood. To reduce the contribution of sediment to the diverted Little Cherry Creek, water would flow into a constructed channel that would be designed to be geomorphically stable and adequate to handle the 2-year flow event estimated for the increased watershed size. A floodplain would be constructed along the channel to allow passage of the 100-year flow.

MMC also would evaluate potential locations for ponds to capture and retain sediment from the two channels and for creating wetlands in the floodplain of Libby Creek. The majority of sediment generated would occur during the initial channel flush after construction and subsequent high flow and runoff events. In the event of heavy precipitation during construction of the channel, substantial erosion and brief increases in sedimentation to the lower channel and Libby Creek would occur. Natural and biodegradable materials and vegetation would be used along streambanks and on the floodplain to minimize erosion, stabilize the stream channel and floodplain, and minimize sedimentation to the lower channel and Libby Creek. MMC would construct bioengineered and structural features in the two channels to reduce flow velocities, and minimize erosion and sedimentation, where access was possible to complete such work. Long-term monitoring and maintenance would be required until the agencies determine that the channel was stabilized. With these mitigation measures, the naturally designed constructed channel may be subject to erosion and sedimentation during construction and until vegetation stabilized the streambanks and floodplain.

Following reclamation of the impoundment, the constructed channel would undergo an additional period of channel adjustment when runoff from the impoundment surface would be directed to the Diversion Channel. No runoff would be diverted to Bear Creek as in Alternative 2. The increase in flow to the constructed channel would be about 50 percent higher at closure than during operations. The increased flow would likely cause brief increases in sedimentation in the lower channel and possibly in Libby Creek. Over the longer term, runoff from the impoundment would decrease and eventually cease. Sedimentation in the lower channel and Libby Creek would not be expected to occur except during storm events larger than the channel was designed to handle.

Within the mine permit area boundary, all stormwater runoff from roads would be captured by ditches and sediment ponds sized to contain the 10-year/24 hour storm. Infrequent stormwater discharges would flow toward MPDES permitted Outfalls 004, 005, 006, 007, and 008. Precipitation and runoff from the Libby Adit pad area would be collected and directed to Outfall 001. Discharges from the outfalls to Libby, Ramsey, and Poorman creeks would be monitored, and would be required to meet applicable effluent limits (DEQ 2015b). For access roads located outside of the mine permit area boundary, Table 132 provides the results of the sediment modeling (ERO Resources Corp. 2015b). To minimize sediment reaching streams, BMPs and monitoring discussed under Alternative 3 would be implemented on a site-specific basis and be monitored to determine their effectiveness.

3.13.4.4.3 Risk of Impoundment Failure and Risk of Water Collection and Treatment System Failure

The agencies did not specifically evaluate the risks associated with the agencies' modifications to the Little Cherry Creek impoundment. The Little Cherry Creek impoundment in Alternative 4 would have a similar risk profile as Alternative 2. The risk and effects of impoundment failure and water collection and treatment system failure would be the same as Alternative 3 (sections 3.13.4.3.7, *Risk of Impoundment Failure* and 3.13.4.3.8, *Risk of Water Collection and Treatment System Failure*).

3.13.4.5 Uncertainties Associated with the Water Quality Assessment

Changes in surface water and groundwater quality were projected using an analytical technique known as a chemical mass balance analysis. The mass balance analysis estimates the changes in concentrations of metals and other constituents in a receiving stream when discharges from the proposed operation are added. Projected changes in groundwater concentrations are calculated in a similar manner. The projections assume complete mixing of the discharged wastewater and ambient receiving waters. Variables used in the mass balance analysis include flow rate and ambient water quality in the receiving stream, and the rate and water quality of the proposed discharges.

The mass balance analysis uses the estimated wastewater quality shown in Appendix K and the discharged quantities provided in the water balances for each alternative to predict the resulting water quality after mixing with ambient water quality at low flows. At the LAD Areas, average precipitation and evapotranspiration rates for the 6-month growing season were used.

Projections of surface water quality involve a number of uncertainties. These include the ambient and discharge water qualities, ambient water quantities, the effectiveness of treatment of the various water quality parameters by the Water Treatment Plant or land application, discharge water quantities, the effectiveness of mixing in the stream, the exact location where surface water would be affected, and the environmental effect from increased metal concentrations on aquatic life. Because of the complexity of the water quality assessment, each of these uncertainties is discussed briefly in the following sections.

3.13.4.5.1 Ambient Water and Wastewater Quality

Mean or median water quality concentrations of ambient water and wastewater frequently could not be easily estimated because reported water quality concentrations for many parameters, particularly metals, were below the analytical detection limits. The detection limit is the lowest concentration of a parameter detectable by a laboratory using a particular analytical procedure. Parameters with concentrations reported with a “less than” symbol (<) are those parameters with concentrations below the detection limit. For concentrations reported with a less than symbol, the value shown is the “detection limit” reported by the analytical laboratory. If a concentration of a parameter is below the detection limit, the actual concentration is not absolutely known.

In developing estimates of ambient water and wastewater quality, the agencies used the detection limit in determining a representative concentration when the reported concentration was below the detection limit. For all assessment locations, representative concentrations of all samples collected at a particular location were used to represent concentrations during low flow conditions. The method for deriving representative concentrations is described in the *Final Baseline Surface Water Quality Technical Report* (ERO Resources Corp. 2011c). Representative concentrations may be higher or lower than actual concentrations during low flow periods. The projected final concentrations after mixing would be greater if the ambient low flow concentration was higher than the representative concentration or lower if the ambient low flow concentration was lower. A comparison of chemical concentration data with corresponding streamflow measurements was generally inconclusive due to a lack of water quality data collection at high flows.

3.13.4.5.2 Geochemical Characterization

Geochemical sampling was limited to ore and waste rock available from archived rock core that was drilled before the withdrawal of the CMW from mineral entry, and to waste rock obtained from exposures within the Libby Adit. Additional geochemical characterization is needed to expand and refine the available data and requires additional sample collection during the Evaluation and Construction Phases of the project. Early (pre-1992) efforts to characterize the geochemistry of the Rock Creek-Montanore and Troy deposits were limited in scope based on the consistent mineralogy observed in the deposits, and vary in the extent to which they meet current expectations of sampling intensity. Available datasets for each of the similar Revett-style deposits focus on geochemical characterization of particular materials. For example, considerably more waste rock data are available for the Prichard and Burke formations at Montanore than for Rock Creek or Troy, but a greater number of ore samples have been characterized at a more comprehensive level for Rock Creek. Many more water quality monitoring data have been collected over 30 years of operation under facility specific conditions (*e.g.*, underground workings or tailings impoundment) at Troy than at Rock Creek or Montanore.

The elements of uncertainty related to the extent of sampling, such as collection of waste rock from unexposed portions of the Revett, Prichard and Burke formations or analysis of bulk tailings samples for Montanore-specific ore zones, are addressed in the sampling and analysis plans described in Appendix C and by Geomatrix (2007a). The elements of uncertainty related to the use of monitoring data from the geochemical analog at the Troy Mine would also be addressed through Evaluation and Operations Phase monitoring as defined in Appendix C.

Environmental geochemistry data were collected for Montanore, as well as Rock Creek and Troy, for more than 20 years. Changes in analytical methods and quantitation limits have resulted in analysis of different analytes and reporting of multiple detection limits, particularly for trace metals. The absence of some regulated parameters in particular analyses, or the reporting of below detection limit values for some elements at levels above current standards, both introduce uncertainty into predictions of metal mobility for proposed facilities. The need for more comprehensive analyses of metals, at appropriate detection limits, when representative samples of ore, waste, and tailings are accessible in the Libby Adit is addressed in the agencies' Geochemical Sampling and Analysis Plan provided in Appendix C.

Laboratory and field data offer different strengths and limitations that complement one another in predictions of future water quality. Laboratory analyses test the potential for sulfide oxidation and metal release under controlled, pre-defined, short-term experimental conditions (*e.g.*, surface area, dilution, oxygen exposure, acidity, etc.), while *in situ* monitoring provides a measurement of these geochemical processes under longer term, field-scale conditions. Laboratory tests can evaluate specific subsamples representative of the range of natural variation, while field-scale studies integrate that variation into a single measurement. It is typically easier to test discrete representative samples under laboratory conditions than to obtain equally representative *in situ* data, particularly for a facility that has not yet been built. The ability to compare results from multiple samples tested using accepted laboratory methods, within and across several Revett-style deposits, with long-term monitoring data from the Libby Adit and Troy Mine reduces uncertainty in predictions made for the Montanore Project. Collection of additional data as specified in the geochemistry sampling and analysis plan provided in Appendix C would reduce the identified uncertainty and allow MMC to appropriately modify waste rock and water management plans before beginning mining operations. Operational monitoring of mined materials and water quality, as recommended by Geomatrix (2007a), and refinement of baseline predictions would allow further reduction of uncertainty before closure.

3.13.4.5.3 Ambient Water Quantity

Surface water low-flow conditions are conservative flows for assessing impacts from pollutant discharges. For the mass balance analysis, estimated $7Q_{10}$ flow were used for assessing potential impacts on surface water quality, or, for LB-300, the modeled baseflow was used (see section 3.13.2.2.2, *Impact Analysis*). Use of a $7Q_{10}$ flow is consistent with the DEQ's standard surface water mixing zone rules (ARM 17.30.516). Measured low flows during the baseline monitoring period were lower at some assessment locations than the estimated $7Q_{10}$ flow. Flows lower than the $7Q_{10}$ flow would result in less dilution and higher instream concentrations than projected, if other assumptions in the mass balance analysis remained constant. Flows higher than the baseflow used in the LB-300 analysis would result in more dilution and lower instream concentrations than projected, if other assumptions in the mass balance analysis remained constant.

A groundwater flux was estimated for assessing impacts on groundwater beneath the two tailings impoundment sites and LAD Areas. MMC's and the agencies' estimates of groundwater flux are based on available data from the two tailings impoundment sites and LAD Areas. To derive groundwater flux, estimates of groundwater gradient and hydraulic conductivity are required. If actual conductivities or gradients were higher than estimated, more water would be available for mixing, and lower groundwater concentrations than those projected would occur. Groundwater flux less than the estimated flux would result in less water available for mixing and higher groundwater concentrations than projected, if other assumptions in the mass balance analysis remained constant.

3.13.4.5.4 Wastewater Quantity

Projected wastewater quantity is based on the estimated water balance for each alternative. Water balances are point estimates of water production and use, developed using standard methods and reasonable assumptions. Actual flow rates for a number of water sources described by the water balance, such as precipitation, evaporation, and dust suppression, would vary seasonally and annually from the rates shown in the estimated water balances. Actual mine and adit inflows would vary as the mine would be developed, partly in response to short-term higher flows from fractures and faults intersected by the mine void, and partly in response to increasing the volume of the mine void as mining progresses. Grouting would reduce mine and adit inflows. The groundwater model provides estimates of mine and adit inflow as mining progresses, but does not consider short-term higher inflow from dewatering fractures and faults.

The agencies used mine and adit inflows predicted by the 3D model by phase to assess impacts on surface water and groundwater quality. Mine and adit inflows actually encountered during all mine phases may be higher or lower than those predicted by the 3D model. Although the 3D model predicted a maximum short-term peak of 800 gpm, the short-term peak of 800 gpm assumed instantaneous development of two new adits and therefore over-estimated peak inflows. The amount of wastewater discharged during each mine phase to the Water Treatment Plant (all alternatives) or to the LAD Areas (Alternative 2 only) would depend on mine and adit inflow rates. Before the Operations Phase began, MMC would expand the capacity of the Water Treatment Plant to accommodate discharges during the estimated wettest year in a 20-year period and would seek amendment of its MPDES permit. The agencies' estimate of the discharge rate to the LAD Areas for Alternative 2 is presented in Appendix G and discussed in section 3.10.4.2.1, *LAD Areas* of the *Groundwater Hydrology* section. Because of uncertainties in the operational water balance and the discharge rates, the agencies would require monitoring of flows and discharges during all mine phases (Appendix C).

3.13.4.5.5 Water Quality Assessment Locations

In all alternatives, water from the Water Treatment Plant would discharge to a percolation pond or drainfield adjacent to Libby Creek or, when the percolation pond reached capacity, to Libby Creek via an overflow pipe immediately upstream of LB-300. In Alternatives 3 and 4, discharges may be needed in Ramsey Creek to protect senior water users or to Libby Creek at a location lower than LB-300 if DEQ determines flow changes are significant. Any Water Treatment Plant discharge location would be monitored as required by the MPDES permit. For Alternative 2, some uncertainty is associated with how and where streams would be affected by discharges from the LAD Areas. In projecting impacts on surface water quality, the agencies chose monitoring stations on Ramsey Creek, Poorman Creek, and Libby Creek, some of which are long-term water quality monitoring sites. For example, the agencies estimated the percentage of the wastewater from LAD Areas 1 and 2 for Alternative 2 that would flow to Ramsey Creek, Poorman Creek, or Libby Creek based on site topography; the actual rate of discharge to each stream may be different. In addition, the locations in each stream at which water from the LAD Areas would discharge may be above or below the monitoring locations used for the impact analysis. A station on Libby Creek (LB-1000) was used to assess the effects of all discharges in Alternative 2.

3.13.4.5.6 Land Application Treatment

Land application of mine wastewater is proposed only for Alternative 2. Land application treatment is site- and effluent-specific. The amount of precipitation that occurs on a land treatment site, the quality of the precipitation, and the rate of evapotranspiration from the land treatment site, are variable and uncertain. Many factors affect treatment effectiveness. The treatment rates for total dissolved solids, nitrogen, and metals are uncertain (see LAD Area discussion under section 3.13.4.2.1, *Evaluation and Construction Phases*). It is not possible to estimate actual removal rates for total dissolved solids, nutrients, and metals until mine wastewater application to the LAD Areas occurred and monitoring data were collected. For the analysis of the effects of land application of wastewater, it was assumed that there would be no operational issues at the LAD Areas, such as uneven application of wastewater or runoff from the site directly to streams before treatment. It was also assumed that the treatment rates would not change over time, which may be realistic if the LAD Areas were properly monitored, inspected, and maintained.

For the water quality impact analysis, it was assumed that the percolation of treated groundwater from the LAD Areas would be essentially a direct discharge into the receiving stream. Depending on the effective porosity of the aquifer under the LAD Areas (which is unknown, but estimated) and the actual flow path, the water treated at the LAD Areas may take from less than a year up to 10 years to reach receiving streams.

3.13.4.5.7 Environmental Effects on Aquatic Life

The concentration at which metals and nutrients affect aquatic life in the analysis area is uncertain. Montana surface water quality standards shown in Table 120 are based on a hardness of 25 mg/L as calcium carbonate ($CaCO_3$); actual hardness in area streams ranges between about 5 and 25 mg/L. Environmental effects on aquatic life from those metals that are hardness-related (cadmium, chromium, copper, lead, nickel, silver, and zinc) may occur at concentrations less than those shown in Table 120. The BHES Order established a limit of 1 mg/L for total inorganic nitrogen, and the DEQ nutrient regulations have a standard of 0.275 mg/L for total nitrogen and 0.025 mg/L for total phosphorus. The general variance for total nitrogen in the draft renewal MPDES permit would allow a variance at the end-of-pipe at the Water Treatment Plant of 15 mg/L. The BHES Order limit of 1 mg/L for TIN may be the applicable limit for total nitrogen because nitrate would be the dominant nitrogen form in the Water Treatment Plant effluent. The uncertainty of effects to fish and other aquatic life of nitrogen and phosphorus concentrations being within these limits in Libby Creek downstream of the Water Treatment Plant discharge point is discussed in section 3.6, *Aquatic Life and Fisheries*.

3.13.4.6 Effectiveness of Agencies' Proposed Monitoring and Mitigation Plans

3.13.4.6.1 Monitoring

Geochemical Monitoring

Additional sampling would be conducted during the Evaluation, Construction, and Operations Phases, when a more representative section of waste rock would be available for sampling. Characterization of metal release potential for tailings and waste rock is limited and would be expanded in Alternatives 3 and 4. Descriptions of mineralogy in rocks exposed by the Libby Adit ore zone (for the Revett Formation) and development adits (for the Burke and Prichard formations) would be used to identify subpopulations with sulfide altered waste zone overprints. Their relative importance, in terms of tonnage to be mined, would guide sampling density. If the Wallace Formation was intercepted, samples of the lithology would be collected and characterized. The information would be used to redefine geochemical units for characterization and evaluate potential selective handling and encapsulation requirements.

Waste rock would be stockpiled and runoff from the pile would be contained and treated, if necessary. Waste rock would be used at the impoundment site for dam construction, using selective handling criteria that would be defined during the Evaluation Phase (see section C.9.7, *Data Analysis*). It is not clear which fraction of the Revett Formation waste rock would be brought to the surface. Once more detailed information about the Revett and Prichard formations waste rock was available during the Evaluation Phase, along with updated predictions of metal concentrations for tailings, these sources would be incorporated into updated mass balance calculations found in Appendix G.

Surface Water and Groundwater Monitoring

The agencies' plan (Appendix C) includes monitoring of all surface water bodies and groundwater potentially affected by the project, including collection of additional water quality, temperature, flow, and lake level data before the Evaluation and Construction Phases, during all mine phases, and after mine closure. The quality of the treated effluent would also be monitored. As required by the draft renewal MPDES permit, continuous temperature data would be collected in Libby Creek above and downstream of the discharge point to determine if the temperature aquatic life standard was exceeded in the creek due to effluent discharges. The plan also includes action levels based on monitoring data that would trigger corrective measures to be implemented by MMC. The agencies anticipate that the monitoring plan would successfully identify, measure, and separate water quality effects due to mining from natural variability. To accomplish this, MMC would be required to collect water quality samples from benchmark reference sites located near the analysis area, but outside of the area that might be affected by the project (Appendix C). The benchmark sites would be subject to similar ranges in parameters that cause natural variability of data within the analysis area, such as precipitation and temperature. These benchmark sites would include Wanless Lake, a lake similar to Rock Lake; Swamp Creek, a stream west of the divide similar to upper East Fork Rock Creek and East Fork Bull River; and Bear Creek, a stream east of the divide similar to upper Libby Creek. The monitoring plan would be evaluated during each mine phase and modified if needed. The action levels and associated corrective measures, as well as adaptive management, would be effective in minimizing the potential for adverse changes in surface water or groundwater quality.

3.13.4.6.2 Mitigation for Potential Changes in Sediment Delivery to Streams

1. The disturbance area of Alternatives 3 and 4 would be less than Alternative 2, which would effectively minimize sediment delivery in all analysis area streams.

2. In Alternatives 3 and 4, runoff from the reclaimed tailings impoundment would be directed toward Little Cherry Creek instead of Bear Creek proposed in Alternative 2. As part of the final closure plan, MMC would complete a H&H analysis of the proposed runoff channel during final design that would include a channel stability analysis and a sediment transport assessment. The runoff channel would be effective in minimizing adverse effects of increased streamflow on Little Cherry Creek.

3. In Alternatives 3 and 4, MMC would develop and implement a Road Management Plan addressing all roads used, closed, and stabilized in the alternative. MMC would complete reclamation work (described in section 2.5.7.1.2) at five sites in Libby Creek, Little Cherry Creek, and Poorman Creek to reduce sediment delivery to analysis streams. Twenty-five roads would be closed, some before the Evaluation Phase, some before the Construction Phase, and some during the Closure Phase to mitigate for project access

effects on grizzly bears. After changes to the roads were made, sediment delivery to area streams would be minimal. Road closures would have direct and long-lasting beneficial effects on sediment delivery in all analysis area streams. Inside the mine permit area boundary, capture of all stormwater runoff by ditches and sediment ponds that would direct runoff to MPDES permitted outfalls where discharges to creeks would be monitored, and would be required to meet applicable effluent limits, is expected by the agencies to be effective in preventing sediment from reaching RHCAs. Outside the mine permit area boundary, the agencies expect BMPs implemented to minimize sediment delivery from forest roads to be between 70 and 100 percent effective (Burroughs and King 1989, Gucinski *et al.* 2001, Kennedy 1997, Riedel *et al.* 2001). The DNRC has conducted field reviews every 2 years since 1990 of BMPs used for forestry, including road construction. The reviews evaluated the effectiveness of mitigation. A BMP's effectiveness was rated adequate if small amounts of material eroded, but material did not reach draws, channels, or a floodplain. The field review teams evaluated a total of 1,309 practices for effectiveness, and rated them as adequate 99 percent of the time. For those BMPs considered not adequate, the most frequent departures and impacts were associated with road maintenance and road surface drainage (DNRC 2012).

4. MMC would implement and maintain all appropriate BMPs for roads during their use by the project. Appropriate BMPs for roads during use would be those that: 1) disconnect road surfaces, fillslopes, cutslopes and drainage ditches from streams; 2) shorten road surface lengths draining to surface waters; 3) revegetate disturbed soils and erosive areas; 4) reduce scouring and stream channel and bank erosion at stream crossings; and 5) harden road surfaces and prevent rutting. BMPs that accomplish these would be the most effective way to minimize sediment delivery from analysis area forest roads.

5. In the agencies' preferred alternative (Alternative 3), the tailings impoundment would be at the Poorman Impoundment Site, which would not require the diversion of Little Cherry Creek. The elimination of potential erosion and sediment delivery to the diverted Little Cherry Creek and Libby Creek associated with the diversion would reduce water quality effects on the diverted Little Cherry Creek. In Alternative 4, the tailings impoundment would be in the Little Cherry Creek channel. The diversion channel would be designed to minimize erosion and sedimentation in the diverted Little Cherry Creek and Libby Creek

3.13.4.6.3 Mitigation for Other Potential Water Quality Changes

6. The LAD Areas would not be used in Alternatives 3 and 4 and all excess water would be treated at the Water Treatment Plant before discharge. Effluent discharged from the Water Treatment Plant to Libby Adit Site outfalls would be required to meet the MPDES permitted effluent limits. The Water Treatment Plant would be designed to treat up to the rate estimated for the wettest year in a 20-year period. The use of a high-capacity Water Treatment Plant would be effective in ensuring effluent limits were met and beneficial uses protected. Alternatives 3 and 4 would have only one point of discharge, which could be much more effectively monitored and controlled.

7. Pumpback wells would be used to capture all seepage from the tailings impoundment that reached groundwater, which would minimize effects to groundwater quality and prevent any seepage from reaching nearby streams and affecting surface water quality. Whether the pumpback wells would effectively capture all of the seepage would be determined by installing numerous monitoring wells downgradient of the pumpback wells (Appendix

C). MMC would monitor downgradient wells to detect any groundwater quality changes. If water quality changed at compliance wells due to inadequate capture by the pumpback wells, MMC would be required to increase pumping rates or install additional pumpback wells. Maintaining capture of tailings seepage would be effective in minimizing effects on surface water quality.

8. Runoff and seepage from waste rock stockpiles would be collected and treated at the Water Treatment Plant during the Construction Phase, or used in milling operations during the Operations Phase. Establishment of selective handling criteria and waste rock management in Alternatives 3 and 4 would effectively eliminate waste rock in impoundment dam construction as a potential source for affecting the quality of streams and groundwater within the analysis area.

9. Based on preliminary design, the Libby Plant Site would not be built with waste rock. If waste rock was not used to build the plant site, waste rock would be eliminated as a potential source of metals and nutrients in infiltration and surface water runoff.

10. As needed to minimize water quality effects on the west side streams, springs and lakes, buffer zones would be maintained near Rock Lake and the Rock Lake Fault. The buffer zone thickness would be reassessed through the use of an updated hydrologic model.

11. After the mine area groundwater model was updated at the end of the Evaluation Phase, MMC would submit an updated mine plan to the agencies for approval. The mine plan would identify two barrier pillars 20 feet wide across the width of the ore body that would be left in place (except for openings needed for access) during the first 5 years of mining until additional refinement of the hydrologic model was completed and the need for barrier pillars was evaluated. By the fifth year of operations, MMC would assess the need for barrier pillars and/or bulkheads to minimize post-mining changes in East Fork Rock Creek and East Fork Bull River streamflow and water quality. If needed, MMC would submit a revised mine plan to the agencies for approval. Grouting would also be implemented in the mine during construction and operations. These mitigations would be effective in reducing wastewater discharges and the potential risk of post-mining water quality effects on west side streams and Rock Lake.

12. Tailings and reclaimed water pipelines would be buried, which, along with a leak detection system, would be effective in reducing the risk of any tailings or reclaimed water reaching surface water resources.

13. Treating sanitary waste on-site (as described in section 2.5.4.4) and pumping to the tailings impoundment during operations rather than storing and shipping off-site for disposal would effectively reduce the risk of untreated sanitary wastewater reaching surface water or groundwater.

14. MMC would comply with Forest Service policies when disposing of demolition debris during closure. It is Forest Service policy to discourage the disposal of solid waste on National Forest System lands unless such use is the highest and best use of the land. No solid wastes other than waste rock would be buried underground in mined-out areas. Limiting solid waste disposal on National Forest System lands would be effective in minimizing effects on groundwater quality from waste disposal.

15. To further reduce the potential for metals and sediment to reach analysis area streams, ditches and sediment ponds that would contain process water or mine drainage would be designed for a 100-year/24-hour storm (rather than the 10-year/24-hour storm proposed in Alternative 2). This mitigation would be more likely to capture all stormwater containing process water or mine drainage during the life of the project and would be effective in reducing water quality effects on east side streams.

16. In Alternatives 3 and 4, to control dust on mine access roads, MMC would use either a chemical stabilization that does not attract wildlife or groundwater appropriated using its existing water right. This mitigation would be effective in eliminating effects on water quality from dust suppression watering.

17. After the electric transmission line (either the 34.5-kV underground line or the 230-kV overhead line) was operational at the mine site, the operation of the diesel generator at the mill would not exceed 16 hours during any rolling 12-month time period (DEQ 2011a). Tier 4 engines and ultra-low sulfur diesel fuel also would be used in underground mobile equipment and generators during all mine phases. These measures would be effective in reducing nitrogen and sulfur deposition into wilderness lakes.

3.13.4.7 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Possible impacts on streams due to construction, operations, and maintenance of a new transmission line would not occur.

3.13.4.8 Alternative B – MMC Proposed Transmission Line (North Miller Creek Alternative)

The Ramsey Plant Site's electrical service would be provided via a new, overhead transmission line. MMC's proposed alignment would be in the Fisher River, Miller Creek, Midas Creek, Libby Creek, and Ramsey Creek watersheds. Before the KNF and DEQ would allow MMC to start construction, MMC would obtain a permit to discharge stormwater from disturbances associated with installation of the transmission line. MMC could amend its MPDES permit or obtain coverage under Montana's General Permit for Storm Water Discharges Associated with Construction Activity if the project was eligible for coverage under the General Permit. MMC would amend its SWPPP to include construction activities associated with the transmission line.

Construction of the Sedlak Park Substation and loop line would not affect water quality. The BPA would obtain a general permit from the DEQ for any stormwater discharges. The BPA would prepare and implement a SWPPP during substation and loop line construction to minimize water erosion. The substation site would have a stormwater containment system.

This alternative would create the greatest amount of disturbance close to streams because it would have the highest new road mileage and disturbed acreage in areas with severe erosion risk, high sediment delivery to nearby streams, and greatest slope failure potential (see Table 171, p. 910). Possible sediment sources would include new road construction, existing road upgrades, timber and vegetation clearing, soil salvage, and structure installation. The highest risk of increased sedimentation would occur during the Construction Phase of the transmission line, when vegetation was removed from the transmission line corridor, substation site, and access roads. Occasional brief increases in the amount of sediment in analysis area streams would be likely within all watersheds. For activities not covered by a MPDES or general stormwater permit, MMC may request and the DEQ may approve a 318 authorization for short-term increases in turbidity and total suspended solids discussed on p. 705.

Alternative B would have the greatest effect within the watersheds of impaired streams (Table 134) and Class 1 streams (Table 135). Libby Creek is impaired from 1 mile above Howard Creek to the US 2 bridge due to alteration in stream-side vegetative cover and physical substrate habitat alterations. Clearing and the construction of a new road (Figure 41) would affect 17 acres in the Libby Creek drainage, reducing stream-side vegetative cover. MMC's proposed Environmental Specifications for the 230-kV transmission line (MMI 2005b) contain additional measures to minimize sedimentation and erosion. Physical substrate habitat is unlikely to be adversely affected. The Fisher River is impaired from the Silver Butte/Pleasant Valley junction to the Kootenai River due to high flow regime and streambank modification and destabilization. Peak flow increases would be negligible (Appendix H). Streambanks may be further impaired due to erosion and sediment movement toward the river during construction. Alternative B would

Table 134. Transmission Line Disturbances in the Watersheds of Impaired Streams.

Criteria	Alternative B North Miller Creek (ac.)	Alternative C-R Modified North Miller Creek (ac.)	Alternative D-R Miller Creek (ac.)	Alternative E-R West Fisher Creek (ac.)
Fisher River Watershed				
Clearing area†	82	21	21	21
New roads + closed roads with high upgrade requirements	2	<1	<1	<1
Libby Creek Watershed				
Clearing area†	15	13	13	13
New roads + closed roads with high upgrade requirements	2	<1	<1	<1

†Acreage is based on a 150-foot clearing width for monopoles (Alternative B) and 200-foot width for H-frame structures (other alternatives except for a short segment of the West Fisher Creek Alternative E-R that has monopoles). Actual acreage cleared would be less than listed and would depend on tree height, slope, and line clearance above the ground.
Source: GIS analysis by ERO Resources Corp. using DEQ data (DEQ 2012b).

Table 135. Transmission Line Disturbances in the Watersheds of Class 1 Streams.

Feature	Alternative B – North Miller Creek (acres)	Alternative C-R – Modified North Miller Creek (acres)	Alternative D-R – Miller Creek (acres)	Alternative E-R – West Fisher Creek (acres)
New/High Upgrade Roads	7	<1	<1	<1
Vegetation Clearing (other than for roads)	107	72	47	47

No Class 2 streams are in the transmission line analysis area.
Source: GIS analysis by ERO Resources Corp. using FWP data.

parallel about 4.7 miles of line in the Fisher River, where soils with severe erosion risk and high sediment delivery are found. Two structures and a new road would be required immediately adjacent to the river near the Fisher River crossing. Clearing for the transmission line would disturb about 82 acres in the watershed, and new or upgraded roads would disturb 2 acres (Table 134). Streambanks may be further impaired due to erosion and sediment movement toward the river during construction.

Alternative B line clearing also would disturb 15 acres and 2 acres by new or upgraded roads in the Libby Creek drainage. Tree clearing across Libby Creek would be 150 feet wide. The soils at the Libby Creek crossing have severe erosion risk and high sediment delivery. Libby Creek starting at 1 mile above Howard Creek is listed for alteration in streamside vegetative cover, which could result in additional sediment delivery to the creek, and Libby Creek below the US 2 bridge is listed as impaired for sediment and siltation. To address the sediment TMDL on Libby Creek, MMC would implement BMPs included in the SWPPP.

Mitigation to stabilize existing and new roads would include BMPs, revegetation, and access restrictions. NFS road #4784 (upper Bear Creek Road) would be used year-long for the life of the project. NFS road #4724 (South Fork Miller Creek) would be used on a seasonal basis (April 1 to June 30) for the life of the project.

Implementation of a SWPPP and use of BMPs, Environmental Specifications, and other design criteria would minimize sediment and dust reaching area streams during construction and decommissioning under most conditions, including large runoff-producing weather events. After construction was completed, disturbed areas would be stabilized and revegetated. Erosion and sediment delivery would decrease after vegetation cover was re-established. The DEQ would require on-site inspections of perennial stream crossings to determine the method that would result in minimizing impacts on streambanks and water quality considering the nature and cost of the available crossing methods.

Vegetation clearing would occur at stream crossings of new or widened roads and the transmission line. The removal of all riparian vegetation for road construction and reconstruction and riparian vegetation along streams would increase direct solar radiation to streams. The transmission line alternatives would cross between four and five perennial streams and numerous smaller streams (Table 117). Vegetation clearing for the transmission line would be up to 150 feet wide in Alternative B. Five new road crossings over non-perennial streams would be required (Table 117). The transmission line would cross 1.1 miles of floodplains and require 1.6 acres of new roads within a floodplain (Table 117). The effects to stream temperature due to clearing would be the same as discussed for Alternative 3.

3.13.4.9 Transmission Line Alternatives C-R, D-R, and E-R

3.13.4.9.1 Alternative C-R

Before the KNF and DEQ would allow MMC to start construction, MMC would obtain a permit to discharge stormwater from disturbances associated with construction of the transmission line. MMC could amend its MPDES permit or obtain coverage under Montana’s General Permit for Storm Water Discharges Associated with Construction Activity if the project was eligible for coverage under the General Permit. MMC would amend its SWPPP to include construction activities associated with the transmission line. For activities not covered by a MPDES or general stormwater permit, MMC may request and the DEQ may approve a 318 authorization for short-term increases in turbidity and total suspended solids discussed on p. 705.

Construction of the Sedlak Park Substation and loop line would not affect water quality. The BPA would obtain a general permit from the DEQ for any stormwater discharges. The BPA would prepare and implement a SWPPP during substation and loop line construction to minimize water erosion. The substation site would have a stormwater containment system.

The agencies developed two primary alignment modifications to MMC's proposed North Miller Creek alignment in Alternative B. One modification would be routing the line on an east-facing ridge immediately north of the Sedlak Park Substation instead of following the Fisher River. This modification would reduce potential erosion and sedimentation by crossing less area with soils that are highly erosive soils and those with potential for high sediment delivery and slope failure (see Table 171, p. 910) and locating the line farther from streams and wetlands. The other alignment modification would use an alignment up and over a ridge between West Fisher Creek and Miller Creek, reducing clearing in the West Fisher Creek watershed. Other modifications to the alignment are relatively small shifts along an unnamed tributary to Miller Creek that would locate the line farther from these streams and reduce the likelihood of sediment entering the streams. H-frame structures, which generally allow for longer spans and fewer structures and access roads, would be used on this alternative. In some locations, a helicopter would be used to place the structures. These two modifications would reduce potential impacts on water quality and reduce effects to impaired streams by reducing clearing and disturbance associated with new access roads. For analysis purposes, Alternative C-R would end at the Libby Plant Site proposed in Alternatives 3 and 4. Effects would be slightly greater than discussed below if this alternative were selected with Alternative 2 because the plant site would be in the Ramsey Creek watershed. Effects of Alternative C-R on Class I watersheds and watersheds of impaired streams would be the same as Alternative D-R (Table 134; Table 135).

3.13.4.9.2 Alternative D-R

Like the Modified North Miller Creek Alternative, this alternative modifies MMC's proposed North Miller Creek Alignment by routing the line on an east-facing ridge immediately north of the Sedlak Park Substation. The crossing of the Fisher River and West Fisher Creek also would be the same as Alternative C-R. Compared to the other alternatives, this alignment would cross less area with soils that are highly erosive soils and those with potential for high sediment delivery and slope failure, reducing the potential for increased sediments in nearby streams (Table 171, p. 910). H-frame structures, which generally allow for longer spans and fewer structures and access roads, also would be used on this alternative, reducing clearing associated with new access roads and potential erosion. For analysis purposes, Alternative D-R would end at the Libby Plant Site proposed in Alternatives 3 and 4. Effects would be slightly greater than discussed below if this alternative were selected with Alternative 2 because the plant site would be in the Ramsey Creek watershed.

Before the KNF and DEQ would allow MMC to start construction, MMC would obtain a permit to discharge stormwater from disturbances associated with construction of the transmission line. MMC could amend its MPDES permit or obtain coverage under Montana's General Permit for Storm Water Discharges Associated with Construction Activity if the project was eligible for coverage under the General Permit. MMC would amend its SWPPP to include construction activities associated with the transmission line. For activities not covered by a MPDES or general stormwater permit, MMC may request and the DEQ may approve a 318 authorization for short-term increases in turbidity and total suspended solids discussed on p. 705.

Construction of the Sedlak Park Substation and loop line would not affect water quality. The BPA would obtain a general permit from the DEQ for any stormwater discharges. The BPA would prepare and implement a SWPPP during substation and loop line construction to minimize water erosion. The substation site would have a stormwater containment system.

New road mileage and disturbed acreage would be less in Alternative D-R than Alternative B (Table 171, p. 910). The sediment analysis results for the existing and proposed transmission line roads for Alternative D-R are provided in Table 136. Existing NFS Road #2316 currently has low traffic, and NFS roads #4724 and #4780 have high traffic. During the 2-year construction and 2-year decommissioning period for the transmission line, traffic would be high. Each individual road would have high traffic for 1 to 3 months during each period. During operations and after decommissioning, traffic levels on the three roads would return to existing conditions. During high use, reducing the contributing road length to 150 feet would reduce sediment leaving the road buffers by 21 percent, and during low use, would reduce sediment leaving the road buffers by an estimated 37 percent. The estimated decreases would be small in comparison to the estimated existing sediment load of 1,621 tons/year and the estimated future sediment load of 1,102 tons/year in the upper Libby Creek watershed, but would assist in achieving the Libby Creek TMDL.

Table 136. Estimated Sediment Delivery from Assessed Transmission Line Roads to Analysis Area Streams for Alternative D-R.

	Existing Roads[1]	Proposed Roads[2]
Existing Conditions		
Average annual sediment leaving buffers (lbs.)	100	NA
High Use with Contributing Road Length Reduced to 150 feet		
Predicted average annual sediment leaving buffers	79	0
Change with project (lbs.)	-21	—
Low Use with Contributing Road Length Reduced to 150 feet		
Predicted average annual sediment leaving buffers	42	0
Change with project (lbs.)	-37	—

[1]Existing roads assessed were roads 2316, 4724, and 4780.
[2]Proposed roads assessed were short roads near road 2316, between Libby and Howard creeks, near Miller Creek, and in the Fisher River watershed.
Source: ERO Resources Corp. 2015b.

The five proposed new transmission line roads would be graveled, have contributing road lengths of 150 feet, and have 40- to 60-foot buffers to eliminate any sediment from entering RHCAs. For both high and low road use, further reducing the contributing road lengths and adding a gravel surface to roads that currently do not have a gravel surface would further reduce the amount of sediment leaving the roads and buffers; the WEPP:Road Batch model assumes a linear relationship between contributing road length and the amount of sediment leaving a road and buffer. When not in use, new roads would be changed to intermittent stored service roads, and would be treated to minimize erosion and sediment movement from the roads. The roads would be monitored throughout the project to ensure that BMPs implemented to prevent sediment from moving from roads to streams were effective.

Alternative D-R would have fewer disturbances in the watersheds of impaired streams than Alternative B (Table 134). Clearing for the transmission line would disturb 21 acres in the Fisher River watershed and 13 acres in the Libby Creek watershed. Tree clearing across Libby Creek would be about 200 feet wide. New or upgraded roads would disturb less than an acre in both watersheds. Clearing adjacent to Libby Creek would reduce stream-side vegetative cover. Physical substrate habitat in Libby Creek is unlikely to be adversely affected. Peak flow in the Fisher River increases would be negligible (Appendix H). The streambanks of the Fisher River are unlikely to be adversely affected. The following mitigation in the agencies' Environmental Specifications would minimize effects on impaired streams:

- Installing culverts, bridges, or other structures at perennial stream crossings would be specified by the agencies following on-site inspections with the DEQ, Forest Service, FWP, landowners, and local conservation districts
- Installing culverts or other structures in a water of the United States would be in accordance with the U.S. Army Corps of Engineers 404 and DEQ 318 authorization conditions
- Developing and implementing a Vegetation Removal and Disposition Plan to minimize clearing
- Locating structures outside of riparian areas if alternative locations were technically and economically feasible
- Preserving small trees and shrubs to the greatest extent possible during clearing of survey lines or the right-of-way
- Leaving shrub species 10 feet in height or less in the clearing corridor.

The clearing width of the agencies' alternatives would be wider than in Alternative B, and the potential to increase stream temperatures at stream crossings would be greater. None of the agencies' alternatives would require new roads across a perennial stream. Alternatives C-R and D-R would not require new roads across non-perennial streams (Table 117). The following mitigation in the agencies' Environmental Specifications would minimize effects on stream temperatures:

- Installing culverts, bridges, or other structures at perennial stream crossings would be specified by the agencies following on-site inspections with the DEQ, Forest Service, FWP, landowners, and local conservation districts
- Developing and implementing a Vegetation Removal and Disposition Plan to minimize clearing
- Preserving small trees and shrubs to the greatest extent possible during clearing of survey lines or the right-of-way
- Leaving shrub species 10 feet in height or less in the clearing corridor.

The agencies' mitigation of road closures would reduce the contribution of additional sediment to below existing levels in the Libby Creek watershed. Other effects of Alternative D-R would be the same as Alternative B.

3.13.4.9.3 Alternative E-R

Like the Modified North Miller Creek Alternative, this alternative modifies the North Miller Creek Alternative by routing the line on an east-facing ridge immediately north of the Sedlak Park Substation. MMC and the BPA would obtain a stormwater permit for construction activities and implement a SWPPP to minimize erosion, as described for Alternative C-R. The effect of the substation and loop line on water quality would be the same as Alternative B. Alternative E-R would have one new 30-foot wide road across a non-perennial stream (Table 117). The crossing of the Fisher River and West Fisher Creek also would be the same as Alternative C-R. Effects of Alternative E-R on Class I watersheds and watersheds of impaired streams would be the same as Alternative D-R (Table 134; Table 135).

H-frame structures, which generally allow for longer spans and fewer structures and access roads, would be used on this alternative in most locations. In some locations, a helicopter would be used to place the structures. These two modifications would reduce potential impacts on water quality by reducing clearing associated with new access roads. For analysis purposes, Alternative E-R would end at the Libby Plant Site proposed in Alternatives C-R and D-R. Effects would be slightly greater than discussed below if this alternative were selected with Alternative B.

New road mileage and disturbed acreage would be less in Alternative E-R than Alternative B (Table 171, p. 910). Mitigation to stabilize existing and new roads would include BMPs, revegetation, and access restrictions.

3.13.4.10 Cumulative Effects

Past and current actions, particularly timber harvest, road construction, and mining, have altered surface water quality in the area by increasing sedimentation, destabilizing stream channels and removing streamside vegetation. The DEQ's listing of impaired streams indicates Libby Creek between Howard Creek and the US 2 bridge is impaired due to alteration in stream-side vegetative covers and physical substrate habitat alterations. Probable sources of impairment were impacts from abandoned mine lands and historical placer mining. The lower impaired segment begins at the US 2 bridge and is impaired for sediment and siltation. Past activities have also impaired water quality in segments of the Fisher River, Big Cherry Creek, Rock Creek, and East Fork Rock Creek.

Suction dredging activities are currently permitted in the Libby Creek drainage. Monitoring by the KNF indicates limited sediment increases in the stream below dredging operations. At low flows, pools tend to accumulate sediment that is transported as bedload. Deposition of bedload would be more pronounced near the dredging sites. Unless substantial bank erosion occurs, increased sediment transport is limited because the overall sediment load delivered to the channel remains the same, and the effects downstream are probably minor (KNF 2007c). Other human activities that may impair surface water quality include septic field installation, livestock grazing, new roads, and other construction. Stream channel and bank stabilization or restoration projects may improve stream water quality.

The Miller-West Fisher Vegetation Management Project consists of commercial timber harvest, pre-commercial thinning and prescribed fire, access management changes, trail construction and improvement, treatment of fuels in campgrounds, and watershed rehabilitation activities in the Miller, Silver Butte, and West Fisher Creek watersheds. If timber harvest activities occurred during the transmission line construction, the two projects may cumulatively increase sediment in

Miller Creek or West Fisher Creek over the short term, depending on the transmission line alignment. Road and access management, and watershed condition improvements proposed in the Miller-West Fisher Vegetation Management Project would minimize adverse cumulative effects on surface water quality. Stabilization of streambanks in West Fisher Creek and Montanore road closures in Alternatives C-R, D-R, and E-R would cumulatively reduce sediment delivery in West Fisher Creek over the long term.

The proposed Wayup Mine in upper West Fisher Creek and the Libby Creek Ventures drilling plan adjacent to Upper Libby Creek Road would have negligible cumulative effect on water quality. The Montanore and Rock Creek Projects would cumulatively reduce streamflow in Rock Creek and East Fork Bull River. Mine dewatering and the resulting drawdown of bedrock groundwater may subtly change the water quality of the East Fork Rock Creek and East Fork Bull River.

3.13.4.11 Regulatory/Forest Plan Consistency

This section discusses compliance with applicable laws and regulations regarding changes in water quality. Section 3.11.4.10, *Regulatory/Forest Plan Consistency* in the previous *Surface Water Hydrology* section discusses compliance with laws and regulations regarding changes in streamflow and floodplains.

3.13.4.11.1 Organic Administration Act and Forest Service Locatable Minerals Regulations

The Forest Service is responsible for ensuring that mine operations on National Forest System lands comply with Forest Service locatable mineral regulations (36 CFR 228 Subpart A) for environmental protection. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. 36 CFR 228.8 also requires that mining operators comply with applicable state and federal water quality standards including the Clean Water Act; comply with applicable Federal and State standards for the disposal and treatment of solid wastes; take all practicable measures to maintain and protect fisheries and wildlife habitat which may be affected by the operations; construct and maintain all roads so as to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values; and reclaim the surface disturbed in operations by taking such measures as preventing or controlling onsite and off-site damage to the environment and forest surface resources. 36 CFR 228.8(h) states that "certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations."

The BPA's Sedlak Park Substation and loop line would be on private land and would not be subject to compliance under the Organic Administration Act and Forest Service locatable minerals regulations.

Minimize Adverse Environmental Impact (36 CFR 228.8)

Alternative 2 would have a disturbance area of 2,582 acres. The disturbance area of Alternative 4, which would have a tailings impoundment at the same location as Alternative 2, would be smaller than Alternative 2 by 658 acres by eliminating the LAD disturbance area and minimizing the disturbance area around the tailings impoundment. The disturbance area of Mine Alternative 3 would be the smallest. Because the clearing width for Transmission Line Alternative B would be narrower than the agencies' transmission line alternatives, the maximum clearing width for

Alternative B would be less than the agencies' alternatives. Clearing associated with the agencies' transmission line alternatives would be minimized through the development and implementation of a Vegetation Removal and Disposition Plan. The agencies' transmission line alternatives would have less clearing and new road development in the watersheds of impaired streams, in watersheds of Class 1 streams, and on soils with severe erosion risk, high sediment delivery, and slope failure. The predicted delivery of sediment to analysis area streams from roads in the agencies' mine and transmission line alternatives would be less than in MMC's alternatives. All mine and transmission line alternatives would include the use of BMPs to minimize erosion and effects on surface water quality. The agencies' alternatives would include more frequent BMP monitoring than MMC's alternatives. In summary, Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8 because MMC did not propose to implement feasible measures to minimize the disturbance area and adverse environmental impacts on surface water quality. Mine Alternatives 3 and 4 Transmission Line Alternatives C-R, D-R, and E-R would comply with 36 CFR 228.8 because the modifications to the disturbance area are feasible and would minimize adverse environmental impacts on surface water quality.

In Alternative 2, MMC proposed to use land application for its primary water treatment method. If land application of excess water resulted in BHES Order limit or nondegradation criteria exceedances, MMC would treat the additional water at the Water Treatment Plant instead of discharging it to the LAD Areas. The agencies' analysis of MMC's proposed plans for land application of excess water predicted, without additional primary treatment before land application, concentrations would be greater than BHES Order limits or applicable nonsignificance criteria in groundwater beneath the LAD areas and in surface water in Ramsey, Poorman, and Libby creeks. The agencies' analysis also indicated that tailings water in Alternative 2 would reach surface water without pumpback wells. Any exceedances of BHES Order limits or applicable nonsignificance criteria would not comply with state and federal water quality standards. MMC committed to implementing seepage control measures, such as pumpback recovery wells, if required to comply with applicable standards.

The agencies' mitigation in Alternatives 3 and 4 (using a Water Treatment Plant for all discharges, modifying the existing treatment plant as necessary to treat parameters such as nutrients or metals to meet MPDES permitted effluent limits, increasing the capacity of the existing treatment plant, and requiring a pumpback well system around the impoundment) would minimize changes in water quality in Libby Creek and eliminate changes in water quality of Ramsey and Poorman Creek. In Alternatives 3 and 4, the operation of the diesel generator at the mill site would not exceed 16 hours during any rolling 12-month time period after the electric transmission line was operational. Tier 4 engines and ultra-low sulfur diesel fuel also would be used in underground mobile equipment and generators during all mine phases. These measures would minimize nitrogen and sulfur deposition into wilderness lakes. Alternative 2 would not fully comply with 36 CFR 228.8 because MMC did not propose to implement feasible measures to minimize adverse environmental impacts on surface water quality and fisheries habitat. Alternatives 3 and 4 would comply with 36 CFR 228.8 because the proposed water treatment modifications are feasible and would minimize adverse environmental impacts on surface water quality and fisheries habitat.

Ditches and sediment ponds that would contain process water or mine drainage would be designed in Alternative 2 for a 10-year/24-hour storm. In Alternatives 3 and 4, the ditches and sediment ponds would be designed for a 100-year/24-hour storm. The larger conveyance capacity would more likely capture all stormwater containing process water or mine drainage during the life of the project and would minimize water quality effects on east side streams and fisheries habitat.

In Alternatives 3 and 4, runoff from the reclaimed tailings impoundment would be directed toward Little Cherry Creek instead of Bear Creek proposed in Alternative 2. As part of the final closure plan, MMC would complete a H&H analysis of the proposed runoff channel during final design that would include a channel stability analysis and a sediment transport assessment. The runoff channel would be designed to minimize adverse effects of increased streamflow on Little Cherry Creek water quality and fisheries habitat.

Waste rock management would not comply with 36 CFR 228.8 in Alternative 2. Waste rock would be temporarily stored at an unlined area in the LAD Area 1, Libby Adit Site, and/or Ramsey Adit portal, or hauled to the tailings impoundment area and then used in the impoundment dam. In Alternative 2, the Ramsey Plant site would be constructed of waste rock and be sited in a RHCA. In Alternatives 3 and 4, waste rock would be stored temporarily in lined stockpiles, hauled to a lined location within impoundment footprint, and then used in impoundment dam. The Libby Plant Site in Alternatives 3 and 4 would not be built with waste rock and waste rock would be eliminated as a potential source of metals and nutrients in infiltration and surface water runoff. Alternatives 3 and 4 would comply with 36 CFR 228.8 because the proposed waste rock modifications are feasible and would minimize adverse environmental impacts on surface water quality and fisheries habitat.

State and Federal Water Quality Standards (36 CFR 228.8(b))

In Alternative 2, MMC proposed to use land application for its primary water treatment method. If land application of excess water resulted in BHES Order limit or nondegradation criteria exceedances, MMC would treat the additional water at the Water Treatment Plant instead of discharging it to the LAD Areas. MMC committed to implementing seepage control measures, such as pumpback recovery wells, in Alternative 2 if required to comply with applicable standards. The agencies' analysis of MMC's proposed plans for land application of excess water predicted, without additional primary treatment before land application, concentrations would be greater than BHES Order limits or applicable nonsignificance criteria in groundwater beneath the LAD areas and in surface water in Ramsey, Poorman, and Libby creeks. The agencies' analysis also indicated that tailings water in Alternative 2 would reach surface water without pumpback wells. Any exceedances of BHES Order limits or applicable nonsignificance criteria would not comply with state and federal water quality standards. Alternative 2 would have a greater risk of not complying with state and federal water quality standards than Alternatives 3 or 4.

The agencies' mitigation in Alternatives 3 and 4 (using a Water Treatment Plant for all discharges, modifying the existing treatment plant as necessary to treat parameters such as nutrients or metals to meet MPDES permitted effluent limits, increasing the capacity of the existing treatment plant, and requiring a pumpback well system around the impoundment) are designed to minimize changes in surface water quality in the Libby Creek watershed, eliminate changes to groundwater quality by avoiding land application, and ensure compliance with State and Federal water quality standards. The agencies' alternatives expanded MMC's proposed monitoring plans and would include action levels for specific parameters (see Appendix C). Because EPA delegated Montana authority to implement the provisions of the Clean Water Act applicable to surface water and the Montanore Project, compliance with state and federal water quality standards is discussed below under the Clean Water Act and the Montana Water Quality Act.

Solid Waste Disposal (36 CFR 228.8(c))

All mine and transmission line alternatives would comply with applicable Federal and State standards for the disposal and treatment of solid wastes. All mine alternatives would dispose of tailings and reclaim the tailings impoundment in a manner to minimize adverse impact on the environment and forest surface resources. All mine and transmission line alternatives would comply with the applicable portions of 36 CFR 228.8(c) regarding federal and state standards for solid waste and tailings disposal. In Alternative 2, MMC would occasionally bury certain wastes underground in mined-out areas. In the agencies' mine and transmission line alternatives, MMC would comply with Forest Service policies when disposing of demolition debris during closure. The agencies' transmission line alternatives would comply with the Environmental Specifications (Appendix E) regarding solid waste disposal. It is Forest Service policy (FSM 2130) to discourage the disposal of solid waste on National Forest System lands unless such use is the highest and best use of the land. No solid wastes other than waste rock would be buried underground in mined-out areas. Reinforced concrete foundation materials may be buried on National Forest System lands only under certain conditions. These measures would minimize the impact on the environment and forest surface resources. The plans for waste disposal in the agencies' alternatives would comply with 36 CFR 228.8(c).

Fisheries and Wildlife Habitat (36 CFR 228.8(e))

The differences in water treatment methods between Alternative 2 and Alternatives 3 and 4 were discussed in the above section. The agencies' analysis of MMC's proposed plans for land application of excess water predicted, without additional primary treatment before land application, water quality concentrations would be greater than BHES Order limits or applicable nondegradation criteria in surface water in Ramsey, Poorman, and Libby creeks, which would adversely affect fisheries habitat. Alternative 2 would have a greater risk of not complying with 36 CFR 228.8(e) as it applies to water quality than Alternatives 3 or 4.

The above section discussed the differences in the disturbance area, clearing, road construction, and post-closure runoff from the impoundment between the MMC's alternatives and the agencies' alternatives. These modifications in the agencies' alternatives are practicable measures to maintain and protect fisheries. MMC's mitigation plans contained limited measures to protect fisheries habitat from changes in streamflow. The agencies' alternatives would create or secure genetic reserves through bull trout transplanting or habitat restoration; rectify factors that are limiting the potential of streams to support increased production of bull trout; and eradicate non-native fish species, especially brook trout that are a hybridization threat to bull trout.

Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8(e) because MMC did not propose to implement practicable measures to minimize adverse environmental impacts on surface water quality and fisheries habitat. Mine Alternatives 3 and 4 Transmission Line Alternatives C-R, D-R, and E-R would comply with 36 CFR 228.8(e) because the changes in disturbance area, clearing, road construction, and post-closure runoff from the impoundment are practicable and would minimize adverse environmental impacts on surface water quality and fisheries habitat.

Roads (36 CFR 228.8(f))

The following discussion applies to the requirements of 36 CFR 228.8(f) as they apply to surface water quality. Compliance with 36 CFR 228.8(f) regarding roads management is discussed in section 3.6.4.11.4, *National Forest Management Act/Kootenai Forest Plan* (RF-2 through RF-5), beginning on page 477.

In all mine and transmission line alternatives, roads would be constructed and maintained to ensure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values. The agencies' alternatives include specific BMPs to minimize road-related effects on water quality. The Environmental Specifications describe how transmission line roads would be constructed and maintained to ensure adequate drainage and to minimize or eliminate damage to resource values. The agencies' transmission line alternatives would have less new road development in the watersheds of impaired streams, in watersheds of Class 1 streams, and on soils with severe erosion risk, high sediment delivery, and slope failure. The predicted delivery of sediment from roads to streams in the agencies' mine and transmission line alternatives would be less than in MMC's alternatives. At the end of operations, all mine and transmission line alternatives would have roads no longer needed for operations. The agencies' mitigation provides more specificity regarding management of roads no longer needed for operations. Such roads would be placed either in intermittent stored service or decommissioned. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8(f) as it relates to water quality because MMC did not propose to implement practicable measures to minimize adverse environmental impacts on surface water quality and fisheries habitat. Mine Alternatives 3 and 4 Transmission Line Alternatives C-R, D-R, and E-R would comply with 36 CFR 228.8(f) as it relates to water quality.

Reclamation (36 CFR 228.8(g))

The following discussion applies to the reclamation requirements of 36 CFR 228.8(g) as they apply to surface water quality. Compliance with 36 CFR 228.8(g) regarding reclamation requirements is discussed in section 3.19.4.6 under *Soils and Reclamation*, p. 927. All mine and transmission lines alternative would comply with the requirements of 36 CFR 228.8(g) regarding controlling erosion, controlling surface water runoff, and isolating toxic materials. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8(g) to implement practicable measures to prevent or control onsite and off-site damage to the environment and forest surface resources. MMC did not propose to implement practicable measures to minimize erosion and maximize reclamation success. The agencies' alternatives would include developing and implementing a final Road Management Plan and a Vegetation Removal and Disposition Plan; increasing the salvage and replacement of suitable soil materials for reclamation; removing a majority of coniferous forest debris removed before soil removal; consolidating soil stockpiles and reclaiming them incrementally; and salvaging disturbed wetland soils for use in constructing new wetlands. These measures would minimize erosion and ensure reclamation success. The agencies' alternatives would comply with 36 CFR 228(g) as it relates to water quality.

3.13.4.11.2 Clean Water Act and Montana Water Quality Act

The Forest Service is responsible for ensuring that mine operations on National Forest System lands comply with Forest Service locatable mineral regulations (36 CFR 228 Subpart A) for environmental protection. Operators must comply with applicable federal and state water quality standards, including regulations issued pursuant to the Clean Water Act. The DEQ is responsible for ensuring all mine operations comply with the Montana Water Quality Act and its implementing rules.

The BPA is responsible for ensuring construction and operation of the Sedlak Park Substation and loop line comply with the Clean Water Act and the Montana Water Quality Act. Construction and operation of the Sedlak Park Substation and loop line would comply with the Clean Water Act and the Montana Water Quality Act. The BPA would obtain authorization to discharge stormwater during construction of the substation and loop line and would prepare and implement a SWPPP during substation and loop line construction to minimize water erosion.

The previous sections discussed the differences in disturbance area, clearing, road construction, and post-closure runoff from the impoundment between the MMC's alternatives and the agencies' alternatives. The modifications in the agencies' alternatives are practicable measures to reduce nonpoint source pollution. All mine and transmission line alternatives would include the use of BMPs to minimize erosion and effects on surface water quality. The agencies' alternatives would include more frequent BMP monitoring than MMC's alternatives. All mine and transmission line alternatives would comply with the USDA Nonpoint Source Water Quality Policy Directive 9500-007.

In Alternative 2, MMC proposed to use land application for its primary water treatment method. If land application of excess water resulted in BHES Order limit or nondegradation criteria exceedances, MMC would treat the additional water at the Water Treatment Plant instead of discharging it to the LAD Areas. MMC committed to implementing seepage control measures, such as pumpback recovery wells, in Alternative 2 if required to comply with applicable standards. The agencies' analysis of MMC's proposed plans for land application of excess water predicted, without additional primary treatment before land application, concentrations would be greater than BHES Order limits or applicable nonsignificance criteria in groundwater beneath the LAD areas and in surface water in Ramsey, Poorman, and Libby creeks. The agencies' analysis also indicated that tailings water in Alternative 2 would reach surface water without pumpback wells. Any exceedances of BHES Order limits or applicable nonsignificance criteria would not comply with the Clean Water Act or the Montana Water Quality Act. Any tailings water reaching surface water would not comply with the ELGs promulgated under Clean Water Act. Alternative 2 would have a greater risk of not complying with the Clean Water Act or the Montana Water Quality Act than Alternatives 3 or 4.

The agencies' mitigation in Alternatives 3 and 4 (using a Water Treatment Plant for all discharges, modifying the existing treatment plant as necessary to treat parameters such as nutrients or metals to meet MPDES permitted effluent limits, increasing the capacity of the existing treatment plant, and requiring a pumpback well system around the impoundment) are designed to minimize changes in water quality in Libby Creek, eliminate changes in water quality of Ramsey Creek and Poorman Creek, eliminate changes to groundwater quality at the LAD areas, and ensure compliance with the Clean Water Act and the Montana Water Quality Act. The agencies' alternatives expanded MMC's proposed monitoring plans and included action levels for specific parameters (see Appendix C).

The DEQ will discuss compliance with applicable water quality regulations including the ELGs and nondegradation rules in the ROD and the MPDES permit. Unless the DEQ waives its issuance, a 401 certification from the Montana DEQ would certify that MMC's proposed discharges of fill permitted under a Section 404 permit are in compliance with all applicable water quality requirements of the Clean Water Act. Unless the 401 certification is waived, the mining operator must give a copy of the 401 certification to the Forest Service before the KNF would allow MMC to commence any activity that requires a 404 permit.

36 CFR 228.8(h) states that “certification or other approval issued by state agencies or other federal agencies of compliance with laws and regulations relating to mining operations will be accepted as compliance with similar or parallel requirements of these regulations.” DEQ’s permit decision and associated conditions in the MPDES permit and on any other state water quality permit would constitute compliance with Montana water quality requirements and Clean Water Act requirements regarding water quality.

3.13.4.11.3 Kootenai Forest Plan

Compliance with the 2015 KFP is described in the following sections.

GOAL-WTR-01: All mine and transmission line alternatives would maintain water quality conditions that support ecological functions and beneficial uses. The DEQ will discuss compliance with applicable water quality regulations addressing streamflow including nondegradation rules in the ROD, the MPDES permit, and 401 Certification. DEQ’s permit decision and associated conditions in the MPDES permit or on any other state water quality permit would constitute compliance with Montana water quality requirements and Clean Water Act requirements regarding water quality. The alternatives would be neutral with regard to progress toward this goal.

FW-DC-WTR-01: Watersheds and associated aquatic ecosystems would retain their inherent resilience to respond and adjust to disturbance without long-term, adverse changes to their physical or biological integrity in the agencies’ mine and transmission line alternatives. The agencies’ alternatives include appropriate mitigation for all reasonably foreseeable adverse water quality effects on watersheds and associated aquatic ecosystems. The agencies’ alternatives would be neutral with regard to progress toward this desired condition.

FW-DC-WTR-02. Alternative 2 would have a greater risk of not complying with the Clean Water Act or the Montana Water Quality Act than Alternatives 3 or 4. The agencies’ mitigation in Alternatives 3 and 4 (using a Water Treatment Plant for all discharges, modifying the existing treatment plant as necessary to treat parameters such as nutrients or metals to meet MPDES permitted effluent limits, increasing the capacity of the existing treatment plant, and requiring a pumpback well system around the impoundment) are designed to minimize changes in water quality in Libby Creek, eliminate changes in water quality of Ramsey Creek and Poorman Creek, eliminate changes to groundwater quality at the LAD areas, and ensure compliance with the Clean Water Act and the Montana Water Quality Act. The DEQ will discuss compliance with applicable water quality regulations including nondegradation rules in the ROD, the MPDES permit, and the 401 certification. DEQ’s permit decision and associated conditions in the MPDES permit or on any other state water quality permit would constitute compliance with Montana water quality requirements and Clean Water Act requirements regarding water quality. The agencies’ alternatives would be neutral with regard to progress toward this desired condition.

FW-DC-WTR-04: MMC’s alternatives would not affect municipal watersheds or public water supplies. The agencies’ alternatives may include fisheries mitigation activity in Flower Creek, the source of Libby’s water supply. Activity may cause a brief increase in turbidity and sediment concentrations in Flower Creek. The activity would be subject to permit conditions designed to avoid or minimize effects on Flower Creek water quality. The alternatives would be neutral with regard to progress toward this desired condition.

FW-STD-WTR-01: See above discussion on desired condition FW-DC-WTR-04. MMC's alternatives would not affect municipal watersheds or public water supplies. The effects of activity in Flower Creek in the agencies' alternatives would be brief and support long-term benefits to bull trout. The agencies' alternatives would be designed in exact accordance with this standard.

FW-GDL-WTR-01: The intent of wasteload allocation for the Montanore facility would be met by adhering to the MPDES permit requirements in all mine and transmission line alternatives. Beginning on the effective date of the MPDES permit, MMC would monitor all discharges to surface water for sediment, and report sediment concentrations to DEQ monthly (see Appendix C). Any failures of the sediment BMPs detected through monitoring would require MMC to implement corrective measures in accordance with the MPDES permit.

No streams in the analysis area are on the DEQ's 303(d) list. All mine and transmission line alternatives would be designed in accordance with this guideline.

FW-GDL-WTR-02: All mine and transmission line alternatives would ensure decommissioned and stored roads had hydrologic stability and would be designed in accordance with this guidelines.

FW-GDL-WTR-03. Project-specific BMPs would be incorporated in all mine and transmission line alternatives as a principle mechanism for controlling non-point pollution sources, meeting soil and water goals, and protecting beneficial uses. Ditch and road surface runoff would be disconnected from streams and other water bodies to the extent practicable. The agencies' alternatives would require more extensive monitoring of BMP effectiveness. All mine and transmission line alternatives would be designed in accordance with this guideline.

GA-DC-WTR-LIB-02: See above discussion on desired condition FW-DC-WTR-04 and standard FW-STD-WTR-01. The alternatives would be neutral with regard to progress toward this desired condition.

3.13.4.12 Irreversible and Irretrievable Commitments

Water quality impacts resulting from mine inflows post-mining would be an irreversible commitment of surface water resources.

3.13.4.13 Short-Term Uses and Long-Term Productivity

Any change in stream water quality due to discharging mine water to area streams would be a short-term use of the resource. Changes that may occur that would affect the long-term productivity of surface water resources in terms of water quality are water quality changes that may occur due to loss of deep groundwater supply to streams, springs, and lakes.

3.13.4.14 Unavoidable Adverse Environmental Effects

If less groundwater were contributed to Rock Lake, the lake total dissolved solids, silica (needed by diatoms), and nutrient concentrations may decrease in the lake.

3.14 Geotechnical Engineering

This section discusses the lead agencies' analysis of the risk of subsidence in the underground mine, and the stability of the tailings impoundment for Alternatives 2 and 4 (Little Cherry Creek) and Alternative 3 (Poorman). Also included in this section is a comparison of the two alternative tailings sites.

3.14.1 Analysis Area and Methods

The analysis area for potential direct, indirect, or cumulative effects associated with subsidence and impoundment stability is the area overlying the ore body and the two tailings impoundment areas analyzed in detail.

Subsidence as related to mining is the downward displacement of the ground surface resulting from the collapse of underground mine workings. The vertical displacement and areal extent of the surface subsidence is related to the size of the underground mine void, its depth below the ground surface, and the area over which the underground collapse has occurred. For this analysis, the area for the subsidence evaluation is the area overlying the Montanore ore body.

Current subsidence prediction and evaluation methods depend on past experience and observed behavior from historical subsidence events. One approach examines the ability of the in place rock to remain stable over a mined-out void, or conversely stated, determining under what conditions rock will fail and collapse into the mined void. This analysis method is suitable for chimney-type failures where the failure process is confined to a relatively narrow chute and the resulting surface subsidence is manifested by sinkholes. MMC used this approach in their subsidence evaluation (Call & Nicholas, Inc. 2005a) by examining the ability and likelihood for there to be sustained caving of rock between the underground workings and the ground surface, which if occurs, would result in subsidence. This analysis method is often used in the design of mines dependent on caving as the ore extraction technique. The lead agencies evaluated the results of MMC's analysis for chimney subsidence, but used a different approach by determining whether the underground pillars were adequately sized to prevent collapse of the underground workings (Agapito Associates, Inc. 2007b). If enough of the pillars fail, the excess weight transferred to adjacent pillars can cause a chain-reaction of pillar failure known as cascading pillar failure. Cascading pillar failure frequently results in surface subsidence over a far greater area (trough subsidence) than what is generated by a chimney-type failure. Evaluating whether mine pillars are adequately sized is also a commonly used technique in underground mine design.

The agencies performed a Failure Mode and Effects Analysis (FMEA) following methods used by Klohn Crippen (1998, 2005) for the Rock Creek Project to assess the risks of the project. MMC completed a modified FMEA of the Little Cherry Creek impoundment (Klohn Crippen 2005). The agencies updated the FMEA in 2008 to include all project infrastructure in Alternatives 2 and 3 (Klohn Crippen Berger 2009).

The KNF completed a FMEA of the Rock Creek Project underground mine, taking into account the Troy Mine experience, and developed mitigations as part of agency-modified alternatives (Agapito Associates, Inc. 2014a, 2014b). The FMEA took into account Troy Mine subsidence experience. Because of similarities between the Montanore and Rock Creek projects, the agencies applied the results of Rock Creek Project underground mine FMEA to the Montanore Project.

Klohn Crippen (2005) updated the original design of the proposed Little Cherry Creek tailings impoundment and all associated facilities, incorporating new data on seismicity, ground conditions, and seepage parameters since the NMC design from the 1990s, and making design changes required by the lead agencies in their 1992 project approvals. The lead agencies developed a design for an alternative Poorman Tailings Impoundment Site between Poorman and Little Cherry creeks in Alternative 3 in sufficient detail to analyze its effects in the EIS.

The following sections describe the available geotechnical data and the approaches used by the lead agencies in analyzing potential effects. The subsequent section on the affected environment describes the best available geotechnical information regarding the analysis area. The KNF and the DEQ determined that the baseline data and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on resources in the analysis area potentially affected by geotechnical issues, and to enable the decision makers to make a reasoned choice among alternatives. Section 3.10.2.4, *Additional Data Collection* and Appendix C describe the geotechnical data that would be collected during all phases of the project, including the Evaluation Phase and for final design. The agencies did not identify any incomplete or unavailable geotechnical information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.14.2 Affected Environment

3.14.2.1 Seismicity and Seismic Hazard

The analysis area is located at the northern end of the Intermountain Seismic Belt, which extends from southern Nevada northward through Utah and eastern Idaho and western Montana. In western Montana, the Intermountain Seismic Belt is up to 62 miles wide. The Intermountain Seismic Belt is characterized by moderate to large earthquakes with shallow focal depths. The vast majority of historical seismic activity within western Montana has been concentrated along the Intermountain Seismic Belt (Klohn Crippen 2005)

The seismic analysis for the tailings impoundment employed a deterministic approach by using a known active fault as the source of the seismic event, assigning an earthquake magnitude, and calculating a resulting ground motion at the tailings impoundment site. Five faults identified as being potentially active in the last 1.6 million years are located within 50 miles of the impoundment sites. The closest known potentially active fault to the analysis area is the Bull Lake Fault, located about 12 miles west of the project site. The Bull Lake Fault was used to estimate the site seismicity and is summarized in Table 137 (Klohn Crippen 2005). The site is located in a moderately active seismic area. The design maximum credible earthquake (MCE) is a potential Magnitude 7.0 earthquake on the Bull Lake Fault, which results in a peak ground acceleration of 0.22 g. The fault is part of a series of northwest-southeast trending faults, although the activity along the fault is uncertain. Larger faults, which typically are associated with larger seismic events, are located farther away and do not control the design seismicity. The Bull Lake Fault is unlikely to affect any of the transmission line alignments or the Sedlak Park Substation and loop line.

Table 137. Maximum Credible Earthquake and Site Seismicity.

Parameter	Value
Magnitude (M)	M7.0
MCE Assumed Epicentral Distance	12 miles (19 km)
Source	Bull Lake Fault, classified as later Quaternary, <700,000 years old and potentially active
Peak Bedrock Acceleration (average from attenuation relations)	0.22 g(*) (average from attenuation relations)
Duration of Significant Shaking	27 seconds

*g = gravitational acceleration (32.2 ft/sec^2).
Source: Klohn Crippen 2005.

3.14.2.2 Avalanches and Landslides

Numerous avalanche chutes occur in both upper Libby Creek and Ramsey Creek valleys. The only facility within an avalanche chute path is the Libby Adit Site (Figure 48). Three avalanche chutes are near the Libby Adit Site. The Upper Libby Adit Site, proposed in Alternative 3, is between two avalanche chutes. Because of the high elevation of the chute tops and the narrow widths of the valleys below, avalanches can cross valleys and move up the opposite side. None of the three avalanche chutes currently cross NFS road #2316, which is between the terminus of each chute and facilities at the Libby Adit. The primary facilities at the Libby Adit, the Water Treatment Plant and the shop where emergency generator would be housed, are between chutes should they extend beyond their current termini.

No landslides or unstable slopes were identified near mine facilities, along the transmission line alignments, or near the Sedlak Park Substation and loop line. Fine-grained soils derived from glaciolacustrine silts and clays are susceptible to slope failures if undercut. Section 3.19.3.1.2, *Glaciolacustrine Soils* discusses these soils in more detail.

3.14.3 Environmental Consequences

3.14.3.1 Subsidence

3.14.3.1.1 Alternative 1 – No Mine

No mining would occur; therefore, the potential for mining-related subsidence would not be present. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ's approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that do not affect National Forest System lands. Potential subsidence from the Libby Adit would be mitigated by backfilling the entire adit length that occurs in unconsolidated bedrock.

3.14.3.1.2 Alternative 2 – MMC's Proposed Mine

Summary

The lead agencies' evaluation (Agapito Associates, Inc. 2007b) concluded that chimney subsidence breaching the surface to form sinkholes is unlikely given the geotechnical setting (thickness of the overlying rock above the mine workings, and the strength of the overlying rock) and the mine plan proposed by MMC. Isolated roof failure and chimney subsidence to some height above the workings is likely, and could lead to increased rock fracturing and higher groundwater hydraulic conductivity within the overlying strata. The evaluation also estimated that chimney subsidence impacts on groundwater may occur up to about 400 feet above the mine workings. The agencies' evaluation concluded that trough subsidence, while not likely, cannot be entirely dismissed at the current level of design.

Introduction

Underground mining causes a redistribution of stress, which in turn causes displacements in the affected strata. Subsidence is the result of downward displacement of the rock mass from closure or collapse of underground openings. The terms "subsidence" and "surface subsidence" are generally used interchangeably; subsidence has the potential to affect groundwater where it is encountered, even where subsidence has not progressed to the surface.

The magnitude and extent of mining-induced subsidence are directly related to the type and extent of the mining activity. In partial-extraction mining (such as the room-and-pillar method proposed for the Montanore Project), rock strength is estimated and pillars are sized and left permanently to support the overburden, so that subsidence is not planned to occur during active mining. The complex interaction of rock strength, zones of structural weakness, local and regional tectonic forces, and gravity make accurate projections on the likelihood of subsidence very difficult. A stable underground environment during the mining process, could over time become unstable due to some triggering event or changed ground condition. Subsidence after mine abandonment due to time-dependent pillar, roof, or floor failure may still occur and may be the dominant form of subsidence in room-and-pillar mining even in the absence of secondary pillar recovery (Singh 1992). Further, residual subsidence may occur tens or even hundreds of years after active mining (Thorburn and Reed 1977; Mahar and Marino 1981). It is difficult to know if and when conditions will change sufficiently to initiate collapse of underground workings which could lead to surface subsidence.

The two major modes of subsidence associated with mining are chimney subsidence and trough subsidence. Chimney subsidence is associated with roof collapse over small areas, such as individual drifts (Figure 77). Mining through structural weaknesses zones such as a faults can trigger and increase the height of chimney subsidence. Two chimney subsidence events that resulted in sinkholes at the Troy Mine have been reported (Tetra Tech and R Squared 2006). The collapsing rock strata cave progressively upward toward the surface in a chimney-like fashion until either the increased volume of the caved material arrests cave progression, or caving breaches the surface. If chimney subsidence breaches the surface, a sinkhole is formed. Trough subsidence, in which a subsidence basin is formed above caved and sagging strata, occurs over larger areas (*e.g.*, many acres) and is associated with wide-scale pillar, roof, or floor failure.

Geologic Setting

The ore deposit at Montanore occurs in two nearly parallel zones within the lower Revett Formation, part of the Belt Supergroup. The average thickness of the Zone 1 is 30 feet and Zone 2 averages 34 feet. A barren lead zone, ranging in thickness from 0 to 200 feet and averaging about 30 feet, separates the two ore zones. The ore body lies on the lower limb of an overturned syncline (Figure 63) that plunges to the northwest. The syncline is bounded to the west by the Rock Lake Fault, a steeply dipping normal fault, and to the east by the Libby Lake Fault. Ore body dip follows the northwest plunge of the syncline, and ranges from about 5° to 50°. Dimensions of the ore body are about 2,000 feet wide by 11,000 feet long. The thickness of the unmineralized zone overlying the ore body ranges from zero (0) feet at the outcrop at Rock Lake to about 3,800 feet near Libby Lakes (Agapito Associates, Inc. 2007b). Most of the ore body is overlain by between 2,000 and 3,500 feet of cover.

The lower Revett Formation consists primarily of quartzite with some siltite and silty quartzite beds. In addition to the Revett Formation, overlying rocks belong to the St. Regis and Wallace formations. The St. Regis Formation consists of siltites and argillites with some quartzite. The Wallace Formation consists of argillite, siltite, limestone, and dolomitic quartzite. Additional information about the geology of the mine area is found in section 3.9, *Geology and Geochemistry.*

Several lakes exist over or adjacent to the ore body, including Rock Lake on the extreme southern end of the deposit (the ore body outcrops beneath and near Rock Lake), St. Paul Lake on the northern end, and the Libby Lakes near the eastern boundary. Additional information about the surface water resources in the mine area is found in section 3.11.3, *Affected Environment.*

Two other economic copper/silver deposits exist in the general vicinity of the Montanore Project. The Troy Mine (Spar Lake deposit) was permitted in 1979 and was in production until 1993. In late 2004, the Troy Mine was brought back into production. In December 2012, Revett suspended all underground mining activities following back and pillar failures in both the north and south ore bodies in the Middle Quartzite of the Revett Formation that manifested as surface cracking and shallow subsidence (Call & Nicholas 2014). The Rock Creek Project is west of the Montanore Project; the KNF currently is conducting additional environmental analysis of the project (see section 3.3.2.1, *Rock Creek Project*). Although the lithology and mineralogy of the ore zones of the Spar Lake, Rock Lake, and Rock Creek deposits are similar, there are significant differences in the character of the sediments overlying the deposits (Tetra Tech, Inc. and R Squared Incorporated 2006). Continental glaciation in the vicinity of the Troy Mine has resulted in unconsolidated sediments up to 70 feet thick, whereas the Rock Lake and Rock Creek deposits typically has little unconsolidated sediment overlying the bedrock.

MMC’s Plan to Minimize Subsidence

MMC has indicated that pillar and opening dimensions would be designed with the goal of preventing surface subsidence. Spans of about 40 feet to 45 feet are planned. A pillar design study (Call & Nicholas 2005a) recommended 62-foot-long pillars, 40-foot-wide openings, and pillar widths varying from 19.5 feet to 49 feet, including 2 additional feet of both width and length to compensate for blast damage. These pillar widths were based on the Wilson pillar design approach (Wilson 1972) and a 1.3 safety factor. Required pillar widths would increase with cover depth (the amount of rock overlying the mine) and pillar height. The Call & Nicholas pillar design study provided for a cover range of 1,000 feet to 3,800 feet. As part of the Libby Adit Evaluation Phase, MMC would conduct additional underground core drilling before developing final mine plans. The drilling would be used to collect detailed information on underground geologic structures, ore thicknesses, ore grades, and hydrology. MMC did not explicitly eliminate the possibility of secondary recovery, or “pillar robbing,” at the end of mining, which, if conducted, would increase subsidence risk. Any change to the final mine plan would require the agencies’ approval. Additional information about MMC’s mine plan is discussed in section 2.4.2.1, *Mining*.

To reduce possible subsidence risk and the interception of groundwater in the potential subsidence area, MMC plans to observe a 500-foot vertical and horizontal buffer zone where the mineralized ore horizon outcrops near Rock Lake. In addition, a 100-foot barrier pillar is planned as a buffer to the Rock Lake Fault. It is anticipated that additional developmental drilling would better define the fault zone and, thus, the limit of mining near the fault and lake. MMC may use a narrower barrier, but only with the agencies' prior approval, should additional testing determine that a smaller buffer zone would be adequate to protect against subsidence and/or hydrologic disturbance. Alternately, the additional testing may indicate that a larger buffer zone would be necessary and MMC would be required to stay farther from the fault or lake.

Potential for Chimney Subsidence, and Likely Effects Were it to Occur

Due to the depth of cover over the mine workings and the high strength of the rock overlying the mining horizon, it is unlikely that chimney subsidence would breach the surface to form sinkholes (Agapito Associates, Inc. 2007b). Some roof failure at mine level would be likely over time, especially after mine abandonment. Caving propagation (incremental upward movement) to some height above the workings would likely occur, but the strength of the overlying rock and the magnitude of the *in situ* tectonic forces likely would lead to the formation of a stable arch of rock over the collapsed area. Should such caving occur, MMC's estimates of final cave height are between 150 feet and 380 feet, or 2.1 to 5.4 times the assumed maximum 70 feet mining height (Call & Nicholas 2006). Due to the thickness of rock overlying the Montanore ore body, and the buffers proposed by MMC, these cave heights would not breach the surface. Any groundwater intercepted by the caved strata would be rapidly transmitted to the mine workings. A fractured zone with increased hydraulic conductivity may exist for some distance above the caved zone, but given the likely diameter of the caved zone (a few feet to tens of feet), the thickness of the fractured zone would be limited and not likely to reach the surface based on the amount of rock overlying the ore. No other direct impacts are anticipated should chimney subsidence occur.

Two chimney subsidence events that resulted in sinkholes at the Troy Mine have been reported (Tetra Tech and R Squared 2006). As discussed in 3.9, *Geology and Geochemistry*, the mineralogy of the ore zone at the Troy Mine is similar to that of Montanore. Sinkhole #1 was initially observed in October 1997 (Call & Nicholas 2005b), about 4 years after the mine had been shut down. At that time, the sinkhole was about 8 feet deep and 15 feet in diameter. By spring 2005, the sinkhole had increased to about 50 to 55 feet deep and 50 feet in diameter. At the mine level, material from the East Fault, a north-northwest trending normal fault that dips at about 65° to the northeast, had accumulated in two separate drifts sometime between the mine closing in 1993 and spring of 2005. Based on measurements of the accumulation of fault material in the mine, estimation of the sinkhole volume, estimates of fault gouge bulking factors, spatial relationships between the East Fault and the mine workings, and other factors, Call & Nicholas (2005b) concluded that the sinkhole was probably not related to underground excavation.

A second sinkhole formed in February 2006, and both sinkholes #1 and #2 were analyzed by Tetra Tech and R Squared (2006). Sinkhole #2 was about 135 feet long and 100 feet wide, with a depth between 20 and 30 feet. It was first noticed 4 days after a ground failure and cave in the underground workings of the Troy Mine. Based on projections of the East Fault to the surface, the location of the sinkholes relative to these projections, and on calculations regarding swell factor and chimney size, Tetra Tech and R Squared concluded that the sinkholes were mining related. The structurally weak East Fault acted as a conduit for progressive rock failure. The overlying rock in and next to the fault was so highly broken, fractured and degraded that it lacked sufficient inherent strength to form a stable arch.

While relevant to the analysis of subsidence potential at Montanore, the formation of sinkholes above the Troy Mine does not imply a similar risk of sinkhole formation at Montanore. The mining depths associated with the two Troy sinkholes were 270 feet and 320 feet, respectively (Tetra Tech and R Squared 2006). Minimum mining depth at Montanore would be 500 feet. Assuming similar mining heights, the increased depth at Montanore would reduce the likelihood of sinkhole subsidence, as would MMC's plan to leave a 100-foot horizontal buffer between mining activity and the Rock Lake Fault. No such plan was required at the Troy Mine, where the East Fault was routinely approached and/or penetrated as part of the mining operation. Had a mitigation plan similar to the Montanore plan been in place at the Troy Mine, it is unlikely that sinkhole subsidence would have occurred (Agapito Associates, Inc. 2007b).

Potential for Trough Subsidence, and Likely Effects Were it to Occur

MMC's design calls for stable pillars to be left in place. If the design assumptions were met, trough subsidence and associated impacts would not occur. Any change to the final mine plan would require the agencies' approval. In order to quantify worst-case impacts, the remaining discussion in this section assumes that design assumptions were not met, and that trough subsidence occurred.

Based on published data from historical incidences of subsidence, trough subsidence over the workings due to unforeseen roof, pillar, or floor failure may result in maximum surface subsidence of 0.1 to 0.2 times the 70 feet mining height, or 7 feet to 14 feet. Surface subsidence would be much less than this if the width of failure at mine level were less than about 1.4 times the cover depth (Agapito Associates, Inc. 2007b). In this case, subsidence at the surface may be minimal or visually undetectable. If substantial surface subsidence were experienced, it would be measured over a surface area that somewhat approximates the area affected at mine level. The area affected at mine level is defined by the draw angle, the angle, in section, measured from the vertical, between the edge of the mine workings and the point on the surface at which subsidence is not detectable. A negative draw angle results in an affected surface area smaller than the area of failure, whereas the opposite is true for a positive draw angle. Based on case studies of initial draw angles in caving operations, it is estimated that the draw angle could vary from -12° to 28°. Using the latter as a worst-case scenario at maximum cover, subsidence could be measured for horizontal distances up to 2,000 feet beyond the footprint of failure. Surface damage is not likely to occur over the full angle of draw, but over the angle of critical deformation, which is typically about 10° less. Therefore, surface subsidence effects may occur up to 1,200 feet beyond the footprint of failure, based on an angle of critical deformation of 18°.

Following back and pillar failures in both the north and south ore bodies in the Middle Quartzite of the Revett Formation that manifested as surface cracking and shallow subsidence, the KNF required Revett to evaluate the pillar design and mining methods used at the Troy Mine to aid in the determination of the causes and contributing factors leading to ground subsidence. Call & Nicholas, Inc. prepared an analysis of subsidence and ground fall at the Troy Mine (Call & Nicholas 2014). The KNF contracted an independent third party review of the Call & Nicholas report and related documents, and an independent evaluation of the Troy Mine subsidence through back-analysis of pillar safety factors (Agapito Associates, Inc. 2014b). In addition, the KNF and the DEQ contracted review of information related to recent surface subsidence observed above the Troy Mine in the context of implications to the Montanore Project (Agapito Associates, Inc. 2014a).

The Call & Nicholas (2014) describes the history of instability associated with middle and lower quartzite mining at the Troy Mine. Before the 2012 failures, no surface subsidence was observed. In 2012, an undetermined number of pillars failed west of the main drive in the north ore body, and a progressive pillar and back collapse was initiated. Access to the area was completely cut off and a full assessment of the damage was not possible. Call & Nicholas investigated surface subsidence and reported that "the surface subsidence observed indicates that the back and pillar failures in both the [north ore body] and [south ore body] of the Middle Quartzite were insufficiently bulked shut by caved material before the down-dropped block,…was undercut and allowed to move along several surface expressed faults. While some portion of the closure was accommodated by separation of bedding, the remainder was expressed as surface subsidence."

If design assumptions were not met and trough subsidence occurred, surface resources that may be affected include wildlife and vegetation, wetlands, and visual quality. Assuming this worst-case scenario, the lead agencies evaluation concluded the potential for impacts on these resources would be low (Agapito Associates, Inc. 2007b). The referenced report explains the conclusion in more detail.

Possible Effects on Groundwater

Subsidence has the potential to affect groundwater where it is encountered, even where subsidence has not progressed to the surface. Chimney or trough subsidence would have the potential to affect surface water and groundwater in several ways and the effects of subsidence on the hydrologic regime can be highly variable and complex. Numerous case studies have been presented in the literature, and conflicting conclusions between studies are common (Peng 1992). The major factors controlling subsidence effects on hydrology include the horizontal and vertical distance between the caved zone and the water resource and the hydrologic properties of the intervening strata. The severity of hydrologic damage decreases with distance from the subsidence and the presence of low permeability stratum. Peng (1992) suggests an angle of influence of 16° to 26° is appropriate for estimating the distance beyond which hydrologic resources should be unaffected.

Within the angle of influence, hydrologic effects are expected to vary according to where water resources were intercepted vertically. If unplanned trough subsidence occurred, rapid transmission of any groundwater to the workings is expected in the caved zone, for a distance of 2 to 8 times the mining height, or 140 feet to 560 feet, assuming a total mining height of 70 feet (Agapito Associates, Inc. 2007b). A fractured zone would exist over the caved zone, extending perhaps 1,400 feet to 2,100 feet above the mine workings. Increased permeability would be associated with the fractured zone, and permeability would increase from the top of the fractured zone downward. Above the fractured zone, surface fissures may develop, but they probably would not to extend to the fractured zone, as tensile stresses would likely die out and become compressive at some distance beneath the surface. Groundwater flows may be affected from the surface to the fractured zone; any such interruption would continue until post-mining hydraulic heads stabilize.

As previously discussed, the caving height associated with chimney subsidence is estimated between 150 feet and 380 feet, or 2.1 to 5.4 times the assumed maximum 70 feet mining height (Call & Nicholas 2006). Groundwater within this zone would be transmitted to the workings. Increased permeability above this zone would exist, although the zone of increased permeability would likely be of limited extent. The effect on groundwater hydrology is discussed in section 3.10.4.2.1, *Evaluation through Operations Phases*.

The potential for chimney or trough subsidence would be largely a function of mine design and the condition of the rock surrounding the underground workings. MMC has proposed collecting additional underground geotechnical data as part of its Libby Adit evaluation program. The evaluation program would provide additional data to assess local ground conditions, subsidence potential, pillar sizing requirements to minimize the risk of trough subsidence, and the potential of fractures above the mine workings to affect groundwater.

3.14.3.1.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative and Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 3 and Alternative 4 would have the same risk of subsidence and are discussed together. MMC would undertake additional measures regarding pillar design, structural setting, interaction of mine voids and pillars in the two ore zones, and roof support analyses to finalize room and pillar dimensions and the ground support plan. MMC would use a minimum 0.8 pillar width to height ratio as a preliminary numeric criterion, to be finalized during later design efforts, and subject to KNF and DEQ approval. These measures are described under Alternative 3, section 2.5.2.6.4, *Final Underground Mine Design Process*. In addition, the agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring, described in Appendix C, coupled with final design criteria submitted for the agencies' approval, would minimize the risk of subsidence and associated effects on surface resources in the CMW.

Agapito Associates' back-analysis of pillar safety factors (Agapito Associates, Inc. 2014b) led to the development of three key mitigation measures designed to minimize subsidence risk:

- Use a variety of pillar strength estimation approaches such as Obert and Duvall (1967), Wilson (1972), Hedley and Grant (1972), Hardy and Agapito (1975), Bieniawski (1981), Stacey and Page (1986), Abel (1988), and Esterhuizen *et al.* (2008) to calculate pillar strength and corresponding factor of safety. This would allow the agencies to better evaluate the MMC design in relation to other standard approaches.
- Use a minimum 0.8 pillar width to height ratio as a preliminary numeric criterion (Agapito Associates, Inc. 2014b). Pillars with less than a 0.8 width to height ratio would require justification by MMC as to their stability.
- Explicitly assess sill pillar stability during all mine planning phases.

MMC would submit a final subsidence monitoring plan to the agencies for approval following the completion of the Libby Adit evaluation program. The most valuable geotechnical data are obtained during mining itself. A rock mechanics program that includes the agencies' mitigations on pillar design, structural geology, interaction between workings, and entry stability and support would reduce the potential for trough subsidence. A comprehensive underground drilling and mapping program would identify zones of structural weakness, such as faults, which could be avoided thereby reducing the potential for triggering a chimney type failure.

The KNF completed a FMEA of the Rock Creek Project underground mine, taking into account the Troy Mine experience, and developed mitigations as part of agency-modified alternatives (Agapito Associates, Inc. 2014a, 2014b). The KNF concluded for the Rock Creek Project that the risks of all failure modes identified during the FMEA for the underground mine, after applying compensating factors, were low or inconsequential. No high or moderate risk failure modes were identified. Because similar compensating factors considered in the FMEA of the Rock Creek

Project underground mine would be incorporated into the Montanore mine plan, the agencies concluded the risks of subsidence at Montanore also would be low or inconsequential. The plans and mitigations for Montanore are discussed in section 2.5.2.6.4 *Final Underground Mine Design Process*.

Effectiveness of Agencies' Proposed Mitigation Measures in Alternatives 3 and 4

The agencies' mitigation for subsidence, described in section 2.5.2.6.4, *Final Underground Mine Design Process*, the agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring, described in Appendix C, coupled with final design criteria submitted for the agencies' approval, would effectively minimize the risk of subsidence and associated effects on surface resources in the CMW. In addition to the agencies' mitigation measures and monitoring, MMC would fund and facilitate biannual surveys of the underground workings that would be completed by an independent qualified mine surveyor. MMC also would fund an independent technical advisor to assist the agencies in review of MMC's subsidence monitoring plan, underground rock mechanics data collection, and mine plan. Based on the agencies' mitigation and monitoring measures and funding of independent technical assistance during all phases of the project, the agencies conclude the risk of subsidence would be less than in Alternative 2.

3.14.3.2 Impoundment Stability

3.14.3.2.1 Alternative 1 – No Mine

The risk of an impoundment failure and associated impacts would not exist. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ's approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that do not affect National Forest System lands.

3.14.3.2.2 Alternative 2 – MMC's Proposed Mine and Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

The impoundment design in Alternative 2 would be the same as Alternative 4, and both alternatives are discussed together. Through the rest of this section, the impoundment design and analysis is referred to only as the Alternative 2 design or impoundment. In Alternatives 3 and 4, MMC would implement the final design process described in section 2.5.2.6, *Final Design Process*. Technical review of the final tailings facility design would be made by a technical advisory group established by the KNF described in the same section.

The tailings impoundment dam in all alternatives would be considered by the DNRC as a high-hazard dam. The DNRC classifies a dam as high-hazard if it impounds more 50 acre-feet and the DNRC determines that a loss of human life is likely to occur within the flooded area as a result of failure of the dam. The hazard classification is based on the potential loss of life downstream and is not an assessment of the safety of the structure. Dams under a DEQ Operating Permit are exempt from Montana's Dam Safety Act.

MMC used commonly accepted industry criteria and standards for dam design and construction for this point in the design process. The origin and basis of the criteria are founded in years of geotechnical engineering research, design, construction, and performance monitoring. These criteria are set and followed by the U.S. Corps of Engineers (2003) and U.S. Bureau of

Reclamation (1977) and serve as the design standards for State dam safety rules and regulations. The same standards also apply to soil and rock structures such as waste rock stockpiles, and cut and fill slopes.

Site Seismicity

The estimated Peak Ground Acceleration (PGA) of 0.22 g (Table 137) is sufficient to demonstrate the feasibility of providing dynamic stability in the layout and design of the tailings impoundment. The site seismicity would be re-evaluated during final design to ensure the estimated PGA is the most appropriate value for the Montanore site and for construction of a high-hazard dam. The PGA is the maximum rate of ground motion that will occur at a site. In MMC's analysis, PGA was based on occurrence of the maximum credible earthquake (Table 137).

Morrison-Knudsen Engineers completed the original seismicity assessment for the project in 1990 (Morrison-Knudsen Engineers 1990). Morrison-Knudsen Engineers' estimated PGA value was the median (middle) probabilistic value obtained from several procedures used to estimate

Table 138. MMC Design Criteria and Calculated Values for Factor of Safety for Alternatives 2 and 4 Impoundment.

Loading Condition	Standard	Minimum Allowable Design Value	Calculated Value
Static Loading Condition	Limit-Equilibrium Factor of Safety (FOS)	FOS = 1.5 For operations and closure. FOS = 1.3 For end-of-construction conditions†.	2.06 1.8
Maximum Credible Earthquake (MCE)	Limit-Equilibrium FOS (Pseudo-static)	FOS = 1.15 For operating and end-of-construction conditions†.	1.34 1.17
	Displacements Estimated by Pseudo-Static Stability Analyses	Horizontal displacement of dam toe = 10 feet. Vertical settlement at the ultimate dam crest limited to less than 3 feet to prevent release of tailings.	2.5 to 10 feet Not Available
Post-Earthquake	Limit Equilibrium Factor of Safety	FOS = 1.1 Using residual strength in liquefied tailings and glaciolacustrine clay.	1.18
	Dynamic Deformation Analysis	Assessment using Makdisi-Seed, and Hynes-Griffith and Franklin empirical methods, as cited in Klohn Crippen 2005.	2 to 10 feet (horizontal)

†End-of-construction stability generally refers to completion of a compacted earthfill dam, not a cycloned sand dam as construction would be ongoing. Values reported are for cyclone dam at end of 5 years of operation. End-of-construction FOS for the compacted starter dam and saddle dams are not available.
Source: Klohn Crippen 2005.

ground motion attenuation. In its update, Klohn Crippen confirmed the appropriateness of Morrison-Knudsen Engineers' PGA value. The estimated PGA value is based on a given probability that a seismic event of a certain magnitude would occur at the site. If the probability of occurrence is changed, a new PGA is determined at the site. Generally, a higher probability of occurrence of an earthquake along a given fault results in a lower magnitude of earthquake and a lower PGA at the site. A deterministic PGA value (a selected PGA value based on the upper range of estimated ground accelerations regardless of the probability (percent chance) of the event occurring and impacting the site) may be more appropriate for the Montanore tailings impoundment. This approach is consistent with seismic design guidelines for tailings dams (International Commission on Large Dams (1989) and the United States Committee on Large Dams (1999) (recommended design criteria by Klohn Crippen (2005)).

The design guidelines proposed by MMC (Klohn Crippen 2005) set the basis for a safe design and construction of the tailings impoundment. The references and agency guidelines cited by MMC, including the DNRC's dam safety regulations, do not provide specific standards with respect to seismic stability of large, high-hazard dams. The agencies' mitigation in Alternatives 3 and 4 would include incorporation of guidelines from other states, as appropriate, during final design.

Stability

MMC addressed the stability of the tailings impoundment dams through a series of minimum allowable safety factors against failure for static and dynamic loading conditions of the facilities (Klohn Crippen 2005). The factors of safety (FOS) for stability are summarized in Table 138. In addition, MMC completed a qualitative risk assessment of potential causes of failure of the tailings facility (Klohn Crippen 2005).

Included in the stability evaluation was a liquefaction analysis (the potential for a soil to act as a heavy fluid with little or no shear strength) to determine the locations of liquefiable or potentially liquefiable ground during the MCE of M7.0. The analysis was based on the number of hammer blows required to drive the soil sampler one foot (blow counts or 'n' values) obtained from Standard Penetration Tests (SPT) recorded during the different geotechnical work conducted in the Little Cherry Creek drainage basin. Under the Little Cherry Creek Tailings Impoundment Main Dam foundation area, the soils with SPTs that were found to indicate potentially liquefiable foundation materials are generally near the ground surface. The liquefaction assessment found that most of the foundation materials under the Alternative 2 tailings Main Dam are medium dense to dense. Only isolated pockets of material have the potential to liquefy during seismic loading with little or no impact on dam stability if left undisturbed during dam construction. Foundation materials under a portion of the Diversion Dam are loose to medium dense and could control the stability of the dam. The influence of the potential liquefaction zones was considered in the stability analyses for the Diversion Dam in Alternative 2 (Klohn Crippen 2005).

Liquefaction of the glaciolacustrine clay beneath the Main Dam foundation would be very unlikely due to the high fines content (*i.e.*, >30%), but could occur under the right conditions. Large seismic events can be expected to generate elevated pore pressures in the clay and could produce a short-term loss of strength following the seismic event (Klohn Crippen 2005). The location of a clay layer within the foundation beneath the right (south) abutment of the Starter Dam and its potentially low shear strength characteristics make the presence of the clay in the foundation a concern with respect to the design and stability of the tailings impoundment Main Dam. As a precaution, MMC proposes to remove a portion of the clayey material and backfill with compacted fill to act as a “shear key” for stability (Figure 9). A shear key is an area of backfilled and compacted material beneath a dam to enhance resistance against the dam sliding horizontally along a preferred plane and to increase the shear resistance of the material under the embankment thereby inhibiting the formation of a circle failure plane. Based on preliminary design, up to three shear keys may be required under the final dam footprint. The extent of the glaciolacustrine clay and its strength would be assessed during final design to determine how much of the material would be removed and to optimize the location and dimensions of shear keys. Similar materials have not been identified in the foundation of the Poorman tailings dam site, but geotechnical data are limited and would need to be expanded to confirm suitability of the dam foundation materials and stability of the dam.

The MCE earthquake estimated for the project site probably would not cause the tailings to liquefy and result in a catastrophic failure. As discussed in section 3.9, *Geology and Geochemistry*, the tailings at the proposed Montanore Mine are likely to be similar to the tailings at the Troy Mine. The tailings at Troy were found to be dilatant (Knight-Piesold and Co. 2007). A dilatant material (also termed shear thickening) is one in which viscosity (commonly perceived as “thickness,” or resistance to flow) increases with the rate of shear.

MMC’s design criteria (Table 138) outlined the stability evaluation techniques and set the target FOS values to be used. Operational performance and dam safety depend upon on the quality of the geotechnical data and the correct application and use of industry accepted design procedures to complete the design and estimate the FOS. For this reason, thorough geotechnical field studies and complete laboratory test programs are essential in achieving a safe dam structure. The more reliable the available data, the fewer and less conservative are the assumptions for unavailable or unknown design information. Data that is less reliable or available increase the assumptions and the conservatism required to achieve a safe design. Critical conditions have been evaluated and conservative assumptions have been made regarding foundation conditions and strength parameters. Based on the data presented by Klohn Crippen (2005), it has been demonstrated that a safe tailings dam structure could be constructed for Alternatives 2 and 4 with respect to meeting the minimum allowable FOS design criteria based on currently available data. Based on the stability analyses and estimated FOS values for the tailings impoundment dam, the Main Dam would be stable and not exhibit signs of distress or failure. The analyses presented by Klohn Crippen (2005) adequately demonstrate the feasibility of constructing, operating, and reclaiming a stable tailings dam under Alternative 2. Additional geotechnical field and laboratory tests would be needed to address assumptions made in the preliminary design and confirm the stability of the dam. In Alternative 4, the seismic design parameters would be re-evaluated using more current data and evaluation procedures, and the dynamic stability confirmed based on any revised parameters. In addition, circular failure plane assessments through the near-dam tailings and dam section and through the dam crest and slope would be completed during final design of the dam.

Tailings slurry deposition patterns used in operations of the impoundment can influence tailings facility stability: the impoundment capacity, and tailings particle size segregation, which can influence the tailings consolidation characteristics. These two issues are not high risk items and normally not an influence in demonstrating the feasibility of a project. For the Little Cherry Creek site, the issues become important due to limited space for dam expansion beyond that proposed. In addition, changes in dam height and dam configuration to increase the impoundment capacity would be critical as it affects other design issues, such as the material mass balance for the cyclone sand dam. Dam stability could be affected should additional dam height be required to store the tailings. Tailings deposition patterns and settled density would be re-evaluated during final design.

Perimeter discharge of tailings slurry, as planned by MMC, typically results in tailings surfaces sloped downward toward the interior of the impoundment area. This downward slope of the tailings away from the embankment crest reduces the available capacity at a given height compared to capacity calculated assuming level tailings deposition. The current height-volume relationship for the Alternative 2 tailings impoundment site is based on level tailings deposition in the impoundment, with some freeboard allowance for the slope of the tailings surface (Klohn Crippen 2007). The agencies' analysis indicates that the height of the dam necessary to achieve the required tailings capacity would need to be slightly higher than the crest elevation estimated by Klohn Crippen. This in turn would require a modification to the dam design and a re-evaluation of the dam stability. Final determination of the dam height versus impoundment capacity would be based on tailings deposition plans and the proposed final end-of-operation surface grading plan. The final dam height and dam configuration would be detailed during final design to confirm the appropriate dam height for use in the final stability analyses.

Tailings deposition patterns into the impoundment also influence the dam height and ultimate stability should the average settled density be less than estimated. Larger particles settle nearest the discharge point and finer particles settle farther out as the tailings slurry flows away from the discharge point. Long travel distances from the point of discharge often result in particle segregation within the tailings impoundment, which typically results in a tailings mass that exhibits lower average settled densities and consolidation characteristics from what was achieved during laboratory testing. Densities lower than estimated may require additional dam height to provide the same storage capacity. Lower tailings densities may also impact the dam stability analyses when considering stability of the upstream section of the dam crest.

In the 1992 Montanore Project Final EIS, artesian groundwater conditions beneath the Little Cherry Creek impoundment site were discussed. Artesian pressures at both impoundment sites (Little Cherry Creek and Poorman) were identified in some boreholes during the site investigations conducted by NMC (Morrison-Knudsen Engineers, Inc. 1990). NMC proposed to use a system of pressure relief wells to relieve artesian water pressures. In 1992, the agencies concluded an adequately designed pressure relief well system would relieve artesian pressure and ensure dam stability during all project phases. MMC reviewed the hydrogeology and assessed the potential effects of the artesian pressures on the dam stability (Klohn Crippen Berger Ltd. 2008), and concluded:

- The stability of the downstream slope of the dam is controlled primarily by the soft glaciolacustrine clay, and the strength of the clay is controlled by the undrained shear strength
- The proposed downstream slope of the dam is flatter than the original design by Morrison-Knudsen
- The impoundment design includes an extensive underdrain system, which would limit the transfer of hydraulic head from the impoundment into the foundation soils
- Existing artesian pressures are not expected to become significantly higher due to impoundment construction and the artesian pressures would not affect the failure mode, including a failure plane through the glaciolacustrine clay

- The dam would be raised in stages over the life of the mine and piezometric pressures in the foundation would be monitored

The agencies concurred with MMC's conclusions regarding artesian pressures based on available data. In addition, MMC would install pumpback recovery wells in Alternatives 3 and 4 to collect tailings seepage not intercepted by the Seepage Collection System. The pumpback recovery wells would be located beyond the dam toe, and would be designed to collect seepage not collected by the drain system. The pumpback well system would reduce artesian pressures beneath both impoundment sites in Alternatives 3 and 4. The foundation design would be confirmed as part of the final design studies.

Failure Modes Effects Analysis

In addition to completing stability analyses to verify that the design criteria FOS would be met for the tailings dam, MMC completed a qualitative risk assessment of the Little Cherry Creek impoundment using a modified FMEA process (Klohn Crippen 2005). The agencies updated the analysis in 2008 to include all project infrastructure in Alternatives 2 and 3 (Klohn Crippen Berger 2009). A FMEA is an engineering reliability technique used to systematically identify, characterize, and screen risks that derive from the failure of an engineered system to operate or perform as intended. The term "risk" encompasses the concepts of both the likelihood of failure (the expected frequency of failure), and the severity of the expected consequences if such events occurred. FMEA seeks to characterize risks in a systematic way and is intended to identify the main risks or failure modes (McLeod and Plewes 1999). Because predictive risk assessment involves foreseeing the future, it is an imprecise art (Robertson and Shaw 2003).

An assessment of likelihood and consequences of failure for construction, operations, and closure was made for each of the design and operational components. Five issues were included in the 2008 FMEA related to the tailings dam stability: 1) higher than predicted pore pressure in glaciolacustrine clays; 2) higher than predicted uplift groundwater pressure; 3) loose glacial outwash layer liquefying under seismic loading; 4) plugging of dam underdrains increasing pore pressures; and 5) plugging of impoundment underdrains increasing pore pressures(Klohn Crippen Berger 2009).

The FMEA was completed in a sequential manner by identifying the following:

1. Likelihood of failure quantified on a five-level scale based on an annual probability of failure/percent chance of occurrence (>50%, 10-50%, 1-10%, 0.1-1%, and <0.1%)
2. Consequences of failure ranked on a five-level scale (insignificant to catastrophic) for four areas (water quality, biophysical, community-social, and costs)
3. Level of confidence in the likelihood of failure and/or the consequences based on a three-level scale of high, moderate, and low
4. Compensating factors to reduce the risk for each failure mode and effect

The factors were compared and a Level of Risk was determined for each failure mode. The Level of Risk ranged from Level 5 (completely unacceptable) to Level <1 (lowest level of risk). Each Level of Risk was identified by a pairing of likelihood of an occurrence with consequences of the occurrence. As the Level of Risk decreased, the possibility of occurrence/outcome pairings that resulted in that Level of Risk increased, as summarized below.

- Risk Level 5 – A likelihood of "always certain" and "catastrophic" consequences
- Risk Level 4 – Likely occurrence and catastrophic consequences to always certain occurrence and major consequences
- Risk Level 3 – Possible occurrence and catastrophic consequences to always certain likelihood and moderate consequences
- Risk Level 2 – Unlikely occurrence and catastrophic consequences to always certain likelihood and minor consequences
- Risk Level 1 – Conceivable but improbable occurrence and catastrophic consequences always certain occurrence and insignificant consequences
- Risk Level <1 – Inconsequential risks

Of the failure modes evaluated in 2008 for the Little Cherry Creek impoundment, three were judged to have a risk level of 2, and the other modes had a risk level of 1 or less. The identified Level 2 risks and associated management strategies are shown in Table 139.

Table 139. Level 2 Risks of Little Cherry Creek Tailings Impoundment Site.

Risk	Management Strategy
Loose glacial outwash layer liquefies under seismic loading, leading to dam failure.	Dam design to assume that some material could liquefy. Additional site investigations would better define the spatial extent of any loose layers (see section 2.5.2.6, *Final Design Process*).
"Pervious" soil connection between tailings and bedrock aquifer. "Unknown" aquifer connection to former Little Cherry Creek.	Install pumpback wells to intercept seepage. Install wells downstream of tailings facility for monitoring seepage collection and groundwater quality. Analyze tailings water balance and track seepage return flow to estimate seepage discharging into groundwater (see section C.10.5.5, *Water Balance* in Appendix C).
Erosion due to extreme precipitation on closure.	Closure design to reduce risk of erosion with riprap in potential high flow areas. Long-term care and maintenance would provide for potential repairs after extreme events (see discussion of long-term site monitoring and maintenance in section 1.6.3.2.3, *Other Reclamation Costs*).

Source: Modified from Klohn Crippen Berger 2009.

3.14.3.2.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Stability

The lead agencies completed a stability evaluation of Alternative 3. The purpose was to confirm the feasibility to locate and design a stable Poorman Tailings Impoundment facility at a 120 million-ton capacity between Little Cherry and Poorman creeks.

Design criteria for minimum FOS values for static and dynamic loading conditions were the same as set for the Little Cherry Creek impoundment site. The PGA value used in the pseudo-static analysis was assumed to be the same as Alternative 2. The two sites (Alternatives 2 and 3) are adjacent to one another and based on limited drilling information from the Poorman site (Alternative 3) appear to have similar foundation conditions. In addition, Poorman site borrow soils and cyclone sand foundation materials were assumed to be similar to the Little Cherry Creek site materials; therefore, the Little Cherry Creek site strength parameters were used in the stability analysis. In some cases, lower values were used in the analysis as a degree of conservatism because site-specific data for the Poorman Impoundment site are limited and the impoundment would be a critical facility of the project. The strength parameters for the tailings were slightly increased to a friction (phi) value equal to 20° because Alternative 3 tailings would be deposited as a high-density slurry resulting in a denser (*i.e.*, higher strength) in-place product. Tailings placed as a high-density slurry generally show an increase in shear strength parameters over tailings placed at a lower slurry density (Klohn Crippen 2005).

The stability of the Alternative 3 tailings dam was evaluated using the slope stability computer program STABL developed at Purdue University. The use of the STABL program is widely accepted in the dam design/geotechnical industry as a suitable design tool, as is the Slope/W program used by Klohn Crippen for the Alternative 2 stability analysis. Both programs incorporate the same methods of analyses in estimating the FOS of a slope. Several commercial software programs that incorporate the STABL program are available. The commercially available software XSTABL 5.0 was used to facilitate data input and view plots of the most critical surfaces (lowest FOS) determined in the analyses. Potential failure surfaces were searched for within the downstream sections of the dam and tailings impoundment, and through the embankment crest and tailings on the upstream side of the dam. In addition, the stability of the tailings slope deposited from the back of the impoundment and above the dam crest elevation was checked to assess the feasibility of placing the tailings in such a configuration. Based on the results of the analyses, the Alternative 3 tailings facility can be designed as a safe and stable structure under both static and pseudo-static loading conditions. Table 140 presents a summary of the results.

Table 140. Calculated Values for Factor of Safety for Alternative 3 Impoundment.

Case	Static FOS	Pseudo-Static FOS	Post-Earthquake FOS
Average Strength Parameters			
Cyclone Sand Dam Minimum allowable FOS	1.9 (1.5)	1.4 (1.15)	1.4 (1.1)
Upper Tailings Slope Minimum allowable FOS	- (1.5)	1.8 (1.15)	2.7 (1.1)
Reduced Strength Parameters			
Cyclone Sand Dam Minimum allowable FOS	1.5 (1.5)	1.1 (1.15)	1.3 (1.1)
Upper Tailings Slope Minimum allowable FOS	5.4 (1.5)	1.5 (1.15)	1.8 (1.1)

Source: Glasgow Engineering 2008.

The tailings deposited from the back slope of the impoundment area and at an elevation above the constructed embankment crest elevation would create the most critical situation for instability in Alternative 3. This situation was evaluated in the stability analyses completed for Alternative 3 (Glasgow Engineering 2008). Based on the results of the analyses presented in Table 140, the proposed cyclone dam and tailings slope would be stable under static and pseudo-static loading conditions and post-earthquake strength reductions. In all but one case, the minimum FOS was met or exceeded in the analyses. The one case that did not meet the minimum was the pseudo-static analysis of the cyclone sand dam assuming reduced shear strength values. The estimated FOS was greater than 1.0 (*i.e.*, not indicating a likely slope failure), but was lower than the minimum allowable FOS. Impacts of failure of the tailings slope would be similar to liquefaction of the tailings slope as discussed in the following paragraph.

Liquefaction potential of the tailings slope deposited at the rear of the impoundment was not considered in the stability review, although recently deposited tailings are subject to liquefaction. The volume of the liquefied mass located at the rear of the impoundment is critical to impoundment stability only if the available storage volume within the impoundment at the dam crest elevation were less than the volume of the liquefied tailings *and* if all of these liquefied tailings were to move *en* masse as a uniform debris flow from the back of the impoundment, down into the impoundment area, and toward the dam. This would not be a critical issue until near the end of the Year 16 of operations. At the end of Year 16, mud wave action from the liquefied tailings and displacement of water stored in the impoundment could result in the overtopping of the embankment crest and possible breach of the dam. This potential for release of tailings from the impoundment may be the most critical situation related to Alternative 3. Such a failure mode has not been quantified but should be included in the final design of the facility. The primary mitigation measure would be increased dam freeboard above the storage level of the tailings. This situation would be most critical in the later years of operations, as it is possible that tailings would not be stored very far above the dam crest until after Year 10 of operations.

The issues of discharge patterns and tailings consolidation patterns related to the dam stability are less influential than as described under Alternative 2. The anticipated slope of the thickened tailings was considered in the conceptual layout of Alternative 3. Also, thickened tailings would not “flow” out into the impoundment in the same manner as slurried tailings. In-place particle segregation and changes in consolidation characteristics are typically not as critical with thickened tailings as with slurry.

Failure Modes Effects Analysis

The Poorman site has a very similar risk profile as the Little Cherry Creek site. Some of the risks differed because of use of more complex technology (thickened tailings), uncertainty of foundation conditions, and proximity to private land. Of the failure modes evaluated for the Poorman Impoundment, six were judged to have a risk level of 2, and the other modes had a risk level of 1 or less. The Level 2 risks identified for the Little Cherry Creek impoundment site would apply to the Poorman site. The additional Level 2 risks and associated management strategies identified for the Poorman Impoundment Site are shown in Table 141.

Table 141. Additional Level 2 Risks of Poorman Tailings Impoundment Site.

Risk	Management Strategy
Pore pressure in clay requires flatter slopes and less storage capacity.	Site investigation would be carried out (see 2.5.2.6, *Final Design Process*)
Foundation more permeable than predicted affects local landowner and require more seepage control.	Site investigations would be carried out and the design modified to reduce seepage. Groundwater monitoring wells and pumpback wells would be installed and monitored during the Construction, Operations, and Closure Phases.
Deposited densities less than predicted requiring more storage capacity.	Test tailings during final design process (see agencies' testing requirements in section 2.5.2.6, *Final Design Process*). Plant operations may require additional backup systems (see prior discussion in the *Operation Flexibility and Impoundment Expansion Potential* section.

Source: Modified from Klohn Crippen Berger 2009.
These risks are in addition to those presented for Little Cherry Creek in Table 139.

Effectiveness of Agencies' Proposed Mitigation Measures in Alternatives 3 and 4

Section 2.5.2.6, *Final Design Process* describes the process that MMC would use to complete final design of the tailings impoundment in Alternative 3. The design process would likely include a preliminary design phase and a final design phase. Site information would be collected during field studies during final design. The impoundment site in Alternative 4 likely has been sufficiently characterized and geotechnical field studies in Alternative 4 would be limit.

During final impoundment design in Alternatives 3 and 4, MMC would update the seismic stability analysis using the most recent attenuation relationships, update the pumpback well design and analysis, and avoid or minimize to the extent practicable filling waters of the U.S. or locating facilities in a floodplain. MMC would fund an independent technical review of the final design as determined by the lead agencies. Technical review of the final tailings facility design would be made by a technical advisory group established by the lead agencies. The tailings technical advisory group (TAG) would be comprised of agency experts in geotechnical, geochemical, and water quality issues related to current practices in the construction, operations, and closure of tailings facilities. The TAG would advise on the development of the quality assurance/quality control protocols for the tailings facility. The tailings TAG would also advise the lead agencies as to whether the environmental impacts associated with final design remained within the scope of those impacts identified in the Final EIS. The agencies' mitigation would be effective in ensuring the safe design and construction of a tailings impoundment that minimizes environmental impact.

3.14.3.3 Little Cherry Creek (Alternatives 2 and 4) and Poorman (Alternative 3) Tailings Site Comparison

This section presents a comparison of Little Cherry Creek (Alternatives 2 and 4) and Poorman (Alternative 3) tailings impoundment sites. The intent is to provide a summary of available data in each alternative in a comparative format. In general, the Poorman site was developed to avoid or minimize several environmental impacts of Alternative 2.

The primary technical difference in tailings disposal in Alternatives 2 and 3 is the method of tailings deposition used in each alternative. Alternative 2 is based on cyclone separation of the coarse fraction of the tailings for use in dam construction followed by slurry deposition of the finer fraction of the tailings into the impoundment area. Alternative 3 is based on cyclone separation of the coarse fraction of the tailings for use in dam construction as in Alternative 2, and then thickening of the retained finer grained portion of the tailings before deposition in the impoundment. The tailings would be thickened to increase the average in-place density of the tailings thereby reducing the required impoundment capacity.

The following sections present a comparison of the two alternatives based on data and information presented in Chapters 2 and 3, and MMC's Plan of Operations (MMI 2005a, MMC 2008). The comparison is divided in technical issues identified during the analysis process of the two alternatives. The data for each issue are presented in a summary format with brief discussions provided only as needed to clarify the comparison.

3.14.3.3.1 Site Capacity and Expansion Potential Tailings Deposition

Tailings Production

- Alternative 2 – Primary and secondary cyclone for sand generation and use in dam construction; 55 percent slurry density deposited into impoundment from primary cyclone overflow. Direct deposition of secondary cyclone overflow into the impoundment. Tailings surface slope at 1 to 1.5 percent average.
- Alternative 3 – Primary and secondary cyclone for sand generation and use in dam construction; thicken slurry density of primary and secondary cyclone overflow to a 70 percent slurry density at deposition into impoundment. Tailings surface slope at 3 to 5 percent.

120 million ton Capacity Requirement

- Alternative 2 impoundment capacity is reported by MMC as 115 to 120 million tons for a level tailings surface. Tailings discharge patterns into the impoundment have not been configured for a sloped tailings surface and is subject to reduction of total capacity at the proposed dam crest elevation. The net capacity has not been confirmed at 120 million tons.
- Alternative 2 Tailings Deposition – Slurry tailings at 55 percent solids by weight with an average density at the end of operation of 75 pcf (pounds per cubic foot). Deposition of thickened tailings was not considered necessary unless final design studies showed higher density tailings were required to maintain the proposed dam and impoundment footprint.
- Alternative 3 capacity is 120 million tons with thickened tailings deposition from a higher elevation along the back of the impoundment and a sloped tailings surface.
- Alternative 3 Tailings Deposition – Thickened tailings at 70 percent solids by weight with an average settled density of 85 pcf. Deposition of slurry tailings at 55 percent solids by weight was not considered practical as the tailings volume corresponding to this density would require an additional 15 feet of dam height. The ability to achieve these densities is discussed in the following *Operation Flexibility and Impoundment Expansion Potential* section.

Dam Construction

- Alternative 2 – Requires a Starter Dam, a North Saddle Dam, a ridge line South Saddle Dam later raised with cyclone sand, and a Main Dam constructed with cyclone sand (Figure 8).
- Alternative 3 – Requires a Starter Dam, a Rock Toe Berm to anchor toe area of main sand dam, an earthfill Saddle Dam, and a Main Dam constructed with cyclone sand (Figure 25).

Foundation Conditions and Borrow Material

- Alternative 2 – Foundation conditions generally good except that glaciolacustrine clay in Main Dam foundation potentially affects dam design. A portion of the clay would be excavated and backfilled with compacted fill to act as a shear key for stability. High groundwater level in Main Dam area. Sufficient borrow materials available within facility footprint and adjacent areas. Granular materials available through commercial sources. The volume of cyclone sand available for dam construction per year based on yearly production rates versus required volume of sand to raise the dam annually to maintain adequate storage capacity in the impoundment area has not been generated to date by MMC.
- Alternative 3 – Foundation conditions generally good and similar to Alternative 2. Glaciolacustrine clay may not be present in foundation; additional geotechnical investigations would be required. High groundwater level in Main Dam area. Sufficient borrow materials available within facility footprint and adjacent areas. Granular materials available through commercial sources. The volume of cyclone sand available for dam construction per year based on yearly production rates would meet required volume of sand to raise the dam annually to maintain adequate storage capacity in the impoundment area based on the proposed dam layout and impoundments operations. The annual dam volumes were interpolated from dam sections generated from raises at 40-foot height increments.

Seepage Control

- Alternative 2 – Seepage control in Alternative 2 would be provided primarily by collection drains in the impoundment and the dam foundation. The estimated seepage loss to groundwater is 25 gpm into the foundation footprint. Additional design components to reduce seepage losses would include an increased density of the impoundment drainage system, a pumpback well system between the dam and Seepage Collection Pond, or a deeper cutoff trench below the starter dam and under the saddle dams. Seepage interception would be facilitated by the cross-valley dam design. Seepage interception would be more difficult south of the South Saddle Dam, which would be immediately adjacent to the Diversion Channel. A coarse-textured paleochannel under the impoundment may capture and transmit more tailings water seepage than modeled in the seepage analysis.
- Alternative 3 – Seepage control in Alternative 3 would be similar to the Alternative 2 design for seepage control. It is assumed that the average seepage loss would be about 25 gpm as in Alternative 2. The potential for additional seepage control is similar to Alternative 2 and would employ the same alternatives. Due to the wide footprint of the dam face the Poorman Impoundment Site would require a more extensive seepage collection system. In addition, there would be less room downstream of the dam footprint to install a pumpback well system or other seepage interception systems between the dam toe and private property not owned by MMC.

Operation Flexibility and Impoundment Expansion Potential

- Alternative 2 – Upsets in daily operations such as pump failures and surges in the tailings system could likely be handled or accommodated without problems or threat of breach because of excess storage capacity in the tailings impoundment, and options for redirecting water and/or tailings to other storage facilities. An operating plan would address occurrences such as excess water build up or reduction in available cyclone sand. Generation of tailings slurry at 55 percent by weight is a commonly achieved density for tailings using the milling process proposed for Montanore. Less dense slurry deposition could occur due to improper design of the thickener or pumping system, temporary upsets in operations or improper operation practices. Such upsets are expected to be infrequent and short-term and should not affect the operation (water balance and storage capacity) of the impoundment. If extra impoundment capacity were needed, expansion of impoundment capacity beyond the proposed layout would require modifications in the design and construction of the dam crest. The perimeter area for extending the toe of the dam and continuing raises per design to increase capacity is very limited beyond the proposed footprint. Potential alternatives for dam crest raises would include over-steepening the downstream slope in subsequent raises or designing a modified upstream raise of the crest.
- Alternative 3 – Upsets in the tailings thickeners and in daily operations would require an operating plan to accommodate short periods of conventional (less dense) slurried tailings deposition within the impoundment. Such occurrences could be handled and include short-term increases in the amount of water sent to the impoundment with the tailings. The system required to thicken fine tailings to a slurry density of 75 percent has not been determined, but currently available thickening systems have achieved this density. The Montanore ore body consists of hard, unaltered rock that would be crushed to a fine-grained non-plastic material, which is generally amendable to thickening without the use of filters. The thickening system best suited for Montanore tailings would be determined before final design of the site was initiated. Once a system was determined feasible, the potential for upsets would be minimized and limited to infrequent and short-lived upsets as in Alternative 2. In the event it is demonstrated that the tailings could not be thickened in a reasonable manner, the suitability of Alternative 3 tailings facility would have to be re-evaluated and compared to Alternative 2. Expansion of impoundment capacity beyond the proposed layout would require modifications in the original design or in the design and construction of the dam crest sometime after operations began. The perimeter area for extending the toe of the dam and continuing raises per design to increase capacity is limited beyond the proposed footprint. Potential alternatives for dam crest raises would include over-steepening the downstream slope in subsequent raises or designing a modified upstream raise of the crest. Depending upon the characteristics of the thickened tailings, upstream deposition patterns and discharge elevations could also be modified to increase storage capacity.

Based on these comparisons, both alternatives have equally positive as well as limiting attributes and characteristics. The single significant difference between the two alternatives appears to be the ability to deposit the finer fraction of the tailings as a slurry at 55 percent solids by weight in Alternative 2 versus the likely necessity to deposit the tailings as a thickened tailings at 75 percent solids by weight in Alternative 3. This is due to limits on the available impoundment footprint area at the Poorman Creek site. A secondary difference is that the storage capacity in Alternative 2 has not been confirmed relative to deposition patterns and the preferred tailings surface configuration at closure. The impoundment capacity in Alternative 3 was based on specific deposition patterns and a defined final tailings surface configuration. Another secondary difference between the alternatives is the potential for additional seepage control once in operation. Alternative 2 site conditions are likely better suited for the installation of remedial mechanisms or facilities for seepage control and collection than in Alternative 3 because of there being more room available for the installation of collections systems downgradient of the embankment toe. Additional design studies are required for both alternatives before identifying a preferred alternative based on technical comparisons such as those presented above. The difference in expansion potential for the two sites is negligible, based on the available data and site layouts.

3.14.3.4 Cumulative Effects

None of the reasonably foreseeable future actions would result in cumulative effects of subsidence risk or impoundment stability with the Montanore Project.

3.14.3.5 Regulatory/Forest Plan Consistency

The 2015 KFP does not have specific goals, objectives, and standards for subsidence and impoundment stability. It includes desired conditions, standards, and guidelines for the CMW. Goals can be found in the CMW Management Plan (2009). All mine alternatives have the potential to indirectly affect wilderness qualities. Mitigation measures identified in Chapter 2 for Alternatives 3 and 4 and monitoring required for Alternatives 3 and 4 (Appendix C) would be implemented to minimize changes in wilderness character. In Alternatives 3 and 4, potential subsidence affecting wilderness lakes and wilderness character would be minimized by the agencies' mitigation described in section 2.5.2.6.4, *Final Underground Mine Design Process*. Key mitigation measures include:

- Completing pre-mine surficial topographic survey and geologic mapping of lands overlying the mine area to identify structures that could affect subsidence potential;
- Using a variety of pillar strength estimation approaches to calculate pillar strength and corresponding factor of safety; using a minimum 0.8 pillar width to height ratio as a preliminary numeric criterion and providing a justification for pillars with less than a 0.8 width to height ratio as to their stability;
- Explicitly assessing pillar stability during all mine planning phases; identifying two barrier pillars 20 feet wide across the width of the ore body that would be left in place (except for openings needed for access) during the first 5 years of mining until additional refinement of the hydrologic model was completed and the need for barrier pillars was evaluated;
- Maintaining at least a 1,000-foot buffer from Rock Lake and a 300-foot buffer from the Rock Lake Fault;
- Maintaining during mining a 100-foot buffer from identified faults;
- Keeping the size and number of drives through the identified faults to the minimum necessary to achieve safe and efficient access across the fault; and
- Explicitly stating that no secondary mining (reduction in pillar width or length, or increase in pillar height from designed final dimensions) would be allowed.

Mitigation measures and monitoring requirements in Alternatives 3 and 4 are reasonable stipulations for protection of the wilderness character and are consistent with the use of the land for mineral development. Alternatives 3 and 4 would be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness, and to preserve the wilderness character consistent with the use of the land for mineral development and production in compliance with 36 CFR 228.15 and the Wilderness Act. The agencies' mine and transmission line alternatives would comply with the Wilderness Act. Alternatives 3 and 4 would minimize adverse environmental impacts on surface resources within the wilderness, and thereby comply with the regulations (36 CFR 228, Subpart A) for locatable mineral operations on National Forest System lands.

3.14.3.6 Irreversible and Irretrievable Commitments

This section is not applicable to geotechnical engineering.

3.14.3.7 Short-term Uses and Long-term Productivity

This section is not applicable to geotechnical engineering.

3.14.3.8 Unavoidable Adverse Environmental Effects

Some roof failure would occur in all action alternatives.

3.15 Land Use

3.15.1 Regulatory Framework

3.15.1.1 Kootenai Forest Plan

The 2015 KFP describes desired conditions, objectives, standards, guidelines, and land suitability for project and activity decision making on the KNF, guiding all resource management activity (USDA Forest Service 2015c). This direction applies either forestwide or specific to management or geographic area allocations. MMC's proposal for the Montanore Project and the agencies' alternatives were originally developed under the 1987 KFP; in this Final EIS, each alternative has been evaluated in light of the management direction in the 2015 KFP.

3.15.1.2 Montana Fish, Wildlife, and Parks/Plum Creek Conservation Easement

The FWP holds a conservation easement on some lands owned by Plum Creek where the transmission line may be located. Under the terms of the conservation easement, the FWP has reserved the right to prevent any inconsistent activity on or use of the land by Plum Creek or other owners and to require the restoration of any areas or features of the land damaged by such activity or use. Activities and uses prohibited or restricted include installing any natural gas or other pipelines or power transmission lines greater than 25-kV unless the prior written approval is given by the FWP.

3.15.1.3 Local Plans

Unincorporated Lincoln County has no comprehensive or general plan, zoning regulations, or growth policies.

3.15.2 Analysis Area and Methods

3.15.2.1 Analysis Area

The analysis area for direct, indirect, and cumulative effects on land use encompasses an area with a 2,000-foot buffer surrounding project facilities: along the Bear Creek Road south from US 2, the proposed permit boundary areas for the mine facilities, the area crossed by the four transmission line alternatives and associated access roads, and the Sedlak Park Substation site and loop line area (Figure 78).

3.15.2.2 Methods

MMC's mine permit application (MMI 2005a, MMC 2008) contained information about land use in the mine area. In 2005, MMC completed a land use inventory for the transmission line corridors that MMC analyzed by reviewing, refining, and updating existing data (Power Engineers 2005c). The KNF provided digital data on the distribution of the 2015 KFP's MAs on National Forest System lands.

The effects analysis assessed how the transmission line and mine facilities may alter existing land uses on both private and public lands within the land use analysis area. The changes in land use in the mine area were calculated based on the acreage of each permit area, and a 100-foot wide road corridor along the Bear Creek Road (NFS road #278), which is outside of a permit area.

The 2015 KFP does not identify any corridor avoidance areas, nor does it allocate a specific MA for transmission corridors. The plan identifies, at a programmatic level, existing and anticipated utility corridors. The Montanore utility corridor is described and a general location is identified in Appendix D of the 2015 KFP with final approval subject to the site-specific NEPA as is provided in this Final EIS.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on land use in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.15.3 Affected Environment

The KNF manages most lands in the land use analysis area (Figure 78), encompassing a total of 13,235 acres in the mine analysis area, and 14,010 acres in the transmission line analysis area. Private land occurs along Libby Creek, Little Cherry Creek, Miller Creek, West Fisher Creek, and Fisher River. Mine facilities associated with the Montanore Project would be developed on patented mining claims and on unpatented mining claims on National Forest System lands under KNF's management. The KNF manages public land for multiple use benefits, including wood products, recreation, range, wildlife, mineral development, and wilderness. Forest industry land is primarily managed for wood products, and private lands are managed to satisfy individual landowner objectives. Plum Creek, Libby Placer Mining Company, or MMC own most of private lands in the land use analysis area. Plum Creek and other property owners own land along the transmission line corridors; Plum Creek also owns the land proposed for the Sedlak Park Substation and loop line; Libby Placer Mining Company and MMC own land near the proposed mine facilities (Figure 78). Private land within the analysis area includes 446 acres owned by MMC, 5,399 acres owned by Plum Creek, and 4,151 acres owned by other private entities.

The National Forest System lands of the Libby Ranger District provide about 6 to 8 million board feet (mmbf) of timber annually. As discussed in section 3.3, *Reasonably Foreseeable Future Actions or Conditions*, the KNF completed an EIS on the Miller-West Fisher Vegetation Management Project in the land use analysis area. Timber harvest activity also occurs on private, forest-industry lands. The amount of timber harvested has declined in the past 10 years. Small-scale timber harvests occur in the range of 2 to 6 mmbf annually on the private lands in the land use analysis area. Plum Creek has harvested several tracts of private, forest-industry lands on lower Miller Creek and along the Fisher River.

One parcel of State land would be crossed by the West Fisher Creek transmission line alignment. The DNRC manages the surface and mineral resources for the benefit of the common schools and six administrative land offices, under the direction of the State Board of Land Commissioners. The DNRC's obligation for management and administration of Trust Land is to obtain the greatest benefit for the beneficiaries. The greatest monetary return must be weighed against the long-term productivity of the land to ensure continued future returns to the trusts. The Northwestern Land Office of the DNRC facilitates local management of the State lands within the land use analysis area. Hunting also occurs on State land (Power Engineers 2005c).

Some mineral activity currently occurs in the land use analysis area, including small placer operations on Libby and Big Cherry creeks, and small lode mining operations along Libby Creek. A number of mineral operators do some form of mine development work along the east face of the Cabinet Mountains each year. The DEQ permitted three small sand and gravel operations within the land use analysis area. One electrical transmission line is located in the land use analysis area. The BPA currently operates the Noxon-Libby 230-kV transmission line near the proposed Sedlak Park Substation. No pipelines 8 inches or greater in diameter occur within 1 mile of the transmission line alternatives. Four Montana Department of Agriculture registered general (commercial) apiaries are located in the land use analysis area. Commercial apiaries are used for honey production and/or pollination. General (commercial) apiary registrations are apiaries placed by permission on someone's property and contain more than five hives.

3.15.3.1 Private Lands

Southern Lincoln County is a rural area with no major population centers. Large-lot residential properties, ranches, and cabins are found along US 2 near Libby Creek Road (NFS road #231), Bear Creek Road (NFS road # 278), the Fisher River, and Pleasant Valley. The City of Libby is along the Kootenai River about 15 miles north of the land use analysis area. Twenty residences are within 1 mile of the four transmission line alternatives. Most of these properties are within 0.5 mile of US 2 (Figure 79). No platted subdivisions are within 1 mile of the transmission line alternatives. The Libby Adit Site and portions of the Little Cherry Creek Impoundment Site are private lands owned by MMC.

In 2003, Plum Creek sold a conservation easement to the FWP on 142,000 acres in northwest Montana, some of it (3,658 acres) within the land use analysis area (Figure 78). The land covered by the Thompson-Fisher conservation easement offers opportunities for the continuation of forest and resource management, commercial timber harvesting and other commodity use, recreational characteristics, and open space, all of which provide fish and wildlife habitat. The conservation easement was partially funded by the Forest Legacy Program for the purpose of preventing the land from being converted to non-forest uses. One of the stated purposes of the conservation easement is to "preserve and protect in perpetuity the right to practice commercial forest and resource management." The conservation easement was mapped and reviewed during the transmission line screening analysis process (ERO Resources Corp. 2006b).

Plum Creek lands not covered by the conservation easement are currently managed the same as easement lands (*i.e.*, timber harvest and other commodity use, recreation, and wildlife habitat). Because these lands are not subject to the conservation easement, future land uses by Plum Creek or subsequent owners could change to include activities prohibited by the easement (Parker, pers. comm. 2008).

3.15.3.2 Kootenai National Forest Land Management Plan

Land management direction of the KNF is described in the following sections. The 2015 KFP provides a framework and text that guides resource management. It describes goals, desired conditions, objectives, standards, guidelines, and suitability for various resources including recreation, wildlife and fish, vegetation, soils, water, and air resources, minerals and geology, and land use. This direction applies at three scales, either forestwide, or within specific management or geographic areas. Only National Forest System lands are managed by the 2015 KFP. The 2015 KFP does not change existing authorized uses.

3.15.3.2.1 Forestwide Goals, Desired Conditions, Objectives, Standards, Guidelines, and Suitability

Goals

Goals are concise statements that describe an overall desired condition the Forest will strive to achieve. It is normally expressed in broad, general terms and is timeless in that it has no specific date by which it is to be accomplished. Goal statements form the principal basis from which objectives are developed (36 CFR 219.3). There are no mineral-specific goals in the 2015 KFP.

Desired Conditions

Desired conditions are the social, economic, and ecological attributes that will be used to guide management of the land and resources of the Plan area. Desired conditions are not commitments or final decisions approving projects and activities. The desired condition for some resources may currently exist, or for other resources may only be achievable over a long time period. The 2015 KFP includes a desired condition for "the forest continues to contribute to the economic strength and demands of the nation by supplying mineral and energy resources while assuring that the sustainability and resiliency of other resources are not compromised or degraded. " (FW-DC-MIN-01).

Standards

Standards are a limitation or requirement that is applied to project and activity decision making to help achieve goals and objectives. Standards can be developed for forestwide application or for specific areas and may be applied to all management activities or selected activities. The 2015 KFP includes one -forestwide standard related to locatable minerals (FW-STD-01)—that locatable mineral development is not allowed in areas withdrawn from mineral entry. This standard does not apply because valid existing rights were established prior to the CMW being withdrawn from mineral entry. In addition, the retained INFS (USDA Forest Service 1995a) includes three mineral-related standards and guidelines that the 2015 KFP considers KFP standards. These are MM-3 regarding solid and sanitary facility locations, MM-4—a leasable minerals standard not applicable to the Montanore Project, and MM-5—a mineral materials standard not applicable to the Montanore Project.

Guidelines

Guidelines are an operational practice and procedure that is applied to project and activity decision making to achieve goals, desired conditions, and objectives. Guidelines can be developed for forestwide application or for specific areas and may be applied to all management activities or selected activities. For all other minerals management direction in the retained INFS other than the three standards discussed above, the 2015 KFP considers the direction as guidelines (MM-1, MM-2, and MM-6). These are minimizing adverse effects to inland native fish species (MM-1), to locate and construct structures, support facilities, and minerals-related roads outside of RHCAs (MM-2), and to develop inspection, monitoring, and reporting requirements for mineral activities (MM-6).

3.15.3.2.2 Management Area Goals and Standards

In addition to forestwide goals, desired conditions, standards, and guidelines, the 2015 KFP includes geographic area- and management area-specific desired conditions and guidelines. MMC's proposed mine facilities and transmission line would be in the Libby Geographic Area, MA 6–General Forest, and MA 5b-Backcountry Motorized Year-round. The surface facilities associated with the agencies' alternatives would be in the MA 6 and MA 5b. MA 5b consists of relatively large areas generally without roads and provides a variety of motorized and non-motorized recreation opportunities. MA 6 consists of relatively large areas with roads, trails, and structures, as well as sign of past and ongoing activities designed to actively manage the forest vegetation. Because the 44 acres of MA 5b affected by Alternative 2 would be within an IRA, the access direction is that road construction and reconstruction follow direction found in the 2001 Roadless Rule (USDA Forest Service 2001). The 2015 KFP has no specific locatable minerals direction for MA 5b or MA 6, but management direction in the 2015 KFP as a whole is subject to valid existing rights and defers to overarching applicable laws and regulations.

3.15.4 Environmental Consequences

3.15.4.1 Alternative 1 – No Mine

The changes in land use associated with a mine would not occur. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ's approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Disturbances on private land at the Libby Adit Site would remain until reclaimed in accordance with existing permits and approvals. Use of National Forest System lands would continue to be managed in accordance with the 2015 KFP. Existing land use of private land in the Little Cherry Creek Tailings Impoundment Site and along the Bear Creek Road (NFS road #278) would continue.

3.15.4.2 Alternative 2 – MMC's Proposed Mine

Most of the proposed mine facilities would be on National Forest System lands. Most of the lands would be within MA 6–General Forest. The Ramsey Creek Plant Site and access road would disturb 122 acres within MA 5b–Backcountry Motorized Year-round in upper Ramsey Creek; 44 of these acres would be within an IRA. During the life of the operation, use of the lands within the permit areas would be devoted to mining and associated activities. The operating permit area and the disturbance along the Bear Creek access road (NFS road #278) would total 3,628 acres; about 2,582 acres would be disturbed. Adjacent land use during the operation would be affected to some extent; these impacts are described in other sections on recreation, noise, scenic resources, and wildlife. Disturbance at the Libby Adit Site, Rock Lake Ventilation Adit Site, and portions of the Little Cherry Creek Impoundment Site (286 acres) are private lands owned by MMC (Table 142). LAD Area 2 would be immediately adjacent to private land along Libby Creek (Figure 78). Disturbance associated with the Little Cherry Creek Impoundment Site and LAD Area 2 may result in indirect effects on adjacent private lands. These effects on air quality, aquatic life and fisheries, surface water hydrology, scenery, and sound are discussed in greater detail in sections 3.4.4, 3.6.4, 3.11.4, 3.17.4, and 3.20.4. Widening of the Bear Creek Road would affect about 9 acres of private land in three separate parcels between 1 and 3 miles south of the road's intersection with US 2.

MMC would purchase 2,758 acres of private lands to mitigate for habitat losses not offset by KNF's road access changes. In some instances, MMC may purchase a conservation easement with fee title remaining with the private party. The conveyance of title or a conservation easement

Table 142. Summary of Land Ownership and Disturbance Areas for each Mine Alternative.

Ownership	Alternative 2 – MMC's Proposed Mine	Alternative 3 – Agency Mitigated Poorman Impoundment Alternative	Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative
National Forest System Land	2,288	1,549	1,639
MMC Owned	286	16	276
Other Private	9	9	9
Total	2,582	1,565	1,924

All units are in acres.

Source: GIS analysis by ERO Resources Corp. using KNF data.

on private land would restrict future residential and commercial development on 2,758 acres of private lands.

All lands disturbed by the project would be revegetated and, except for the Bear Creek Road and the tailings impoundment facilities, would return to pre-mine uses and productivity over time. The Bear Creek Road from US 2 to the Bear Creek Bridge would not be restored to its narrower pre-mining width. Successful reclamation would result in reforestation of disturbed lands. The goal of reclamation would be to restore lands to productive use. The Little Cherry Creek Tailings Impoundment and the upper part of the Diversion Channel would not support pre-mining timber production. The disturbance associated with the Bear Creek Road widening also would not support pre-mining timber production.

3.15.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Like Alternative 2, most of the proposed mine facilities would be on National Forest System lands Most of the lands are within MA 6-General Forest, with 43 acres in MA 5b-Backcountry Motorized Year-round. During the life of the operation, use of the lands within the permit areas would be devoted to mining and associated activities. The operating permitted area and the disturbance along the Bear Creek access road (NFS road #278) would total 2,157 acres; about 1,565 acres would be disturbed (Table 142). Effects of Alternative 3 would be similar to Alternative 2. The Libby Adit Site is private land owned by MMC. The Poorman Impoundment Site would be immediately west of private land along Libby Creek, with the same indirect effects on adjacent private land as Alternative 2. Effects of widening of the Bear Creek Road would be the same as Alternative 2.

MMC would acquire or place a conservation easement on 5,387 acres of private land for grizzly bear mitigation in Alternative 3. MMC also would convey land used for isolated wetland mitigation along Little Cherry Creek to the Forest Service. The conveyance of title or a conservation easement on private land would restrict future residential and commercial development on these lands.

All lands disturbed by the project would be revegetated and, except for the Bear Creek Road and the tailings impoundment facilities, would return to pre-mine uses and productivity over time.

The Poorman Tailings Impoundment and the disturbance associated with the Bear Creek Road widening would not support pre-mining timber production.

3.15.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Like the other alternatives, most of the proposed mine facilities would be on National Forest System lands. Most of the lands are within MA 6-General Forest, with 43 acres in MA 5b-Backcounrty Motorized Year-round. Management emphasis of the permit area of other facilities is mineral development, recreation, and commercial timber production. During the life of the operation, use of the lands within the permit areas would be devoted to mining and associated activities. The permitted area and the disturbance along the Bear Creek access road (NFS road #278) would total 2,979 acres; about 1,924 acres would be disturbed (Table 142). Effects of Alternative 4 would be similar to Alternative 2. Land use of MMC's private land at the Libby Adit Site, Rock Lake Ventilation Adit Site, and the Little Cherry Creek Impoundment Site would be the same as Alternative 2. Indirect effects of the Little Cherry Creek Impoundment Site on adjacent private land, and the effects of widening of the Bear Creek Road would be the same as Alternative 2.

MMC would acquire or place a conservation easement on 6,151 acres of private land for grizzly bear mitigation in Alternative 4. The conveyance of isolated wetland mitigation lands would be the same as Alternative 3. The conveyance of title or a conservation easement on private land would restrict future residential and commercial development on these lands.

All lands disturbed by the project would be revegetated and, except for the Bear Creek Road and the tailings impoundment facilities, would return to pre-mine uses and productivity over time. The Little Cherry Creek Tailings Impoundment, upper part of the Diversion Channel, and the disturbance associated with the Bear Creek Road widening would not support pre-mining timber production.

3.15.4.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, Sedlak Park Substation, and the loop line for the Montanore Project would not be built. No changes in land use in Alternative A would occur. Use of National Forest System lands would continue to be managed in accordance with the 2015 KFP. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Existing land use of State land along West Fisher Creek, Plum Creek lands, and private land along US 2 and at scattered parcels in the Miller Creek, West Fisher Creek, and Standard Creek drainages would continue.

3.15.4.6 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

In the North Miller Creek Alternative, the alignment would cross Plum Creek land in the Fisher River valley and in three sections immediately west of the Fisher River (Figure 78). These segments would parallel existing road corridors (roads on Plum Creek lands, US 2 and NFS road #385). Alternatives B through E-R would use or parallel existing road corridors, including open, gated, barriered, or impassable roads. The North Miller Creek Alternative would have 5.1 miles of centerline within 100 feet of an existing road (Table 143).

Table 143. Use of Existing Road Corridors.

Alternative	Miles of Centerline within 100 Feet of Existing Road Corridors
Alternative B – North Miller Creek Alternative	5.1
Alternative C-R – Modified North Miller Creek	3.8
Alternative D-R – Miller Creek	3.6
Alternative E-R – West Fisher Creek	5.9

Source: GIS analysis by ERO Resources Corp. using KNF data.

All transmission line alternatives would include the Sedlak Park Substation and loop line (steel monopoles would be used). The Sedlak Park Substation and loop line would affect 4.4 acres of Plum Creek land, all of which are covered by the conservation easement. About 7.2 miles of Plum Creek land would be crossed, 5.4 miles of which are covered by the conservation easement with FWP. Two sections of Plum Creek land west of the Fisher River not covered by the conservation easement with FWP would be crossed. Clearing of up to 129 acres of Plum Creek land, which is compatible with Plum Creek's land management, would be needed for the transmission line (Table 144). About 10 acres of additional clearing would be needed for access road construction on private land (Table 145). Following construction, the transmission line could restrict cable logging in areas adjacent to the line. Plum Creek land is managed primarily for timber production; some dispersed recreation also occurs on Plum Creek land. This alternative would cross less than 0.1 mile of other private land near the Fisher River.

Table 144. Summary of Land Ownership within Clearing Areas for each Transmission Line Alternative.

Ownership	Alternative B – North Miller Creek		Alternative C-R – Modified North Miller Creek		Alternative D-R – Miller Creek		Alternative E-R – West Fisher Creek	
	(ac.)†	(mi.)	(ac.)	(mi.)	(ac.)	(mi.)	(ac.)	(mi.)
National Forest System Land	168	9.3	206	8.5	220	9.1	200	8.3
State of Montana	0	0.0	6	0.2	6	0.2	25	1.1
Plum Creek (with conservation easement)	97	5.4	86	3.6	86	3.6	89	3.7
Other Plum Creek	32	1.8	19	0.8	19	0.8	49	2.0
Other Private	1	<0.1	0	0.0	0	0.0	0	0.0
Total	297	16.4	317	13.1	331	13.7	363	15.1

All values are in acres.
†Acreage is based on a 150-foot clearing width for monopoles (Alternative B) and 200-foot width for H-frame structures (other alternatives except for a short segment of the West Fisher Creek Alternative that has monopoles). Actual acreage cleared would be less than listed and would depend on tree height, slope, and line clearance above the ground.
Totals may vary slightly due to rounding.
Source: GIS analysis by ERO Resources Corp. using KNF data.

Table 145. Estimated Road Construction or Reconstruction in Each Transmission Line Alternative.

MA Direction on Road Development†	Alternative B – North Miller Creek		Alternative C-R – Modified North Miller Creek		Alternative D-R – Miller Creek		Alternative E-R – West Fisher Creek	
	(ac.)	(mi.)	(ac.)	(mi.)	(ac.)	(mi.)	(ac.)	(mi.)
National Forest System Lands - Road Construction Allowed (MA 6)	18.8	6.2	4.4	1.4	10.5	3.4	6.3	2.1
National Forest System Lands - Road Construction Restricted (MA5b)	2.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0
State Lands	0.0	0.0	0.5	0.2	0.5	0.2	0.4	0.2
Private Lands	10.0	3.3	4.5	1.5	4.5	1.5	5.0	1.6
Total	30.9	10.2	9.4	3.1	15.5	5.1	11.7	3.9

New roads and roads with extensive requirements for upgrading are assumed to be 25 feet wide. Values are rounded to the nearest 0.1 acre and mile, and conversion between the two may vary due to rounding.
Source: GIS analysis by ERO Resources Corp. using KNF data.

MMC would purchase 68 acres of private lands to mitigate for habitat losses not offset by KNF's road access changes. In some instances, MMC may purchase a conservation easement with fee title remaining with the private party. The conveyance of title or a conservation easement on private land would restrict future residential and commercial development on 68 acres of private lands.

Alternative B would remove 104 acres of timber production on lands covered by FWP's conservation easement. MMC did not propose to mitigate for this loss of timber production.

The remaining 9.3 miles of North Miller Creek Alternative would be on National Forest System lands managed by the KNF. Fourteen residences are within 0.5 mile of this alignment (Figure 79), 11 of which are greater than 450 feet from the centerline of the right-of-way and the remaining three are within 450 feet. About 1,760 feet of this alternative would pass through the Libby Creek Recreational Gold Panning Area. Alternative B would require tree clearing on 40 acres in MA 5b.

All transmission line alternatives would require construction of between 3 and 10 miles of new access roads or extensive upgrading of existing access roads. MMC proposes to restrict motorized activity associated with transmission line construction from April 1 to June 15 within bear habitat in the Miller Creek and Midas Creek drainages. MMC also would restrict transmission line construction during the winter in big-game winter range areas.

3.15.4.7 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

The Modified North Miller Creek Alternative would affect Plum Creek land in the Fisher River valley and in three sections immediately west of the Fisher River similar to the North Miller Creek Alternative (Figure 78). About 4.3 miles of Plum Creek land would be crossed, all of which are covered by the conservation easement with FWP. The Sedlak Park Substation and loop line would affect 4.4 acres of Plum Creek land, all of which are covered by the conservation easement. No other private land would be affected (Table 144). This alternative would use H-frame structures, which have a wider clearing width than the monopoles proposed in Alternative B; up to 105 acres of Plum Creek land and 6 acres of State land would require clearing for the transmission line. Some additional clearing would be needed for access road construction (Table 145). Alternative C-R would have 3.8 miles of centerline within an existing road corridor (Table 143).

The remaining 8.5 miles of the Modified North Miller Creek Alternative would be on National Forest System lands. All four residences within 0.5 mile of this alignment are more than 450 feet from the centerline. Like Alternative B, 1,750 feet of Alternative C-R would pass through the Libby Creek Recreational Gold Panning Area in the same location. All disturbances and clearing would be in MA 6.

A minimum of 26 structures (about 4.2 miles of line) would be set using a helicopter, minimizing new access road construction or extensive upgrading of closed roads). Additional structures may be set using a helicopter at the contractor’s discretion. About 1.4 miles of new road would be constructed on National Forest System lands.

Alternative C-R would physically disturb 13 acres of grizzly bear habitat and remove 91 acres of timber production on lands covered by FWP’s conservation easement. As mitigation, MMC would acquire or place a conservation easement on 26 acres of private land for grizzly bear mitigation in Alternative C-R. In addition, MMC would convey title or a conservation easement to FWP to up to 91 acres of private land. The acquisition of or placement of a conservation easement on private land would restrict future residential and commercial development on these lands.

3.15.4.8 Alternative D-R – Miller Creek Transmission Line Alternative

The Miller Creek Alternative would have essentially the same effect on Plum Creek land in the Fisher River valley and in three sections immediately west of the Fisher River as the Modified North Miller Creek Alternative. This alternative also would use H-frame structures; up to 105 acres of Plum Creek and 6 acres of State land would require clearing for the transmission line. Some additional clearing would be needed for access road construction. It would make least use of existing road corridors, with 3.6 miles of centerline within 100 feet of existing roads (Table 143).

The remaining 9.1 miles of the Miller Creek Alternative would be on National Forest System lands. All six residences within 0.5 mile of this alignment are more than 450 feet from the centerline. About 2,120 feet of the alignment would pass through the Libby Creek Recreational Gold Panning Area. All disturbances and clearing would be in MA 6.

A minimum of 16 structures (about 2.4 miles of line) would be set using a helicopter; additional structures may be set using a helicopter at the contractor’s discretion. About 3.4 miles of new road would be constructed on National Forest System lands.

MMC would acquire or place a conservation easement on 40 acres of private land for grizzly bear mitigation in Alternative D-R. The acquisition of or placement of a conservation easement on private land would restrict future residential and commercial development on these lands. The mitigation for loss of 91 acres of timber production on lands covered by FWP's conservation easement would be the same as Alternative C-R.

3.15.4.9 Alternative E-R – West Fisher Creek Transmission Line Alternative

The West Fisher Creek Alternative would cross 5.7 miles of Plum Creek lands, 3.7 miles of which is covered under the conservation easement. This alternative would use H-frame structures, except in the section of State land west of the Fisher River (Figure 78). Up to 138 acres of Plum Creek land would require clearing for the transmission line. Some additional clearing would be needed for access road construction. The Sedlak Park Substation and loop line would affect 4.4 acres of Plum Creek land, all of which are covered by the conservation easement. No other private land would be affected. Up to 25 acres of State land would require clearing for construction of the transmission line.

The remaining 8.3 miles of the West Fisher Creek Alternative would be on National Forest System lands. All six residences within 0.5 mile of this alignment are more than 450 feet from the centerline. About 2,120 feet of the alignment would pass through the Libby Creek Recreational Gold Panning Area. Alternative E-R would make the best use of corridors, with 5.9 miles of the centerline within 100 feet of existing roads (Table 143). All disturbances and clearing would be in MA 6.

A minimum of 31 structures (about 4.5 miles of line) would be set using a helicopter; additional structures may be set using a helicopter at the contractor's discretion. About 2.1 miles of new road would be constructed on National Forest System lands.

Alternative C-R would physically disturb 15 acres of grizzly bear habitat and remove 94 acres of timber production on lands covered by FWP's conservation easement. As mitigation, MMC would acquire or place a conservation easement on 30 acres of private land for grizzly bear mitigation in Alternative E-R. In addition, MMC would convey title or a conservation easement to FWP to up to 94 acres. The acquisition of or placement of a conservation easement on private land would restrict future residential and commercial development on these lands.

3.15.4.10 Cumulative Effects

Past actions, such as past mining and road construction, have altered the existing land use. Areas disturbed by past mining and road construction do not provide for timber production or wildlife habitat. The Rock Creek Project and the Montanore Project would cumulatively increase the amount of National Forest System lands on the KNF managed for transmission line corridors and mineral development.

3.15.4.11 Regulatory/Forest Plan Consistency

Following the amendments to the 2015 KFP described in section 2.12, *Forest Plan Amendments*, the preferred mine and transmission line alternatives would comply with the 2015 KFP direction. The amendments to the 2015 KFP described in section 2.12, *Forest Plan Amendments* would be needed if any of the action alternatives were selected. Additional amendments to the 2015 KFP would be needed if MMC's proposed alternatives were selected in the ROD. Should MMC's proposed alternatives be selected in the ROD, additional amendments will be discussed in the ROD. Other sections of Chapter 3 discuss compliance with the 2015 KFP. If the selected transmission line were approved by the FWP, it would comply with the FWP-Plum Creek conservation easement.

3.15.4.12 Irreversible and Irretrievable Commitments

The tailings impoundment area, about 600 acres in each mine alternative, would no longer be suitable for timber production. The area covered by asphalt and gravel by widening the Bear Creek Road would not be returned to pre-mine uses. Timber would be harvested sooner in areas cleared for project facilities. Continued tree clearing along the transmission line would reduce timber production during the life of the project. These resources would be irretrievably affected. Any indirect development associated with the project, such as new permanent residential or commercial development in or around Libby, would likely be permanent.

3.15.4.13 Short-term Uses and Long-term Productivity

In the short term, mine operations would dominate land use on about 2,700 to 3,700 acres, depending on the alternative. Similarly, timber production on 300 to 350 acres, depending on the transmission line alignment, would be eliminated along the transmission line clearing width and access roads. Actual clearing width and lost timber production would be slightly less, and would depend on tree height, slope, and line clearance above the ground. After operations ceased, land uses in most areas affected by the mine, Sedlak Park Substation and loop line, and transmission line would return to pre-mine uses. In addition, 2,826 to 6,225 acres of private land, depending on the combined alternative, would be acquired and managed for long-term grizzly bear habitat.

3.15.4.14 Unavoidable Adverse Environmental Effects

During mine and transmission line construction and operations, all action alternatives would unavoidably alter land use in the land use analysis area.

3.16 Recreation

3.16.1 Regulatory Framework

3.16.1.1 Kootenai Forest Plan

The 2015 KFP includes goals and desired conditions for recreation settings, experiences, and opportunities. Generally, the recreation-related plan direction calls for providing a range of recreational opportunities while minimizing impacts to wildlife, allowing responsible development of mineral resources, meeting domestic livestock grazing needs where feasible, and providing for legitimate special needs on National Forest System land. Applicable 2015 KFP direction for recreation is:

> **FW-DC-AR-01.** Quality, well-maintained recreation facilities exist at key locations to accommodate concentrations of use, enhance the visitor's experience, and protect the natural resources of the area. Day use access is available for relaxation, viewing scenery and wildlife, and for water and snow-based play. Recreation rental cabins and lookouts provide safe, comfortable, overnight facilities that allow visitors to experience and learn about the rich history of the area. Dispersed camping opportunities are available for a wide variety of users while considering resource concerns, activity conflicts, or over-use. Food and garbage storage do not contribute to conflicts between recreation users and wildlife.
>
> **FW-DC-AR-03.** Opportunities for outdoor recreation, such as hunting, fishing, wildlife viewing, berry picking, firewood gathering, and bird watching are available for a wide variety of users. Interpretation and education opportunities enrich the visitors experience and promote a land ethic that preserves the cultural and natural resources of the Forest for future generations.
>
> **FW-DC-AR-04.** Provide year-round outdoor recreation opportunities and experiences in a range of settings as described by the recreation opportunity spectrum (ROS). The desired distribution of forestwide ROS settings are displayed in table 7.
>
> **FW-DC-AR-05.** A variety of motorized and non-motorized winter and summer recreation opportunities are available. Well-designed and maintained trailheads exist and offer adequate parking and turnaround areas. Trails are designed and maintained for the given users (saddle stock, snowmobiles, OHV users, hikers, mountain bikers, etc.).
>
> **FW-DC-AR-06.** Solitude and non-motorized experiences are available in remote settings. Non-motorized areas are of sufficient size and configuration to minimize disturbance from other uses. Non-motorized use is also available in more developed areas, but provides less opportunity for solitude and challenge than in the more remote settings. A well-maintained non-motorized trail network accesses locations of interest for a variety of users.
>
> **GA-DC-AR-LIB-02.** Opportunities for winter motorized access are maintained or considered in areas such as Pipe Creek, East Face of the Cabinets, and Bear Creek. Opportunities for changing snowmobile routes are considered as vegetation or other conditions change over time.

Executive Order 12962 mandates disclosure of effects on recreational fishing as part of a nationwide effort to conserve, restore, and enhance aquatic systems and provide for increased recreational fishing opportunities.

3.16.1.2 State and Local Plans

Outdoor recreation is an important part of the lifestyle and economy throughout Montana. Recreation survey data presented in the Montana Statewide Comprehensive Outdoor Recreation Plan (SCORP) cited fishing, hunting, and backpacking to be among the top five outdoor recreation activity for Montana residents. Over the next 35 years, SCORP projected increases in developed and undeveloped skiing, challenge activities like mountain climbing, rock climbing, and motorized water activities. Activities that will see large decreases in per capita participation include visiting primitive areas, hunting, and fishing (FWP 2014a).

The FWP manages wildlife populations and establishes limits on fishing and hunting activities statewide including on National Forest System lands. The FWP has several general statewide goals that relate to recreational use in the analysis area (FWP 2009a). The FWP's goals are to provide quality opportunities for public appreciation and enjoyment of fish, wildlife, and parks resources, and maintain and enhance the health of Montana's natural environment and the vitality of its fish, wildlife, cultural, and historic resources through the 21st century. The FWP's goals are not enforceable standards. Lincoln County does not have a comprehensive recreation plan.

One 640-acre parcel of State land would be crossed by the West Fisher Creek transmission line alignment. Another parcel of State land is crossed by the Libby Creek Road, which would be used for access during the Evaluation and Construction Phases. The DNRC manages the surface and mineral resources for the benefit of the common schools and six administrative land offices, under the direction of the State Board of Land Commissioners. Hunting also occurs on State land (Power Engineers 2005c).

3.16.2 Analysis Area and Methods

The analysis area direct, indirect, and cumulative effects on recreation consists of an area west of US 2, primarily east of the Cabinet Mountains ridge line (except for a ventilation adit located near Rock Lake on the west side of the ridge line), south from the Bear Creek Road corridor and north from NFS road #231. The four transmission line alternative alignment corridors also are included in the analysis area.

A land use inventory of the analysis area, which refined and updated existing recreation-related data, was used for the evaluation of recreation effects (Power Engineers 2005c). One of the components contained in the land use inventory included parks, recreation, and preservation areas. The analysis of recreational impacts was based on the number of roads and trails proposed for closure and the effect these closures would have on recreational access in the area. In addition, secondary effects associated with diminished recreation quality on lands adjacent to mining activities were evaluated.

The 2015 KFP ROS provides a forest wide desired condition for a range of settings distributed across the forest. The 2015 KFP ROS desired conditions (FW-DC-AR-04) are based on mapping protocol (USDA Forest Service 2003c) using travel routes, digital elevation model, and MA direction. The 2015 KFP ROS reflect the desirable range of opportunities across the forest.

The analysis of potential changes in ROS classes for this project was based on ROS delineation procedures developed by the Forest Service (USDA Forest Service 2003c). The ROS procedure used for this site-specific analysis included set buffer, instead of the digital elevation model used in the 2015 KFP. This included a 0.5-mile buffer around any road to be used by the project; any new road; and any road proposed for access changes. For roads near the CMW, the buffer was extended 3 miles into the CMW. The set buffer method was used to quantitatively display site specific changes in recreation opportunities within the analysis area. The analysis only considered National Forest System lands in the analysis area. Anticipated changes to ROS classes along existing and proposed road corridors, adjacent to proposed mine facilities, and along proposed transmission line corridors were mapped and quantified. The analysis considered changes during two mine phases: 1) during construction when the maximum effect of motorized road use would occur and when all of the access changes would have been implemented; and 2) during post-closure when all motorized activity associated with the project would cease.

Changes to ROS classes were evaluated during the summer, when the maximum effect of motorized road use would occur. MMC's and the agencies' proposed access changes would reduce winter motorized activities in some drainages (see Table 28 and Table 29 in Chapter 2). The effects on winter-time ROS would be minor and consistent with 2015 KFP desired conditions. The anticipated changes in summer ROS classes are described in this section. Maps showing existing and anticipated summer ROS classes are available in the project record.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on wilderness character in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.16.3 Affected Environment

3.16.3.1 Recreational Opportunities and Uses

Northwest Montana is known for its lakes, rivers, and mountains that provide a variety of recreational opportunities. National Forest System lands make up a large percentage of the Lincoln County land base and offer public access for a variety of motorized and non-motorized recreational activities including: hunting for big game and upland game birds, fishing, hiking, wildlife observation, photography, backpacking, horseback riding, snowmobiling, cross-country skiing, mountain biking, picnicking, sightseeing, off highway vehicle (OHV) use, rock hounding, and camping. Recreational use in the analysis area occurs largely within the 350,000-acre Libby Ranger District. Recreational use of the Libby Ranger District is highest in the summer with camping, hiking, and fishing on the weekends being the major activities. These activities in the analysis area are concentrated at Howard Lake and along popular hiking trails. Recreation activities continue to take place during fall, although use declines. Fall use of the analysis area is mainly dispersed hunting and berry picking.

In the last two decades, the number and types of users have increased in the analysis area, partly as a result of growth in the Flathead Valley and Missoula (Kocis *et al.* 2003). The analysis area provides different types of user experiences; the CMW and the small drainages provide users with a more solitary experience compared to the more structured user experience at Howard Lake or the Libby Creek Recreational Gold Panning Area. The KNF has management responsibility for recreational uses of these lands.

KNF uses the ROS inventory as a tool for defining classes of outdoor recreation opportunity environments, making management decisions, and as a way to communicate recreation priorities with the public (USDA Forest Service 1982). ROS classifies recreational opportunities into six categories: Primitive, Semi-Primitive Non-Motorized, Semi-Primitive Motorized, Roaded Natural, Roaded Modified, and Rural (Table 146) (USDA Forest Service 1990).

Based on an updated ROS mapping protocol (USDA Forest Service 2003c), current ROS classes for the Poorman Creek and Ramsey Creek drainages are Semi-Primitive Motorized, while the Little Cherry Creek drainage and most of the Libby Creek drainage are classified as Roaded Natural and Semi-Primitive Motorized. In the transmission line corridor areas, current ROS class for the West Fisher Creek, Miller Creek, and Midas Creek drainages is Roaded Natural, with areas of Semi-Primitive Motorized and Semi-Primitive Non-Motorized in areas between the drainages. All of the CMW in the analysis area was mapped as Semi-Primitive Non-Motorized because of roads extending within 3 miles of the CMW boundary.

Table 146. Description of ROS Classes.

ROS Class	Description
Primitive	Characterized by essentially unmodified natural environment of fairly large size. Interaction between users is fairly low and evidence of other users is minimal. Motorized use is not permitted.
Semi-Primitive Non-Motorized	Characterized by predominantly natural or natural-appearing environment of moderate to large size. Interaction between users is low, but there is often evidence of other users. Motorized use is not permitted.
Semi-Primitive Motorized	Characterized by predominantly natural or natural-appearing environment of moderate to large size. Concentration of users is low, but there is often evidence of other users. Motorized use is permitted.
Roaded Natural	Characterized by predominantly natural appearing environment with moderate evidence of human sights/sounds. Interaction between users is may be low to moderate, with evidence of other users prevalent. Conventional motorized use is provided for in the construction and design of facilities.
Rural	Characterized by substantially modified natural environment. Resource modification and utilization practices are primarily to enhance specific recreation activities and to maintain vegetation cover and soil. Sights and sounds of man are readily evident, and the interaction between users is often moderate to high. Facilities for intensified motorized use and parking are available.

Source:. USDA Forest Service 1982.

3.16.3.1.1 Hunting

In Montana, 19 percent of residents hunt, the highest level of participation in the nation (FWP 2007). Every fall, hunters frequent the hunting districts close to Libby. The FWP conducts an annual statewide harvest survey to determine hunter activity throughout the state. Data for hunter activity in the analysis area are summarized in Table 147. The Libby Ranger District has 14 permitted outfitters with five operating in the south end of the district.

Table 147. Analysis Area Hunter Activity by Hunting District.

Hunting District	Location	Species	Year	Hunters	Hunter Days
103	East of US 2	Elk	2011	1,990	16,409
104	West of US 2	Elk	2011	1,345	11,658
100	West of US 2 and East of Montana 58	Goat	2011	6	63
105	West of US 2	Moose	2011	20	272
106	East of US 2	Moose	2011	12	147
123	West of US 2	Sheep	2011	4	56
103	East of US 2	White-tailed and Mule Deer	2011	2,852	20,163
104	West of US 2	White-tailed and Mule Deer	2011	1,988	15,186

Note: The analysis area generally includes only small portions of the much larger Hunting Districts. Hunter days are defined as the number of days or partial days spent hunting by active hunters.
Source: FWP 2012.

Hunting opportunities also are available on private lands as a result of FWP actions through the block management program and conservation easements. The block management program is a cooperative effort between FWP, landowners, and land management agencies to provide free public hunting access to private and isolated public land. Other lands with conservation easements generally offer some level of public hunting access. Hunting in the analysis area occurs on Plum Creek lands covered by a conservation easement, other private lands and also on state school trust land. Hunting on private land is subject to landowner discretion.

3.16.3.1.2 Fishing

Fishing opportunities within the analysis area occur primarily in easily accessible streams and rivers and at Howard Lake. Other lakes in the CMW, including Leigh Lake, Rock Lake, and Geiger Lake, provide additional fishing opportunities. Fishing is a relatively minor activity in Libby Creek, Poorman Creek, Howard Creek, and West Fisher Creek. Most fishing in the analysis area occurs on the Fisher River and Howard Lake. For example, total angler days between 2003 and 2009 averaged 3,685 days on Fisher River, 990 days on Howard Lake, and 385 days on Libby Creek (FWP 2012). The proportion of angler days on the Fisher River and Libby Creek that occurs in the analysis are is unknown. The FWP does not track fishing use of Little Cherry Creek, Standard Creek, and Miller Creek because they provide a very small portion of the recreational fishing opportunity.

3.16.3.1.3 Scenic Driving

Scenic driving occurs along the forest roads within the analysis area. The most heavily used roads are the Libby Creek Road (NFS road #231), the Bear Creek Road (NFS road #278), and US 2. Less traveled roads used for scenic driving connect with these primary roads.

3.16.3.1.4 Camping and Picnicking

Howard Lake Campground is the only fee campground within the analysis area. This campground offers swimming, fishing, hiking, boating, and a water well, RV sites, and toilets. A maintained trail provides access to dispersed camping on one side of the lake. Easy access to Libby Creek and Libby Lakes trailhead facilitates other recreational opportunities in the area. Average annual use by campers paying the fee for Howard Lake Campground during the 2010 and 2011 seasons was 240 campsites (595 campers) (KNF 2011). Recreationists engaged in day use activities dominate Howard Lake Campground. Recreation visits to Howard Lake are about 3,000 annually in 2004 (Power Engineers 2005c).

Camping at dispersed sites is widely scattered throughout the analysis area. Dispersed camping is generally associated with roads and occurs primarily during the summer and fall months.

3.16.3.1.5 Forest Product Gathering

Firewood gathering, Christmas tree cutting, and huckleberry and mushroom picking occur in the analysis area. Firewood is collected primarily in the spring and fall, but because of the large number of wood-burning stoves in the area, firewood collection is constant. The Forest Service considers huckleberry picking to be an important recreational use of the area, although no information is available concerning the number of individuals who visit the area for this purpose, or the economic values that may result (Jeresek, pers. comm. 2006). Huckleberry season (late summer through early fall) brings many people to the area to take part in the berry harvest. The Forest Service estimates that about 80 percent of the pickers are local residents (Jeresek, pers. comm. 2006).

3.16.3.1.6 Gold Panning

The Libby Creek Recreational Gold Panning Area offers the general public the opportunity to pan for gold in a historical area of placer mining. The area has no developed parking lots or camping facilities. Camping at the area is primitive with dispersed sites.

3.16.3.1.7 Winter Activities

Winter activities include ice fishing, cross-country skiing, and snowmobiling. Winter activities in the analysis area are the most common near Bear Creek and Poorman Creek, which provide good areas for skiing and snowmobiling. Bear Creek Road is plowed all winter by Lincoln County to about 1 mile north of Bear Creek, providing skiing and snowmobiling access to Bear Creek and Poorman Creek areas. Libby Creek Road is currently plowed by Lincoln County to Crazyman Road (NFS road #6209), about 1 mile south of US 2. Some winter activities occur on the unplowed portion of Libby Creek Road. Ice fishing occurs on Howard Lake.

3.16.3.1.8 Trails

Several National Forest System trails access the CMW within the east side of the analysis area (Bear Creek south to West Fisher Creek) (Figure 80). These trails are: Trail 119 Libby Creek, Trail 820 Ramsey Creek, Trail 129 Poorman Creek, Trail 821 Cable Creek, Trail 116 Standard Creek, and Trail 117 Great Northern Mountain. Other trails near the transmission line alternatives include Trail 716 Libby Divide, Trail 118 Miller Creek, Trail 6S Divide 6 Trail, and Trail 859 Kenelty Caves Trail. Some of the National Forest System trails are on roads that are closed to motorized use (Power Engineers 2005c). Other trails within or in proximity to the analysis area are shown in Figure 80.

The Leigh Lake trailhead is the highest used trailhead in the analysis area. The trail is accessible from May 1 to September 30. Between 2001 and 2003, the average number of annual visitors at Leigh Lake was 2,827 and the average number of visitor days (equivalent to one person using the resource for 12 hours) was 3,485 (Power Engineers 2005c). Data was not available for other trails. These trails are generally lightly used, with most of the activity occurring in the summer and fall.

Seasonal use data for managed trailheads and unmanaged trailheads indicate a gradual increase in wilderness use since 1988. Seasonal use data reflect high use during the summer (about 85 percent of total), moderate use during the fall (about 10 percent), and light use during the winter (about 5 percent) (MMI 2005a). The Forest Service estimates total annual visitation to the entire wilderness to be 12,100 (USDA Forest Service 2009)

3.16.4 Environmental Consequences

3.16.4.1 Alternative 1 – No Mine

Alternative 1 would have no impact upon recreation in the analysis area. Access to roads and trails would continue as in the past. The DEQ’s approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ’s approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Visitors to the area may experience increased noise levels from activities at the Libby Adit Site. These effects would be temporary and there would be no long-term effects on visitors’ recreational experiences if no mine were constructed.

3.16.4.2 Alternative 2 – MMC’s Proposed Mine

3.16.4.2.1 Short-term Effects During Construction, Operations, and Closure Phases

In general, recreational use and access to the analysis area would continue, although the configuration of some access roads would change slightly and the overall character of recreation opportunities within or adjacent to mine facilities would change substantially. Short-term effects during mine construction, operations, and reclamation would include restricted public access, increased noise, and increased night lighting within and adjacent to the mine facility areas. Public motorized and non-motorized access would be restricted to mine and agency personnel in all permit areas. These effects would reduce the amount of area available for hunting and other dispersed recreation activities. The combination of mine development and improved recreational access may displace some dispersed recreation activities (such as hunting, hiking, and dispersed camping) within the analysis area to other portions of the KNF, since individuals who are currently accustomed to these areas may use other areas of the forest with fewer visitors and developed facilities. The overall effect on recreation use and opportunity in the KNF would be negligible.

The proposed mine and associated facilities in Alternative 2 would reduce public recreational access due to road closures. Public motorized and non-motorized access would be restricted to mine and agency personnel in all permit areas. Specific road closures would include the Little Cherry Loop Road (NFS road #6212) within the proposed Little Cherry Creek Tailings Impoundment Site, the Poorman Creek Road (NFS road #2317) in the lower portion of the Poorman Creek drainage, and NFS road #4784 in the Bear Creek drainage (which is already proposed for an access change as part of the Rock Creek Project mitigation). The South Fork Miller Creek road (NFS road #4724) would be closed on a seasonal basis.

MMC would fund access changes on the Bear Creek Road (NFS road #4784) in the Bear Creek drainage if it was not already closed by the Rock Creek Project. This road is currently open from July 1 to October 14 to motor vehicles, and gated with motorized access restricted to administrative uses other times of the year. It is open to snow vehicles December 1 through April 30 (Table 28). In MMC's grizzly bear mitigation plan, all motorized use including administrative uses, along with wintertime use, would be eliminated for the life of the project. This access change would improve the opportunities for solitude and primitive recreation in the Cabinet Face East IRA for the life of the project. The road would return to existing conditions after the project ceased operations and completed closure and the improved opportunities for solitude and primitive recreation would cease.

Before mine operations, Libby Creek Road (NFS road #231) and Upper Libby Creek Road NFS road #2316 would be continue to be plowed in the winter as part of a 2-year Libby Adit evaluation program and a 1-year Bear Creek Road (NFS road #278) reconstruction. The improvements to the Bear Creek Road would improve recreational access to the area and would safely accommodate mine-related and public traffic. Because the Bear Creek Road would be plowed in the winter, its use would improve winter recreation access to areas near the road. Similarly, the Libby Creek Road would be plowed for 2 to 3 years during construction, improving winter recreation access to areas off of the road. Snowmobile and cross country skiing use of the Libby Creek Road and parts of Upper Libby Creek Road during the Evaluation and Construction Phases, and of the Bear Creek Road during the Operations Phase, would be eliminated.

Access restrictions at the permit area boundary of each mine facility would eliminate access to all roads within the permit boundary that are currently closed to motorized use but open to non-motorized use. These closures would eliminate all public recreation access to the Poorman Creek and Ramsey Creek drainages (NFS road #2317 and NFS road #4781, respectively) (Figure 16). Similarly, non-motorized access to existing trails in the Poorman Creek (Trail 129) and Ramsey Creek (Trail 820) would be lost. Non-motorized trail access up the Libby Creek drainage (Trail 119) would not be affected (trail locations are shown on Figure 80).

The overall character of the trail user experience would be altered in the Libby Creek drainage due to noise, traffic, and visual effects associated with the proposed facilities. Within the CMW and the adjacent Cabinet Face East IRA, the recreational enjoyment of trails, lakes, and overall wilderness values in the upper Ramsey Creek drainage may be adversely affected due to the construction, operation, and reclamation of the Ramsey Plant Site. Visual effects on user experience due to the construction and operation of proposed facilities are described in section 3.17, *Scenery*. The proposed Rock Lake Ventilation Adit, located east of Rock Lake on a small parcel of private land outside of the CMW, would potentially be visible from some locations within the CMW. The surface features at the ventilation shaft and the overall effect of those features would be minimal and would not affect recreation. The Howard Lake Campground and the Libby Creek Recreational Gold Panning Area would not be directly affected by any of the proposed facilities or road closures, but these and other recreation resources may be subject to increased use due to better road access and familiarity among mine employees in the area.

In Alternative 2, Little Cherry Creek would be diverted in a permanent Diversion Channel around the impoundment. Most of the diversion would be within the operating permit area for the tailings impoundment, and access would be restricted. The KNF and the FWP estimated a loss of 383 angler-hours of recreational fishing opportunity. The fisheries mitigation proposed by MMC in Alternative 2 was identified in the KNF's 1993 ROD (USDA Forest Service 1993) as adequate mitigation for the loss of recreational opportunity. The 1992 Final EIS effects analysis and 1993 ROD mitigation did not consider the likely need for a pumpback well system to prevent tailings seepage from reaching surface water. Flow in the diverted Little Cherry Creek would be substantially reduced during operations and closure, as the pumpback well system, as long as it operated, would likely eliminate very low flow in the diverted creek. The loss of available habitat in the diverted Little Cherry Creek would adversely affect the redband trout population in the diverted creek because the remaining habitat would not support the population at its current numbers, if at all.

3.16.4.2.2 Changes to Recreation Setting

During mine operations, the level of mine facility development proposed in Alternative 2 would change the ROS classes for some portions of the analysis area (Table 148). The Ramsey Creek drainage within the analysis area would change from Semi-Primitive Motorized to Rural in character. The Little Cherry Creek drainage and most of the Libby Creek drainage would primarily change from Roaded Natural to Rural (the upper portions of the Libby Creek drainage, west of the adit site, would remain Semi-Primitive Motorized). As in all action alternatives, the Bear Creek Road (NFS road #278) corridor would remain Roaded Natural from US 2 to the impoundment site, and would change to Rural near the impoundment site, LAD Areas, and plant site.

These changes from less developed to more developed recreation settings would likely displace some recreationists seeking a more remote and dispersed recreation experiences. Most of the Libby Creek Road (NFS road #231) would remain as Roaded Natural, except for small portions nearest the mine facilities that would change to Rural. The changes in ROS in the mine area during the Construction Phase would continue during the Operations Phase.

3.16.4.2.3 Long-term Effects After Closure

The long-term effects on recreation after completion of mine operations and reclamation include the elimination or closure of several roads within the permit area boundary. Motorized access to the Little Cherry Creek Loop road (NFS road #6212) within the Little Cherry Creek Tailings Impoundment Site would change due to the tailings impoundment, reducing motorized access for scenic driving, hunting, fishing, and other uses.

Over the long term, public access would be restored to portions of NFS road #5182 through the Little Cherry Creek Tailings Impoundment Site and NFS road #4781 through LAD Area 2. The restoration of access along NFS road #4781 would provide long-term motorized access to the Poorman Creek drainage (NFS road #2317/Trail 129) and both motorized and non-motorized access to the Ramsey Creek drainage (motorized access along NFS road #4781 and non-motorized access to Trail 820).

Table 148. Estimated Change in Acres of ROS Class within the Mine and Transmission Line Analysis Area.

ROS Class	Rural		Roaded Natural		Semi-Primitive Motorized		Semi-Primitive Non-Motorized	
	Acres	% change	Acres	% change	Acres	% change	Acres	% change
Existing Conditions	0		33,530		11,424		27,487	
Alternative 2B								
Construction	9,439	See note	28,393	-15%	7,553	-34%	27,056	-2%
Reclamation	0	0%	33,529	0%	11,399	0%	27,514	0%
Alternative 3C-R								
Construction	5,606	See note	28,773	-14%	2,430	-79%	35,633	30%
Reclamation	0	0%	31,549	-6%	3,701	-68%	37,191	35%
Alternative 3D-R								
Construction	5,606	See note	27,417	-18%	2,749	-76%	36,669	33%
Reclamation	0	0%	31,549	-6%	3,944	-65%	36,948	34%
Alternative 3E-R								
Construction	5,606	See note	27,106	-19%	3,060	-73%	36,669	33%
Reclamation	0	0%	31,549	-6%	3,944	-65%	36,948	34%
Alternative 4C-R								
Construction	6,905	See note	27,341	-18%	2,440	-79%	35,756	30%
Reclamation	0	0%	31,396	-6%	4,109	-64%	36,936	34%
Alternative 4D-R								
Construction	6,905	See note	25,985	-23%	2,759	-76%	36,792	34%
Reclamation	0	0%	31,396	-6%	4,109	-64%	36,936	34%
Alternative 4E-R								
Construction	6,905	See note	25,675	-23%	3,069	-73%	36,792	34%
Reclamation	0	0%	31,396	-6%	4,109	-64%	36,936	34%

Notes: ROS categories of Primitive were not identified in the analysis area and are not shown in this table.
Total analysis area is 72,441 acres.
% increase in rural ROS setting during Construction is not calculable as existing Rural ROS is 0 acres.
Source: GIS analysis by ERO Resources Corp. using KNF ROS delineation procedures.

No long-term effects on trail-user access or experiences in the CMW, the Howard Lake Campground, and the Libby Creek Recreational Gold Panning Area would occur. The long-term ROS classes throughout the analysis area would return to preexisting categories as disturbed areas became successfully revegetated and tree cover returned to pre-mine conditions (see descriptions of reclamation and revegetation plans in Chapter 2). The increased access and familiarity of the area for recreation would likely displace current dispersed users in and around the analysis area.

Flow in the diverted Little Cherry Creek would likely be eliminated if a pumpback well system was installed and continued to operate. The diverted creek would not be capable of supporting redband trout. Flow from the tailings impoundment at closure would be directed toward Bear Creek, with flow in the diverted Little Cherry Creek estimated to be 45 percent less than existing flow. Reestablishment of the redband trout population in Little Cherry Creek would not likely occur after the pumpback wells ceased operating and flows increased. Recreational fishing opportunity in the diverted creek would be eliminated or substantially reduced. MMC's proposed mitigation would partially offset the loss of fishing opportunity.

3.16.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

3.16.4.3.1 Short-term Effects During Construction, Operations, and Closure Phases

The overall short-term effects of Alternative 3 on recreation would be similar to Alternative 2, except as discussed below. Public motorized and non-motorized access would be restricted to mine and agency personnel in all permit areas.

Noise levels between 45 and 55 dBA from the Libby Plant Site may adversely affect recreational use and enjoyment of the Libby Creek Recreational Gold Panning Area (see section 3.20.4, *Environmental Consequences* of the *Sound, Electrical and Magnetic Fields, Radio and TV Effects* section). Visual effects on user experience due to the construction and operation of proposed facilities are described in section 3.17.4, *Environmental Consequences* of the *Scenery* section.

The specific configuration of the Little Cherry Loop Road (NFS road #6212) closure and other road closures within the proposed Poorman Tailings Impoundment Site would be different from Alternative 2, but the effect of the closures (restricting both motorized and non-motorized recreation access) would be the same.

Non-motorized recreation and trail access to the upper Poorman Creek drainage (NFS road #2317/Trail 129) would be retained and improved due to the development of a recreational parking area adjacent to LAD Area 1 along Poorman Creek Road (NFS road #2317). The recreational enjoyment of the Libby Creek Trail (Trail 119), west of the Libby Adit Site, and overall wilderness values in the CMW would be altered in the upper Libby Creek drainage due to noise, traffic, and visual effects associated with the proposed facilities in the Libby Creek drainage. Unlike Alternative 2, non-motorized recreation access would be permitted through the permit area boundary on NFS road #4781/Trail 820 to the upper Ramsey Creek drainage. The improvements to the Bear Creek Road (NFS road #278) would improve recreational access to the area. Because the Bear Creek Road would be plowed in the winter, it would improve winter recreation access to the analysis area (although the existing snowmobile use of the road would be affected).

In Alternatives 3 and 4, MMC would fund access changes on numerous roads for wildlife mitigation (see Table 28 and Table 29 in Chapter 2). Seven roads totaling 14.8 miles that are currently open would be barriered year-long. Four roads totaling 9.3 miles would be gated seasonally between April 1 and June 15. In addition, MMC would decommission or place into intermittent stored service NFS road #4784 (upper Bear Creek Road) if the Rock Creek Mine mitigation restricting the road with an earthen barrier had not been implemented before Forest Service approval to initiate the Evaluation Phase. These closures would eliminate motorized recreational access and use, such as camping and hunting, in these locations, but would not affect the overall quality or accessibility or recreation in the analysis area. Non-motorized access would be maintained. These access changes would improve the winter-time opportunities for solitude and primitive recreation in the analysis area. Other access changes, such as changing access restrictions from a gate to an earthen barrier or converting restricted roads to trails, would not affect recreation access. The development of a scenic overlook along the Bear Creek Road (NFS road #231) downstream of the Midas Creek crossing with views of the tailings impoundment and interpretive information about the mine would benefit recreation opportunities by providing an additional amenity in the area. Overall recreation effects would be mitigated through funding a campground host from Memorial Day through Labor Day at Howard Lake Campground during the Construction and Operations Phases of the mine.

The agencies' proposed migratory bird and water resources monitoring would require monitoring of avian and water resources in the East Fork Rock Creek, East Fork Bull River, and Swamp Creek drainages (see Appendix C). Increased use by project personnel conducting the monitoring would decrease opportunities for solitude or a primitive and unconfined type of recreation in the East Fork Rock Creek, East Fork Bull River, and Swamp Creek drainages.

Channels affected by the Poorman Tailings Impoundment Site are not fish-bearing and do not provide recreational fishing access. Alternative 3 would not affect recreational fishing opportunities.

3.16.4.3.2 Changes to Recreation Setting

The level of mine facility development proposed in Alternative 3 would change the ROS classes for the analysis area (Table 148). Most of the Libby Creek drainage within the analysis area would change in character from Roaded Natural to Rural, while the upper portions of the drainage would change from Semi-Primitive Motorized to Semi-Primitive Non-Motorized due to road closures. Likewise, most of the Ramsey, Poorman, and Bear Creek drainages would change to Semi-Primitive Non-Motorized due to road closures. A permanent increase of 8,200 to 9,200 acres, depending on the transmission line alternative, would occur in the Semi-Primitive Non-Motorized class.

Most of the decrease would be in the Semi-Primitive Motorized class, which would decrease between 8,400 and 9,000 acres, depending on the transmission line alternative. The southern portion of the Little Cherry Creek drainage would change from Roaded Natural to Rural. As in all action alternatives, the NFS road #278 corridor would not change (Roaded Natural) from US 2 to the impoundment site, but would change to Rural near the impoundment site, LAD Areas, and plant site. The changes in ROS in the mine area during the Construction Phase would continue during the Operations Phase.

Changes from less developed to more developed recreation settings near the mine development facilities would likely displace some recreationists seeking a more remote and dispersed recreation experience, but those types of experiences would be increased in most of the upper drainages that would change to a less developed, non-motorized recreation setting.

3.16.4.3.3 Long-term Effects After Closure

The long-term effects of the mine operations, after closure and reclamation are complete, would include the elimination of several roads within the tailings impoundment site, including NFS road #6212.

Long-term recreational access to the roads and trails in the Poorman, Ramsey, and Libby Creek drainages would be similar to existing conditions. Roads and trails closed for wildlife mitigation would no longer be used for motorized access. No long-term effects on trail-user access or experiences in the CMW, the Howard Lake Campground, and the Libby Creek Recreational Gold Panning Area would occur. New recreation amenities, including a recreational parking area along Poorman Creek Road (NFS road #2317) and a scenic overlook along Libby Creek Road (NFS road #231) would provide long-term recreation benefits. A permanent increase of 9,500 to 9,700 acres, depending on the transmission line alternative, would occur in Semi-Primitive Non-Motorized characteristics.

3.16.4.4 Effectiveness of Agencies' Proposed Mitigation

While the effects of the mine alternatives would result in the loss of some recreation opportunities and aesthetic changes near mine facilities, the proposed mitigation measures would mitigate some of the impacts on recreation. These measures include:

- Construction of a scenic overlook with interpretive signs with views of the tailings impoundment on NFS road #231 would provide an amenity for visitors who are curious about or interested in the function and purpose of the mine.
- Pay the reimbursement funding for a volunteer campground host from Memorial Day through Labor Day at Howard Lake campground using an Volunteer Services Agreement for Natural Resources agencies (Optional Form 301a) throughout the life of the project would enhance the level of service and quality of the experience for campground guests, potentially offsetting some of the aesthetic impacts of the nearby mine.
- Inspection and maintenance of access changes (*e.g.*, road and trail closures) would help ensure that appropriate visitor access is safe and easily understood.
- Development of a small parking area along Poorman Creek Road would offset some of the road and trail closures by proving a new amenity and giving visitors a clear transition point between the road closure and new or existing trail access opportunities.
- Development of a new hiking trail between Poorman and Ramsey Creeks would provide non-motorized access to upper Ramsey Creek which would offset some of the effects of road closures and may provide new non-motorized recreation opportunities.

During operations, these mitigation measures would be effective in reducing the impact on the mine on some recreationists. These measures would not address the effects on all visitors, due to the individual nature of dispersed recreation in and near the analysis area.

3.16.4.5 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

The effects of the plant site, adits, and LAD Areas in Alternative 4 on recreation and recreation setting would be the same as those described under Alternative 3. The effects of the tailings impoundment in Alternative 4 on recreation would be the same as those described under Alternative 2. Additional fisheries mitigation would compensate for all lost aquatic habitat and recreational fishing opportunity in diverted Little Cherry Creek. The long-term effect on ROS classes would be the similar to Alternative 3. Proposed mitigation would be the same as Alternative 3. A permanent increase of 9,500 acres would occur in Semi-Primitive Non-Motorized class. Most of the decrease would be in the Semi-Primitive Motorized class, which would decrease between 8,400 and 9,000 acres, depending on the transmission line alternative.

3.16.4.6 Alternative A – No Transmission Line

Alternative A would not affect recreation in the analysis area. Access to roads and trails would continue as it is currently. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. The Sedlak Park Substation and the loop line to BPA's Noxon-Libby line would not be constructed.

3.16.4.7 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

The North Miller Creek Alternative would have the greatest amount of new access roads (10.2 miles) for the construction and maintenance of the transmission line (Table 145). These roads would be closed to motorized vehicles. These new roads would benefit non-motorized recreation access (*i.e.*, walk-in hunting and fishing access, hiking, berry picking) on both National Forest System lands and on private lands where public access was permitted.

Alternative B would cross through the Libby Creek Recreational Gold Panning Area for a distance of 1,760 feet, and also would cross Trails 118, 716, and 820 (Figure 80). Transmission line construction would adversely affect the short-term use and enjoyment of these areas due to increased noise, traffic, and construction activity. During mine operations, the existence of the transmission line would alter the scenic integrity and landscape character of trail corridors and the Gold Panning Area. The alteration of scenic integrity in these localized areas would have minor adverse effects on enjoyment of recreational amenities that would be crossed by the transmission line. Alternative B would not be visible from Howard Lake and would have no effect on Howard Lake recreation.

The ROS classes of most of the transmission line corridor would not change, except for a segment of Semi-Primitive Motorized that would change to Roaded Natural in the area north of Miller Creek. This change from a less developed to a more developed recreation setting may displace some recreationists seeking a more remote and dispersed recreation experience. The ROS change would return to existing conditions (Semi-Primitive Motorized) after the transmission line was constructed, but would be affected again when the transmission line was removed at the end of operations. Over the long term, the ROS classes in this area would return to existing conditions (Semi-Primitive Motorized).

Construction of the Sedlak Park Substation and the loop line to BPA's Noxon-Libby line would not adversely affect recreation. Both would be located on private land.

3.16.4.8 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

Alternative C-R would benefit non-motorized recreation access by providing 3 miles of new access roads on both National Forest System and private lands where public access is permitted (Table 145). These new road corridors would enhance non-motorized recreation access. The length of new roads in Alternative C-R (and subsequent recreation benefits) would be the least among the transmission line alternatives. Alternative C-R would cross trails 65, 118, 716, and 859 (Figure 80), as well as the Libby Creek Recreational Gold Panning Area for a distance of 1,750 feet. The adverse effects on trails and the Gold Panning Area would be the same as Alternative B. Alternative C-R would not be visible from Howard Lake and would have no effect on Howard Lake recreation.

The ROS classes of most of the transmission line corridor would not change, except for a segment of Semi-Primitive Motorized that would change to Roaded Natural in the area north of Miller Creek. This change from a less developed to a more developed recreation setting may displace some recreationists seeking a more remote and dispersed recreation experience. The ROS change would be similar to existing conditions (Semi-Primitive Motorized and Semi-Primitive Non-Motorized) after the transmission line was constructed, but would be affected again when the transmission line was removed at the end of operations. Over the long term, the ROS classes in most of this area would return to existing conditions (Semi-Primitive Motorized), while some of the area would change to a less developed setting of Semi-Primitive Non-Motorized.

Construction of the Sedlak Park Substation and the loop line to BPA's Noxon-Libby line would not adversely affect recreation. Both would be located on private land.

3.16.4.9 Alternative D-R – Miller Creek Transmission Line Alternative

Alternative D-R would have more miles (5.1 miles) of new access roads (and related benefits to non-motorized recreation access) than Alternative C-R. Alternative D-R would cross trails 65, 300, 505, 716, and 859, (Figure 80), as well as the Libby Creek Recreational Gold Panning Area for a distance of 2,120 feet. The effects on trails and the Gold Panning Area would be the same as Alternative B. About 0.4 miles of the Alternative D-R transmission line corridor would be visible from Howard Lake. Such visual effects may diminish the quality of the recreation experience for some visitors.

The ROS classes of most the transmission line corridor would not change, except for a small segment near the eastern edge that would change from Semi-Primitive Non-Motorized to Roaded Natural. This change from a less developed to a more developed recreation setting may displace some recreationists seeking a more remote and dispersed recreation experience. The ROS change would return to existing conditions (Semi-Primitive Motorized) after the transmission line was constructed, but would be affected again when the transmission line was removed at the end of operations. Over the long term, the ROS classes in this area would return to existing conditions (Semi-Primitive Motorized).

Construction of the Sedlak Park Substation and the loop line to BPA's Noxon-Libby line would not adversely affect recreation. Both would be located on private land.

3.16.4.10 Alternative E-R – West Fisher Creek Transmission Line Alternative

The length of new access roads in Alternative E-R (and related benefits to non-motorized recreation access) (4.0 miles) would be greater than Alternative C-R, but less than Alternative B and D. Alternative E-R would cross trails 65, 505, 716, and 859 (Figure 80), as well as the Libby Creek Recreational Gold Panning Area for a distance of 2,120 feet. The effects on trails and the Gold Panning Area would be the same as Alternative B. About 0.4 miles of the Alternative E-R transmission line corridor would be highly visible from Howard Lake. Such visual effects may diminish the quality of the recreation experience for some visitors. These changes would not substantially affect the ROS classes.

Construction of the Sedlak Park Substation and the loop line to BPA's Noxon-Libby line would not adversely affect recreation. Both would be located on private land.

3.16.4.11 Cumulative Effects

Past actions within the analysis area include the establishment of forest access roads and logging roads and the development of the Howard Lake Campground and Libby Creek Recreational Gold

Panning Area. These past actions have resulted in the existing recreation setting described above under section 3.16.3, *Affected Environment*. Population increases due to these projects would slightly increase demand for recreational opportunities in the region. Even with this increased demand, an abundance of outdoor recreational opportunities would remain for residents and visitors.

The agencies' proposed monitoring would require monitoring of avian and water resources in the East Fork Rock Creek, East Fork Bull River, and Rock Creek drainages for both the Montanore and Rock Creek projects. Increased use by project personnel conducting the monitoring would cumulatively decrease opportunities for solitude or a primitive and unconfined type of recreation in these drainages.

3.16.4.12 Regulatory/Forest Plan Consistency

All action alternatives would maintain forestwide progress toward desired condition FW-DC-AR-01. None of the alternatives would directly affect recreation facilities or forestwide dispersed camping opportunities. Proposed food and garbage storage would not contribute to conflicts between recreation users and wildlife. The agencies' alternatives would include mitigation to support forest recreation management, such as supporting a campground host and developing a scenic overlook with interpretive signs. The agencies' alternatives would contribute to achieving progress toward desired conditions.

All action alternatives would maintain forestwide progress toward achieving desired condition FW-DC-AR-03. All action alternatives would have short-term effects on the outdoor recreation activities within the analysis area. The proposed mitigation measures would mitigate some of the impacts on recreation area. The effect on forestwide recreational opportunity would be negligible.

The agencies' alternatives would make progress toward the ROS desired condition (FW-DC-AR-04) over the long term, even if the alternatives would adversely affect progress toward ROS desired condition in the short term. During the life of the project, Rural ROS class would increase by between 5,600 and 6,900 acres in the agencies' alternatives and 9,400 acres in MMC's alternatives. In the context of forestwide recreation opportunities, the increase would be less than 1 percent of the Rural ROS class on the KNF. MMC's would be neutral long-term toward the desired condition of decreased Semi-Primitive Motorized and increased Semi-Primitive Non-Motorized ROS classes. The agencies' alternatives would make long-term progress toward the desired condition of decreased Semi-Primitive Motorized and increased Semi-Primitive Non-Motorized ROS classes.

All action alternatives would be neutral toward achieving desired condition FW-DC-AR-05 and 06. The agencies' alternatives would include recreation management activities such as relocating trailheads and converting roads to trails. The trailhead construction design includes adequate parking and turnaround area.

All alternatives considered opportunities for winter motorized access in areas such as the East Face of the Cabinets and Bear Creek. MMC's alternatives would have less effect on winter motorized access in areas such as the East Face of the Cabinets and Bear Creek than the agencies' alternatives. The agencies' alternatives would eliminate winter motorized access on 8.8 miles of roads in the East Face of the Cabinets and Bear Creek. The agencies' alternatives would reduce April winter motorized access on 7.6 miles of roads in the East Face of the Cabinets.

This analysis complies with Executive Order 12962 that mandates disclosure of effects on recreational fishing.

3.16.4.13 Irreversible and Irretrievable Commitments

The recreational experience of some users may be irretrievably affected by the project, due to loss of access to particular areas, increased noise, or visual impacts. These effects, combined with increased knowledge of and access to the general analysis area, would likely displace some dispersed recreation (hunting, hiking, and dispersed camping) to other areas of the forest. Long-term road closures within the tailings impoundment and other areas for grizzly bear mitigation in all action alternatives would result in an irretrievable loss of recreational access.

3.16.4.14 Short-term Uses and Long-term Productivity

All of the action alternatives would include both short-term and long-term road closures within the permit area boundary. Short-term closures would have the greatest effect on recreation access in Alternative 2, which would restrict access to the Ramsey and Poorman creek drainages. Long-term road closures in all action alternatives would reduce recreation access within and adjacent to the tailings impoundment. The long-term effects of the proposed project on recreation access in the analysis area would be small.

The noise and visual effects of the proposed project would be most noticeable during the 16 to 19 years of operations. Noise would return to pre-mine levels when reclamation activities ceased, while visual effects would be reduced over time as revegetation efforts were completed and the forest cover re-established in disturbed areas. Over the long term, the proposed project would not affect the ability of the analysis area to provide a variety of forest recreation opportunities.

3.16.4.15 Unavoidable Adverse Environmental Effects

Alternatives 2, 3, and 4 would restrict access and recreational use along the Little Cherry Creek Loop Road (NFS road #6212), which would be restricted to public motorized and non-motorized access. Alternative 2 would restrict recreational access to the Ramsey Creek and Poorman Creek drainages. In addition, all of the proposed transmission line alternatives would alter the scenic integrity of the Libby Creek Recreational Gold Panning Area, as well as several trail corridors. The proposed mine alternatives would adversely affect some recreational experiences due to noise and visual impacts. These aesthetic impacts would be concentrated in the Ramsey and Libby creek drainages in Alternative 2, the Libby Creek drainage in Alternatives 3 and 4, and along NFS road #278 (Tailings Impoundment Sites) in all mine alternatives.

3.17 Scenery

3.17.1 Regulatory Framework

The Organic Administration Act authorizes the Forest Service to regulate the occupancy and use of National Forest System lands. The Forest Service's locatable minerals regulations are promulgated at 36 CFR 228, Subpart A. The regulations apply to operations conducted under the U.S. mining laws as they affect surface resources on National Forest System lands under the jurisdiction of the Secretary of Agriculture. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. 36 CFR 228.8 also requires that mining operators to the extent practicable, harmonize operations with scenic values through such measures as the design and location of operating facilities, including roads and other means of access, vegetation screening of operations, and construction of structures and improvements which blend with the landscape (36 CFR 228.8(d)).

Scenic resources under the 2015 KFP are managed through the Scenery Management System (USDA Forest Service 1995b) and the Forest Service Manual (FSM 2380). The Scenery Management System evolved from and replaced the Visual Management System. The essence of the Visual Management System remained intact, with terminology changes, and the system was expanded to incorporate updated research. The Scenery Management System recognizes natural disturbance processes and ecological processes: the resulting landscapes are dynamic ecosystems with some man-made components of the landscape that contribute to the landscape's valued character.

The 2015 KFP contains the following direction for scenic resources:

- **FW-DC-AR-02.** The scenic resources of the KNF complement the recreation settings and experiences while reflecting healthy and sustainable ecosystem conditions.
- **FW-GDL-AR-01.** Management activities should be consistent with the mapped scenic integrity objective, see Plan set of documents. The scenic integrity objective is High to Very High for scenic travel routes, including Pacific Northwest National Scenic Trail, designated Scenic Byways, and National Recreation Trails.

3.17.2 Analysis Area and Methods

3.17.2.1 Analysis Area

The analysis area for direct, indirect, and cumulative effects on scenery resources was determined by the location of the proposed mine facilities, the location of four transmission line alternatives, the location of the Sedlak Park Substation and loop line, and the visible portions of proposed project facilities that would affect the landscape character and scenic integrity. Scenery in the analysis area includes the summit and shoulder terrain of the Cabinet Mountains, forested mountains, and valleys adjacent to and east of the Cabinet Mountains; and a 6-mile portion of US 2 east of the Cabinet Mountains (Figure 82). The Libby Loadout would be in the previously disturbed Kootenai Business Park, would not affect the scenic resources in the business park, and is not discussed further. Mitigation activities, such as culvert removals proposed in the wetland mitigation plan, would have negligible effect on scenery resources.

3.17.2.2 Methods

Several previous visual resource reports and additional analysis were used to describe and assess effects on scenery. MMC assessed visual resources near the mine facilities alternatives, excluding the transmission line alternatives, in 2005 (Maxim Technologies 2005). The report assessed the visual effects of proposed mine facilities using USDA Forest Service methods for analysis. The methods used KNF user data and observation points from a previous visual resource baseline study (Woodward-Clyde Consultants 1989d).

Several transmission line alternatives developed by MMC for its MFSA certificate application were assessed in a visual impacts report (Power Engineers, Inc. 2006b). The report used the same two methods as the Maxim Technologies report to analyze visual impacts.

In addition to the use of previous visual resources reports, the lead agencies assessed current mine and transmission line alternatives from 11 key observation points (KOP) selected by the KNF and DEQ (Holdeman Landscape Architecture 2006). KOP selection and landscape character regions were determined during a site visit in 2006. Criteria for KOP selection was based on recreational uses of specific KNF roads, scenic overlooks, and Howard Lake (Table 149). The Scenery Management System (USDA Forest Service 1995b) and guidance in the Forest Service Manual 2380 were used to describe impacts on scenery for the mine and transmission line alternatives.

Table 149. Reasons for Selecting KOPs.

KOP	Reason for Selection	KOP	Reason for Selection
1	High use NFS road with a parking pullout	7	High use NFS road
2	High use scenic overlook with unobstructed views of Cabinet Mountains	8	High use NFS road
3	Hiking trail destination at the top of Elephant Peak	9	Intersection of two high use roads (NFS road and U.S. highway)
4	High use NFS road with a parking pullout and scenic overlook sign	10	High use U.S. highway
5	High use Howard Lake boat ramp	11	Permanent residences
6	High use NFS road		

Visual analysis of the transmission line alternatives consisted of two viewshed analyses. One viewshed analysis was performed from each of the 11 KOPs. Vegetation was included in the analysis by adding an average tree height to the digital terrain model to determine the length of each transmission line alternative visible from each KOP. Different tree heights were estimated for timber harvested areas from KNF data identifying the dates of harvesting. Digital polygons were developed to represent the shape of the tree clearing areas required for the lines, structures, and access roads. The digital polygons were "elevated" electronically above the ground to the various tree heights. The total length of transmission line alternative visible from each KOP was determined using GIS. A qualitative analysis is also provided regarding the level and type of use at each KOP. The qualitative analysis was developed from field observations and photographic simulations from four of the 11 KOPs (Figure 82).

The second viewshed analysis was performed from the corridor of each transmission line alternative. The same polygons used in the first analysis were used in the second one. This analysis determined the number of KOPs, length of high-use roads, and acres of CMW visible from each transmission line corridor. Roads used in the analysis were NFS roads #4776, #4724, #231, #385, and US 2. Based on the analysis, segments of each transmission line were rated as having high, moderate, low, or no visibility, as shown in Table 157 (Holdeman Landscape Architecture 2010). Because the transmission line would introduce contrasts in line, color, and texture to the landscape character, the visibility of those contrasts becomes an important variable in disclosing the impacts of the alternatives. Table 150 displays how the level of visibility influences whether specific Scenic Integrity Objectives would or would not be met.

Table 150. Approach to Assessing Consistency of Transmission Line Alternatives with Mapped Scenic Integrity Objectives.

Scenic Integrity Objective	Visibility			
	No	Low	Moderate	High
High	Consistent	Inconsistent	Inconsistent	Inconsistent
Moderate	Consistent	Consistent	Inconsistent	Inconsistent
Low	Consistent	Consistent	Consistent	Inconsistent

The visibility of the transmission line from the Howard Lake Campground was evaluated in two transmission line alternatives, Miller Creek and West Fisher Creek. These two alternatives would use the same alignment east of the lake and campground. Using digital elevation data, a profile of the ground surface was developed for each transmission line structure near the lake. Trees 75 feet high between the viewer on the west side of the lake and the transmission line were used to determine line visibility. The analysis is on file in the project record.

Compliance with KFP scenic integrity objectives across alternatives are disclosed for both the short and long term. Short term is defined as during the operation (over the next 20 years) and long term (post-operation and rehabilitation). The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on scenery resources in the analysis area. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.17.3 Affected Environment

The analysis area is characterized visually by the summit peaks of the Cabinet Mountains surrounded by the adjacent densely forested mountains and valleys, with some flat, open creek or stream valleys of dense low-growing herbaceous vegetation interspersed with the forest. The four transmission line alternatives and mine facilities alternatives would be located in montane forest and valley characteristic landscapes within the KNF. Multiple alpine peaks in the Cabinet Mountains are also an important part of views from most of the key observation points. Current sources of night lighting are activities at the Libby Adit and limited residential development on private land.

3.17.3.1 Landscape Character and Existing Scenic Integrity

Landscape Character describes the area’s positive biophysical and cultural attributes. Scenic integrity describes the degree to which those attributes are intact. Landscape Character serves as the baseline for assessing the existing scenic integrity and to evaluate whether predicted changes from management actions will meet the desired integrity (scenic integrity objectives). Three distinct landscapes are found in the analysis area: alpine, montane forest, and montane valley.

3.17.3.1.1 Alpine Landscape Character

The alpine landscape character is defined by a portion of the Cabinet Mountains along a north-south line from Snowshoe Peak to Baree Mountain (about 35 miles long and 7 miles wide), centered along the range's highest peaks; and includes some mountainous areas below timberline known as the Cabinet Shoulders. Mountain summit landforms with dominant vertical and steep slopes above timberline typify the alpine characteristic landscape. Near mountaintops and above timberline, areas of snow are frequently present. The summit topography possesses strong contrasting characteristics with the sky and landforms below.

The mountain slopes below and near timberline support sparse populations of evergreen trees with a ground cover of shrubs and grasses. The forested portion of the alpine characteristic landscape also includes large, mostly bare rock formations, creating many open areas among the trees. This region has the highest elevations (8,738 feet at Snowshoe Peak) in the analysis area.

Although no mine facilities or transmission line alternatives would be located in the alpine characteristic landscape, one KOP is located in this area. Additionally, this characteristic landscape is an important component of the views from most of the other KOPs. This characteristic landscape is the highest quality scenery as defined by the Scenery Management System (USDA Forest Service 1995b).

The KOP in the alpine characteristic landscape is located on Elephant Peak in the CMW. Views from this location are unobstructed in nearly all directions; are mostly absent of artificial forms; and include a large variety of landforms, rock forms, water forms, colors, and textures. The views from this KOP are representative of most of the Cabinet Mountains peaks and some of the CMW above timberline. Most of the proposed mine facilities, not including the tailings impoundments, and portions of all four transmission line alternatives would be visible from this KOP.

3.17.3.1.2 Montane Forest Landscape Character

Most mine and transmission line alternatives would be located in the montane forest landscape character. Densely forested mountain landforms typify this landscape. Due to the high density and the height of the forest near roads, only a small number of long-distance views exist from roads. Most views along roads are of the forest and restricted to short distances.

The analysis area has few developed recreational facilities; most observation points are from roads, mountains, and hill tops, or at the edge of the forest. An exception is the developed campground area at Howard Lake, which has a KOP located on the beach next to the lake. Timber harvest areas have created some openings in the forest along roads that provide views of the Cabinet Mountain summits and valleys below. These few locations offer tree-framed views with a large variety of mountainous landforms, vegetation communities, and sky conditions. KOPs 1, 2, 4, and 6 are located in montane forests.

3.17.3.1.3 Montane Valley Landscape Character

Gentle to nearly flat landforms with creeks or streams define the montane valley landscape character, which is interspersed within the montane forest characteristic landscape. Some mine facilities and transmission line alternatives would be located in the montane valley characteristic landscape. Montane valleys include forested areas similar to the adjacent mountains and openings with low-growing herbaceous vegetation and deciduous shrubs and trees concentrated along creeks. Views of the Cabinet Mountain summits are visible from the valleys with low-growing vegetation. Valley areas also include the only buildings visible from KOPs in the analysis area. All of the buildings are residences or associated outbuildings, and most of the residences are located along US 2. Due to the relatively small quantity, very low density, and partial obscurity by low density vegetation, these structures rarely distract from scenic views by travelers and other recreationists.

Some timber harvest areas of the KNF and adjacent private lands are visible from KOPs located in montane valleys. A few timber harvest areas are immediately adjacent to the public roads and are therefore highly visible. Timber harvest areas on mountainsides are typically only partially visible due to the screening effects of vegetation and topography. KOPs 7, 8, 9, 10, and 11 are located in montane valleys.

3.17.3.2 Scenic Integrity Objectives

The 2015 KFP established four levels of scenic integrity objectives, derived from the landscape's attractiveness and the public's expectations or concerns. These objectives apply to National Forest System lands and not to State or private lands. Each scenic integrity objective depicts a level of scenic integrity used to direct landscape management: very high (unaltered), high (appears unaltered), moderate (slightly altered), and low (moderately altered). The scenic integrity objective of very low (heavily altered) was not used in the 2015 KFP. Generally, landscapes that are most attractive (as classified by scenic attractiveness class) and are viewed from popular travel routes (as classified by concern level) are assigned higher scenic integrity objectives. Under the 2015 KFP, the scenic integrity objectives in the analysis area are very high, high, moderate, and low. None of the mine or transmission line facilities would be in areas with a very high scenic integrity objective.

The CMW and the headwaters of East Fork Rock Creek outside of the CMW have a scenic integrity objective of very high. A 0.5- to 3-mile wide area east of the CMW has a scenic integrity objective of high. Large areas with a moderate scenic integrity objective are found between US 2 and the area east of the CMW. Small areas with a low scenic integrity objective are between Ramsey and Bear creeks. The primary scenic integrity objective for each project facility is presented in Table 151.

Table 151. Primary Scenic Integrity Objective for Each Project Facility.

Facility and Alternative	Primary Scenic Integrity Objective
Adit Sites Libby Adit and Rock Lake Ventilation Adit (All mine alternatives) Upper Libby Adit (Alternatives 3 and 4)	 Private land; does not apply High
Plant Sites Ramsey Plant Site (Alternative 2) Libby Plant Site (Alternatives 3 and 4)	 High Moderate
Impoundment Sites Little Cherry Creek Site (Alternatives 2 and 4) excluding portions on private land Poorman Site (Alternative 3)	 Moderate Moderate
LAD Areas (Alternative 2)	Moderate
Access Roads—231 and 278 (all alternatives)	Moderate
Transmission Line Alternative B Agency Alternatives	 Moderate; high in upper Midas and Ramsey creeks Moderate; high in upper Midas Creek
Sedlak Park Substation and Loop Line (all transmission line alternatives)	Private land; do not apply

3.17.4 Environmental Consequences

3.17.4.1 Alternative 1 – No Mine

The existing views from KOPs and existing scenic integrity would not change in the No Mine Alternative. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150, would remain in effect. The DEQ's approval of revisions to DEQ Operating Permit #00150 (revisions 06-001, 06-002, and 08-001) also would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. The existing Libby Adit Site disturbances would remain, and would be visible only from KOP 4 in a montane forest at a NFS road #231 Pullout (Figure 82). Disturbances on private land at the Libby Adit Site would remain until reclaimed in accordance with existing permits and approvals.

3.17.4.2 Alternative 2 – MMC's Proposed Mine

For all action alternatives, and for the duration of the mine's and transmission line's operations, mine facilities, presence of haul vehicles, and introduction of night lighting at all mine facilities and along NFS roads would alter views from KOPs and other locations. Following mine closure, reclamation of most mine facilities would return disturbed areas to a condition similar to a timber harvested area, which would be consistent with scenic integrity objectives. The tailings impoundment would permanently change scenic integrity. Existing scenic integrity objectives and short- and long-term scenic integrity of project facilities in Alternative 2 are summarized in Table 152.

Table 152. Scenic Integrity Objective and Short- and Long-term Scenic Integrity of Project Facilities, Alternative 2.

Facility	Scenic Integrity Objective			Scenic Integrity During Operations			Long-term Scenic Integrity		
	H (ac.)	M (ac.)	L (ac.)	H (ac.)	M (ac.)	VL (ac.)	H (ac.)	M (ac.)	L (ac.)
Adit Sites	1	0	0	0	0	1	1	0	0
Plant Site	52	0	0	0	0	52	52	0	0
Impoundment Footprint	0	532	0	0	0	532	0	0	532
Other Impoundment Site Disturbances	0	1,094	34	0	0	1,128	0	1,094	34
LAD Areas	45	326	59	0	0	430	45	326	59
Bear Creek Road to Impoundment Site	4	68	0	4	68	0	4	68	0
Other Access Roads	22	39	12	0	0	73	22	39	12
Total	123	2,059	105	4	68	2,215	123	1,527	636

H = high; M = moderate; L = low; VL = very low
Totals may vary slightly due to rounding.
Source: GIS analysis by ERO Resources Corp. using KNF data.

3.17.4.2.1 Libby Adit Site and Rock Lake Ventilation Adit

The existing disturbance at the Libby Adit Site is on private land and new disturbance at the site in all mine alternatives would be minimal. Activity at the site would increase during all mine phases in all mine alternatives. The existing Libby Adit Site would continue to alter scenic integrity from the scenic overlook at KOP 2, Elephant Peak (KOP 3), the south NFS road #231 pullout (KOP 4), a portion of NFS roads #231 and #4776, portions of the CMW, and a portion of a private land parcel along Libby Creek northeast of the adit site (Figure 82). Viewing significance, as defined by the Concern Levels from the three KOPs and two roads, would be high due to high visitor use and long viewing duration due to stationary viewers or a high viewing angle above the site's location. The visible scenic integrity would be changed through landform modifications and vegetation pattern interruptions. The change would alter scenic integrity by introducing noticeable contrasts of new buildings, fencing, night lighting, and the presence of mine traffic. The visual absorption level of the Libby Adit Site is high, indicating a substantial capacity to accommodate change. Noticeable changes from KOP 4 would be substantial due to a direct unobstructed line of sight to the adit and long duration views. Because of the screening effects of trees and topography, a relatively small portion of the adit site would remain visible from a private land parcel southeast of the site. Because the Libby Adit Site is and the Rock Lake Ventilation Adit would be on private land, scenic integrity objectives do not apply. Following the mine closure, regrading and revegetation would create areas with similar landscape characteristics to the existing timber harvested areas and unpaved, abandoned roads.

The Rock Lake Ventilation Adit would be an air ventilation opening on the ground, about 15 feet by 15 feet in size, and covered by a metal grate. No mine materials would be transferred to or from this location, and a temporary construction disturbance would be limited (less than 1 acre) because the adit would be constructed from the mine underground. The adit would be located on the west side of the Cabinet Mountains and, therefore, not visible from 10 of the 11 KOPs. The adit would be very difficult to see from KOP 3, Elephant Peak, because of the site's relatively small size and the screening effects of topography. Some views of the adit from Rock Lake would be partially obscured by topography and timberline vegetation. Following the mine closure, regrading would create an area with similar landscape characteristics to the existing treeless areas at timberline.

3.17.4.2.2 Ramsey Plant Site

Construction and use of the Ramsey Plant Site would alter the scenic integrity from the scenic overlook at KOP 2, Elephant Peak (KOP 3), a portion of NFS roads #231 and #4776C, and portions of the CMW (Figure 82). Viewing significance would be high due to high visitor use along NFS road #4776C and at KOP 2, and the high view angle above the plant site and unobstructed view from Elephant Peak (KOP 11). Although Elephant Peak is 1 mile from the plant site, it receives very low visitor use due to its remote location and non-motorized accessibility. Because the plant site and adit entrances would be between two vegetated ridges to the north and south, views from the roads would be very short duration and partially obscured by vegetation; views from the CMW would be partially or entirely obstructed by topography and vegetation.

Landscape attributes would be changed over the short term due to the construction of the plant facilities, specifically to the vegetation pattern and land use. These changes would alter scenic integrity by introducing noticeable contrasts. The visual absorption capability of the plant site is high, indicating a substantial capacity to accommodate change, and the area of disturbance would be relatively small in most views.

The plant site would have a scenic integrity of very low during construction, operations, and closure. Following the mine closure, regrading and revegetation would create areas with similar landscape characteristics to the existing timber harvested areas. The plant site would return to its existing scenic integrity of high after revegetation was successful.

3.17.4.2.3 LAD Areas

Use of the two LAD Areas would alter the scenic integrity over the short term from the representative viewpoint along NFS road #4776C at KOP 2, the scenic overlook at KOP 3, a portion of NFS roads #231 and #4776, and portions of the CMW (Figure 82). Viewing significance from the two KOPs and two roads is high due to high visitor use and/or close proximity to the LAD Areas. Views from the KOPs are also long duration, while views from the two roads are short duration and partially obscured by vegetation. Viewing significance from the private land parcel east and south of the LAD Areas would be high due to potential long duration viewing times and close viewer proximity to the LAD Areas. The private land parcel north of Bear Creek would not be affected due to the screening effects of trees and topography.

The visible landscape attributes, such as the landform, vegetation pattern, and land use, would be changed over the short term due to the use of the LAD Areas. These changes would alter scenic integrity by introducing noticeable and substantial contrasts. The visual absorption capability of the LAD Areas is high, indicating a substantial capacity to accommodate change. For example, tree clearings would be designed to blend with the existing vegetation patterns in the vicinity as the LAD Areas. Following the mine closure, regrading and revegetation of the LAD Areas would potentially create areas with natural vegetation patterns. MMC expects all waste rock to be used in construction of various facilities. It is anticipated that no waste rock would remain at the LAD Area 1 stockpile after cessation of mining operations.

The creation of a new access road between the impoundment site and LAD Areas would noticeably alter the line, color, texture, and form of the existing forest. The new access road would be highly evident from KOPs 2 and 3, and some other KNF locations.

The LAD Areas would have a scenic integrity of low during construction, operations, and closure. Following the mine closure, regrading and revegetation would create areas with similar landscape characteristics to the existing timber harvested areas. The LAD Areas would return to their desired scenic integrity of low, moderate, or high after revegetation was successful.

3.17.4.2.4 Little Cherry Creek Tailings Impoundment Site

The Little Cherry Creek Tailings Impoundment Site would alter scenic integrity from KOPs 1, 2, and 3, a portion of NFS roads #231 and #4776, and portions of the CMW. Viewing significance from the three KOPs and two roads is high due to high visitor use, close proximity to the impoundment, long viewing duration, and a high viewing angle above the impoundment site. From KOP 2, the scenic overlook, about one-fourth of the impoundment site would be obstructed from view due to the screening effects of topography and vegetation. Although the visual absorption capability of the tailings impoundment location is moderate, its relatively large size in all views would create noticeable contrasts in landscape character and substantial alterations in scenic integrity. A visual simulation of the Little Cherry Creek Tailings Impoundment Site from KOP 2, a representative view from NFS road #4776C, is presented in Appendix I.

KOPs 1, 2, and 3, would have a mostly unobscured direct line of sight and view of a majority of the tailings impoundment. Because each KOP is a destination for scenic viewing, these views are also long in duration. KOPs 1 and 2 receive high visitor use. These two points are easily accessed by all vehicle types and are located relatively close to Libby and US 2. Local residents often bring out-of-town visitors to these KOPs for scenic viewing.

Views of the tailings impoundment from NFS roads #231 and #4776 would be partially obscured by vegetation. Openings in the vegetation also would frame, and emphasize views of the tailings impoundment. Although these views would be mostly from slow-moving vehicles with short-viewing durations, the tailings impoundment would be visible from about 2 miles of NFS road #231, and about 1 mile of NFS road #4776. From NFS road #231 views of the tailings impoundment would be mostly perpendicular to the direction of travel, and from NFS road #4776 views would be directly in line with the direction of travel to the northwest. These two roads are the main vehicular access to KOPs 1 and 2.

Above timberline, dispersed recreational users in some areas of the CMW, would have unobstructed views of the entire tailings impoundment. Views from the CMW below timberline would be similar, but would be partially obscured by vegetation. The landform contrast and relatively large size of the tailings impoundment would create a noticeable deviation to the landscape from KOP 3, Elephant Peak, most locations in the CMW east of the major peaks ridgeline, and up to 6 miles away.

Scenic integrity from the private land parcel southeast of the impoundment dam, about 0.5 mile (2,700 feet) between dam and nearest property line, would be permanently altered. Scenic integrity would be reduced in northwesterly views from the north end of the private parcel due to a view of the impoundment dam face partially obscured by trees and topography. Scenic integrity would be minimally reduced in northwesterly views from the southern portion of private land due to the increasing screening effects of the forest with increasing distance from the impoundment. The perceived size of the impoundment also would diminish with increasing viewing distance.

Scenic integrity from the private land parcel north of the impoundment site, about 0.25 mile (1,400 feet) between impoundment site and nearest property line, would not be affected, or affected only nominally. Visibility of the impoundment site, in southerly views only, would be mostly, or completely, obscured by topography and trees.

The visual absorption capability of the tailings impoundment location and surrounding vicinity is moderate, indicating a moderate capacity to accommodate noticeable change. Disturbances of landform, major disruptions of vegetation patterns, or substantial changes in land use at the impoundment site would be highly noticeable. The line, color, texture, and form of the existing forest vegetation and topography would be in high contrast with the adjacent unaffected vegetation and landforms. The Little Cherry Creek Impoundment Site would have a scenic integrity of very low during construction, operations, and closure. Scenic integrity objectives do not apply to those portions of the impoundment and other disturbances on private land.

Following the mine closure, grading and revegetation of the tailings impoundment and other disturbances would restore some color and texture characteristics similar to the adjacent undisturbed vegetation. Because of the large size and contrasting form, the tailings impoundment would remain an interruption of the scenic integrity of the site. Following mine closure, revegetation of the tailings impoundment would partially reduce color and texture contrasts between the tailings impoundment and surrounding landscape. The large, inconsistent landform of the impoundment would remain. The Little Cherry Creek Impoundment would have a permanent scenic integrity of low. The impoundment would not meet the scenic integrity of moderate after revegetation was successful because of the permanent change in landform. Other disturbances, such as the Seepage Collection Pond and soil stockpiles, would be graded and revegetated. Other disturbances at the impoundment site would meet the scenic integrity objectives of low or moderate after revegetation was successful.

3.17.4.2.5 Main Access Roads

MMC would use the Libby Creek Road during the Evaluation Phase and for a year or two while the Bear Creek Road was reconstructed. The Libby Creek Road would not be widened or paved. Minor stream improvements, such as culvert replacement, would be completed before the Evaluation Phase. Disturbed areas at culvert replacement sites would be revegetated immediately after disturbance. Activities on the Libby Creek Road would not affect the scenic integrity objective of moderate. Scenic integrity objectives do not apply to those segments of the Libby Creek Road on State or private land.

The Bear Creek Road from US 2 to the Bear Creek bridge would be widened from its existing 14-foot width to 20 to 29 feet and paved. Within the tailings impoundment area, the Bear Creek Road would be relocated and reconstructed in four locations (Figure 8). These sections, and non-realigned sections, would be chip-sealed and the roadway widened to 20 to 29 feet, consistent with the road north of Bear Creek. About 0.5 miles south of the tailings impoundment area and west of the Bear Creek Road, MMC would build 1.7 miles of new single lane road that would connect the Bear Creek Road with the Ramsey Creek Road (NFS road #4781) (Figure 16). Disturbed areas, such as cut and fill slopes, would be revegetated immediately after construction. For several years after construction, the Bear Creek Road would have a scenic integrity of low. The widening and paving Bear Creek Road would alter the landscape character attributes seen by forest visitors on the road. The scenic integrity would improve to moderate or high as the revegetation became established. Scenic integrity objectives do not apply to those segments of the Bear Creek Road on private land.

3.17.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

In the agencies' mine and transmission line alternatives, MMC would implement a number of measures to harmonize operations with scenic values (section 2.5.3.7.2, *Scenery and Recreation*). MMC would complete vegetation clearing operations and painting of structures under the supervision of an agency representative with experience in landscape architecture and revegetation. Where practicable, MMC would create clearing edges with shapes directly related to topography, existing vegetation community densities and ages, surface drainage patterns, existing forest species diversity, and view characteristics from KOPs. MMC would avoid straight line or right-angle clearing area edges. MMC would paint structures to blend in with the surrounding landscape. MMC would not create symmetrically-shaped clearing areas.

MMC would transition forested clearing area edges into existing treeless areas by varying the density of the cleared edge under the supervision of an agency representative. MMC would mark only trees to be removed with water-based paint, and not mark any trees to remain. MMC would cut all tree trunks at 6 inches or less above the existing grade in clearing areas located in sensitive foreground areas such as within 1,000 feet of residences, roads, and recreation areas. These locations would be determined and identified by an agency representative before clearing operations.

Existing scenic integrity objective and short- and long-term scenic integrity of project facilities in Alternative 3 are summarized in Table 153.

3.17.4.3.1 Libby and Rock Lake Adits

Effects on scenery at the adit sites would be slightly greater than Alternative 2 because of a 1-acre area of contrasts created by the Upper Libby Adit. Although the disturbed area would remain relatively small in the views from KOPs 2 and 3, the roads, and the CMW, the contrasts would create a slightly greater visual distraction. The Upper Libby Adit Site would have a scenic integrity of very low during construction, operations, and closure. Following the mine closure, regrading and revegetation would be implemented to match natural vegetation patterns. The site would return to its existing scenic integrity of high after revegetation was successful. Effects on landscape character and scenic integrity of the Libby Adit and the Rock Lake Ventilation Adit, located on MMC private land, would be the same as Alternative 2. MMC would, where possible, screen the Rock Lake Ventilation Adit from view using native materials.

Table 153. Scenic Integrity Objective and Short- and Long-term Scenic Integrity of Project Facilities, Alternative 3.

Facility	Scenic Integrity Objective			Scenic Integrity During Operations			Long-term Scenic Integrity		
	H (ac.)	M (ac.)	L (ac.)	H (ac.)	M (ac.)	VL (ac.)	H (ac.)	M (ac.)	L (ac.)
Adit Sites	1	0	0	0	0	1	1	0	0
Plant Site	0	76	0	0	0	76	0	76	0
Impoundment Footprint	0	434	156	0	0	590	0	0	590
Other Impoundment Site Disturbances	0	657	26	0	0	682	0	657	26
LAD Areas	0	0	0	0	0	0	0	0	0
Bear Creek Road to Impoundment Site	4	79	0	4	79	0	4	79	0
Other Access Roads	26	52	16	0	0	93	26	52	16
Total	30	1,297	197	4	79	1,442	30	863	631

H = high; M = moderate; L = low; VL = very low
Totals may vary slightly due to rounding.
Source: GIS analysis by ERO Resources Corp. using KNF data.

3.17.4.3.2 Libby Plant Site

Construction and use of the Libby Plant Site would alter the scenic integrity from KOPs 2, 3, and 4, a portion of NFS roads #231 and #4776C, portions of the CMW, and the private land parcel east of the plant site (Figure 82). The plant site would be located on a ridge between the Libby and Ramsey Creek valleys and would be highly visible. Viewing significance from KOP 2 is high due to high visitor use along NFS road #4776C, the high view angle above the plant site, and an unobstructed view of the entire plant site. Views from KOP 3 and Elephant Peak would have similar viewing significance and views of the plant site as KOP2. Views from NFS roads #231 and #4776C would be short duration and partially obscured by vegetation. Views from CMW in the forest also would be partially obstructed by vegetation. Views from CMW above timberline would be completely unobstructed. Only a relatively small portion of the plant site would be visible from the private land parcel due to the screening effects of trees and topography.

The scenic integrity would change due to the construction of the plant facilities, specifically to the vegetation pattern, landform, and land use. These changes would alter scenic integrity by introducing noticeable contrasts. The visual absorption capability of the plant site is low, indicating a small capacity to accommodate change. Following the mine closure, regrading and revegetation would be implemented to match natural vegetation patterns. The agencies' mitigation would reduce the visual contrast of the plant site during reclamation. The Libby Plant Site would have a scenic integrity of very low during construction, operations, and closure. Following the mine closure, regrading and revegetation would be implemented to match natural vegetation patterns. The plant site would meet the scenic integrity objective of moderate after revegetation was successful.

3.17.4.3.3 Poorman Tailings Impoundment Site

Effects on scenic integrity due to the Poorman Tailings Impoundment Site would be similar to the Little Cherry Creek Tailings Impoundment Site in Alternatives 2 and 4. Because of the impoundment's location, the entire impoundment site would be visible from the scenic overlook at KOP 3. All other scenic integrity, landscape character, and visual absorption capability characteristics would be the same as Alternatives 2 and 4. The agencies' mitigation would reduce the visual contrast of the impoundment during reclamation. MMC would develop a design to recontour faces of the tailings impoundment dams to more closely blend with the surrounding landscape than proposed in Alternative 2. Sand deposition would be varied during final cycloning and placement of sand on the dams. This design would incorporate additional rocky borrow at selected locations on the dam face and use benches in some locations. Islands of trees and shrubs would be planted in the rocky areas. The seed mixture on the dam face would vary to reduce uniformity of the revegetated dam.

A visual simulation of the Poorman Impoundment Site from KOP 2 is presented in Appendix I. The Poorman Tailings Impoundment Site would have a scenic integrity of very low during construction, operations, and closure. The large, inconsistent landform of the impoundment would remain following closure. After reclamation, the Poorman Impoundment would have a scenic integrity of low, which would meet the scenic integrity objective of low. The impoundment would not return to its existing scenic integrity of low or moderate after revegetation was successful because of the permanent change in landform. Other disturbances, such as the Seepage Collection Pond and soil stockpiles, would be graded and revegetated. Other disturbances at the impoundment site would return to its existing scenic integrity of low or moderate after revegetation was successful.

Scenic integrity from the private land parcel due east of the impoundment dam, about 0.06 miles (350 feet) between dam and nearest property line, would be permanently and substantially altered. Scenic integrity would be permanently and substantially reduced in westerly views from the north end of the private parcel due to a mostly unobstructed view of the 270-foot high impoundment dam face. Scenic integrity would be moderately reduced in northwesterly views from the southern portion of this parcel due to the increasing screening effects of the forest with increasing distance from the impoundment. The size of the impoundment also would be diminishing with increasing viewing distance.

Scenic integrity from the private land parcel north of the impoundment site, about 1.1 miles (5,700 feet) between impoundment site and nearest property line, would not be affected, or affected only nominally. Visibility of the impoundment site in southerly views only, would be mostly, or completely, obscured by topography and trees. Following mine closure, revegetation of the tailings impoundment would partially reduce color and texture contrasts between the tailings impoundment and surrounding landscape.

3.17.4.3.4 Main Access Roads

Effects on scenic integrity due to the main access roads would be similar to Alternative 2. Less new road would be constructed in the tailings impoundment area. MMC would complete vegetation clearing operations and painting of structures under the supervision of an agency representative with experience in landscape architecture and revegetation. Where practicable, MMC would create clearing edges with shapes directly related to topography, existing vegetation community densities and ages, surface drainage patterns, existing forest species diversity, and view characteristics from KOPs. MMC would avoid straight line or right-angle clearing area edges. Visual effects of the main access roads would be minimized in Alternative 3.

3.17.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Effects on scenic integrity due to the main access roads, Libby Plant Site, Libby Adit Site, upper Libby Adit Site, and Rock Lake Ventilation Adit would be the same as for Alternative 3. The agencies' mitigation would reduce the visual contrast of the impoundment during reclamation. Effects on scenic integrity and landscape character due to the Little Cherry Creek Tailings Impoundment Site would be the same as for Alternative 3. The scenic integrity objective and short- and long-term scenic integrity of project facilities in Alternative 4 are summarized in Table 154.

Table 154. Scenic Integrity Objective and Short- and Long-term Scenic Integrity of Project Facilities, Alternative 4.

Facility	Scenic Integrity Objective			Scenic Integrity During Operations			Long-term Scenic Integrity		
	H (ac.)	M (ac.)	L (ac.)	H (ac.)	M (ac.)	VL (ac.)	H (ac.)	M (ac.)	L (ac.)
Adit Sites	19	0	0	0	0	19	19	0	0
Plant Site	0	76	0	0	0	76	0	76	0
Impoundment Footprint	0	528	0	0	0	528	0	0	528
Other Impoundment Site Disturbances	0	821	10	0	0	831	0	821	10
LAD Areas	0	0	0	0	0	0	0	0	0
Bear Creek Road to Impoundment Site	4	68	0	4	68	0	4	68	0
Other Access Roads	40	74	16	0	0	130	40	74	16
Total	63	1,567	26	4	68	1,584	63	1,038	554

H = high; M = moderate; L = low; VL = very low
Totals may vary slightly due to rounding.
Source: GIS analysis by ERO Resources Corp. using KNF data.

3.17.4.5 Alternative A – No Transmission Line

The analysis area's existing scenic integrity as viewed from KOPs would not change in Alternative A. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. The visual effect of the Libby Adit would remain until it was reclaimed in accordance with existing permits and approvals.

3.17.4.6 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

The segments of the North Miller Creek Alternative visible from the viewing locations, KOPs, high use roads, and the CMW, are shown on Figure 82. This alternative would be visible from the most KOPs. About 6.4 miles of transmission line would be visible from five of the 11 KOPs, 3, 8, 9, 10, and 11 (Table 155). KOPs 8, 9, and 11 are located on private land. Visibility of the transmission line, structures, and tree clearing area would be very low and partially obscured from KOPs 8 and 9 due to the screening effects of topographic changes and trees. Effects on KOPs would be negligible because a relatively small portion of the tops of the transmission line structures would be visible above evergreen treetops, and the visible tops would be a very small size within the views. Additionally, the tops of the structures would be relatively small portions of views from the KOPs. This alternative would have visibility of the transmission line from the most acres of CMW and second least miles from high use roads (Table 156). The length of high use roads with transmission line visibility would be the same as Alternative D-R.

The North Miller Creek transmission line alternative would have 1.3 miles of line (24 acres of clearing) on National Forest System lands that would not be visible from KOPs, high use roads, or the CWM; these segments would be consistent with the scenic integrity objective of moderate or high. An additional 0.7 miles of line (12 acres of clearing) would have low visibility from KOPs, high use roads, or the CWM. Because of the low visibility, the changes in line, color, texture, and form of the transmission line clearing would remain visually subordinate to the landscape character being viewed. These segments would be consistent with the scenic integrity objective of moderate. The remaining 7.2 miles of line (131 acres of clearing) on National Forest System lands would have a moderate or high visibility. Because of the high visibility, the changes in line, color, texture, and form of the transmission line clearing would not remain visually subordinate to the landscape character being viewed. These segments would not be consistent with the scenic integrity objective of moderate or high. Clearing for 21 acres of roads on National Forest System lands in upper Miller and Midas Creek drainages would have low scenic integrity during construction and would not meet the scenic integrity objective of moderate or high. The scenic integrity of all disturbances associated with the transmission line would improve to moderate or high after the line was decommissioned and vegetation became re-established.

BPA's Sedlak Park Substation and loop line would be on private land owned by Plum Creek. It is not be subject to Forest Service visual management standards. The substation's perimeter would be illuminated during nighttime hours, and lighting would be directed downward to mitigate light and glare. One residence would have a direct view of the proposed substation location.

3.17.4.7 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

The agencies' transmission line alternatives incorporated several mitigations to avoid or minimize effects on visual resources. All agency alternatives use an alignment that route the line on an east-facing ridge immediately north of the Sedlak Park Substation instead of following the Fisher River, reducing visibility from US 2. All agency alternatives also would use wooden H-frame structures, which are shorter and would be less visible. During final design, MMC would submit a final Vegetation Removal and Disposition Plan for lead agencies' approval. The plan's goal would be to minimize vegetation clearing, particularly in riparian areas. The agencies modified MMC's proposed Environmental Specifications to incorporate current transmission line construction practices. The agencies' Environmental Specifications, shown in Appendix D, would be

Table 155. Transmission Line Length Visible from KOPs.

KOP	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
1	—	—	—	—
2	—	—	—	—
3	2.83	0.58	—	—
4	—	—	—	—
5	—	—	0.42	0.42
6	—	—	—	—
7	—	—	—	—
8	0.24	—	—	—
9	1.78	0.31	0.31	0.17
10	0.74	0.04	0.04	0.04
11	0.83	—	—	—
Total	6.42	0.93	0.77	0.63

All units are miles.
— = Not visible from KOP.
KOP = Key Observation Point.
Source: GIS analysis by ERO Resources Corp. using KNF data.

Table 156. Visibility of Transmission Line from KOPs, Roads, and the CMW.

Location	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
KOPs (number)	5	3	3	3
High use roads (miles)	11.19	9.89	11.92	11.99
CMW (acres)	1,630	1,480	1,450	1,470

KOP = key observation point.
CMW = Cabinet Mountains Wilderness.
Source: GIS analysis by ERO Resources Corp. using KNF data.

implemented for transmission line construction, operation, maintenance, and decommissioning activities in all of the agencies' transmission line alternatives. The agencies' Environmental Specifications also include sensitive areas, such as high visibility areas, where special measures would be taken to reduce impacts during construction and reclamation activities. In all of the agencies' transmission line alternatives, MMC would implement the measures to harmonize operations with scenic values discussed under Alternative 3.

The segments of the Modified North Miller Creek Alternative visible from the viewing locations, KOPs, high use roads, and the CMW, are shown on Figure 82. About 0.9 miles of transmission line would be visible from three of the 11 KOPs (Table 155). Visibility of the transmission line, structures, and tree clearing area would be very low and partially obscured from KOPs 9 and 10 due to the screening effects of topographic changes and trees. Effects on KOP 3 would be the same as for Alternative B.

This alternative would have visibility of the transmission line from the second most acres of CMW, and least miles of from high use roads (Table 156). The visual effect of BPA's Sedlak Park Substation would be the same as Alternative B. The Modified North Miller Creek transmission line alternative would have 1.1 miles of line (27 acres of clearing) on National Forest System lands that would not be visible from KOPs, high use roads, or the CWM; these segments would be consistent with the scenic integrity objective of moderate or high. An additional 1.8 miles of line (44 acres of clearing) would have low visibility from KOPs, high use roads, or the CWM. Because of the low visibility, the changes in line, color, texture, and form of the transmission line clearing would remain visually subordinate to the landscape character being viewed. These segments would be consistent with the scenic integrity objective of moderate. The remaining 5.5 miles of line (134 acres of clearing) on National Forest System lands would have a low to high visibility; these segments would not be consistent with the scenic integrity objective of moderate or high. Clearing for short segments of roads between existing roads and the transmission line corridor on National Forest System lands totaling 4 acres would not create additional new contrasts. The scenic integrity of all disturbances associated with the transmission line would improve to moderate or high after the line was decommissioned and vegetation became re-established.

3.17.4.8 Alternative D-R – Miller Creek Transmission Line Alternative

The segments of the Miller Creek Alternative visible from the viewing locations, KOPs, high use roads, and the CMW, are shown on Figure 82. About 0.8 mile of transmission line would be visible from three of the 11 KOPs (Table 155). Visibility of the transmission line, structures, and tree clearing area would be very low and partially obscured from KOPs 9 and 10 due to the screening effects of topographic changes and trees. Effects on KOP 5, at Howard Lake, would be high visibility, high contrast, and noticeable change to the existing line, color, and texture of the forest. Most visitors to Howard Lake would have unobstructed views of a portion of this alternative. A photographic simulation of the view from the Howard Lake boat ramp with Alternative D-R is in Appendix I.

This alternative would have visibility of the transmission line from the least acres of CMW, and the second most miles from high use roads (Table 156). The visual effect of BPA's Sedlak Park Substation would be the same as Alternative B. The Miller Creek transmission line alternative would have 0.1 miles of line (2 acres of clearing) on National Forest System lands that would not be visible from KOPs, high use roads, or the CWM. Because of the low visibility, the changes in line, color, texture, and form of the transmission line clearing would remain visually subordinate to the landscape character being viewed. These segments would be consistent with the scenic integrity objective of moderate or high. An additional 2.5 miles of line (61 acres of clearing) would have low visibility from KOPs, high use roads, or the CWM. Because of the low visibility, the changes in line, color, texture, and form of the transmission line clearing would remain visually subordinate to the landscape character being viewed. These segments would be consistent with the scenic integrity objective of moderate. The remaining 6.3 miles of line (153 acres of clearing) on National Forest System lands would have a moderate or high visibility; these segments would not be consistent with the scenic integrity objective of moderate or high. Clearing for short segments of roads between existing roads and the transmission line corridor on National Forest System lands totaling 11 acres would not create additional new contrasts. The scenic integrity of all disturbances associated with the transmission line would improve to moderate or high after the line was decommissioned and vegetation became re-established.

3.17.4.9 Alternative E-R – West Fisher Creek Transmission Line Alternative

The segments of the West Fisher Alternative visible from the viewing locations, KOPs, high use roads, and the CMW, are shown on Figure 82. About 0.6 mile of transmission line would be visible from three of the 11 KOPs (Table 155). Effects from KOPs 5, 9, and 10 would be the same as Alternative D-R.

This alternative would have visibility of the transmission line from the second least acres of CMW, and the most miles from high use roads (Table 156). The visual effect of BPA's Sedlak Park Substation would be the same as Alternative B. The West Fisher Creek transmission line alternative would not have any segments not visible from KOPs, high use roads, or the CWM. An estimated 0.4 miles of line (10 acres of clearing) would have low visibility from KOPs, high use roads, or the CWM. Because of the low visibility, the changes in line, color, texture, and form of the transmission line clearing would remain visually subordinate to the landscape character being viewed. These segments would be consistent with the scenic integrity objective of low or moderate. The remaining 7.8 miles of line (189 acres of clearing) on National Forest System lands would have a moderate or high visibility; these segments would not be consistent with the scenic integrity objective of moderate or high. Clearing for roads on National Forest System lands totaling 44 acres would not be consistent with the scenic integrity objective of moderate or high. Clearing for short segments of roads between existing roads and the transmission line corridor on National Forest System lands totaling 6 acres would not create additional new contrasts. The scenic integrity of all disturbances associated with the transmission line would improve to moderate or high after the line was decommissioned and vegetation became re-established.

Based on all KOP, road, and CMW locations with transmission line visibility, Alternative B would have the greatest length of high transmission line visibility at 3.8 miles. Alternative D-R would have the greatest length of transmission line with no visibility of 1.5 miles (Table 157).

Table 157. Visibility Levels of Transmission Line Alternatives.

Visibility	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
No Visibility	2.1	2.5	1.5	1.7
Low	2.5	2.8	4.1	2.8
Moderate	8.0	5.8	6.6	8.1
High	3.8	2.1	1.6	2.7

All units are in miles.
Source: GIS analysis by ERO Resources Corp.

3.17.4.10 Effectiveness of Agencies' Proposed Mitigation

In Alternatives 3 and 4, MMC would regrade and shape flat surfaces to blend with the adjacent landscape and have natural dendritic drainages. Additional fill would be used as necessary to create smooth transitions between human-made and natural landforms whenever project facilities were reclaimed. MMC also would develop a design to recontour faces of the tailings impoundment dams to more closely blend with the surrounding landscape than proposed in

Alternative 2. Although reclaimed areas would generally have noticeably different lines, colors, and textures, the mitigation measures included in the reclamation process in Alternatives 3 and 4 would reduce or eliminate these contrasts. For example, the visible effects of vegetation color contrasts would no longer be apparent sometime after reclamation. At the proposed tailings impoundment location, mitigation measures would reduce but not eliminate the effects of the line, color, and texture contrasts. The proposed reclamation plan for the tailings impoundment sites would be designed to blend the impoundment with surroundings by repeating line, form, color, and texture of the surrounding landscape. The landscape at the impoundment sites would always appear altered.

The effectiveness of other mitigation measures would be:

- Lighted mine facilities and roads used for mining operations would remain highly visible at night. Although shields or baffles at the light sources would prevent most glare from the bulb, the ambient light would be highly visible because the facility locations and roads are mostly dark, except at the Libby Adit.
- Grading to minimize disturbance area for mine facilities would reduce, but not eliminate visible contrasts with the surrounding landforms.
- Following mining operations, placement of waste rock underground in existing disturbed areas, or into the tailings impoundment would eliminate the visible contrasts of color and texture, and minimize areas of disturbance.
- Completing the vegetation clearing operation under the supervision of an agency representative would minimize the areas of disturbance and therefore minimize the visibility of mine facilities and the transmission line. Creating clearing edges with varying shapes responding to the composition of the adjacent forest, existing topography, and views from KOPs would reduce, and possibly eliminate visibility of some mine facilities and the transmission line from some KOPs, and minimize the contrasts of line. Varying the density of the clearing edges would also minimize the visibility of the edges.
- Marking trees for removal as opposed to marking for preservation would not result in paint markings on trees remaining in the vicinity of the proposed facilities and along the transmission line clearing corridor.
- Cutting all trees in clearing areas to within 6 inches of the ground and within 1,000 feet of KOPs, would reduce, but not eliminate, the visible presence of cut tree trunks, and the contrasts of color and texture.
- Locating mine facilities and the transmission line below the horizon line as viewed from the KOPs reduces, but does not eliminate, visibility and the contrasts of line, color, and texture of the facilities and transmission line.

During operations, mitigation measures of the transmission line alternatives would also reduce the noticeable contrasts created by the presence of the line, structures, new roads, and tree clearing corridors. These facilities would remain visible from some locations throughout operations. Although the use of wood poles, non-specular conductors, and non-reflective insulators would reduce the contrasts of texture with the surrounding forest and the reflection of light, these facilities would remain visible from some locations. Variations in the width and shape of the forest clearing corridors would create some forest edge characteristics edges similar to naturally-formed clearings. Leaving a variety of species and tree sizes at the clearing edges would also create the appearance of naturally-formed clearing edges. Clearing corridors would remain highly visible from some locations and in contrast with the surrounding forest. Following the mine closure and reclamation, the visible effects of the transmission line would be eliminated when tree height and density matched the surrounding forest.

During operations, mitigation measures of the mine facilities' night lighting would reduce the amount of visible artificial light. Although light fixture baffles and directional light sources diminish the amount of ambient light emanating from a fixture, some ambient light would remain, and the light source would remain visible from some locations.

3.17.4.11 Cumulative Effects

Past actions of timber harvest and road construction have altered the scenic integrity of characteristic landscapes of the analysis area. Roads have created linear features visible throughout the analysis area. Timber harvests have altered the line, color, and texture of the undisturbed landscape. The future construction and operation activities of the Poker Hill Rock Quarry near NFS road #231 would affect the scenic integrity of views from the road. Both the quarry and planned mine facilities would be visible from NFS road #231. Timber harvest associated with the Miller-West Fisher Vegetation Management Project also would affect views from NFS roads #231 and #385. Cumulative visual impacts would occur for wilderness hikers visiting Ojibway Peak where views extend toward both the East Fork Rock Creek west of the Cabinet Mountains and Libby Creek east of the Cabinet Mountains. From a small area on the peak, both the preferred mill site for the Rock Creek Project and the Libby Plant Site and Libby Adit for the Montanore Project would be visible. Indirect impacts may occur for CMW visitors to other wilderness peaks, as either project may be visible from some wilderness viewpoints.

3.17.4.12 Regulatory/Forest Plan Consistency

3.17.4.12.1 Organic Administration Act and Forest Service Locatable Minerals Regulations

The Forest Service is responsible for ensuring that mine operations on National Forest System lands comply with Forest Service locatable mineral regulations (36 CFR 228 Subpart A) for environmental protection. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. 36 CFR 228.8(d) also requires that mining operators, to the extent practicable, harmonize operations with scenic values through such measures as the design and location of operating facilities, including roads and other means of access, vegetative screening of operations, and construction of structures and improvements which blend with the landscape.

Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8(d). In this alternative, MMC did not propose to implement practicable measures to harmonize operations with scenic values.

The agencies' alternatives (Mine Alternatives 3 and 4 and Transmission Line Alternatives C-R, D-R, and E-R) were developed and incorporated feasible and practicable measures to minimize adverse environmental impacts and harmonize operations with scenic values. Transmission Line Alternatives C-R, D-R, and E-R were developed and revised to address visual issues. The alignment of the line was moved away from private property and located away from the Hwy 2 corridor to reduce visual impacts of the line. The structure type was modified from a monopole to a H frame to reduce visual impacts as well. Mitigation measures in Alternatives 3 and 4, would include regrading and shaping of flat surfaces to blend with the adjacent landscape and have natural dendritic drainages. Additional fill would be used as necessary to create smooth transitions between human-made and natural landforms. MMC also would develop a design to recontour faces of the tailings impoundment dams to more closely blend with the surrounding landscape than proposed in Alternative 2. Additional mitigation measures include baffling or shielding night light, painting of structures to blend in with surrounding landscape minimizing the visibility of the clearing edges. Measures are further described in the previous discussion on *Effectiveness of Agencies' Proposed Mitigation*.

3.17.4.12.2 Kootenai Forest Plan

Although site-specific scenic integrity within the analysis area would be adversely affected, project activities would be neutral with regard to progress toward achieving desired condition FW-DC-AR-02.

Although the agencies' alternatives would include mitigation measures such as facility paint colors, feathering edges of the transmission line corridor, and using shorter utility poles where visible from Howard Lake, none of the mine and transmission line alternatives would be designed and implemented in accordance with guideline FW-GDL-AR-01. Section 2.12, *Forest Plan Amendment* describes the project-specific amendment to the 2015 KFP that the KNF would adopt in all mine and transmission line alternatives. The amendment would allow all mine facilities except the access roads, and segments of the transmission line to vary from the mapped scenic integrity objective for the life of the project and for the tailings impoundment to vary from the mapped scenic integrity objective permanently (Table 158). Design features cannot be applied to the project to achieve the mapped scenic integrity objective. The amendment would apply to National Forest System lands affected by the Montanore Project facilities, and would not apply to State or private lands. No visual regulatory requirements apply to BPA's Sedlak Park Substation and loop line, which would be on private land. A significance determination of the amendments will be in the ROD and is available in the project record.

Table 158. Areal Extent of National Forest System Lands Not Meeting Scenic Integrity Objective.

Duration	MMC's Proposed Alternatives (2B)	3—Agency Mitigated Poorman Impoundment Alternative			4—Agency Mitigated Little Cherry Creek Impoundment Alternative		
		C-R	D-R	E-R	C-R	D-R	E-R
Short-term	2,349	1,576	1,595	1,631	1,718	1,737	1,773
Long-term	532	434	434	434	528	528	528

All units are acres.

3.17.4.13 Irreversible and Irretrievable Commitments

Landform changes caused by the tailings impoundments would alter the scenic integrity and would be an irreversible commitment of visual resources. Changes in scenery from other mine facilities would be an irretrievable commitment of resources. At the mine closure, disturbed areas would be regraded and revegetated, and all buildings and other constructed facilities would be removed. Reclaimed areas would have noticeably different lines, colors, and textures than the adjacent undisturbed landscape.

3.17.4.14 Short-term Uses and Long-term Productivity

Short-term uses affecting scenery would include construction of all proposed mine facilities and the transmission line. In addition, there would be the short-term effects from the presence of fugitive dust from construction activities, night lighting for construction operations, and vehicle traffic.

Long-term effects on scenery would be loss of vegetation and landform changes at all mine facilities and along the transmission line during the life of the mine. Following mine closure, landscape reclamation at all mine facilities, except the tailings impoundment, would create areas similar in appearance to abandoned roads and timber harvest areas. The tailings impoundment would have physical characteristics in substantial contrast to the surrounding landscape. The scenic integrity changes at the impoundment site would be noticeable indefinitely.

3.17.4.15 Unavoidable Adverse Environmental Effects

Visual impacts of all action alternatives would be unavoidable. Existing settings and landscapes in the analysis would be altered during mine operation and for several decades following operations.

3.18 Social/Economics

3.18.1 Regulatory Framework

3.18.1.1 Forest Plan

The 2015 KFP describes desired conditions, objectives, standards, guidelines, and land suitability for project and activity decision making on the KNF, guiding all resource management activity. This direction applies either forestwide or specific to management or geographic area allocations. The 2015 KFP includes the forestwide desired condition to "contribute to the economic strength and demands of the nation by supplying mineral and energy resources while assuring that the sustainability and resiliency of other resources are not compromised or degraded" (FW-DC-MIN-01). As well as desired conditions to generate outputs and values which contribute "to sustaining social and economic systems" (FW-DC-SES-01), "contribute to the local economy through the generation of jobs and income" (FW-DC-SES-02), and "contribute to community stability or growth, and the quality of lifestyles in the Plan area" (FW-DC-SES-03).

3.18.1.2 Hard Rock Mining Impact Act

The Hard Rock Mining Impact Act is designed to assist local governments in handling financial impacts caused by large-scale mineral development projects. A new mineral development may result in the need for local governments to provide additional services and facilities before mine-related revenues become available. The resulting costs can create a fiscal burden for local taxpayers. The Hard Rock Mining Impact Board (HRMIB) oversees an established process for identifying and mitigating fiscal impacts on local governments through the development of a Hard Rock Mining Impact Plan. Under the Impact Act, each new large-scale hard-rock mineral development in Montana is required to prepare a local government fiscal Impact Plan. In the plan, the developer is to identify and commit to pay all increased capital and net operating costs to local government units that will result from the mineral development.

MMC updated the Impact Plan with the cooperation of the affected local governments (Western Economic Services, LLC 2005) and submitted it to Lincoln County for its review. Lincoln County approved the updated plan in 2007. Because the Montanore Project as currently proposed would change employment projections, MMC submitted an amendment for consideration by the HRMIB. The HRMIB approved the amendment in 2008.

3.18.1.3 Major Facility Siting Act

The purposes of the MFSA for the construction of electric transmission lines are to: ensure the protection of the state's environmental resources; ensure the consideration of socioeconomic impacts; provide citizens with an opportunity to participate in facility siting decisions; and establish a coordinated and efficient method for the processing of all approvals and authorizations required for regulated facilities. The MFSA directs the DEQ to approve a facility if, in conjunction with other findings, the DEQ finds and determines that the facility would minimize adverse environmental impacts considering the state of available technology and the nature and economics of the various alternatives.

3.18.2 Analysis Area and Methods

The socioeconomic analysis area is based on various factors that may influence the location and magnitude of potential socioeconomic impacts. Some of these factors include:

- The location of and access to the ore body and to the proposed permit area
- The likely residence area for people working at the mine (existing residents and/or any in-migrating project employees)
- The rate and magnitude of in-migration (which will be influenced by the availability of a trained or trainable local workforce and a developer-sponsored training program)
- The rate and magnitude of population and employee turnover (including student population turnover in schools, employee turnover at the mine, and employee turnover from existing jobs to employment with the Montanore Project)
- The availability and location of existing housing and potential housing and the capacity and condition of existing local services and facilities
- The people directly/indirectly affected economically by the proposed mining operation (e.g., from wages and taxes)
- The willingness and ability of community residents and local government personnel to deal with change
- The allocation and magnitude of costs associated with in-migration of workers and allocation of tax revenues
- Impacts on Sanders County from removing ore and processing in Lincoln County

Based on these factors, the socioeconomic analysis area for the proposed project is Lincoln County and the Towns of Libby, Troy, and Eureka. Affected jurisdictions in the analysis area include the incorporated municipalities of Libby and Troy as well as the Libby, Troy, and Eureka School Districts (Western Economic Services, LLC 2005).

Economic effects on Sanders County would result primarily from the distribution of metal mines tax revenues to Sanders County. Relevant baseline information in Sanders County is provided in section 3.18.3.7, *Fiscal Conditions* because socioeconomic effects are likely to be limited to direct payments to Sanders County that would be distributed among various county agencies. Other baseline data for Sanders County related to population, housing, income, employment, and quality of life are not provided for because in-migrating mineworkers are not expected to establish residency there, and effects on Sanders County would be negligible (Western Economic Services, LLC 2005). Unless otherwise specified, socioeconomic data contained in this section are based on information provided in the *2005 Socioeconomic Report for the Mines Management Montanore Project* (Western Economic Services, LLC 2006).

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on social and economic conditions in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.18.3 Affected Environment

3.18.3.1 Population and Demographics

3.18.3.1.1 Historical Population Trends and Characteristics

Since 1950, Lincoln County has experienced relatively substantial fluctuations in its population. Lincoln County experienced the largest increase in population (44 percent) between 1960 and 1970 due to construction of Libby Dam. Between 1970 and 1980, Lincoln County's population declined by about 1.7 percent. This decline is attributable to the out-migration of construction workers when Libby Dam was completed. The population recovered, by almost 8 percent, from 17,481 people in 1990 to 18,837 people in 2000 (Table 159). The U.S. Census Bureau's 2010 population estimate of 19,687 people in Lincoln County indicates that the population has grown by 4.5 percent since 2000 (U.S. Census Bureau 2012a).

Table 159. Lincoln County Population Characteristics (1970-2010).

Year	1970	1980	1990	2000	2010
Lincoln County	18,063	17,752	17,481	18,837	19,687
% Change		-1.7	-1.5	7.8	4.5
Libby	3,286	2,748	2,532	2,626	2,628
% Change		-16.4	-7.9	3.7	<0.1
Eureka	1,195	1,119	1,043	1,017	1,037
% Change		-6.4	-6.8	-2.5	2.0
Troy	1,046	1,088	953	957	938
% Change		4.0	-12.4	0.4	-2.0
Montana	694,409	786,690	799,065	902,125	989,415
% Change		13.3	1.6	12.9	9.7

Source: Western Economic Services, LLC 2006; U.S. Census Bureau 2012a.

In 2010, the median age for both males and females in Lincoln County was 49 years, compared to 40 years in the state. Lincoln County has experienced an increase in the number of older residents due in part to the popularity of second homes in rural mountain communities. From 2000 to 2010, people between the ages of 55 to 64 increased from 2,459 to 3,675 (49.5 percent) and people 65 or older increased from 2,859 to 4,040 (41.3 percent). For the state of Montana over the same period, the number of people between the ages 55 to 64 increased from 85,119 to 138,858 (63.1 percent), and the number of people 65 and older increased from 120,949 to 146,742 (21.3 percent).

3.18.3.1.2 Major Population Centers

Major population centers in Lincoln County include the towns of Libby, Troy, and Eureka. Libby is the largest town in Lincoln County, with about 23 percent of the population (Table 159). Each town's 2010 population was within 5 percent of 2000 populations. Population trends in Libby are similar to those described for the county. Libby has a higher percentage (22.5 percent) of its population over 65 years of age compared to Lincoln County (20.5 percent) and the state of Montana (14.8 percent) (U.S. Census Bureau 2012b).

3.18.3.1.3 Population Projections

Under current conditions, the Lincoln County population is projected to increase by 0.8 percent per year, rising from 19,687 people in 2010 to 22,740 people by 2030 (Table 160). Population projections for municipalities within Lincoln County were obtained by applying county population actual and projected growth rates from 1970 to 2030 to the municipalities. The population in Libby is expected to increase by 518 persons from 2,628 people in 2010 to 3,146 people in 2030. Eureka's population is expected to increase by 181 people and Troy's population is expected to increase by 225. Much of the projected population growth is attributed to expected increases in retirees and other older, affluent newcomers (Lincoln County 2009).

Table 160. Population Projections for Lincoln County and Municipalities (2010 – 2030).

Year	2010	2015	2020	2025	2030
Lincoln County	19,687	19,738	20,483	21,505	22,740
Libby	2,628	2,731	2,834	2,975	3,146
Eureka	1,037	1,057	1,097	1,152	1,218
Troy	938	1,009	1,047	1,100	1,163

Source: Western Economic Services, LLC 2006.

3.18.3.1.4 Minority Populations

Census data for Lincoln County are broken down within Census Tracts to show the distribution of minorities within the county. Libby is located almost entirely in Census Tract 2. Eureka is part of Census Tract 4 and Troy is part of Census Tract 5 (Table 161). In the 2010 Census, racial minorities represented 4.1 percent of the total County population. Another 2.3 percent of the County population falls under the category of individuals of two or more races.

Table 161. Population by Race and Ethnicity.

Race	Census Tract 1	Census Tract 2	Census Tract 3	Census Tract 4	Census Tract 5	Total	% Total Popu-lation
White	3,446	2,268	3,773	5,977	3,417	18,881	95.9
Black	6	3	3	7	4	23	0.1
American Indian or Alaskan Native	29	31	29	62	31	182	0.9
Asian	10	10	14	13	13	60	0.3
Native Hawaiian and Other Pacific Islander	4	1	1	1	2	9	0.0
Some Other Race	6	9	19	31	6	71	0.4
Two or More Races	88	57	83	130	103	461	2.3
Total	3,589	2,379	3,922	6,221	3,576	19,687	100.0
Hispanic	50	64	101	188	59	462	2.4

Source: U.S. Census Bureau 2012c.

3.18.3.1.5 Disabled Populations

Disability is categorized by the Census Bureau into communicative, physical, and mental domains. Broadly, disability is an umbrella term for impairments, activity limitations, and participation restrictions. In the 2000 Census, 4,012 people, or about 21.3 percent of the population in Lincoln County were classified as disabled; this compares to about 12.8 percent of the state population. The large numbered of disabled people can be attributed in part to former vermiculite mine workers from the W.R. Grace Mine who suffer from asbestos-related diseases. Specifically, for a 20-year period (1979 to 1998) examined, asbestosis mortality in Libby was 40 to 80 times higher than expected and lung cancer mortality was 1.2 to 1.3 times higher than expected when compared to Montana and the United States (Agency for Toxic Substances and Disease Registry 2002).

3.18.3.2 Employment

Employment conditions for Lincoln County are presented in terms of historical employment trends, current types of employment, and baseline (*i.e.*, with no mine) employment projections. Lincoln County's economy has typically centered on natural resource extraction industries such as mining and logging. Mining has historically been a dominant feature of the Lincoln County economy. The Rainey Creek and Fisher River Districts, east of Libby, and the Sylvanite and Keystone Districts, north of Troy, were productive mining areas before the 1940s. Gold, silver, copper, zinc, and lead were extracted from mines throughout Lincoln County. Until 1990, when the W.R. Grace mine was closed, Lincoln County was also the world's largest producer of vermiculite. Mining sector businesses represented 0.6 percent of all businesses, but about 7.0 percent of all County employment in 1986. In 2010, mining sector businesses represented 1.1 percent of all businesses and accounted for 4.6 percent of all County employment (Montana Department of Labor and Industry 2012a).

According to the Montana Department of Labor and Industry, lumber and wood products represented 42.1 percent (16 of 38) of all manufacturing establishments and 89.7 percent (651 of 726) of all manufacturing employment in 2000 in Lincoln County when Owens & Hurst Lumber, Plum Creek Lumber, and Stimson Lumber Company were the three largest lumber and wood product employers. During 2010, the latest data available, the lumber and wood products industry represented 27.6 percent (8 of 29) of all manufacturing establishments, and employment had declined to 24.1 percent (48 of 199) of manufacturing employment in Lincoln County. The strength of the lumber and wood products industry in Lincoln County has historically been tied to the strength of the national housing and construction market, as well as the local availability of timber. Between 1993 and 2005, five lumber mills closed, leaving only Plum Creek with continuing operations in Lincoln County.

In 2010, the top three employment sectors in Lincoln County were government and government enterprises, retail trade, and construction. The government and government enterprises sector, with 15 percent of total employment, was the largest sector in Lincoln County. The retail trade sector was the next largest with 11.9 percent of total employment followed by the construction sector with 8.6 percent of total employment (Table 162). Contributing to many sectors is a vibrant recreation industry that provides visitors numerous camping, hiking, skiing, snowmobiling, hunting and fishing, wildlife viewing, and other recreation opportunities.

The top 9 private employers for Lincoln County during the second quarter of 2011, listed in alphabetical order, were A Full LiveLife Agency, Genesis Inc., Harlow's School Bus Service, Libby Care Center, Mountain View Manor, Rosauer's Food and Drug, St John's Lutheran Hospital, Stein's IGA, and Town Pump (Montana Department of Labor and Industry 2012a).

Table 162. Lincoln County Employment Trends (2008 - 2010) for Major Industrial Sectors.

Industrial Sector	2008		2009		2010	
	Persons	%	Persons	%	Persons	%
Forestry, Fishing, and Related Activities	496	5.2	388	4.2	388	4.2
Mining	282	3.0	249	2.7	273	3.0
Construction	946	9.9	853	9.2	788	8.6
Manufacturing	413	4.3	359	3.9	353	3.8
Retail Trade	1,123	11.8	1,114	12.1	1,088	11.9
Government and Government Enterprises	1,354	14.2	1,382	15.0	1,373	15.0
Total Employment	9,537		9,241		9,176	

Employment based on the number of full- and part-time jobs.
Source: U.S. Bureau of Economic Analysis 2012a.

The labor force in Lincoln County, defined as persons working or seeking work, increased by 287 persons, from 7,623 in 2005 to 7,910 in 2010. This is an increase of 3.8 percent compared to an increase of 3.5 percent statewide over the same period. In Lincoln County, the average annual unemployment rate, the number of unemployed persons as a percentage of the labor force, increased from 7.4 percent in 2005 to 15.6 percent in 2010 (Montana Department of Labor and Industry 2012a). This was about twice the average annual unemployment rate of Montana, which was 7.2 percent during 2010 (Montana Department of Labor and Industry. 2012b).

Total employment in Lincoln County is projected to increase to 12,572 people by 2030. This increase represents an average annual growth rate of 1.3 percent between 2003 and 2030, higher than the historical 1970-2002 growth rate of 0.5 percent (Western Economic Services, LLC 2006).

3.18.3.3 Income

The 2010 median family income in 2010 in Lincoln County was $39,600, about 28.9 percent lower than the state-wide median family income of $55,725. Lincoln County's per capita personal income, adjusted for inflation, was $28,404 in 2010, compared to $36,159 in Montana. This represents an increase of 37.5 percent since 1969 compared to an increase of 79.1 percent statewide over the same period (U.S. Bureau of Economic Analysis 2012b). Lincoln County's average wage of $31,213 per year in 2010 was lower than the statewide average of $34,610 per year. The top-paying sectors of the economy included mining ($62,571 per year), government ($42,928 per year), and forestry and logging ($42,318 per year).

Between 2006 and 2010, Lincoln County had a greater percent (38.4 percent) of households earning less than $25,000 a year than in the state of Montana (27.5 percent). A total of 3,548 households in Lincoln County had incomes of less than $25,000. Census Tract 4, in which Eureka is located, had the highest concentration in the county, with 27.8 percent of households with incomes of less than $25,000 (U.S. Census Bureau 2012a).

3.18.3.4 Economic Activities that Rely on Natural Resources

The following sections briefly describe economic activities in the study area that rely on natural resources such as recreation, logging, mineral exploration, and agriculture. The *Logging*, *Mineral Exploration*, and *Agriculture* sections only discuss relevant activities near the analysis area, and are not designed to discuss all of Lincoln County. Additional information on these activities is discussed in sections 3.15*, Land Use* and 3.16*, Recreation.*

3.18.3.4.1 Recreation

National Forest System lands make up a large percentage of the Lincoln County land base and offer public access for a variety of motorized and non-motorized recreational activities including: hunting for big game and upland and migratory game birds, fishing, hiking, wildlife observation, berry picking, photography, backpacking, horseback riding, snowmobiling, mountain biking, picnicking, sightseeing, OHV use, amateur geology, and camping. Visitation estimates for 2007 on the KNF were 892,000 national forest visits. Greater than 72 percent of these visits were from people who lived within 100 miles of the KNF (USDA Forest Service 2013c).

Most of the visits to the KNF are day visits. The average visit to the KNF lasts about 10 hours; more than half of the visits to the KNF last less than five hours. Less than 10 percent of the visits involve recreating at more than one location on the KNF. Because of the local nature of the visiting population, frequent visitors are quite common. More than 38 percent of all visits are made by people who visit more than 50 times per year. Conversely, only about 25 percent of the visits are made by people who visit, at most, five times per year (USDA Forest Service 2013c).

3.18.3.4.2 Logging

The National Forest System lands of the Libby Ranger District provide about 6 to 8 million board feet (mmbf) of timber annually. No KNF timber sales are currently under contract in the land use analysis area as of 2012. As discussed in section 3.3, *Reasonable Foreseeable Future Actions or Conditions*, the KNF completed an EIS on the Miller-West Fisher Vegetation Management Project in the land use analysis area. Timber harvest activity also occurs on private, forest-industry lands. The amount of timber harvested has declined in the past 10 years. Small-scale timber harvests occur in the range of 2 to 6 mmbf annually on the private lands in the land use analysis area. Logging has taken place along Libby Creek on public lands since the late 1960s. Timber was harvested from upper Libby Creek and Ramsey Creek following the Libby Creek Road extension in the mid-1970s, resulting in a number of clear-cut areas within the analysis area. Plum Creek has harvested several tracts of private land on lower Miller Creek and along the Fisher River (Power Engineers, Inc. 2005c).

3.18.3.4.3 Mineral Exploration

Some mineral activity occurs near the proposed mine. This activity includes small placer operations on Libby and Big Cherry creeks, small lode mining operations along Libby Creek, Snowshoe Creek, at the headwaters of the West Fisher Creek, and in the Prospect Hill area, 4 miles south of Libby. A number of mineral operators do some form of work along the east face of the Cabinet Mountains each year (Power Engineers, Inc. 2005c).

3.18.3.4.4 Agriculture

No prime and unique farmland was identified near the proposed mining facilities; some land along US 2 is used for hay and grazing. In addition, no land is enrolled in the Conservation Reserve Program, and no grazing allotments are present on nearby National Forest System lands

(Power Engineers, Inc. 2005c). Four commercial apiaries are located near the proposed mining facilities. Commercial apiaries are used for honey production and/or pollination.

3.18.3.5 Housing

In 2010, the U.S. Census Bureau reported that Lincoln County had 11,413 year-round housing units and that Sanders County had 6,678 year-round housing units. These were increases of 22.5 percent in available housing in Lincoln County and 26.7 percent in Sanders County since 2000. Overall, the percent of owner-occupied housing units in both counties (about 76.2 percent in Lincoln County and 75.1 percent in Sanders County) was higher than the state's 68 percent in 2010.

3.18.3.6 Public Services and Infrastructure

3.18.3.6.1 Schools

Eight elementary schools, eight middle schools, and three high schools are located in Lincoln County. Troy, Libby, and Eureka have an elementary, middle, and high school each. Fortine, McCormick, Sylvanite, Yaak and Trego have an elementary/middle school each. Total school enrollment for public schools in Lincoln County declined by 22.9 percent between 2000 and 2010. In 2011, Libby K-12 Schools consolidated their middle and high schools.

3.18.3.6.2 Law Enforcement

Law enforcement services in the Lincoln County study area are provided by the Lincoln County Sheriff's Office, the Montana Highway Patrol, the Eureka Police Department, the Troy Police Department, and the Libby Police Department. Twenty-one full-time law enforcement officers were employed in Lincoln County in 2003. Two jail facilities occur within the study area: a 24-cell adult jail in Libby; and a 4-bed juvenile holding facility in Troy.

3.18.3.6.3 Fire Protection

Fire protection in Lincoln County is provided by nine fire departments. The rural/city Libby Fire Department has two fire marshals and 29 volunteers, and the Troy rural/city Fire Department has 25 volunteers. The Montana DNRC and the Forest Service are responsible for fire protection in lands under their jurisdictions.

3.18.3.6.4 Health Care Facilities

The healthcare needs of Lincoln County are provided by St. John's Lutheran Hospital, Northwest Community Health Center, Libby Clinic, The Center for Asbestos Related Disease, Libby Care Center, Troy Medical Arts Building, and multiple dental practices. In 2012, St. John's Lutheran Hospital began construction of a new hospital located adjacent to the existing hospital. The hospital will retain its status as a 25-bed Critical Access Hospital with the new construction.

3.18.3.6.5 Water Supply

More than 50 percent of the households in Lincoln County use private wells for their water supply. About 4,750 households in Libby; 1,000 households in Troy; and 1,100 households in Eureka are served by a municipal water system. Libby obtains its water from Flower Creek. Troy receives its municipal water supply from two wells and O'Brien Creek.

3.18.3.6.6 Wastewater Treatment

Libby has operated a public wastewater treatment facility since 1964 and converted from a primary to a secondary treatment facility (*i.e.*, an activated sludge oxidation ditch system) in 1985. In Troy, sewer service is obtained for a fee of $36.27 per month for residential and $40.97 per month for commercial service.

3.18.3.6.7 Utilities

Residential telephone service in the Lincoln County study area is provided by Frontier, a subsidiary of Citizens Communications. The long distance service is provided by AT&T. Electric service for Libby is provided by Flathead Electric Cooperative. Lincoln Electric Cooperative is an electric distribution cooperative headquartered in Eureka, providing electricity service to northeast Lincoln County. Northern Energy provides propane to the local area. Northern Lights, Inc. is the electricity provider in the Troy area. Heating sources in the analysis area include oil, propane, wood, and electricity.

3.18.3.7 Fiscal Conditions

The proposed project would affect the public budgets of Lincoln and Sanders counties; Libby, Troy, Eureka; and those cities' school districts. Basic descriptions of key budget areas for each of these jurisdictions are presented in the following sections.

3.18.3.7.1 Lincoln County

Taxable valuation for Lincoln County increased from $30.78 million in FY 2009 to $31.24 million in FY 2010. This is an increase of $460,000, or 1.5 percent. Countywide levies increased slightly, from 115.85 mills in FY 2009 to 115.95 mills in FY 2010. Total funds appropriated for Lincoln County in 2011 were $6.05 million, representing a 17.8 percent increase over the period from 2007 to 2011 (Montana State University 2011).

3.18.3.7.2 Municipalities

Taxable valuation for Libby was $2.8 million in 2010. From 2006 to 2010, taxable valuation for Libby increased 12.8 percent. Taxable valuation for Libby in 2011 remained at $2.8 million. Total funds appropriated for Libby for 2010 were $1.31 million, representing a 27.2 percent increase from 2006 to 2010. Total funds appropriated in 2011 were $1.33 million.

Taxable valuation for Troy was $772,830 in 2010. From 2006 to 2010, taxable valuation for Troy increased 6.1 percent. Taxable valuation for Troy in 2011 increased to $796,890. Total funds appropriated for Troy for 2010 were $537,880, representing a 43.5 percent increase from 2006 to 2010. Total funds appropriated in 2011 were $529,700. Taxable valuation for Eureka was $987,820 in 2010. From 2006 to 2010, taxable valuation for Eureka increased 5.9 percent. Taxable valuation for Eureka in 2011 increased to $993,830. Total funds appropriated for Eureka for 2010 were $357,350, representing a 67.8 percent decrease from 2006 to 2010. Total funds appropriated in 2011 decreased further to $301,702.

3.18.3.7.3 School Districts

The taxable valuation for all school districts in Lincoln County increased from $30.75 million in FY 2009 to $33.79 million in FY 2011. Countywide mill levies to support schools have remained at about the same level since the early 1990s. Taxable valuation for Troy Public Schools experienced a slight decline from FY 2009 to FY 2010 compared to the other school districts in the County. Taxable valuation for the elementary school declined by 1.1 percent, from $5.49

million in 2009 to $5.43 million in 2010 and then increased to $6.25 million in 2011. Troy High School The taxable valuation for Troy High School declined 3.5 percent, from $6.97 million in 2009 to $6.93 million in 2010. Taxable valuation for Libby K-12 Public Schools experienced an increase of 5.4 percent, from $12.3 million in 2009 to $12.97 million in 2011 (Lincoln County Superintendent of Schools 2009, 2010, 2011).

From 2009 to 2011, Eureka Public Schools experienced an increase of 11.8 percent for the elementary school in taxable valuation, increasing from $8.97 million in FY 2009 to $10.03 million in 2011. Taxable valuation for Fortine Elementary School experienced an increase of 10 percent, from $1.3 million in 2009 to $1.43 million in FY 2011. Taxable valuation for McCormick-Sylvanite Elementary School experienced an increase of 34.8 percent, from $678,646 in FY 2009 to $914,862 in FY 2011. Taxable valuation for Yaak Elementary School experienced an increase of 10.1 percent, from $669,172 in FY 2009 to $736,484 in 2011 (Lincoln County Superintendent of Schools 2009, 2010, 2011).

3.18.3.7.4 Sanders County

Total taxable valuation in Sanders County increased from $31.82 million in FY 2009 to $33.29 million in FY 2010. This is an increase of $1.47 million, or 4.6 percent. Countywide levies decreased, from 97.66 mills in FY 2009 to 96.65 mills in FY 2010. Total funds appropriated for Sanders County increased in 2011 were $10.76 million, representing a 13.1 percent decrease over the period from 2007 to 2011 (Montana State University 2011).

3.18.3.8 Quality of Life and Lifestyle

Social structure and interaction in Lincoln County have been shaped primarily by geographic isolation, migration, and settlement; a resource-extractive economy; global influences on the economy; and a cyclical economy. A cultural overview for the analysis area is provided in section 3.7, *Cultural Resources*.

Libby area residents have adapted to the cyclic nature of the economy by living off the land (*i.e.*, hunting, fishing, gardening, firewood gathering, and berry picking). Local residents tend to acquire vehicles, homes, and other possessions that are functional rather than ostentatious (Western Economic Services, LLC 2006). Residents of Lincoln County, because of their livelihoods, are closely linked to the natural environment and have a conservation ethic. Residents do not favor preservation that would prohibit development of natural resources, but rather favor promoting stability through healthy local economies, lifestyles, and use of natural resources in a sustainable fashion.

A quality of life survey conducted with Lincoln County residents indicates that residents highly valued the natural environment and rural, small town atmosphere of the area (Western Economic Services, LLC 2006). Limited economic opportunities were cited as the largest drawback of the area, although residents felt positive about Lincoln County as a place to live.

Community services were generally viewed as average, with the exception of fire protection and rescue, which were rated above average. Day-to-day shopping varied from Libby, to Kalispell, Missoula, or other avenues such as catalogues and the internet, and respondents cited the limited selection of goods as a drawback to local businesses. Shopping for major purchases was generally done in Libby, Spokane, or Missoula.

Social problems in the area reported by survey respondents include drug and alcohol abuse, family problems or domestic abuse, poverty, and unemployment. Alcoholism and drug abuse were cited most frequently by about half of the respondents. Libby is also now in the midst of addressing hundreds of deaths and illnesses linked to former vermiculite mining operations.

In the 1920s, mining of a large vermiculite deposit north of Libby began. W.R. Grace owned and operated a vermiculite mine and vermiculite processing facilities in Libby from 1963 to 1990. The vermiculite deposits in Libby were contaminated with a form of asbestos similar to tremolite. Asbestos is regulated under the Clean Air Act as a hazardous air pollutant. Studies have shown that exposure to asbestos can cause life-threatening diseases, including asbestosis, lung cancer and mesothelioma. Mining and processing activities resulted in the spread of vermiculite – and the associated asbestos fibers – to numerous homes, businesses, and schools throughout the town. In addition, children played in the discarded batches, and local residents brought home bags of vermiculite to pour into attics for insulation or use in their gardens. Health studies on residents of the Libby area show increased incidence of many types of asbestos-related disease, including a rate of lung cancer that is 30 percent higher than expected when compared with rates in other areas of Montana and the United States. The health problems resulting from the vermiculite mine have resulted in premature deaths, increased health costs, and social division in the Libby area.

The analysis area, like much of the Intermountain West, has seen an increase in rural residences. Many of these rural residences are second homes. The census does not count second-home owners as part of a community's population, thus the impacts of second homes are not readily apparent from changes in population. These second homes can have an impact on local government finances and quality of life issues.

Tourism in the analysis area is a growing industry as it is in all of Montana. Lincoln County is seeking to diversify its economy from mining and timber, and tourism promises to become more important to the area's economic well-being. Multiple efforts are underway to increase the tourism based income in Lincoln County (Lincoln County 2009).

3.18.4 Environmental Consequences

The socioeconomic effects for the No Action Alternatives and the action alternatives were evaluated. The impacts for all of the action alternatives would be the same, so the discussion of Alternatives 2 through 4 and the transmission line alternatives, which include the Sedlak Park Substation and loop line, were combined.

3.18.4.1 Alternative 1 – No Mine and Alternative A – No Transmission Line

In the No Action alternatives for the mine and the transmission line, the proposed mine, transmission line, and Sedlak Park Substation and loop line would not be built, and existing patterns and trends described in section 3.18.3, *Affected Environment* would continue to drive the social structure and economy of the area. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Economic effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.18.4.2 All Action Mine and Transmission Line Alternatives

3.18.4.2.1 Employment and Income Effects

The USDA Forest Service produced an analysis of potential employment and labor income effects from the proposed Montanore Project during specific years within the four project phases (termed the "Forest Service Effects Analysis" in this section) for use in this EIS (USDA Forest Service 2007c; updated 2012). The Forest Service Effects Analysis estimates employment and labor income of the proposed project during specific years within the four project phases:

- Construction Phase at Year 3 of the proposed project (peak employment during the Construction Phase)
- Production phase at project Years 4 through 19
- Post-mining Closure Phase at Years 20 through 22
- Reclamation and monitoring phase at Years 23 through 42

Project employment and income and the duration of the mine-life phases could vary from projections, depending upon construction progress and the resources applied by MMC toward full-scale operations. Mineral and input market conditions also could cause operations to be curtailed or shut down on short notice at any point during projected mine life.

Employment and income impacts were estimated in the Forest Service Effects Analysis using input-output analysis. Input-output analysis is a means of examining relationships within an economy between businesses, and between businesses and final consumers. Three types of economic impacts (effects) are identified in the analysis: direct, indirect, and induced. Direct effects are production changes associated with the immediate effects of changes in expenditure tied to mine construction, production, post-mining closure, and reclamation/monitoring. Indirect effects are production changes resulting from spending in all phases of operations in industries that supply products and services to construction, production, mine closure, and reclamation and monitoring. Induced effects are changes in economic activity resulting from households spending income earned directly or indirectly as a result of all phases of the proposed project. The sum of indirect and induced effects are referred to as secondary effects, which is the term used in the remainder of the discussion.

Direct employment and labor income effects were estimated using information provided by MMC and a previous EIS for the Montanore Project (USDA Forest Service *et al*. 1992). Indirect effects were estimated using non-labor expenditure information provided by MMC and IMPLAN (MIG 2004). Induced effects were estimated using IMPLAN. Other specific information on the methodological approach and assumptions used in the analysis presented below can be found within the Forest Service Effects Analysis report. Projected employment and labor income effects identified in the Forest Service Effects Analysis are presented below.

3.18.4.2.2 Construction and Production Employment and Income Effects

The estimated total employment during the Construction Phase of the proposed project would be 623 jobs at Year 3 (Table 163). About 21 percent of the direct employment would be construction related and the remainder attributable to production. The input-output model estimated that there would be about 312 secondary jobs associated with the estimated 311 direct jobs related to construction and operations.

Employment during the production phase would vary with the production rate (Table 163). For production Years 4 through 8, total employment would vary from about 547 jobs in Year 4 to about 447 jobs in Years 5 through 8. After construction is completed but before reaching full production, fewer employees are needed than for the Construction Phase. Secondary employment would account for about 236 jobs in Year 4 and would drop to about 201 jobs during Years 5 through 8. In Year 9, the production rate is expected to increase from 12,500 tons per day to 17,000 tons per day. Direct mine employment would increase from 246 jobs to 450 jobs during this production increase. Secondary employment also would increase from about 201 jobs to 336 jobs. At Year 14, production is expected to increase from 17,000 tons per day to 20,000 tons per day. When production increased, direct employment would remain at 450 jobs and secondary employment would increase slightly.

Table 163. Construction and Production Employment Estimates.

Category	Construction Phase	Production Phase			
Project Year	**3**	**4**	**5-8**	**9-13**	**14-19**
Production rate (tons per day)	0	12,500	12,500	17,000	20,000
Employment					
Construction (direct)	65[†]	65[†]	0	0	0
Operations (direct)	246	246	246	450	450
Secondary employment	312	236	201	336	352
Total construction and operations	623	547	447	786	802

[†]Includes estimated 23-person crew required for construction of the 230-kV transmission line.
Source: MMC 2008.

At Year 3 of the proposed project, direct labor income would be about $42.7 million and total labor income would be $50.3 million (Table 164). About 21 percent of the direct labor income would be construction related and the remainder is attributable to production. The 23-person crew required for construction of the 230-kV transmission line would account for about 35 percent or $3.1 million of the direct labor income for construction in Year 3. Estimated total labor income would range from a low of $39.3 million/per year in project Years 5 through 8 to a peak of $63.5 million per year in Years 14 through 19 during the production phase. The increased labor income would correspond to the expansion in mine production. In general, estimated total labor income would exceed $39 million annually. On a per-job basis, direct annual labor income for construction and operations employment would average about $137,000 and $113,000, respectively. Annual labor income for secondary employment would be about $36,000 per job.

Table 164. Construction and Production Annual Labor Income Estimates.

Category	Peak Construction Phase	Production Phase			
Project Year	**3**	**4**	**5-8**	**9-13**	**14-19**
Production rate (tpd)	0	12,500	12,500	17,000	20,000
Labor Income					
Construction (direct)	$8.9	$6.6	$0.0	$0.0	$0.0
Operations (direct)	$33.8	$25.1	$31.8	$43.2	$50.8
Secondary labor income	$7.6	$8.3	$7.5	$11.7	$12.7
Total construction and operations income	$50.3	$40.0	$39.3	$54.9	$63.5

Income shown in 2010 Million $. Actual totals may differ from values shown due to rounding.
Source: USDA Forest Service 2007c; updated 2012.

3.18.4.2.3 Post-mining Closure, and Reclamation and Monitoring Employment and Income Effects

MMC expects the post-mining Closure Phase of the proposed project to last about 3 years. Total employment would be about 227 jobs for the first 2 years and would decline to about 129 jobs in the third year (Table 165). Secondary employment would account for about 37 percent of the total employment during the post-mining Closure Phase.

The reclamation and monitoring phase of the proposed project would follow the post-mining phase and last about 20 years. This phase also would include consolidation of the tailings and placement of the final cover on the tailings impoundment described in section 2.4.3.1.6, *Tailings Impoundment and Borrow Areas*. Total employment (about 79 jobs) would peak in the first 2 years of this phase and decline to about 32 jobs thereafter. Secondary employment would account for about 37 percent of the total employment during this phase of the proposed project. The second phase would consist of longer-term maintenance of specific facilities, such as the Libby Adit Water Treatment Plant or the seepage collection facilities at the tailings impoundment. MMC would maintain and operate these facilities until BHES Order limits or applicable nondegradation criteria in all receiving waters could be met by any project discharge. MMC also would continue monitoring as long as the MPDES permit is in effect. As long as post-closure water treatment operated, the agencies would require a bond for the operation and maintenance of the Water Treatment Plant. Human activity associated with facility maintenance and monitoring is expected to be limited and indistinguishable from current recreational use. The length of time that the second phase of closure activities would occur is not known but may be decades or more.

Table 165. Post-mining and Reclamation Employment Estimates.

Category	Post-mining Closure Phase			Reclamation and Monitoring Phase		
Project Year	**20**	**21**	**22**	**23**	**24**	**25-42**
Contractors (direct)	0	75	50	25†	25†	10
Company workforce (direct)	125	50	25	25	25	10
Secondary employment	102	92	54	29	29	12
Total contractors and company	227	217	129	79	79	32

† Includes estimated 23-person crew required for removal of the 230-kV transmission line.
Source: MMC 2008 and USDA Forest Service 2007c; updated 2012.

Table 166 provides estimated labor income in 2010 dollars for the post-mining closure, and reclamation and monitoring phase of the proposed project. Direct labor income was based on a workforce consisting of operations, technical, administrative, and environmental services skills. Total labor income during the post-mining phase of the proposed project would be about $16.2 and $14.7 million for the first and second year respectively and would decline to about $8.7 million in the third year. Secondary labor income accounts for about 14 percent of the total labor income during the post-mining Closure Phase.

Total labor income (about $4.7 million) would peak in the first 2 years of the reclamation and monitoring phase, and would decline to about $1.8 million thereafter. The 23-person crew required for removal of the 230-kV transmission line would account for about 92 percent or $2.6 million of the total labor income for direct contractors in each of the first 2 years of the reclamation and monitoring phase. Secondary labor income accounts for about 15 percent of the total labor income during this phase of the proposed project.

Table 166. Post-mining and Reclamation Labor Income Estimates.

Category	Post-mining Closure Phase			Reclamation and Monitoring Phase		
Project Year	**20**	**21**	**22**	**23**	**24**	**25-42**
Contractors (direct)	$0.0	$6.9	$4.6	$1.2	$1.2	$0.5
Company workforce (direct)	$14.1	$5.7	$2.8	$2.8	$2.8	$1.1
Secondary labor income	$2.1	$2.1	$1.3	$0.7	$0.7	$0.2
Total contractors and company income	$16.2	$14.7	$8.7	$4.7	$4.7	$1.8

Income shown in 2010 Million $. Actual totals may differ from values shown due to rounding.
Source: USDA Forest Service 2007c; updated 2012.

The mine would become one of the largest single employers in the area, so any changes in operation or production would impact employment levels. Once the local economy had adjusted to a particular operating level, any reductions-in-force would release individuals whose life style would be attuned to mine wage rates and who would find very few opportunities for comparable employment in the local market. Any shutdown of operations for a few weeks or months would cause a sudden drop in local area income while laid off workers, expecting a resumption of operations, would be unlikely to seek other work. While the affected communities, government jurisdictions, and businesses can plan for mine closure, effects of closure after the planned 20-year production period would decrease employment earnings. Unless other large mining projects are operating in the area at the time, closure of the Montanore mine would eliminate many of the resource commodity sector jobs expected to exist in the local area economy in 2030.

3.18.4.2.4 Population Effects

The employment and income effects analysis summarized above assumed that all direct employment demand would be met from the Lincoln County labor supply. This assumption scenario could occur if a large local population, or a high rate of unemployment in the relevant skill sets, provided a large pool of available labor. Lincoln County does have a higher than average unemployment rate in comparison to neighboring counties and the state as a whole, but given the number of workers needed and the specialized skills required for the construction and production phases of the proposed project, all employment demand may not be met by Lincoln County residents. If that happens, some mine workers may move to the area or commute from locations outside of Lincoln County.

Recent experience for large projects indicates that mining and construction workers will tolerate one-way commuting times of about one hour. Beyond that distance, workers may be more likely to relocate closer to the project site (USDA Forest Service and DEQ 2001). For the Montanore Project, this implies a local employment area that could include all of Lincoln County including the towns of Libby, Troy, and Eureka. If non-local workers (*e.g.*, residents outside of Lincoln County) were to move into Lincoln County for project-related jobs, population within Lincoln County would increase above the baseline projections described in the *Affected Environment* section.

Since the proposed Montanore Project is classified as a “large-scale mineral development,” according to the requirements in the Montana Hard-Rock Mining Impact Act, the project proponent is required to evaluate potential impacts on affected local government units as a result of in-migrating workers and their families and prepare a Hard-Rock Mining Impact Plan (Impact Plan). The Impact Plan for the Montanore Project was prepared in 2005 and approved by Lincoln County in 2007. The Impact Plan estimates the number of in-migrating direct and secondary workers and their family members associated with the project. Net in-migration in the first year would be 171 people, and is expected to peak to a net of an additional 429 people in the fourth year of the project at the beginning of the production phase and level off for the rest of the production years (Table 167).

Table 167. Estimated Net Population In-Migration into Lincoln County by Project Year.

Category	Construction Phase			Production Phase		Total
Project Year	**1**	**2**	**3**	**4**	**5**	**1 to 5**
Project Workers	43	81	97	98	92	411
Worker's Family	64	139	191	193	195	782
Secondary Workers and Family	65	118	138	139	126	586
Total	172	338	426	430	413	1,779
Percent Addition to 2010 Lincoln County Population (19,687)	0.9%	1.7%	2.2%	2.2%	2.1%	9.0%

Source: Western Economic Services, LLC 2005.

3.18.4.2.5 Community Effects

The Impact Plan projected the allocations of in-migrating population to various settlement locations in Lincoln County including Libby, Troy, Eureka, and rural areas. In-migration in rural Lincoln County would be a net of 110 people in Year 1, and peak in Year 4 to a net of an additional 275 people. About one-third of the net in-migrating population is expected to settle in Libby (Table 168).

The in-migration projections above incorporate the expectation that housing would be the primary limiting factor for the settlement of in-migrating workers, at least during early project years. Specifically, these projections assume that, with or without assistance from MMC, some temporary housing facilities would be developed on private lands. Such facilities would enable more workers to settle in this area than existing housing allows. Development of new housing on private lands to meet the needs of the entire expected non-local contract construction labor force is unlikely. Because of housing constraints, many would be forced to commute longer distances. Individuals hired for long-term mine jobs may initially have difficulty finding local housing depending on the housing stock available following the preliminary wave of hiring. Some would have to settle initially in communities farther from the mine and then relocate to permanent residences in the Libby/Troy/Eureka area after contract construction workers had left the area (Western Economic Services, LLC 2005).

As noted in the Alternatives 1 and A, discussion of land use trends, population growth in the area is converting areas of private land from timber or agricultural production and open space use into residential subdivisions and ranchettes. The demand on public land resources is also shifting away from traditional resource commodity production toward a greater emphasis on recreation, and aesthetic values. Mine development would add to population and housing demand pressures. Land use demand driven by mine development would differ somewhat from the existing pattern driven by retiree and recreation/tourism/amenity in-migrant population growth. Barring mine shutdowns, mine operations workers would have the kind of jobs with above-average wages that would allow them to purchase or build homes. Some in-migrants hired into secondary and replacement jobs would be in the same situation. Others would be more likely to prefer rental housing or mobile home spaces. In-migration during mine operations would place less strain on local housing supplies than would the earlier influx of construction workers. The development of local businesses catering to new residential areas and commuting mine workers also is expected.

Table 168. Expected Net In-Migrating Population Settlement Locations by Project Year.

Category	Construction Phase			Production Phase		Total[§]
Project Year	**1**	**2**	**3**	**4**	**5**	**1 to 5**
Direct Construction and Production Employees and Families						
Libby	35	72	94	95	94	390
Troy	2	5	6	6	6	25
Eureka	1	2	3	3	3	12
Rural Lincoln County[†]	69	141	184	186	183	763
Total	107	220	287	290	286	1,190
Secondary Employees and Families						
Libby	21	39	45	46	41	192
Troy	1	3	3	3	3	13
Eureka	1	1	1	1	1	5
Rural Lincoln County	41	76	89	89	81	376
Total	64	119	138	139	126	586
Combined Total Net In-Migration by Area						
Libby	56	111	139	141	135	582
Troy	3	8	9	9	9	38
Eureka	2	3	4	4	4	17
Rural Lincoln County	110	217	273	275	264	1,139
Total	171	339	425	429	412	1,776

[§]Total in Table 167 varies from the total in Table 168 due to rounding.
[†]Lincoln County is predominantly a rural county. Urban development is concentrated in the incorporated areas of Eureka, Libby, Rexford and Troy.
Source: Western Economic Services, LLC 2005.

While some construction in-migrants is expected to become long-term residents and would seek to become integrated into the community, others would be well aware of their temporary status and unlikely to participate. An influx of temporary residents with large cash incomes, few ties to the community, and limited social activities in which to engage may pose problems for limited law enforcement resources. The extent these phenomena would surface in the western Lincoln County communities is difficult to predict. The agencies expect some detrimental effects from the influx and departure of the large contract construction workforce. Large influxes of workers and their families would likely impact the social structure of Libby, Troy and surrounding rural areas in terms of local values, school attendance, and community character. Such incoming workers may or may not share the local values of the area and may not have as strong of ties on average to the community as long-time residents. Also, large influxes and/or out-migrations of workers could disrupt both the local social fabric of communities like Libby and their economic viability (both positively and negatively). The Bakken shale development in eastern Montana and North Dakota is an extreme example of some of these impacts, with such impacts from Montanore expected to be much smaller. It is possible that a few longtime residents could leave the area as a result of the influx of workers, but that number would likely be low.

3.18.4.2.6 Public Services

Local governments would need to serve fluctuating populations. Impacts on specific local governmental units within the study area due to in-migrating workers and their families depend entirely upon where the in-migrants choose to reside. In addition to housing-related factors affecting settlement patterns, in-migrants also would consider the availability of public services in making their residency choices.

Local government service-providers would have to respond to an estimated 171 net in-migrants in the first year of mine construction and an expected peak in the fourth project year of an additional 429 total net in-migrants. The population increases during mine startup could cause difficulty for some service providers in responding to demands, requiring change in staffing and resource allocation. Because Lincoln County school enrollments were projected to decline over the next 10 to 15 years (if the mine were not developed), the arrival of students associated with mine operations would not be expected to pose an enrollment problem for the school system. There may be some challenges with staffing and maintaining appropriate classroom size with the addition of new students.

Small communities that lack temporary housing facilities as well as a wide range of public and private services may experience law enforcement problems when a large temporary work force with no community ties, above-average income, marginal housing, and a high percentage of individuals who are not accompanied by families suddenly arrives. If such problems were to develop in association with the startup Construction Phase of the Montanore Project, the problems would be more likely to occur in the communities located nearest to the mine site based on the probable settlement patterns of the work force.

Community fire, emergency, medical, and social service providers may have a hard time adjusting their staffing to the increases in service demands associated with mine construction and startup. Obtaining and training new staff takes time, and the fire and ambulance services, in particular, could experience difficulty finding and training additional volunteers. Any fiscal impacts on local government service providers would be mitigated through payments as established in the Hard Rock Mining Impact Plan (Western Economic Services 2005). These service providers would benefit from the additional tax revenues generated by the mine and should be able to adapt to the long-term changes in demand associated with mine operations. It is anticipated that the mine would maintain its own ambulance and would support and cooperate with local emergency service providers.

3.18.4.2.7 Fiscal Effects

The proposed project would increase local and state government revenues and expenses. The Impact Plan included an analysis of project-related revenues and costs to affected local governments from the mine operations and population increases. Affected local government units within the defined Impact Plan study area include:

- Lincoln County Government (including special districts)
- City of Libby
- City of Troy
- City of Eureka
- Libby School District
- Troy Elementary School District
- Troy High School District
- Eureka Elementary School District

- Lincoln County High School District

New project-related revenues to local governments would come from three primary sources: property taxes on the mine land, plant, and equipment; the gross proceeds tax on the value of ore produced; and property taxes on new homes and commercial facilities built as a result of mine development. The project would increase costs for cities, schools, and counties through mine-related in-migration and resulting increases in local government service costs. The additional tax revenue would largely be used by local governments to pay for capital outlays, personnel, and support costs.

Lincoln County and the Libby, Troy, and Eureka school districts would be the primary recipients of tax revenues from the mine and mill facilities, but Montana law provides for tax-base sharing among affected Montana local government units when a mine is designated as a large-scale mineral development.

When construction of mine facilities was completed, the property tax revenue would be about $2.35 million represented by the land and improvements (*i.e.*, Class 4 property) and all the business equipment (*i.e.*, Class 8 property) (Western Economic Services, LLC 2005). The overall tax revenue would decline as the mine facilities and equipment portion depreciated, reaching fully depreciated values in 10 to 15 years. Annual local tax revenues would depend on local mill levy rates, state property tax equalization, and property tax prepayments and credits.

Montana levies a metal mines license tax on a mine's annual gross revenues in excess of $250,000. This is a percentage tax on the value of ore concentrate shipped to the refinery. Tax revenues would fluctuate depending on silver and copper prices and the project's annual production levels. By law, 75 percent of these revenues would be allocated to Montana's general fund. The remaining 25 percent would be allocated to Lincoln County, and distributed through the county to appropriate departments and districts. The county would be required to reserve at least 37.5 percent of this revenue in a trust fund account. All money not allocated to the trust fund account is distributed as follows; 33.3 percent to elementary school districts, 33.3 percent to high school districts, and 33.3 percent for general planning functions (*e.g.*, economic development activities).

Table 169 summarizes projected fiscal effects from the project. Net impact on local governments would start with a $180,242 deficit in Year 1, followed by net surpluses starting in Year 2 with a net surplus of about $4.8 million in Year 5. MMC's proposed mitigation of $180,000 would mitigate for the Year 1 fiscal deficit. While Sanders County would not have workers migrating into the county due directly or indirectly to the Montanore Project, Sanders County would receive $208,000 in gross proceeds tax in Year 4 and $546,000 in Year 5 (Western Economic Services, LLC 2005). Costs and revenues shown for Year 5 in Table 169 would continue through the Operations Phase, expected to be 16 to 19 years. The projected fiscal effects shown in Table 169 should be considered a representative estimate of actual fiscal effects, which would depend on a number of currently unknown factors and future local government conditions.

Table 169. Net Local Government Fiscal Impact due to Montanore.

Category	Construction Phase			Production Phase	
Project Year	**1**	**2**	**3**	**4**	**5+**
Costs					
Direct Worker Local Government Costs	$253,797	$563,239	$786,312	$798,962	$813,366
Indirect Worker Local Government Costs	$128,987	$236,679	$277,825	$281,063	$255,531
Total Costs to Units of Local Government	$**382,784**	$**799,918**	$**1,064,137**	$**1,080,025**	$**1,068,897**
Revenues					
Montanore Taxes:					
Metal Mines License Tax (to Lincoln County†)	0	0	0	$215,000	$565,000
Gross Proceeds Metal Mines Tax (to Lincoln County‡)	0	0	0	$832,000	$2,184,000
Gross Proceeds Metal Mines Tax (to Sanders County)	0	0	0	$208,000	$546,000
Montana Property Tax (land & improvements)	$10,000	$740,000	$1,290,000	$2,060,000	$2,060,000
Montana Property Tax (business equipment)	$80,000	$150,000	$210,000	$290,000	$290,000
Indirect Worker - Commercial Property Tax	$12,998	$23,774	$27,787	$28,017	$25,355
Direct Worker - Commercial Property Tax	$21,549	$44,204	$57,778	$58,445	$57,568
Indirect Workers - Residential Property Tax	$32,419	$59,296	$69,307	$69,880	$63,241
Direct Workers - Residential Property Tax	$45,576	$85,212	$102,036	$103,163	$97,269
Total	**$202,541**	**$1,102,485**	**$1,756,908**	**$3,864,505**	**$5,888,432**
Impact	**$-180,242**	**$302,567**	**$692,771**	**$2,784,479**	**$4,819,535**

†According to MCA 15-1-501 the Montana Metal Mines License Tax is allocated as follows: 57 percent to the state general fund, 2.5 percent to the hard rock mining impact trust account, 8.5 percent to the hard rock mining reclamation debt service fund, 7.0 percent to the reclamation and development grants program state special revenue account, and 25.0 percent to the county or counties identified as experiencing fiscal and economic impacts.
‡The allocation of the Montana Gross Proceeds Tax, a Class 2 Property Tax, was settled in the early 1990s.
Values shown are in 2004 dollars.
Source: Western Economic Services, LLC 2005.

In all mine and transmission line alternatives, MMC would acquire land for grizzly bear mitigation, ranging from 2,826 acres in Alternative 2B, 5,427 acres in Alternative 3D-R and 6,225 acres in Alternatives 4C-R. Title to these lands may be conveyed to the Forest Service and the County in which they occur would lose property tax revenue. The permanent reduction in property tax revenue would be between $10,000 and $15,000 annually (2015 dollars) in Alternative 3D-R and proportionately higher or lower in the other combined alternatives, depending on the amount of land acquired for grizzly bear mitigation, shown in Table 30 in Chapter 2.

3.18.4.2.8 Quality of Life and Lifestyle

In addition to the effects disclosed in the *Community Effects* section, the Montanore Project would have minor effects on social well-being and quality of life in the analysis area. Mining and other natural resource development has been an important part of the local economy for many years. The ongoing national and regional growth of recreation and tourism would also be a factor, as recreation/tourism would continue to help shape the economy in the analysis area. The analysis area, which is accustomed to yearly recreation and tourism booms, should be able to accommodate the projected short-term mine construction population influx with little difficulty even if the mine construction peak coincides with the peak tourism season. Individuals and social groups within the community would perceive project-related benefits, such as increased economic opportunity, and costs such as social problems associated with population growth, from the variable perspective of their own values, beliefs, and goals. Such perceptions would of course vary. Increased income within the analysis area would create new opportunities in the retail sales and service sector. Some residents believe the proposed project would revitalize and stabilize the depressed local economy.

Negative perceptions of project development may be attributed to people with various other points of view. Many residents express anxiety at the prospect of a major mineral development project, based on their experience with and perceptions of other mining projects. These concerns primarily are that the Montanore Project might generate similar problems, and that state and federal agencies might not adequately monitor and enforce applicable laws and regulations. Persons having these views want their feelings known, but are not necessarily opposed to development of the Montanore Project. Projections for increased housing demand during mine development and operation suggest that most property values (including second homes) in the area would increase, but the value of some specific parcels or types of properties could be affected negatively for some periods during mine construction, operation, and reclamation. It is also possible that the use of a parcel to its current owner, that is its ability to serve the specific purposes for which the property was purchased, may be impacted negatively even though its potential market value may not decrease.

3.18.4.3 Effectiveness of Agencies' Proposed Mitigation

Implementation of the 2005 Hard Rock Mining Impact Plan (Western Economic Services 2005) would effectively mitigate for financial impacts on local governments from the proposed project.

3.18.4.4 Cumulative Effects

In addition to the proposed Montanore Project, the proposed Rock Creek Project would affect Lincoln County. Other mineral activities in the area (*i.e.*, primarily small exploration projects) and the regional timber industry are not expected to lead to major changes in population, employment, or income in the reasonably foreseeable future.

The Rock Creek Project is a proposed underground copper and silver mine and mill/concentrator complex near Noxon, in Sanders County, Montana. The project is owned by Hecla. The nearest town to the proposed Rock Creek development is Noxon, an unincorporated town on MT 200 in Sanders County. Access to the Rock Creek mine would be from the Noxon area, and mine facilities also would be located in Sanders County.

The KNF is preparing a Supplemental Environmental Impact Statement (EIS) for the Rock Creek Project to address deficiencies identified by a Federal District Court in a 2001 Final EIS. The

Supplemental EIS also will disclose effects on resources that may be substantially affected by changes in circumstances or new information. Based on the Supplemental EIS and ROD schedule and a projected 5-year evaluation and construction period, the earliest the Rock Creek Project could go into production is 2021. Mine life of the Rock Creek operation is estimated to be 28 years. Annual earnings from direct and secondary mine-related employment would be about $30.3 million during the Construction Phase and $38.8 million during the production phase.

The estimated total annual direct employment during the Construction Phase for the Rock Creek Project would be 232 workers, with an estimated total annual direct employment of 344 employees during operations (USDA Forest Service 2013e). The peak population increase associated with Rock Creek development in the Noxon/Heron/Trout Creek area (*i.e.*, western Sanders County) is projected to be about 328 people during project construction. The projected long-term population increase in the Noxon/Heron/Trout Creek area attributable to the Rock Creek Project is estimated to be about 378 people. The total peak population increase in Lincoln County from the Rock Creek Project during operations is estimated to be about 280 people. Most effects of the Rock Creek Project would occur in the Noxon/Heron/Trout Creek area (USDA Forest Service and DEQ 2001).

A key factor determining the number of in-migrating workers for both the Rock Creek Project and the Montanore Project is the fate of the Troy Mine. The Troy Mine was placed in care and maintenance in 2015. Upon closure of the Troy Mine, a skilled workforce of 150 may be available either to the Rock Creek or Montanore projects. Depending on the timing of each project's start-up, there would be some direct competition for former Troy workers. Because much of the Troy Mine workforce already lives in the Libby area, some of these workers is expected to seek employment with MMC at Montanore to avoid the longer commuting distance to the Rock Creek Project. Assuming Troy Mine closure and Rock Creek Project startup are relatively concurrent, current Troy Mine workers would continue employment with Revett for the Rock Creek operation because of employee seniority and benefit vesting in Revett.

With the availability of the Troy Mine workforce for one or both of the new projects and current unemployment rates in Lincoln and Sanders counties, 80 percent local hiring for both projects would be still possible. The percentage of local hiring would also depend on workers with the correct skills within the unemployed labor force. If only one of the two projects is developed (either Rock Creek or Montanore, but not both), the displaced Troy Mine workforce may provide a substantial amount of the needed production workforce. If Rock Creek is developed, but the Montanore Project is not, some Lincoln County residents currently working at the Troy Mine may migrate to Sanders County to shorten their commute.

If the Troy Mine, Rock Creek, and Montanore were all to operate concurrently, which is considered a possibility, the Troy Mine workforce would not be available to the two new projects, and the 80 percent local hiring assumption might not be met. This scenario would result in a larger population migration into Sanders and Lincoln counties than would result from the development of only one project. It also would result in the greatest level of community growth and disruption.

Under the most likely situation, no in-migrating workers directly associated with the proposed Montanore Project are expected to reside in Sanders County. The Montanore Project is not expected to have any cumulative effect on population or demand for public services in Sanders

County. The gross proceeds tax received by Sanders County could result in some additional employment in the government sector.

3.18.4.5 Regulatory/Forest Plan Consistency

The Montanore Project would contribute to progress toward FW-DC-MIN-01 and FW-DC-SES-01 through 03 of the 2015 KFP. The project would be consistent with the Hard Rock Mining Impact Act following implementation of the approved Hard Rock Mining Impact Plan.

3.18.4.6 Irreversible and Irretrievable Commitments

There would an irreversible commitment of mineral resources under all of the action alternatives. Economic productivity for timber or other resources from mined lands would be irretrievable lost during mine operations.

3.18.4.7 Short-term Uses and Long-term Productivity

In the short term, the project would increase costs for cities, schools, and counties through mine-related in-migration and resulting increases in local government service costs. A short-term increase in population, as well as increases wages, spending, and tax revenue would occur over the life of the mine. The increase in tax revenue along with the commitment in the Hard Rock Mining Impact Plan (Western Economic Services 2005) to pay all increased capital and net operating costs to local government units that would result from the mineral development should offset any increases in local government service costs. Over the long term following mining, population and income levels may decline, as would the cost for local governments to provide services.

3.18.4.8 Unavoidable Adverse Environmental Effects

Under all mine and transmission line alternatives, increased employment and population would place increased demands on housing and some public services, including schools. With mitigation, as outlined in the Hard Rock Mining Impact Plan (Western Economic Services 2005), the increased demands would not result in unavoidable adverse environmental effects.

3.19 Soils and Reclamation

3.19.1 Regulatory Framework

3.19.1.1 Federal Requirements

The 2015 KFP requires project-specific BMPs to be incorporated into all land management activities as a principle mechanism for protecting soil resources (FW-GDL-SOIL-05 and FW-GDL-WTR-03). In addition, the regional soil quality standards (FSM 2500 – Watershed and Air Management, R1 Supplement No. 2500-2014-1) and Chapter 2550 – Soil Management contains soil management objectives and policies applicable to activities on the KNF. Soil quality standards apply to lands where vegetation and water resource management (*i.e.*, timber sales, grazing pastures or allotments, wildlife habitat, and riparian areas) are the principal objectives. The standards (such as the 15 percent disturbance standard) do not apply to intensively developed sites for minerals production, developed recreation sites, administrative sites, or mineral sites where lands have been or will be converted to non-forest sites. The standards are not intended to prohibit other resource management practices such as installing waterbars or preparing sites for planting, as long as such practices are consistent with long-term sustainability of the soil resource. Permanent roads can affect soil-hydrologic function; their evaluation is more appropriately done on a watershed basis using models and other watershed analysis techniques (FSM 2554.1 R1 Supplement; USDA-ARS National Soil Erosion Research Laboratory 1995). The standards would apply once the mining was complete and the principal objective again became vegetation management. The reclamation plan for the project would include meeting the soil quality standards as one of the long-term reclamation goals. Additional guidance is included in USDA Forest Service's Region 1 guidance for soils (USDA Forest Service 2011e).

The Organic Administration Act authorizes the Forest Service to regulate the occupancy and use of National Forest System lands. The Forest Service's locatable minerals regulations are promulgated at 36 CFR 228, Subpart A. The regulations apply to operations conducted under the U.S. mining laws as they affect surface resources on National Forest System lands under the jurisdiction of the Secretary of Agriculture. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources. 36 CFR 228.8 also requires that mining operators construct and maintain all roads so as to assure adequate drainage and minimize or, where practicable, eliminate damage to soil, water, and other resource values; and reclaim the surface disturbed in operations by taking such measures as preventing or controlling onsite and off-site damage to the environment and forest surface resources. For the Montanore Project, the KNF emphasizes protection of the soil resource and implementation of restoration practices where necessary on National Forest System lands. Standards and BMPs identified in the 2015 KFP would be included as mitigation measures where appropriate and would be used to guide MMC's implementation of the project.

3.19.1.2 State Requirements

MMRA requires that all lands disturbed by mining be reclaimed to a post-mine land use that has stability and utility comparable to that of the pre-mining landscape. The DEQ must evaluate MMC's proposed reclamation plan for areas to be revegetated to ensure that the soil needed to reclaim mine site disturbances would be salvaged and replaced, and areas revegetated to comparable stability and utility. The MFSA directs the DEQ to approve a facility if, in conjunction with other findings, the DEQ finds and determines that the facility would minimize adverse environmental impact, considering the state of available technology and the nature and economics of the various alternatives.

3.19.2 Analysis Area and Methods

The analysis area for direct, indirect, and cumulative effects on soils consists of the areas that would be disturbed by facility construction under each alternative and are shown on Figure 83. The Libby Loadout would be in the previously disturbed Kootenai Business Park; therefore, the loadout is not discussed further. Mitigation activities, such as culvert removals proposed in the wetland mitigation plan, would have negligible, short-term effect on soil resources.

Soil investigations for the mine area facilities and the transmission line corridors were conducted in 1988 and 1989 by NMC to provide soil information for land use management and reclamation (Western Resource Development Corp. 1989b, 1989c). A detailed soil survey using standard USDA soil survey methods was performed in an "intensive study area," which included most of the Little Cherry Creek Tailings Impoundment Site and the Poorman Tailings Impoundment Site, the Ramsey Plant and Libby Adit sites, and most of the two LAD Areas. The "extensive study area" consisted of the proposed access roads, transmission line corridors and Sedlak Park Substation and loop line. Soils information from the KNF soil survey was used for the extensive study area (USDA Forest Service and Natural Resources Conservation Service 1995).

The soil baseline studies contain descriptions of field, laboratory, and interpretation methods (Western Resource Development Corp. 1989b, 1989c). Laboratory analyses were performed for selected physical and chemical parameters of the soils to assist with making interpretations important to mining operations and reclamation. Particle size analysis, percent rock fragments (>2 mm), organic matter percent, soil pH, and percent water at saturation were determined.

Soil interpretations were made for construction, management, and reclamation purposes. For the intensive survey area, soil erodibility, potential slope stability, and soil suitability were determined for each soil map unit. For the extensive study area, soil erodibility, slope failure potential, and revegetation potential were obtained from the KNF soil survey. Because the soils data for the extensive study area are more generalized, soil suitability was extrapolated from the intensive study area to provide more probable site-specific salvageable soil volumes.

Soil baseline studies and interpretations were used to analyze the likely effects for each alternative. Soil suitability was used to determine volumes of salvageable soil to be used for reclamation at each proposed disturbance area. Soil erodibility was used to assess the susceptibility of the soils to erode when disturbed and the likelihood of eroded soil reaching stream channels. Slope failure was used to evaluate soil suitability for road construction and maintenance. Revegetation potential was used to determine if any soils were unsuitable without amendments, and if soils were found to be limited, what amendments would be needed to enhance revegetation potential.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on soil resources in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.19.3 Affected Environment

Soils in the analysis area have been influenced by four geomorphic processes: colluvial (movement downhill as a result of gravity); fluvial (movement by flowing water from streams and rivers); glaciolacustrine (movement or deposition in lakes); and glacial (movement by glaciers). In addition to these four processes, a thin mantle of volcanic ash-influenced loess (fine textured soil deposited by wind) blankets much of the analysis area soils. The loess commonly differs sharply from the soil beneath it and varies in depth based on aspect and elevation. Soil layers formed in loess that have been influenced by volcanic ash or in glacial till have a moderate hazard of erosion. A rating of severe is assigned to soil layers having a sandy texture or a loamy or clayey texture and a content of rock fragments of less than 15 percent, such as soil layers formed in lacustrine deposits or in sandy glacial outwash (USDA Forest Service and Natural Resources Conservation Service 1995). Within the analysis area, the soils vary in age, degree of development, and fertility. Relatively young soils forming in colluvial material generally have little development, are typically high in rock fragment and generally have low fertility (Western Resource Development Corp. 1989b, 1989c). Soils associated with alluvial processes are also relatively young, have little or no development, have abundant rock fragments, and generally have low fertility. Soils forming in glaciolacustrine sediments are of late-Wisconsin glacial age (10,000-25,000 years before present), show weak to strong development, are typically high in silts and clays with few rock fragments, and have low fertility. Other intermediate aged soils have some development, have low fertility, and have some rock fragments. The oldest soils, associated with continental glaciation, are strongly developed, have clay to silty clay textures, and are some of the more fertile soils in the permit area.

3.19.3.1 Soil Types

Soils within the analysis area can be divided into six general groups based on the parent material and the type of geomorphic process in which they formed (Figure 83). The soil group “colluvial/glacial soils” was mapped only in the intensive study areas; because of the scale of mapping, it is not shown in Figure 83. The six groups are:

- Alluvial soils that formed in rocky alluvium
- Glaciolacustrine soils that formed in fine-textured glaciolacustrine deposits
- Alpine glacial soils that formed in rocky alpine glacial drift
- Continental glacial soils that formed in rocky continental glacial drift
- Residuum/glacial soils that formed in rocky residuum and glacial drift
- Colluvial/glacial soils that formed in rocky colluvium and glacial drift

3.19.3.1.1 Alluvial Soils

The alluvial soils group is comprised of landtypes 101, 103, 105, 106, and 110. The soils in the alluvial soils group are deep, well drained to very poorly drained, and contain a high amount of rock fragments. They formed in gravelly and cobbly coarse-textured alluvium and have a volcanic ash surface layer. They occur on nearly level to strongly sloping alluvial and glaciofluvial terraces, terrace escarpments, drainage bottoms, old lake beds, and floodplains. These soils are moderately extensive along Poorman, Libby and Bear creeks at the Little Cherry Creek and Poorman Tailings Impoundment sites, the Ramsey Plant Site, the Libby Adit Site, and along the Fisher River valley bottom near the transmission line alignments. Narrow areas of alluvial deposits occur along all streams in the analysis area. Depth to the water table is variable, with some soils saturated most of the year. Included in this soil group within the proposed Little Cherry Creek Tailings Impoundment Site are very poorly drained areas, such as bogs and wet depressions that contain organic-rich soils.

The surface textures are generally loam, gravelly silt loam, and very gravelly sandy loam with 5 to 55 percent rock fragments. Subsoil textures are generally gravelly silt loam, extremely gravelly silt loam, and loamy sand with 15 to 75 percent rock fragments. Rocky colluvial soils occur on many toeslopes within this soil group. Organic matter content is medium to very high (3 percent to greater than 50 percent in some poorly drained areas) in the surface layers and is typically much lower in subsoil layers. The soils are very strongly acid to moderately acid (pH 4.5 to 5.7). Available water holding capacity is low to high, and soil permeability is slow to rapid. Generally, the surface layers of these soils have low to moderate susceptibility to erosion by water and low to high susceptibility below the surface layer. The soils have low to high sediment delivery efficiency, which is the relative probability of eroded soil reaching a stream channel, and they have high slope stability.

3.19.3.1.2 Glaciolacustrine Soils

The glaciolacustrine soils group is comprised of landtypes 102, 108, and112. Glaciolacustrine soils are deep, well drained, and relatively free of rock fragments. They formed in fine-textured glacial lake sediments and have a volcanic ash surface layer. They are found on nearly level to strongly sloping glaciolacustrine terraces and steep to very steep terrace risers. These soils are of moderate extent in the Little Cherry Creek and Poorman Tailings Impoundment sites, and they occur along the transmission line alignments and at the Sedlak Park Substation Site. Included in this soil group within the proposed Little Cherry Creek Tailings Impoundment Site are very poorly drained areas, such as bogs and wet depressions that contain organic-rich soils

The surface textures are generally silt loam with few rock fragments. Subsoil textures are generally silt loam, silty clay loam, and silty clay with few rock fragments. Clay contents in subsoil layers can exceed 45 percent. Organic matter content is medium (2 to 3 percent) in the surface layers and is typically less than 1 percent below the surface layer. The soils are strongly acid to slightly acid (pH 5.4 to 6.2). Available water holding capacity is high, and soil permeability is very slow. Generally, the surface layers of these soils have moderate to high susceptibility to erosion by water and high susceptibility below the surface layer. The soils have low to moderate sediment delivery efficiency. They generally have high slope stability, but exhibit cutbank sloughing on slopes greater than 15 percent.

3.19.3.1.3 Alpine Glacial Soils

The alpine soils group is comprised of landtypes 104, 404, and 407. Alpine glacial soils are deep, well drained, and contain a large percentage of rock fragments. They formed in gravelly, medium-textured glacial drift and have a surface layer of volcanic ash. They occur at higher elevations on gently to steep glacial moraines and glacial valleys. In places, rock outcrops are extensive within this soil group. These soils are moderately extensive in the valleys at the Ramsey Plant Site, Libby Adit Site, Rock Lake Ventilation Adit, and along the transmission line alignments.

The surface textures are generally gravelly silt loam with about 20 percent rock fragments. Subsoil textures are generally very gravelly silt loam with 40 to 60 percent rock fragments. Organic matter content can be very high in the surface layer due to ash influence, but drops off rapidly to less than 1 percent a few feet below the surface. The soils are generally very strongly acid to strongly acid (pH 5.0 to 5.5). Available water holding capacity is moderate, and soil permeability is moderate to high. Generally, both the surface and subsurface layers have moderate to high susceptibility to erosion by water. The soils have low to high sediment delivery efficiency. They are commonly susceptible to cutbank sloughing and raveling.

3.19.3.1.4 Continental Glacial Soils

The continental glacial soils group is comprised of landtypes 301, 302, 322, 323, 351, 352, and 355. Continental glacial soils are deep, well drained, and rocky. They formed in gravelly, fine-textured old glacial drift and have volcanic ash surface horizons. Some soils in this group formed in rocky colluvium. This soil group, which is at lower elevations than the alpine glacial soils, occurs on nearly level to very steep, continentally glaciated plains, mountain side slopes, and ridges. In places, rock outcrops are extensive within this soil group. These soils are very extensive along the transmission line alignments, at the Sedlak Park Substation Site, at the Little Cherry Creek and Poorman Tailings Impoundment sites, making up over half of the impoundment sites, and most of the Libby Plant Site and LAD Areas. Included in this soil group within the proposed tailings impoundment sites are very poorly drained areas, such as bogs and wet depressions that contain organic-rich soils.

The surface textures are generally silt loam, gravelly silt loam, and clay loam with few to 30 percent rock fragments. Subsoil textures are generally very gravelly and moderately fine and fine, with 10 to 60 percent rock fragments. Clay contents can exceed 60 percent in the subsoil. Organic matter content is medium to high (2 to 5 percent) in the surface layer, but decreases to less than 1 percent below the surface. The soils are generally very strongly acid to moderately acid (pH 4.7 to 5.9) but can be mildly alkaline in the substratum. Available water holding capacity is moderate to high, and soil permeability is very slow to slow. Generally, both the surface and subsurface layers of these soils have moderate to high susceptibility to erosion by water. The soils have low to high sediment delivery efficiency. They are commonly susceptible to cutbank sloughing and landslides can occur in steep drainageways.

3.19.3.1.5 Residuum/Glacial Soils

The residuum/glacial soils group is comprised of landtypes 252, 303, 353, 381, 401, 403, 405, 406, and 408. Residuum/glacial soils are shallow to deep, well drained, and contain a high amount of rock fragments. They formed in gravelly medium textured glacial drift and meta-sedimentary residuum and have a volcanic ash surface layer. They occur on gently sloping to very steep glacial scoured ridge tops, glacial trough walls, and valley side slopes. They are moderately extensive in the Little Cherry Creek and Poorman Tailings Impoundment sites, and they occur along the transmission line alignments.

The surface textures are generally silt loam and gravelly silt loam with few to 30 percent rock fragments. Subsoil textures are generally very gravelly loam with up to 60 percent rock fragments. Rock outcrops occur throughout these soils. Organic matter content is moderately low in the surface layer and low below the surface. The soils are generally very strongly acid to moderately acid (pH 5.2 to 6.0). Available water holding capacity is low, and soil permeability is moderate to rapid. Generally, the surface layers of these soils have moderate susceptibility to erosion by water, and have low susceptibility to erosion by water below the surface layer. These soils have low to high sediment delivery efficiency. They commonly exhibit high slope stability but landslides can occur in steep drainageways, and sloughing and raveling can occur if cutbanks are steep. Avalanche paths occur on some very steep slopes.

3.19.3.1.6 Colluvial/Glacial Soils

The colluvial/glacial soils group was mapped only in the intensive study areas and were not based on landtypes reported in KNF soil survey (USDA Forest Service and Natural Resources Conservation Service 1995). The soils are moderately deep to deep, well drained, and contain high amounts of rock fragments. They formed in gravelly and cobbly medium textured colluvium and glacial drift and have volcanic ash surface layers. They occur on gently sloping to very steep colluvial and glacial side slopes, ridge tops, in cirque basins (semicircular basins near valley heads in mountains caused by glacial erosion), and in avalanche chutes and debris deposits. These soils are extensive at the Ramsey Plant Site. Several avalanche debris fans are located at the Libby Adit Site.

The surface textures are generally silt loam to extremely gravelly silt loam with 10 to 80 percent rock fragments. Subsoil textures are generally very gravelly silt loam and extremely gravelly loam, silt loam, and sandy loam with 35 to 87 percent rock fragments. Many of these soils have a large amount of stones and boulders covering the surface, and rock outcrops occur as inclusions. Organic matter content is medium to high (3 to 6 percent) in the surface layers and is typically less than 1 to 3 percent in subsoil layers. The soils are strongly acid to slightly acid (pH 5.3 to 6.1) but are extremely acid with a pH of 4.4 in areas at the Libby Adit Site. Available water holding capacity is low to moderate and soil permeability is moderate to rapid. Generally, the surface layers of these soils have low to moderate susceptibility to erosion by water and low susceptibility to erosion by water below the surface layer. The soils have moderate to high sediment delivery efficiency. Generally on shallower slopes (less than 25 to 35 percent), these soils have high slope stability and have moderate to low slope stability on steeper slopes.

3.19.3.2 Suitability for Reclamation

The soils in the analysis area are generally suitable for salvage and replacement. Relatively organic-rich surface layers range from 5 to 29 inches thick and average about 10 inches thick. Subsoils are also suitable for salvage and use in reclamation. Salvageable soil, including both surface soil and subsoil layers, ranges from 9 to 33 inches. Organic matter levels in surface soils are generally moderate to high, and pH values range from 4.4 to 6.6, but are typically between 5 and 6. Because of volcanic ash, the surface layers are typically medium textured and have a high water holding capacity. Some surface layers of colluvial/glacial soils have a moderate water holding capacity. A high water table would preclude salvage of some alluvial soils. Soils on slopes greater than 50 percent are generally unsuitable for salvage mainly because of safety considerations for equipment operators (Plantenberg, pers. comm. 2012).

The primary limitation to soil suitability for reclamation is rock fragment content. Soils with more than 50 percent rock fragments are generally considered unsuitable (Plantenberg, pers. comm. 2012), unless they are needed to control erosion on steep slopes. Surface soils commonly have 10 to 50 percent rock fragments, but glaciolacustrine surface layers are relatively free of rock fragments. Many of the colluvial/glacial soils contain high amounts of stones and boulders on the surface. Salvageable soils with stones and boulders would require special handling. Subsoil layers are more variable in texture and pH, but generally have high amounts of rock fragments, except for glaciolacustrine subsoil layers, which generally lack rock fragments. The soils are rated good to poor for road suitability. Poor ratings are typically due to steep slopes and susceptibility of slope failure. Glaciolacustrine soils are rated poor for road suitability due to slumping, and some alluvial soils are rated poor due to excess water. None of the soils in the analysis area have severe reclamation or revegetation potential constraints, *i.e.*, with mitigation, there would be minor losses of soil until re-establishment of vegetation.

3.19.4 Environmental Consequences

This section addresses soil impacts resulting from the action Alternatives 2, 3, and 4. The impacts are typical of any operation where soil would be removed, stored, and replaced. The effects on soils that are common to all action alternatives are presented first, followed by the effects on soils that would be unique to each alternative. Soil impacts resulting from all action alternatives would include:

1) Soil loss from erosion of disturbed areas and losses of salvageable materials through erosion and handling
2) Changes in soil physical, chemical, and biological characteristics
3) Reduction in plant growth due to potentially harmful metals in some subsoils because of the potentially acid pH levels, and in mine wastes that would be part of the revegetated plant community rooting zone

Identification of these impacts, followed by the incorporation of the appropriate mitigation measures included in the project's operating plan and the project's reclamation plan, determine the potential success of reclaiming the land to forest cover and wildlife habitat after operations cease. With respect to soils, limited reclamation success, may result in secondary or long-term negative impacts including soil erosion, and reduced soil/site productivity.

3.19.4.1 Effects Common to All Action Alternatives

3.19.4.1.1 Soil Loss

Areas cleared of vegetation would be susceptible to erosive forces and soil loss. Loss of soil also would occur from the removal and storage of soils during mine operations and from erosion of exposed soils during reclamation and stabilization. The potential for soil erosion caused by wind or water exists during all phases of the project. In general, initial erosion rates would be increased depending on soil exposure, slope steepness, and precipitation patterns. Soil losses on undisturbed lands in northwestern Montana are commonly less than 2 tons/acre/year, but under all action alternatives, soil loss rates would likely exceed 2 tons/acre/year on all disturbed areas until vegetation was established and roads were chip-sealed or graveled. Following reclamation, soil losses of less than 2 tons/acre/year are typically needed for successful revegetation. Past silvicultural/soil rehabilitation activities have displayed that vegetation ground cover is expected to be present within a 3 to 5 year timeframe following reclamation activities, and longer on steep slopes and road cuts, especially on south- and west facing slopes.

Losses of soil at disturbances, such as Ramsey and Libby Plant Sites, Libby Adit Site, Little Cherry Creek and Poorman Tailings Impoundment sites, and soil stockpiles would be captured by sediment control BMPs. Soil losses at soil stockpiles also would be controlled by installing berms around the stockpiles.

Soil losses would occur at cut-and-fill slopes at the plant sites, at mine and transmission line access roads, and at staging areas. Fill slopes would be particularly susceptible to failure, and difficult to revegetate, and cut-and-fill slope raveling (movement of dry soils) may be difficult to control in some locations. Construction of new roads and upgrading of existing roads would cross areas where soils have a severe erosion risk, high sediment delivery potential to enter waterways, and potential for slope failure. Some roads would be reclaimed as work progressed, so surface erosion would be limited. Road-building in steep terrain typically results in accelerated erosion and sedimentation (Megahan and Kidd 1972). Increases in erosion would be highest within the first 2 years, and, after 2 years, the sediment generated by mitigation roads would be negligible (see section 3.13.4, *Water Quality*). Because precipitation is high in the area, cut-and-fill slopes would be immediately stabilized to reduce potential erosion. Road cut-and-fill slopes and other disturbances along roads would be seeded, fertilized, and stabilized with hydromulch, netting, or by other methods as soon as final grades are achieved after construction to minimize erosion and to avoid crusting of the soil surface. Soil crusting would reduce seed establishment and water infiltration and result in more runoff and erosion.

Following construction of the transmission line, interim reclamation (removal of drainage obstructions at road crossings, replacement of soil where it was removed and reseeding) would be used on transmission line access roads placed into intermittent stored service to stabilize the surface and reduce erosion. Erosion from the transportation system is analyzed in section 3.13.4, *Water Quality*. All new roads would be decommissioned at the end of operations when no longer needed and most other existing roads would be reclaimed to preoperational conditions. Some roads would be covered by the tailings impoundment in all mine action alternatives.

Unprotected road surfaces would be susceptible to erosion. Access roads operational for mine life would be chip-sealed or graveled, which would reduce potential erosion, and BMPs would be used to control drainage from road surfaces. For existing roads needing upgrading, sediment controls would be upgraded/installed and appropriate BMPs would be implemented, which would result in long-term reduction of soil loss from existing road corridors. For more information with regard to expected sediment reductions from road BMPs, see section 3.13.4, *Water Quality*.

BMPs have been proven to be an effective tool in limiting nonpoint source pollution (DNRC 2010, KNF 2002b, Logan 2001). If properly constructed and located, BMPs keep soil erosion to a minimum, capture sediment before it enters waterways, and protect water quality by controlling the flow of surface water over exposed areas. Additionally, BMPs help to keep soil particles in place and thereby provides a better plant growth medium for reclamation. The proper use of BMPs prevents, any eroded soil from making its way to the watershed outlet, where it would create problems downstream; the loss of surface soil also would make achieving revegetation goals more problematic. Erosion would occur during reclamation activities when salvaged soils are spread on recontoured surfaces. Areas reclaimed using direct-hauled soils (a reclamation technique whereby soil is stripped from an undisturbed area and immediately placed on a disturbed area that has been prepared for reclamation), such as road cut-and-fill slopes and in places at the Little Cherry Creek and Poorman Tailings Impoundment sites, would have less potential for erosion than areas reclaimed with stored soil. This is because protective vegetation would establish more quickly because direct-haul soils, as opposed to stored soils, are still biologically active and retain a higher level of favorable physical and chemical characteristics than soils stored for prolonged periods (U.S. Congress, Office of Technology Assessment 1986). Only a small, undetermined percentage of the total volume proposed for salvage would be direct-handled because of the timing difference between construction and reclamation.

Wind erosion of exposed soil also would contribute to soil losses. To minimize soil wind erosion, MMC would use standard BMPs, such as periodic watering of unpaved roads and disturbed surfaces, and use of mulch and tackifiers on exposed surfaces until vegetation was established.

Soil losses would occur under all action alternatives, and even with erosion and sediment control BMPs, some soil losses are expected but would be minimized. Soil losses generally would be long-term within all disturbed areas, because erosion rates would remain elevated after reclamation until the vegetation ground cover approaches predisturbance levels in about 3 to 5 years. South- and west-facing cut slopes may require more than 5 years for the vegetation ground cover to reach predisturbance levels without soil amendments. Once vegetation was well established, soil losses are expected to be similar to pre-mine rates.

3.19.4.1.2 Soil Physical, Biological, and Chemical Characteristics

Soil characteristics that would be impacted by all action alternatives would include potential changes in soil physical and chemical properties, and biological activity, including nutrient levels. Soil structure would be altered by handling, salvage, and storage operations. Changes in chemical properties such as heavy metal concentrations and soil pH may also occur at the mine facilities. These changes to the soil characteristics are discussed below.

Physical Characteristics

Changes in physical properties of the soils due to handling, salvage, and storage would result in the alteration of the natural soil profile that has developed since the last major soil disturbing event such as glacial activity, volcanic ash deposition, or flooding. This would be an unavoidable impact of salvaging and replacing soils. Some of these areas have been logged in the past, which disturbed the surface soil profile but not to the extent that mining disturbance would. Changes in soil structure, compaction (destruction of pore space continuity and soil structure), and loss of organic matter due to mixing and storage would occur. Soils salvaged and replaced in a single lift would alter the natural soil profile due to mixing of soil horizons, which would be a long-term impact. Two-lift salvage and replacement is proposed in the tailings impoundment areas that would limit some of the mixing across soil horizons, but the impacts would still be long term. The establishment of vegetation, root systems, and physical processes, such as freezing and thawing, and wetting and drying, would restart the soil-building processes and help rebuild the natural soil profile. Where the soil profile would be altered, it would require many years for soil productivity to return to pre-mine conditions. Compaction from heavy equipment would adversely affect soil plant relations due to decreased soil water-holding capacity, loss of aeration and pore space, and increased soil bulk density (Sharma and Doll 1996). Organic-rich soils, such as surface soils, and fine-grained matrix soils that have a large volume of rock fragments, are less affected, depending on the overall soil composition (Greacen and Sands 1980).

Volcanic ash-influenced soils in northwest Montana have lower initial bulk densities than soils derived from other sources. When disturbed during activities that use heavy equipment (such as logging), these soils are particularly susceptible to compaction (Page-Dumroese 1993; Geist *et al*. 2008; McDaniel and Wilson 2007), and compaction can persist for decades (Johnson *et al*. 2007; Parker *et al*. 2007). Soils with significant amounts of coarse fragments are less susceptible to compaction from heavy equipment (Luckow and Guldin 2004), and soils with higher clay contents (greater than 20 percent clay) are more effective at ameliorating the effects of compaction, due to freezing and thawing and shrink-swell actions than ash soils, which are particularly low in clay content (Parket *et al*. 2007). Volcanic ash soils within the analysis area generally have clay contents less than 23 percent (Western Resource Development Corp. 1989b, 1989c). Additionally, studies have not explored the behavior of ash-influenced soils under prolonged storage in deep piles; therefore, it is not possible to quantify the potential resistance to compaction of these soils.

Fine-textured glaciolacustrine subsoils are susceptible to compaction during the soil salvage process and have lower inherent infiltration and permeability. Non-glaciolacustrine soils in the area would not be as susceptible to this compaction because they often have greater sand and rock fragment contents.

To reduce compaction, severely compacted areas, such as roads, soil stockpile sites, and facility sites, would be ripped before soil placement, and seedbeds would be disked and harrowed before seeding. Soil compaction would be short-term in all disturbed areas with these mitigation measures, and following reclamation, compaction in re-spread soils that are ripped would be similar to pre-mine soils.

Biological Activities

Biological changes would occur in salvaged soils. Since most disturbances would not be reclaimed until the end of operations, most salvaged soils would be stockpiled for 15 years or more. Soils salvaged along transmission line roads would be re-spread within a year. Prolonged storage decreases or eliminates populations of important soil microorganisms (Abdul-Kareem and McRae 1984), such as bacteria, fungi, and algae, which are essential in soil nutrient cycling. In addition, some favorable components normally found in native soils are lost through decomposition during storage. These components include seeds of native plants, rhizomes (underground stems), and other plant parts capable of producing new plants. Replenishment of soil microorganisms would occur with interim revegetation of soil stockpiles but would be limited to the surface (the top 6 to 8 inches) of the stockpile. Most stockpiled soil would have reduced biological activity.

Mycorrhizae (important structures that develop when certain fungi and plant roots form a mutually beneficial relationship) are also eliminated in soil stored for prolonged periods. Mycorrhizae serve as highly efficient extensions of plant root systems, especially for woody species. These associations are important to consider in maximizing plant establishment and productivity because most plants depend on mycorrhizae for adequate growth and survival (Mallock *et al.* 1980). This is especially true in nutrient deficient soils. All of the salvaged soils are considered to have low fertility. Mycorrhizae are particularly important to plant phosphorus nutrition (Bolan 1991) and water uptake (Augé 2004). Thus, the association of mycorrhizae with plants in the study area is especially critical because plant-available phosphorus is expected to be low.

Chemical Characteristics

Aluminum, iron, and manganese are found in native forested soils in the area. These common metals are released by the weathering of soil parent materials, even in non-mineralized areas. They can become concentrated in a particular soil horizon by various soil-formation processes. Although typically not available to plants at neutral pH values, if soil surveys indicate soil pH is around 5.0, the agencies would require soil metal testing to identify possible naturally occurring concentrations of these and other metals. Soil samples tested had pH values from 4.3 to 7.5, with values between 5.0 and 6.0 being the most common. Samples with low pH were generally from the Little Cherry Creek and Poorman Tailings Impoundment sites, but soils with low pH potentially occur at all proposed disturbance areas. Soils having pH conditions below 5 are not proposed to be salvaged. Aluminum in particular may be slightly elevated in volcanic ash-rich loess. Elevated aluminum levels are common in the widespread volcanic forested soils of northwest Montana (McDaniel and Wilson 2007; Page-Dumroese *et al*. 2007), and native vegetation likely has adapted to the ambient soil chemistry.

Heavy metals often associated with mineralized zones, such as lead and copper could hinder plant growth. None of the rock types tested during exploration and past mining operations exhibited highly elevated leachable metal concentrations, which are metals that would become soluble in soil water (see section 3.9.4, *Environmental Geochemistry* for detailed discussion of leachable metals). Preliminary testing shows tailings materials and some of the mine waste rock would have low levels of leachable metals and no net acid generation potential. Considering these results, the mine waste materials would have limited adverse chemical impacts on re-spread soil or on plants whose roots may grow into these materials in the lower part of the rooting zone. MMC would test waste rock and tailings before soil redistribution to reconfirm these results.

3.19.4.1.3 Reclamation Success

Recognition of inherent soil properties and design of salvage programs to retain favorable properties can enhance reclamation success. Soil characteristics important to consider for analyzing impacts and assessing soil salvageability and suitability for reclamation include:

- Depth and horizon (developed soil layer) sequence
- Texture (relative proportion of sand-, silt-, and clay-sized particles)
- Coarse fragment content (size, amount, and shape (rounded or angular))
- Erodibility
- Organic matter content
- Reaction (refers to the acidity or alkalinity of the soil solution and is expressed as pH ranging from 1 to 13, where 1 is the most acidic, 7 is neutral, and 13 is most alkaline or basic)
- Slope steepness; and location and extent of rock outcrop and talus

Soil Salvage and Handling

The potential for reclamation success of disturbed lands is greatly improved when soil is salvaged and later replaced in two or more lifts to provide a suitable growth medium for plants (Montana State University 2004). MMC would salvage and replace soils on most disturbed areas, except where slopes are too steep, at soil stockpile areas, and where soils are too rocky. The primary limitations that affect soil suitability for salvage and reclamation at the site include high rock content and steep slopes, and to a lesser extent, soil texture, soil pH, and a high water table. Salvage may be limited for soils with a volume of more than 50 percent rock fragments (larger than 1/16 inch diameter) or with large rocks (greater than 2 feet in diameter). Soils with up to 60 percent rock fragments would be salvaged in some areas to provide erosion protection on the steep embankment of the Little Cherry Creek and Poorman Tailings Impoundment sites. Salvage would not be required and not be conducted on slopes exceeding 2:1 (50 percent) because of worker safety considerations. Other reclamation limitations at the site include soils with high clay content and pH levels below 5, which increase the potential for metal mobility out of soils.

Soil Amendments

Reclamation success can be enhanced on particular sites by use of soil amendments. Use of mulches and tackifiers can limit soil loss until seedlings can establish. Alkaline amendments can be added to acid soils to raise the pH. Wood based organic amendments can be added to the surface soil to increase organic matter contents, reduce compaction, reduce crusting, increase soil fertility, lower bulk density, and potentially enhance establishment of a fungal based mycorrhizae community that would enhance the establishment and growth of woody plant species. MMC has only proposed the use of mulches to reduce soil erosion.

Revegetation

The main factors relating to revegetation include scheduling of final revegetation, species selection, planting plans, and establishing success criteria to achieve long-term plant cover and density objectives. These factors determine the speed and success of reclaiming the disturbed lands to comparable stability and utility.

MMC would not implement final reclamation for most disturbances until the post-operational phase (after 15 to 20 years). Final reclamation would be done on some sites during the predevelopment period (1 to 3 years). These areas would include the Little Cherry Creek Diversion Channel (Alternatives 2 and 4), cut-and-fill slopes at plant sites, portal patio faces, and the Bear Creek access road north of the proposed Little Cherry Creek Tailings Impoundment. Disturbances reclaimed during operations would include some temporary access roads. Interim reclamation, (replacing soil where it was removed and reseeding) would occur on transmission line access roads placed into intermittent stored service. All other disturbances would be reclaimed after operations cease.

3.19.4.2 Soil Loss

3.19.4.2.1 Alternative 1 – No Mine

Under Alternative 1, the Montanore Project would not be developed. Soil resource impacts would be limited in comparison to the other alternatives. Soil loss due to erosion would be restricted to existing exploration-related or baseline data collection disturbances. All existing soil disturbances by MMC would be reclaimed in accordance with existing laws and permits. Erosion and sedimentation would occur at existing rates along NFS road #278 and other existing roads. Soil erosion losses due to rainfall, runoff, and wind would continue at natural rates at other locations in the analysis area.

3.19.4.2.2 Alternative 2 – MMC's Proposed Mine

Soil losses would occur during construction of access roads and facilities, at soil stockpiles, and when soils are salvaged and re-spread. Table 170 presents a comparison of the likely disturbances in which soil would be salvaged and salvageable soil volumes of mine facilities for each alternative. The disturbance acres in Table 170 do not include proposed soil stockpiles and existing roads because no soil would be salvaged from these areas. Soil would be salvaged from only small portions of LAD Areas such as roads and ponds. The Libby Adit Site is an existing disturbance area, and soil has already been salvaged and stockpiled at the site, so it is not included in Table 170.

Alternative 2 - Soil Losses from Construction of Facilities and Roads

Construction of mine related facilities and roads would result in soil disturbance and a loss of soil productivity on about 2,081 acres (Table 170). Much of the facility disturbances would be covered with structures, such as buildings, or other material, such as tailings and waste rock.

New roads, upgrading existing roads, and pipeline corridors would disturb 153 acres. Unprotected road surfaces would be susceptible to erosion. For access roads operational for mine life, MMC would chip-seal or gravel road surfaces, which would reduce potential erosion, and BMPs would be used to control drainage from road surfaces. For existing roads needing upgrading, MMC proposes to upgrade/install sediment controls and implement appropriate BMPs, which in the long run, would reduce total soil loss (see section 3.13.4, *Water Quality*).

Table 170. Comparison of Disturbances from Soil Salvage and Salvageable Soil for Alternatives.

Disturbance	Units	Alternative 2 – MMC's Proposed Mine	Alternative 3 – Agency Mitigated Poorman Impoundment Alternative	Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative
Tailings Impoundment/Dam†	Acre	620	590	620
Lift 1	cy	754,166	695,571	754,166
Lift 2	cy	1,224,076	1,292,699	1,224,076
Seepage Collection Pond	Acre	8	18	8
Lift 1	cy	8,927	21,461	8,927
Lift 2	cy	20,167	33,999	20,167
Borrow Areas outside tailings impoundment	Acre	419	91	228
Lift 1	cy	393,690	115,023	288,977
Lift 2	cy	393,690	85,224	212,558
Diversion Channel	Acre	40	0	40
Lift 1	cy	50,780	0	50,780
Lift 2	cy	0	0	18,486
Other potential disturbances‡	Acre	761	498	650
Lift 1	cy	943,531	605,664	798,041
Lift 2	cy	1,231,008	786,429	1,187,486
Plant Site	Acre	49	72§	72§
Lift 1	cy	118,580	139,279	139,279
Upper Libby Adit	Acre	0	1	1
Lift 1	cy	0	538	538
LAD Areas	Acre	31	0	0
Lift 1	cy	37,739	0	0
Lift 2	cy	0	0	0
Roads	Acre	153	197	209
Lift 1	cy	372,198	154,024	154,379
Lift 2	cy	0	184,347	193,851
TOTAL	Acre	2,081	1,441	1,791
Lift 1	cy	2,679,611	1,731,560	2,195,087
Lift 2	cy	2,868,941	2,382,698	2,856,624

†Values are for dam and impoundment only. Entire tailings impoundment areas also include Seepage Collection Pond, borrow areas outside tailings impoundment footprint, Diversion Channel (Alternatives 2 and 4), and other potential disturbances shown elsewhere in table.
‡Includes roads, storage areas, ditches, pipelines, etc. Does not include soil stockpiles and existing roads.
§Soils not mapped at intensive level, suitable lift-2 soils likely present; does not include soil stockpile areas and existing roads; acreage may differ from disturbance acres presented in Table 9 for Alternative 2, Table 20 for Alternative 3, and Table 33 for Alternative 4 in Chapter 2.
cy = cubic yard.
Source: GIS analysis by ERO Resources Corp. using soils mapping in Western Resource Development Corp. 1989b, 1989c.

Areas of culvert replacement and/or extension and bridge construction at Ramsey Creek and Poorman Creek would be subject to erosion until stabilized. Short-term increases in sedimentation may occur as a result.

MMC proposed a 10,800-foot Little Cherry Creek Diversion Channel around the tailings impoundment that would flow into Libby Creek. The Diversion Channel would consist of two main sections: an upper engineered channel (designed for the 6-hour Probable Maximum Flood flow and the riprapped channel sides for the 100-year flood flows), and two down gradient existing natural drainage channels that flow toward Libby Creek (Figure 8). These two existing channels, referred two as Drainage 10 and Drainage 5, would both receive flow from the Upper Diversion Channel, which would reduce channel impacts that can occur during peak flow events. The existing channels would not be large enough to handle the expected flow volumes; these channels would undergo channel adjustments until they stabilized. These adjustments would include bank erosion, channel scouring, and sloughing of bank material, which would contribute sediments to Libby Creek.

MMC would construct some bioengineering and structural features based on need and access in the two unnamed tributary channels to reduce flow velocities, minimize erosion in the unnamed tributaries, minimize sedimentation to Libby Creek, and create fish habitat. In addition, MMC would evaluate potential locations for creating wetlands and ponds in low gradient areas to capture and retain most of the sediments generated from the unnamed tributaries and minimize sedimentation to Libby Creek. If wetlands or ponds were not constructed to retain mobilized sediments on the Libby Creek floodplain, the additional input of sediments to Libby Creek may cause channel aggradation, which may result in bank erosion due to channel widening. Bank erosion in the unnamed tributaries and possibly sedimentation to Libby Creek would continue until the tributaries adjusted to the increased flow volumes (see section 3.6, *Aquatic Life and Fisheries*). If substantial erosion occurred once the diversion channel was operational, additional erosion control structures would be constructed as needed.

Once the tailings impoundment was reclaimed, there would be a slight increase in flow to Bear Creek from runoff from the impoundment surface. This runoff would flow to Bear Creek via a diversion ditch. The ditch would be riprapped to minimize erosion and sedimentation in Bear Creek. A small, rockfill check dam would be located just beyond the northwest end of the reclaimed impoundment. If necessary, sediment would be removed from the pond. The check dam would be designed for the 100-year flood event. Short-term erosion in the ditch and subsequent sedimentation in Bear Creek would likely occur during construction of the ditch and check dam. With the additional flow, especially after large runoff events, there could be minor adjustments to the Bear Creek channel resulting in minor scouring and bank erosion.

Alternative 2 - Soil Losses at Soil Stockpiles

All soil stockpiles would be susceptible to erosion. Soil stockpiles would be constructed with 40 percent side slopes and 33 percent sloping ramps where possible. MMC proposes to stabilize stockpiles when they reach their design capacity, and seed during the first appropriate season following stockpiling. This would leave exposed soil on steep slopes for potentially prolonged periods. If left exposed and unprotected for more than a couple of months, regardless of other characteristics, large amounts of soil may erode. To minimize sedimentation to floodplains, wetlands and streams, MMC proposes to locate soil stockpiles on gentle slopes away from drainages, install berms around stockpiles, and construct sediment traps downslope of soil stockpiles where necessary.

Apart from erosion resulting from steep slopes and exposure, each stockpile would have a different potential for erodibility. Each stockpile includes soils from adjacent or nearby salvage areas, thus the nature of each stockpile would be different in terms of soil texture and rock content. For example, soils at the Ramsey Plant Site would be salvaged in one lift and would be composed of predominately silt loam with lesser amounts of gravelly silt loam and very gravelly silt loam. Due to the high silt content and only some soils having high gravel content, these stored soils would have a moderate to high erodibility potential. Some soils at the Little Cherry Creek Tailings Impoundment Site would be salvaged in two lifts and stored separately. The surface lift, which includes the more suitable soil, would be comprised of fine-textured volcanic ash, silt loam, gravelly silt loam, and gravelly loam. First-lift stockpiles would have moderate to high erodibility potential due to the high silt content and low rock fragment content. The second lift would be composed of gravelly to very gravelly loam and clay loam. Second-lift stockpiles would have moderate erodibility potential due to higher rock fragment content and less silt.

For new roads that are to be operational for mine life, MMC proposes to stockpile soils along the entire corridor. Most of these soils have a volcanic ash surface layer and have a moderate to high erodibility potential due to the high silt content and low rock fragment content. Stockpiling soils along entire corridors would increase the surface area of exposed soil and thereby result in more soil losses than if salvaged soils were concentrated in only a few stockpiles in clearings or areas of recent timber harvest immediately adjacent to new roads.

Alternative 2 - Soil Losses from Soil Salvage and Replacement

Soil losses during salvage and replacement activities could affect the volume of soil estimated for salvage, particularly at LAD Areas and at the Libby Adit Site where salvageable soil was limited (soils have already been salvaged and stockpiled at the Libby Adit Site). This in turn would affect proposed redistribution depths at LAD Areas and at the Libby Adit Site and could potentially adversely affect reclamation success. MMC reports that previous reclaimed disturbances with less than 18 inches of re-spread soil at the Libby Adit Site have demonstrated viable vegetation cover, and MMC proposes to re-spread 18 inches of soil at disturbances in LAD Areas requiring soil replacement.

MMC proposes to store all first-lift soils salvaged from the Little Cherry Creek Tailings Impoundment Site together, including surface soils having no or few rock fragments and high erosion potential, such as glaciolacustrine soils, with surface soils having a large amount of rock fragments. This could result in having highly erosive soils on the steep surface of the embankment of the impoundment and lead to excessive erosion of surface soils exposing less fertile subsoil and affecting long-term reclamation success on the impoundment embankment.

MMC proposes to salvage some clay-rich glaciolacustrine subsoils (>40 percent clay) at the Little Cherry Creek Tailings Impoundment Site. This soil type is poorly suited as a plant growth medium due to shrinking and swelling, surface crusting, low water infiltration, slow permeability, and high erodibility potential. If this clay-rich material were used as final re-spread surface soil, plant re-establishment would be impeded and erosion would likely increase, especially on the tailings embankment.

In summary, MMC’s proposed measures to control runoff and sedimentation and combined with some of the native surface soil and subsoil characteristics, such as rock fragment content, would help reduce erosion rates. If glaciolacustrine soils were used as surface soil on the impoundment, soil losses could affect reclamation success in the long term especially on the embankment of the impoundment for reasons discussed previously. Until vegetation ground cover reached predisturbance levels, anticipated to be in about 3 to 5 years in most areas, erosion rates would be higher than before disturbance. Soil losses are not expected to affect reclamation success at other disturbance areas, because sufficient soil material exists to meet MMC's proposed reclamation plan, with the possible exception at LAD Areas and at the Libby Adit Site where salvageable soil was limited.

3.19.4.2.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Alternative 3 would result in a loss of soil productivity on 1,441 acres where soil would be salvaged. It would meet soil quality standards as one of the long-term reclamation goals. In addition to the fewer disturbed acres than Alternative 2, Alternative 3 also would provide additional mitigation measures that would result in less erosion and less sedimentation to Libby Creek and its tributaries. These additional measures are described below.

On all soil stockpiles, interim seeding and mulching would be conducted incrementally as the stockpiles are being constructed and as soon as possible, regardless of season, rather than waiting until the first appropriate season after they reach design capacity. This would reduce erosion potential and potentially reduce sedimentation to drainageways.

For new roads that are to be operational for mine life, salvaged soils would be stockpiled in clearings or in areas of recent timber harvest immediately adjacent to new roads or in other nearby soil stockpiles rather than stockpiling along the entire road corridor. Consolidating soil stockpiles would improve management and control soil losses along road corridors and minimize sedimentation to nearby waterways. MMC would develop and implement a Road Management Plan addressing all roads used in the alternative. Successful implementation of the plan would ensure that erosion and sediment delivery from roads would be minimized.

A Little Cherry Creek Diversion Channel would not be needed under Alternative 3. Elimination of the Diversion Channel would reduce short-term erosion in the unnamed tributaries and sedimentation to Libby Creek. The potential long-term effects of channel aggradation, and bank erosion from channel widening in Libby Creek and the potential for sedimentation and bank erosion in Bear Creek also would be eliminated. Once the tailings impoundment was reclaimed, there would be a 40 to 70 percent increase in average annual flows in Little Cherry Creek as runoff from the impoundment surface would be directed to Little Cherry Creek. This increase in flow would cause some short-term scouring and bank sloughing in Little Cherry Creek closer to the impoundment and some sedimentation farther downstream.

For soil salvage at the Poorman Tailings Impoundment Site, rocky soil would be segregated from non-rocky soil. Soil would be replaced in two lifts 24 inches thick on the embankment and impoundment surface. Rocky subsoil would be used as re-spread subsoil (15 inches thick) over the tailings embankment, and rocky surface soil would be used as the upper 9 inches of re-spread soil on the embankment. This would minimize erosion potential on the embankment. The non-rocky surface soil would be used as the upper 9 inches of re-spread soil on the rest of the impoundment on slopes less than 8 percent. The clay-rich subsoil of glaciolacustrine soils salvaged from the impoundment area would be stockpiled separately from other second-lift soils and used, along with other salvaged soil, as re-spread subsoil (15 inches thick) on top of the tailings impoundment. It could also be used to cover any sandy or gravelly soils exposed during impoundment site stripping and borrow excavation operations to minimize infiltration of water from the tailings impoundment or from the Seepage Collection Pond. An average of 24 inches of surface soils and 12 inches of subsoils at all wetlands would be excavated and used at wetland mitigation sites (see section 2.5.7.1, *Jurisdictional Wetlands and Other Waters of the U.S.*).

With the modifications to control erosion under Alternative 3, soil losses within the disturbed areas would be less and not as severe as under Alternative 2, and sedimentation to waterways would be less for Alternative 3 than for Alternative 2 (section 3.19.4.2.2, *Alternative 2 – MMC's Proposed Mine*). Because 640 fewer acres would be disturbed in Alternative 3 than in Alternative 2, Alternative 3 would have less soil loss.

3.19.4.2.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would salvage soils from 1,791 acres (Table 170). Alternative 4 would provide the same additional mitigation measures as Alternative 3, which would result in less erosion and less sedimentation to Libby Creek and its affected tributaries. MMC would develop and implement a Road Management Plan addressing all roads used in the alternative. Successful implementation of the plan would ensure that erosion and sediment delivery from roads would be minimized.

Under Alternative 4, a Little Cherry Creek Diversion Channel would be built and would consist of two main sections: an upper engineered channel and a constructed lower channel to Libby Creek using an existing drainage channel (Drainage 10 proposed in Alternative 2). The engineered channel would be the same as the engineered channel under Alternative 2 and would be designed for the 6-hour Probable Maximum Flood. It would flow into a constructed channel that would be designed to be geomorphologically stable and to handle the 2-year flow event. The natural-designed channel would have similar channel pattern, dimensions, profile, and bed material as similar-sized channels in the analysis area (see design elements listed in section 2.6.3.2, *Modified Little Cherry Creek Tailings Impoundment*). A floodplain would be constructed along the channel to allow passage of the 100-year flow.

Significant erosion and sedimentation should not occur because construction of the channel would be done in dry conditions. The majority of sediment generated would occur during initial channel flush and subsequent high flow and rainfall events. In the event of heavy precipitation during construction of the channel, significant erosion may occur. Natural and biodegradable materials and vegetation would be used along streambanks and on the floodplain to minimize erosion, stabilize the stream channel and floodplain, and minimize sedimentation to the lower channel and Libby Creek. Long-term monitoring and maintenance would be required, if necessary, until the lead agencies determine that the channel was stabilized. Even with these mitigation measures, the constructed natural-designed channel would be subject to erosion and sedimentation during construction and until vegetation stabilizes the streambanks and floodplain. Short-term increases in sedimentation to the lower channel and Libby Creek would likely occur as a result.

Following reclamation of the impoundment, the constructed channel would undergo an additional period of channel adjustment when runoff from the impoundment surface was directed to the Diversion Channel. The increase in flow would be about 50 percent higher than during operations, and would lead to new channel adjustments. This would likely cause short-term increases in sedimentation in the lower channel and Libby Creek.

For soil salvage at the Alternative 4 Little Cherry Creek Tailings Impoundment, rocky surface soil would be segregated from non-rocky surface soil. Like Alternative 3, rocky subsoil would be used as re-spread subsoil (15 inches thick) over the tailings embankment, and rocky surface soil would be used as the upper 9 inches of re-spread soil on the embankment. This would minimize erosion potential on the embankment. Non-rocky surface soil would be used as the upper 9 inches of re-spread soil on the rest of the impoundment on slopes less than 8 percent. Also like Alternative 3, clay-rich subsoil of glaciolacustrine soils salvaged from the impoundment area would be stockpiled separately from other second-lift soils and would be used, along with other salvaged soil, as re-spread subsoil (15 inches thick) on top of the tailings impoundment. It could also be used to cover any sandy or gravelly soils exposed during impoundment site stripping and borrow excavation operations to minimize infiltration of water from the tailings or from the Seepage Collection Pond, or to line the channel foundation for the Little Cherry Creek Diversion Channel.

With the modifications to control erosion under Alternative 4, soil losses within the disturbed areas would be less and not as severe as Alternative 2 and sedimentation to waterways would be less for Alternative 4 than for Alternative 2 (section 3.19.4.2.2, *Alternative 2 – MMC's Proposed Mine*). Compared to Alternative 3, Alternative 4 would disturb more acres creating greater potential for soils loss, and Alternative 4 would require the construction of the Little Cherry Creek Diversion Channel, which would increase the risk of channel erosion and sedimentation to waterways.

3.19.4.2.5 Transmission Line Alternatives

Alternative A – No Transmission Line

Under Alternative A, the transmission line, Sedlak Park Substation, and loop line for the Montanore Project would not be built. Soil erosion losses due to water and wind would continue at natural rates. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that do not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

Alternative B – North Miller Creek Alternative

MMC's proposed North Miller Creek transmission line corridor would be 16.4 miles long and would require 108 structures. This alternative is slightly longer than the lead agencies' alternatives in part because it ends at the substation at the Ramsey Plant Site where the lead agencies' alternatives end at the substation at the Libby Plant Site about 1.5 miles to the east. The centerline of the transmission line of the North Miller Creek Alternative would cross more steep areas (7.4 miles), more soils with a severe erosion hazard (6.7 miles), and more soils with high sediment delivery (5.1 miles) than the other three alternatives. The disturbance associated with structure placement would increase erosion until vegetation ground cover around the structure locations reached predisturbance vegetation ground cover levels. MMC did not specify the type of logging that would be used. For analysis purposes, the lead agencies assumed all logging would be completed conventionally without the use of a helicopter. Disturbance associated with logging operations would increase soil erosion.

The primary surface disturbance from transmission line construction would be construction of new access roads. The total disturbance for access roads, which would be either new roads or existing closed roads requiring upgrades, would be greater under this alternative (30.9 acres) than the other alternatives. The access roads would disturb 8.9 acres of soil having severe erosion risk, 6.3 acres of soil having high sediment delivery potential to waterways, 13.3 acres of soil having potential for slope failure, and 16.5 acres of slopes greater than 30 percent (Table 171). Disturbances on steeper slopes are generally more difficult to reclaim and require more mitigation measures than on shallower slopes. The majority of soils having severe erosion risks along access roads occur along Libby and Miller creeks and Fisher River. Most soils with high sediment delivery potential disturbed by access roads occur along Ramsey, Libby, and Miller creeks and Fisher River. Most soils having potential for slope failure occur along Ramsey Creek, just east of Libby Creek, and near Fisher River. Access roads on slopes exceeding 30 percent primarily occur along Ramsey Creek, between Libby and Miller creeks, north of Miller Creek, and locations east of the Fisher River (Figure 84).

Table 171. Comparison of Physical Characteristics and Erosion Risks for Transmission Line Alternatives.

Criteria	Units	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
Length of Transmission Line	Miles	16.4	13.1	13.7	15.1
Total road disturbance	Miles	10.2	3.1	5.1	3.9
	Acres	30.9	9.4	15.5	11.7
Severe erosion risk					
Centerline only	Miles	6.7	1.8	1.3	3.4
New roads + closed roads with high upgrade requirements	Acres	8.9	2.4	1.8	2.3
High sediment delivery					
Centerline only	Miles	5.1	0.5	0.5	0.5
New roads + closed roads with high upgrade requirements	Acres	6.3	0.6	0.6	0.6
Slope failure					
Centerline only	Miles	9.3	6.8	7.5	9.4
New roads + closed roads with high upgrade requirements	Acres	13.3	4.7	6.4	6.4
Slopes > 30 percent					
Centerline only	Miles	7.4	7.2	6.4	4.7
New roads + closed roads with high upgrade requirements	Acres	16.5	4.4	7.9	2.5

Source: GIS analysis by ERO Resources Corp. using vegetation mapping in USDA Forest Service and Natural Resources Conservation Service 1995.

Sediment controls and BMPs would be implemented on new and upgraded roads during construction of the transmission line to minimize erosion, sediment delivery to waterways, and slope failure. All access roads, after construction of the transmission line but during the life of the project, would be closed and placed into intermittent stored service and reclaimed with interim reclamation designed to stabilize the surface. This reclamation would include removal of drainage obstructions at road crossings, reseeding the road surface, and where soil had been salvaged from new roads, the road surface would be covered with soil and then reseeded.

After the transmission line was removed, all newly constructed roads on National Forest System lands would be decommissioned. They would be recontoured to match existing topography, obliterating the road prism, and reseeded. Where culverts were removed, streambanks would be recontoured and reseeded. Final closure status of new access roads on private lands would be based on the landowner’s discretion. With sediment controls, BMPs and short duration of exposed soil, there would be no severe reclamation constraints, no significant adverse impacts to the soil resources, and the soil losses along access roads would likely be minor until vegetation was re-established in most areas after 3 to 5 years. Vegetation re-establishment on steep areas, particularly on south- and west-facing slopes, could take longer.

In all action transmission line alternatives, the BPA would construct and operate the Sedlak Park Substation and loop line. The Sedlak Park Substation and loop line site is on a flat terrace of the Pleasant Valley Fisher River. The site is underlain by glaciolacustrine soils, which have severe erosion risk and are prone to slope failure. The BPA would prepare and implement a SWPPP during substation and loop line construction to minimize water erosion. The substation site would have a stormwater containment system. After the transmission line was removed, the substation site would be decommissioned and the site reclaimed. Soil losses at the Sedlak Park Substation and loop line site would be minimal.

Alternative C-R – Modified North Miller Creek Alternative

The Modified North Miller Creek Alternative would be 13.1 miles long, the shortest of all alternatives, require 81 structures, and end at the substation at the Libby Plant Site, which is about 1.5 miles east of the proposed substation at the Ramsey Plant Site under Alternative B. The centerline would cross 7.2 miles of steep slopes, 6.8 miles of slopes prone to failure, 1.8 miles of soils with severe erosion risk, and 0.5 miles of soils with high sediment delivery. The disturbance associated with structure placement would increase erosion until vegetation ground cover around the structure locations reached predisturbance vegetation ground cover levels. MMC would use a helicopter to harvest timber at selected locations, reducing the need for access roads (Figure 44). Conventional logging techniques would be used in other areas. Helicopter logging would result in less soil erosion than conventional logging used in Alternative B.

New access roads and closed roads with high upgrade requirements would be needed for transmission line installation and would create 9.4 acres of disturbance, the fewest of all alternatives and about 22 acres fewer than Alternative B. These roads would disturb 2.4 acres of soils having severe erosion risk, 4.7 acres of soil that have potential for slope failure, the fewest of all alternatives, and 4.4 acres of slopes greater than 30 percent. Alternative C-R (and Alternatives D-R and E-R) would affect few soils with high sediment delivery potential to waterways (0.6 acres). Most soils having severe erosion risks along access roads occur along Libby Creek in the extreme western portion of the transmission line, along Miller and West Fisher creeks, and along Fisher River. Soils having high sediment delivery potential along access roads occur only in two places, along Libby Creek and at the northeast end along the Fisher River. Most soils having potential for slope failure along access roads occur just east of Libby Creek, portions between Miller and West Fisher creeks, and east of Fisher River. Access roads on slopes exceeding 30 percent occur primarily between Libby and Miller creeks, north of Miller Creek, much of the area between Miller and West Fisher creeks, and along portions east of Fisher River (Figure 84). MMC would develop and implement a Road Management Plan addressing all roads used in the alternative. Successful implementation of the plan would help minimize erosion and sediment delivery from roads.

Sediment controls and BMPs would be implemented on new roads to minimize erosion, sediment delivery to waterways, and slope failure. As with Alternative B, new access roads on National Forest System lands would be placed into intermittent stored service after line construction was completed. Intermittent stored service roads would be closed to traffic and would be treated, which would include at a minimum removing drainage obstructions, replacing salvaged soil, seeding, and installing cross drains, so they would cause little resource risk if maintenance were not performed on them during the operation period of the mine and before their future need. Intermittent stored service is described in section 2.9.4.2, *Access Road Construction and Use*.

After removal of the transmission line, transmission line roads on National Forest Systems lands would be decommissioned. The road prism would be obliterated, all watercourses would be restored, and the road prism would be revegetated. Road decommissioning is described in section 2.9.4.2, *Access Road Construction and Use*. Unlike Alternative B, for Alternative C-R, the surface soil that had been in place on access roads for the life of the transmission line would be salvaged, the road prism obliterated, and then the surface soil replaced. The surface soil that had been in place for the life of the transmission line would have higher nutrient levels, higher organic matter content, and greater microbial activity than the underlying soil, and it would be a seed source for the native plants that had established over the life of the transmission line. This would shorten the amount of time for vegetation to re-establish, which would minimize the amount of time bare soil was exposed to erosive forces.

Newly constructed roads on Plum Creek lands would be gated after construction and managed as proposed by MMC in Alternative B. As with Alternative B, final closure status of new access roads on private lands would be based on the landowner’s discretion. With fewer acres of disturbance and the shorter amount of time soil was exposed, impacts probably would be lower than those on Alternative B. With sediment controls, BMPs and short duration of exposed soil, there would be no severe reclamation constraints, no significant adverse impacts to the soil resources are expected, and the soil losses along access roads would likely be minor until vegetation was re-established in about 3 to 5 years for most areas. Vegetation re-establishment on steep areas, particularly on south- and west-facing slopes, could take longer.

Alternative D-R – Miller Creek Alternative

The Miller Creek Alternative would be 13.7 miles long, require 92 structures, and end at the substation at the Libby Plant Site. This alternative would cross the least amount of soil having severe erosion risk (1.3 miles). The centerline of this alternative would cross more soils that have potential of slope failure than Alternative C-R, but would cross fewer steep slopes than Alternative C-R. The Miller Creek Alternative would disturb fewer soils having slope failure potential and steep slopes than Alternative B (Table 171). Some areas would be logged using a helicopter, resulting in disturbances and erosion similar to Alternative C-R.

New access roads and closed roads with high upgrade requirements would create 15.5 acres of disturbance (about 16 fewer acres than Alternative B), and disturb 7.9 acres of slopes that exceed 30 percent, 0.6 acres of soils with high sediment delivery potential to waterways, and 6.4 acres of soil that have potential for slope failure. Access roads for this alternative would cross the fewest acres of soil having severe erosion risk (1.8 acres). Most soils having severe erosion risks along access roads occur along Libby Creek in the extreme western portion of the transmission line, along West Fisher Creek and Fisher River. The majority of soils with high sediment delivery potential along access roads occur only along Libby Creek and at the northeast end along the Fisher River. Most soils having potential for slope failure along access roads occur southeast of Libby Creek near Howard Lake, portions between Miller and West Fisher creeks, and east of Fisher River (Figure 84). Other effects and measures to control soil losses associated with the transmission line and corresponding access roads would be the same as Alternative C-R.

Alternative E-R – West Fisher Creek Alternative

The West Fisher Creek Alternative would be 15.1 miles long, require 103 structures, and end at the substation at the Libby Plant Site. The centerline would cross 4.7 miles of slopes greater than 30 percent, less than all other alternatives, and would cross 9.4 miles of soils that have potential of slope failure, which is essentially the same as Alternative B and more than Alternatives C-R and D-R. The centerline of Alternative E-R would cross fewer miles of soils that have severe erosion risk (3.4 miles) than Alternative B but more miles than Alternatives C-R and D-R. Some areas would be logged using a helicopter, resulting in disturbances and erosion similar to Alternative C-R.

New access roads and closed roads with high upgrade requirements would create 11.7 acres of disturbance (about 19 fewer acres than Alternative B), and would disturb 2.3 acres of soils having severe erosion risks, which occur primarily along Libby and West Fisher creeks and Fisher River. This alternative would affect 6.4 acres of soils with a potential for slope failure, which occur southeast of Libby Creek near Howard Lake, portions north of West Fisher Creek, and east of Fisher River. Access roads would cross 2.5 acres having slopes greater than 30 percent, which is less than any other alternative and occur primarily southeast of Howard Lake, along portions north of West Fisher Creek and along portions east of Fisher River (Figure 84). Other effects and measures to control soil losses associated with the transmission line and corresponding access roads would the same as Alternative C-R.

3.19.4.3 Soil Physical, Biological, and Chemical Characteristics

Soil characteristics that would be impacted by action Alternatives 2, 3, and 4 and by the transmission line action alternatives include changes in soil physical properties, biological activity, and nutrient levels. The likelihood of changes in chemical properties such as changes in heavy metal concentrations and soil pH are also discussed.

3.19.4.3.1 Alternative 1 – No Mine

Under Alternative 1, the Montanore Project would not be developed. Soil changes in physical and chemical properties, biological activities, and nutrient levels would be limited to any existing exploration-related or baseline collection disturbances. All existing exploration-related or baseline collection disturbances by MMC would be reclaimed in accordance with existing laws and permits. In all other areas, soil changes in physical and chemical properties, biological activities, and nutrient levels would continue at natural rates.

3.19.4.3.2 Alternative 2 – MMC Proposed Mine

Alternative 2 - Physical Characteristics

Single lift soil salvage and replacement would alter the natural soil profile by mixing soil horizons that developed over the past 10,000 years. MMC would use the single lift salvage and replacement method at the Ramsey Plant Site, the Libby Adit Site, the LAD Areas, and access roads. The Little Cherry Creek Tailings Impoundment Site would have soils salvaged and replaced in two lifts. This would limit impacts from mixing soil horizons but the loss of soil development and the length of time to re-establish a new soil profile would still take a long time. At other disturbance sites where soils would be salvaged using a two-lift method, the soils would be replaced using a single-lift method. There would be a long-term impact on the soil profile at these sites. Over time, natural processes would rebuild a new soil profile that may or may not resemble the predisturbance condition. The loss of soil development and the time needed to redevelop a new soil profile would be an unavoidable impact of soil disturbance.

To minimize soil compaction, MMC would rip compacted areas before redistribution of soil. Areas expected to be ripped include the adit portal areas, roads, soil stockpile sites, the dam face of Little Cherry Creek Tailings Impoundment, and facility areas. Ripping also would eliminate potential slippage at layer contacts and promote root growth. Following soil redistribution, the seedbed would be disked and harrowed on slopes 33 percent or less, which would minimize compaction of the seedbed. These practices would tend to offset compaction on many reclaimed sites. Some areas, such as road fills and as much as possible at the tailings impoundment site, would receive direct-hauled soil. If seeded immediately, and provided that soils are handled when dry, compaction would be minimal. MMC has not committed to handle soils when dry. If soils were wet when handled, some compaction is expected, especially on slopes greater than 33 percent because the seedbed on these slopes would not be disked and harrowed. The establishment of vegetation, root systems, rodent activity, and physical processes such as freezing and thawing, and wetting and drying would decrease soil compaction. In time, effects related to soil compaction of respread soils would be reduced.

Alternative 2 - Biological Activities

The loss of organic matter and mycorrhizae in soils stockpiled for prolonged periods could lower plant species diversity (Strohmayer 1999). If mycorrhizae-inoculated trees and shrubs species were readily available, MMC would use these species and would use stock raised in containers where the soil medium has been inoculated with mycorrhizae, if it were available. The loss of organic matter and mycorrhizae would be a long-term impact, and if mycorrhizae inoculation were not completed, the long-term survival and growth of woody species, in particular, may be reduced. In time, mycorrhizae would invade reclaimed sites from adjacent undisturbed areas, and species diversity would eventually increase, but not to pre-mine levels as discussed in section 3.22.1.4, *Environmental Consequences*.

Alternative 2 - Soil Nutrients

As is typical of many forest soils, nutrient levels are low to very low partially due to low soil pH. During soil storage, these levels would only decrease as organic matter and biological activity decreased and precipitation leached nutrients through the stockpiles. Soil stockpiles would contain organic debris, such as residual coniferous forest slash that was acidic, that could decrease soil pH as the material weathers.

Soils formed in volcanic ash often fix phosphorus in a form unavailable for plant uptake (McDaniel and Wilson 2007). Organic matter in the upper few inches of native soils acts as a reservoir for phosphorus. Plant-available phosphorus is released by microbial decomposition within and directly below the forest litter layer. Replaced soils would lack organic matter, as explained above; therefore, surface applications of soluble phosphorus fertilizer at the time or before seeding, as proposed by MMC, may be of little value. MMC has proposed to apply organic matter in the form of straw mulch, which has little nutrient value, and wood mulch may be used if straw mulch proved to be ineffective for successful reclamation. MMC would test areas with poor plant germination and/or growth to determine causes of unsuccessful revegetation and then take corrective actions. This would help offset organic matter and/or phosphorous deficiencies.

MMC proposes to salvage equal volumes of first-lift soils and second-lift soils at borrow sites C and D. In doing so, MMC may not necessarily segregate the most suitable soil that would be used as the upper 9 inches of respread soil. Mixing surface soil with subsoil would reduce organic matter content in first-lift replaced soils, which would affect availability of essential nutrients. This may also affect the success of plant re-establishment unless additional organic matter was applied to these areas. The same would be true with using single-lift soil salvage and replacement method at the sites mentioned above. This would mix soil horizons and thereby reduce organic matter content in first-lift replaced soil at these sites.

To minimize these impacts, MMC would complete soil tests before seeding to determine the appropriate fertilizer rates required for successful reclamation. Fertilizer and mulch would be applied on respread soils at the time and before seeding, and nitrogen fertilizer would be broadcasted over the soil surface after seeding early in the subsequent growing season. MMC's proposed soil testing program to identify fertilizer and other possible soil amendment needs, and taking corrective actions in areas of poor plant growth would help offset nutrient deficiencies in respread soils in the short term, and then when vegetation became re-established and soil building processes began on reclaimed areas, nutrient levels would eventually reach predisturbance levels.

Alternative 2 - Chemical Characteristics

Seeps from soil stockpiles in forested regions in other parts of Montana have indicated elevated levels of iron and manganese (USDA Forest Service and DEQ 2001). The levels of tannic acids increase and soil pH is reduced due to the breakdown of coniferous forest vegetation in the stockpiles. Low pH and increased levels of iron and manganese can result in complex nutrient deficiency and/or phytotoxicity problems in many plant species (Kabata-Pendias and Pendias 1984). Reduced plant growth and/or mortality would slow or severely impair reclamation. Applications of composted organic matter have helped improve plant growth on reclaimed sites with affected soils (EPA 2007d). MMC has proposed to apply straw mulch but would test areas with poor plant germination and/or growth to determine causes of unsuccessful revegetation and then take corrective actions.

3.19.4.3.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

To better preserve the natural soil profile, double-lift soil salvage and replacement would be used at most disturbances, including the Poorman Tailings Impoundment Site, Libby Plant Site, and along access roads that already have existing cleared areas to store additional soil or that are near other soil stockpile areas. Single-lift salvage and replacement would be used along road segments that do not have existing cleared areas large enough to store two lifts of soil or that are not near other soil stockpile areas. Where single-lift salvage and replacement would be used for access roads, the soil profile on reclaimed access roads would be more severely impacted and require more time to rebuild than at areas reclaimed using double-lift soil replacement method. Over time, natural processes would rebuild a new soil profile that may or may not resemble the predisturbance condition. The loss of soil development and the time needed to redevelop a new soil profile would be an unavoidable impact of soil disturbance.

To minimize compaction, all salvaged soils would be handled at the low moisture content, and all disturbed areas that have been re-soiled and are to be seeded would be scarified to a depth of 6 to 12 inches before seeding to minimize compaction and improve seed establishment. The entire tailings impoundment and severely compacted areas, such as roads, soil stockpile sites, and facility sites would be ripped up to 18 inches deep with dozer ripping teeth before soil replacement to reduce compaction and break up surface crust to facilitate water infiltration and enhance rooting depth. Soil compaction would be short-term in all disturbed areas with these mitigation measures, and following reclamation compaction in re-spread soils that are ripped would be similar to pre-mine soils.

Where redistributed soils cover non-native material, such as the entire Poorman Tailings Impoundment and if any waste rock storage areas remained at the end of mining, an average of 24 inches of soil would be replaced in two lifts to provide sufficient rooting depth. Other reclaimed sites in Montana have shown that 24 inches of re-spread soil provides sufficient rooting depth (Plantenberg, pers. comm. 2006).

To promote the rebuilding of mycorrhizae in areas where trees are to be planted in respread soils that have been stored for prolonged periods, either an agencies-approved wood-based mulch would be incorporated into the upper 4 inches of re-spread soil (Plantenberg, pers. comm. 2006), and/or inoculated tree-planting stock with the appropriate mycorrhizal fungi would be used, or mycorrhizal fungi would be incorporated into the soil as pellets during seeding.

As mentioned earlier, organic matter in the upper few inches of native soils acts as a reservoir for phosphorus, and replaced soils that were stored for prolonged periods would lack organic matter. To enhance phosphorus and other nutrient levels and to increase organic matter levels, the upper 4 inches of re-spread soil would be amended with an agencies-approved wood-based organic amendment before planting. This also would stimulate the development of fungal based mycorrhizae in the new soil.

Because of the observed metal leaching and low pH problems from soil stockpiles containing large amounts of coniferous vegetation at other mine sites in Montana, most coniferous forest debris would be removed before soil salvage. This also would minimize soil nutrient losses, because low pH conditions can result in complex nutrient deficiency and/or phytotoxicity problems.

The additional mitigation measures of Alternative 3 for limiting the total loss of the natural soil profile, soil compaction, loss of soil biological activity, and reduction of nutrient levels would reduce the severity of these impacts when compared to Alternative 2. In addition, these measures would enhance reclamation success more than Alternative 2. Based on extensive reclamation experience of mined lands, the agencies anticipate that the mitigation measures would be highly effective.

3.19.4.3.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Modifications for Alternative 4 would be similar to the modifications in Alternative 3. The effects of these modifications would be similar as well. The difference would be the tailings impoundment would be at the same location as for Alternative 2, and would disturb 30 more acres than the tailings impoundment in Alternative 3, increasing the potential for soil loss. Other effects from the tailings impoundment would be the same as Alternative 3, because both Alternatives 3 and 4 would require 24 inches of soil to be re-spread over the entire impoundment including the top of the impoundment.

As with Alternative 3, to better preserve the natural soil profile, double-lift soil salvage and replacement would be used at most disturbances, including the same disturbances as Alternative 3 but also at the Little Cherry Creek Tailings Impoundment Site and the Little Cherry Creek Diversion Channel. Single-lift salvage and replacement would be used for some roads segments as Alternative 3.

3.19.4.3.5 Transmission Line Alternatives

Alternative A – No Transmission Line

In Alternative A, the transmission line, Sedlak Park Substation, and loop line for the Montanore Project would not be built. Soil changes in physical and chemical properties, biological activities, and nutrient levels would continue at natural rates. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that do not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

Alternative B – North Miller Creek Alternative

Changes in physical properties of the soils due to handling under the North Miller Creek Alternative, which includes the Sedlak Park Substation and loop line, would be similar to those listed in section 3.19.4.1, *Effects Common to All Action Alternatives*. The natural soil profile would be altered, there would be a loss of soil pore space (an increase in compaction), and a loss of organic matter due to mixing. Most of these changes in the soil (except alteration of the soil profile) would be short-term, in part because all access roads would have soil replaced (if soil were removed) and would be reseeded immediately following transmission line completion. Additionally, protective vegetation on road surfaces would establish more quickly because soils stockpiled for short durations are still biologically active and retain a higher level of favorable physical and chemical characteristics than soils stored for prolonged periods. To minimize soil compaction, MMC would rip access roads, if necessary, when no longer needed. Following soil replacement, the seedbed would be disked and harrowed, which would minimize compaction of the seedbed.

Soils would be salvaged in a single lift for new access roads and for some existing roads altering the natural soil profile that developed over thousands of years. The establishment of vegetation, root systems, and physical processes, such as freezing and thawing, and wetting and drying, would help rebuild a new soil profile, but this would be a long-term impact and would require a long time.

Alternative C-R – Modified North Miller Creek Alternative

Changes in physical, chemical, and biological properties of the soils due to handling from road construction and interim reclamation under the Modified North Miller Creek Alternative would be similar to those listed under the North Miller Creek Alternative.

Because with final reclamation, the surface soil that had been in place for the life of the transmission line would be salvaged and then replaced after the road prism was obliterated, changes in physical and biological properties of the soils due to handling under the Modified North Miller Creek Alternative would be less than under the North Miller Creek Alternative. The natural soil profile would still be altered but not as severely, there would still be a loss of soil pore space (an increase in compaction), the loss of organic matter would be reduced due to less mixing of the soil, and the soil biological activity would be less affected. This would shorten the time to re-establish vegetation and for successful reclamation. The better soil handling methods and the fewer acres of disturbance under the Modified North Miller Creek Alternative (Table 171) would reduce the effects of impacts when compared to the effects in the North Miller Creek Alternative.

Alternative D-R – Miller Creek Alternative

Changes in physical, chemical, and biological properties of the soils due to handling in the Miller Creek Alternative would be similar to Alternative C-R.

Alternative E-R – West Fisher Creek Alternative

Changes in physical, chemical, and biological properties of the soils due to handling in the West Fisher Creek Alternative would be similar to Alternative C-R.

3.19.4.4 Reclamation Success

Factors important to successful reclamation include soil salvage and handling, vegetation removal and disposition, revegetation, and success criteria.

3.19.4.4.1 Alternative 1 – No Mine

Under Alternative 1, the Montanore Project would not be developed. Reclamation would be limited to any existing exploration-related or baseline collection disturbances. All existing exploration-related or baseline collection disturbances by MMC would be reclaimed in accordance with existing laws and permits.

3.19.4.4.2 Alternative 2 – MMI Proposed Mine

MMC's reclamation goal is to establish a post-mining environment compatible with existing and proposed land uses and consistent with the 2015 KFP. Specific goals of reclamation serve a number of purposes as described in MMC's reclamation plan (MMC 2007).

Alternative 2 - Soil Salvage and Handling

Table 170 presents a comparison of the likely disturbances in which soil would be salvaged and salvageable soil volumes of mine facilities for each alternative. The table shows salvageable volumes for first lift and second lift soil. Even though MMC proposes to use double-lift salvage at the Little Cherry Creek Diversion Channel and other potential disturbances within the Little Cherry Creek Tailings Impoundment, they do not propose to use a double-lift replacement at these sites. These second-lift soils would only be used on the tailings impoundment.

MMC proposes to redistribute 24 inches of soil on the embankment of the Little Cherry Creek Tailings Impoundment using a double-lift salvage and replacement method. Replaced soil depths on other disturbed areas would be 18 inches including the top of the tailings impoundment. The double-lift salvage and replacement would provide enhanced soil physical and chemical properties in the reclaimed surface soil layer. First-lift soils would have more favorable conditions for revegetation establishment, such as higher organic matter content, higher nutrient levels, and better soil structure, which has higher porosity that facilitates plant root development. This practice attempts to salvage and replace some of the natural soil profile characteristics that developed on the site since the last major climatic change.

Total soil disturbance of the Little Cherry Creek Tailings Impoundment would be 620 acres (Table 170). Soils in the impoundment area, in part, would be replaced based on soil erodibility and slope steepness. For example, the least erodible colluvial/glacial soils having the greatest rock fragment content would be used as subsoil (15 inches thick) on the embankment of the impoundment to minimize erosion potential. Rock fragments reduce the erodibility of soils by anchoring the surface. First-lift soils, would consist of both rocky and non-rocky surface soils, and would be used as surface soil over the entire impoundment including the embankment. Soil replacement on the embankment would be in two lifts; 15 inches of rocky subsoil on bottom followed by 9 inches of surface soil on top. Over the rest of the impoundment MMC proposes soil replacement in two lifts; 9 inches of second-lift soil followed by 9 inches of first-lift soil. If MMC did not use rocky soil for the upper 9 inches on the tailings embankment, erosion of the surface may occur and expose the less fertile subsoil. If this happened, successful reclamation on the tailings embankment may not be achieved.

The tailings material on the top of the impoundment would be composed of sands and silts that would not be phytotoxic (lethal or damaging to plants). It is likely that this material, especially the silts, would become hard and compacted upon drying. Without scarification or deep ripping before soil placement, this fine tailings material could become an effective barrier to root penetration and could affect long-term establishment of deep rooted plants such as trees and shrubs. Because tailings on the dam face would be coarser and because MMC proposes to deep rip the dam face before soil placement, a physical rooting barrier on the dam face would not be an issue.

Material below salvageable soil depths from borrow areas that occur outside the footprint of the Little Cherry Creek Tailings Impoundment would be used for construction on portions of the Saddle Dams, Starter Dam, Seepage Collection Dam, or toe dike. These borrow areas would create about 419 acres of disturbance (Table 170), and have an average of 14 inches of salvageable soils. About 282 acres of soil in this area have not been mapped at a site-specific intensive level. In addition, about 44 acres of soil in other disturbances in the impoundment area and 139 acres of road disturbance requiring soil salvage and replacement have not been mapped at an intensive level. Not mapping the soils at an intensive level before salvage may result in not salvaging all suitable soil and/or salvaging some unsuitable soils, such as soils having low pH conditions. If unsuitable soils were used as re-spread soils, plant establishment may be adversely affected.

The total disturbance for the Ramsey Plant Site would be 49 acres. Salvageable soil depths at the site are about 24 inches, of which MMC proposes to salvage 18 inches in one lift. The total disturbances for the Little Cherry Creek Diversion Channel would be 40 acres. Salvageable soil depths along the Diversion Channel are about 13 inches, of which MMC proposes to salvage about 9 inches in one lift. The total disturbance from roads would be about 153 acres, on which MMC proposes to salvage and replace soils in one lift. Not utilizing the double-lift salvage and replacement method would mix the relatively organic-rich and nutrient-rich surface soil layer with the poorer quality subsoil layer and place more unproductive soil on the surface. Plant establishment may be reduced and could take longer for reclamation success to be achieved.

The total soil disturbance for the LAD Areas 1 and 2 would be 31 acres. The disturbed areas at the LAD Areas would include ponds, embankments, ditches, soil stockpile areas, and access roads. LAD Area 1 also would include a waste rock disposal area. LAD Area disturbances would require soil salvage (except soil stockpile areas) and reclamation. The larger areas used for land application and disposal would require only selective thinning of trees, access road construction, and little soil removal. Salvageable soil depths at LAD Areas average about 9 inches, but MMC would respread 18 inches of soil over the disturbances at LAD Areas. Some soil likely would be hauled from elsewhere to compensate for the shortage of salvaged soil at LAD Areas. Impacts to reclaimed disturbances at the LAD Areas would be the same as other areas not having a double-lift soil replacement.

Many of the impacts resulting from soil salvage and handling would be moderate in the long term for comparable stability and utility determinations. Long-term effects could occur on the embankment of the Little Cherry Creek Tailings Impoundment if surface erosion occurred and exposed subsoil. Long-term effects could occur on the top of the impoundment if the surface were not ripped to break up any rooting barriers, at areas where unsuitable soils may be used, and at areas where the double-lift soil replacement were not used.

Alternative 2 - Vegetation Removal and Disposition

MMC has not proposed any special plan to deal with vegetation removal and disposition other than harvesting trees and burning slash. This may result in the loss of a source of native plant materials, less organic debris that could be used for BMPs, and loss of potential non-coniferous organic enrichment in stockpiled soils. Opportunities to enhance reclamation success could be lost. If too much coniferous forest debris were left on the soil and salvaged with the soil, soil pH in the stockpiles could be reduced.

Alternative 2 - Revegetation and Success Criteria

MMC has developed two final seeding/planting mixes to accommodate the differences in disturbance areas and an interim seed mix (MMC 2007). These mixes would be dominated by native species, but some introduced species would be included. Introduced species may hinder colonization of native species and could spread off the reclaimed areas. Before reclamation, MMC would submit seed mix information to the lead agencies, so that the agencies would have an opportunity to adjust seed mixes as appropriate for site conditions and to meet any KFP changes. If the agencies required removal of introduced species from seed mixes, the adverse long-term effects that introduced plant species would have on reclaimed sites and surrounding areas would be reduced.

Trees and shrubs would be planted on steeper slopes of the Little Cherry Creek Tailings Impoundment throughout the project life as areas were reclaimed, on cut-and-fill slopes at the Ramsey Plant Site, the Libby Adit Site, and portions of LAD Areas. MMC would plant trees and shrubs at the end of operations on all other disturbances including the top of the impoundment and waste rock dumps, if present at the end of operations. Trees and shrubs would not be planted on the Rock Lake Ventilation Adit, soil stockpile sites, portal patios, and along road corridors. In these areas, reforestation would occur by natural regeneration. This approach would increase the time needed to achieve a natural looking setting, to provide screening, and to achieve important wildlife habitat components. A well-established grass cover in these areas likely would retard the establishment of volunteer trees. It may take up to 20 years for settling to stop and to complete redistributing soil on top of the tailings impoundment. Delaying tree and shrub planting on top of the tailings impoundment would delay development of wildlife habitat.

MMC's proposed 18 inches of re-spread soil on top of the tailings impoundment, rather than 24 inches, and not ripping the tailings surface to break up surface crusting before soil placement may hinder tree root growth and overall growth rates likely would decline. Root systems would eventually penetrate the tailings, but the mass of roots likely would be concentrated in the upper 18 inches of soil, resulting in slower growing and possible stunted trees over time, and trees would likely be more prone to wind throw.

MMC proposes to plant 435 trees per acre; based on a survival rate of 65 percent, the final anticipated stocking rate after 15 years would be about 283 trees per acre. Shrubs would be planted at a rate of 200 stems per acre. The proposed planting rates may not meet overall wildlife or density recommendations by the agencies, and would require many years before stem densities on reclaimed sites have similar densities to that of surrounding landscapes.

The proposed planting plan includes the spacing of trees and shrubs to be continuous on slopes in strips alternating with strips that would be seeded with an herbaceous understory mixture, or would be spaced in randomly placed groupings on level to gently sloping areas. Planting in alternating strips would not match surrounding landscape features, would not meet visual quality objectives and may allow for noxious weed establishment along the planting strips.

If feasible, MMC would consider collecting seed or plant materials onsite to ensure the genetic adaptation of planting stock to local environmental conditions, and inoculating soils used for planting trees and shrubs with mycorrhizae. This would enhance the chances for survival, growth, and reproduction, which are necessary for long-term successful reclamation.

In summary, MMC's revegetation plan may affect long-term reclamation success and results. Potential effects include the introduction of non-native plant species, extended establishment time for trees and shrubs in some areas, and reduced woody plant densities. The potential for the spread of noxious weeds may also increase.

Part of MMC's reclamation goals include revegetation success criteria, which are anticipated to be met after a 3 to 5 year monitoring period. These success criteria include:

- Total plant cover would be at least 80 percent of the total cover of a specific control site or would meet a 70 percent total cover basis with at least 60 percent consisting of a live plant community
- There would be no more than three acceptable plant species that dominate a site based on the seed mix or natural plant community in the area, and noxious weeds would not be more than 10 percent of the plant community
- There would be no rills and gullies greater than 6 inches deep and/or wide

If any success criterion were not met after 3 years of monitoring, MMC would access the problems and correct any deficiencies of seed types, techniques, or methods and take corrective measures. This process would continue until all revegetation goals were met.

3.19.4.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Short- and long-term reclamation objectives would remain the same as for Alternative 2. Modifications and their effects on soil salvage and handling, vegetation removal and disposition, revegetation, and success criteria are discussed below.

Alternative 3 - Soil Salvage and Handling

Soil would be salvaged and replaced in all disturbed areas, with the exception of soil stockpile areas, slopes greater than 50 percent, and cut slopes in consolidated material. Where redistributed soils cover non-native material such as the entire Poorman Tailings Impoundment and waste rock piles (if remaining at end of mine life), the replaced soil depth would average 24 inches using two lifts. This would produce soil depths more comparable to pre-mine conditions and would increase the likelihood of successful revegetation. Research generally has shown that replacement of 24 inches of soil over suitable mine waste rock would produce maximum plant productivity (Coppinger *et al.* 1993). At all other disturbances, soil replacement depths would average 18 inches. Double lift salvage and replacement also would occur at all disturbances requiring soil salvage and replacement except for some road segments and at the Upper Libby Adit, which would have 1 acre of disturbance and there would be no suitable second-lift soil. Double-lift soil salvage and replacement would be used along access roads that already have cleared areas to store additional soil or that are near other soil stockpile areas. To minimize disturbance size and tree removal, single-lift salvage and replacement would be used along road segments that do not have existing cleared areas large enough to store two lifts of soil or that are not near other soil stockpile areas. The lead agencies would identify road areas where double-lift soil salvage and replacement would be appropriate. Reclamation would be enhanced by salvaging some soils to greater depths to provide sufficient salvageable soil volumes to achieve the soil replacement goals for all potential disturbances.

About 47 acres of soil at Borrow Area 2 and the potential rock borrow area, all soils at the Libby Plant Site (106 acres), about 105 acres of soil at other potential disturbances within the Poorman Tailings Impoundment Site, and about 107 acres of soil along roads have not been mapped at an intensive, site-specific level. Before any soils would be salvaged, intensive soil surveys would be conducted in these areas to ensure the most suitable soil and necessary volumes of soil were salvaged.

Other modifications of soil salvage and handling have been discussed in section 2.5.2.6.2, *Soil Salvage and Handling Plan*. These other modifications along with thicker soil replacement depths at most disturbances, and the most suitable soil and maximum volumes would be salvaged, would help to ensure both short-term and long-term successful revegetation.

Alternative 3 - Vegetation Removal and Disposition

A Vegetation Removal and Disposition Plan that would evaluate the potential uses of vegetation removed from areas to be disturbed and would describe disposition and storage plans during mine life would be prepared. This plan would result in the maximum use of native plant materials and organic debris to enhance reclamation success. Where possible, slash of non-coniferous forest debris from timber-clearing would be salvaged and chipped to be used as mulch or as an additive to stored surface soil stockpiles. Because of the observed metal leaching from soil stockpiles containing large amounts of coniferous vegetation at other mine sites in Montana, coniferous forest debris would be removed before soil removal.

Alternative 3 - Revegetation and Success Criteria

Revegetation and success criteria would be developed for all reclaimed areas. These criteria would help ensure revegetation was successful over both the short and long term, that noxious weeds did not exceed unacceptable levels, and desired cover densities were achieved and sustained in the long term.

Alternative 3 would include more stringent requirements for mine reclamation than Alternative 2 (Table 172). A 20-year revegetation monitoring period after reseeding would be required, if necessary, under Alternative 3 to better ensure that revegetation requirements have been achieved. A longer monitoring period also would provide additional time to take corrective measures if revegetation goals had not been met.

Table 172. Mine Reclamation Requirements by Alternative.

Reclamation Requirement	Alternative 2 MMC's Proposed Mine	Alternative 3 Agency Mitigated Poorman Tailings Impoundment Alternative	Alternative 4 Agency Mitigated Little Cherry Creek Tailings Impoundment Alternative
Seed Mix	Native and introduced species; interim and permanent seed mixes	Native; permanent seed mix only	Same as Alternative 3
Tree/Shrub Density After 15 Years	283 trees/acre (assumes a 65% survival rate of 435 trees/acre planted) Unspecified (200 shrubs/acre planted)	400 trees/acre 200 shrubs/acre	Same as Alternative 3
Noxious Weeds	No more than 10% noxious weeds	Less than or equal to the cover of noxious weed species present on agency-approved disturbed/reclaimed control sites in the area	Same as Alternative 3
Total Cover	60% live vegetation cover or 70% of disturbed/reclaimed control site total cover	80% of disturbed/ reclaimed control site total cover	Same as Alternative 3
Monitoring Plan	3 consecutive years of revegetation success	20 years	Same as Alternative 3
Total Acres of Vegetation Disturbance	2,582	1,539	1,886

†Priority weeds described in KFP; see Table 186.

The reclamation requirements for Alternative 3 would increase the minimum vegetation cover required after reclamation compared to Alternative 2. A total of 80 percent cover would be the goal compared to 70 percent for Alternative 2. Alternative 3 would require a sufficient planting of trees and shrubs to achieve 400 trees and 200 shrubs per acre living after 15 years, except in wetlands and meadows. Compared to Alternative 2, this would increase woody plant density. Woody plant densities under Alternative 3 would better match surrounding landscape features and would meet wildlife and density recommendations provided by the agencies.

All seed mixes would be revised so that mixes would be composed of species native to northwestern Montana (if commercially available) instead of a seed mix that includes introduced species as proposed in Alternative 2. This would reduce the spread of aggressive introduced species both in reclaimed sites and nearby sites, and enhance the conditions for re-establishment of native species.

Rather than planting trees and shrubs along strips as proposed in Alternative 2, trees and shrubs would be planted by hand in random patterns to better resemble natural surroundings. Planting in random patterns along with increased woody plant densities, would return reclaimed sites to more natural conditions in less time than under Alternative 2.

Surface soil would be amended before seeding with an agencies-approved wood-based organic amendment to raise soil organic matter levels to a minimum of 1 percent by volume. This would increase water holding capacity of the soil, enhance nutrient levels, stimulate biological activity in the soil, and thereby, help ensure successful revegetation.

3.19.4.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Short- and long-term reclamation objectives would remain the same as for Alternative 2. Modifications to soil salvage and handling, vegetation removal and disposition, revegetation, success criteria, and monitoring are the same as described above in Alternative 3, with a few modifications described below.

Alternative 4 - Soil Salvage and Handling

In Alternative 4, as under Alternative 3, where redistributed soils cover non-native material such as the entire Little Cherry Creek Tailings Impoundment Site and waste rock piles (if remaining at end of mine life), the replaced soil depth would average 24 inches using two lifts. Sufficient salvageable soil volumes are available to achieve the soil replacement goals for all potential disturbances.

The soils at the Libby Plant Site (same as Alternative 3), about 24 acres of soils in the southwestern portion of the Borrow Area outside the impoundment footprint, 19 acres of soil at other potential disturbances within the Cherry Creek Impoundment Site and about 106 acres of soil along access roads have not been mapped at an intensive, site-specific level. Before any soils would be salvaged, MMC would conduct intensive soil surveys in these areas to ensure that the most suitable soil and necessary volumes of soil were salvaged. In addition, a two-lift soil salvage and replacement method would be conducted at the Libby Plant Site, along some portions of access roads, at other disturbances within the Little Cherry Creek Impoundment Site, and at the Little Cherry Creek Diversion Channel.

Other modifications of soil salvage and handling incorporated into Alternatives 3 and 4 have been discussed in section 2.5.2.6.2, *Soil Salvage and Handling Plan*. These modifications along with the modifications mentioned above would help ensure successful long-term revegetation.

3.19.4.4.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, Sedlak Park Substation and loop line for the Montanore Project would not be built. The DEQ's approval of the mine, as permitted by DEQ Operating

Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that do not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.19.4.4.6 Alternative B – MMC Proposed North Miller Creek Alternative

Alternative B - Soil Salvage and Handling

Soils would be salvaged and replaced using a single-lift method and would be handled in the same manner as explained in Alternative 2. Not using the double-lift salvage and replacement method would mix relatively organic-rich and nutrient-rich surface soil with poorer quality subsoil and place more unproductive soil on the surface, which could delay successful reclamation. Where soils are salvaged from new access roads, the soil would be stored adjacent to the disturbance.

Roads opened or constructed for transmission line access would be closed after the transmission line had been built. The road surfaces would be reseeded as an interim reclamation activity designed to stabilize the surface. Where soil had been salvaged from new roads, the road surface would be covered with soil and then reseeded. The new road prism would remain until the transmission line was removed at the end of operations. After the transmission line was removed, all newly constructed roads would be recontoured to match the existing topography, obliterating the road prism, and reseeded.

Alternative B - Vegetation Removal and Disposition

MMC has not proposed any special plan to deal with vegetation removal and disposition other than harvesting trees and burning slash. This could result in the loss of a source of native plant materials, less organic debris for BMPs such as slash filter windrows or use of chipped non-coniferous wood debris, and loss of potential organic enrichment in stockpiled soils. Opportunities to enhance reclamation success could be lost.

Alternative B - Revegetation and Success Criteria

At the end of the mine life and following redistribution of soil, all access roads would be reseeded with the same seed mixes as in Alternative 2. MMC has not proposed to plant trees on reclaimed access roads and other disturbances where trees were removed such as line stringing and tensioning sites, slash burn piles, and construction pads. MMC’s revegetation plan for the transmission line access roads would have the same long-term effects as under Alternative 2, including the spread of introduced plant species, the additional years required for trees and shrubs to become established on reclaimed road surfaces and other disturbance sites, and the potential for spreading noxious weeds. The revegetation, success criteria, and monitoring would be the same as under Alternative 2.

3.19.4.4.7 Alternative C-R – Modified North Miller Creek Alternative

Alternative C-R - Soil Salvage and Handling

Under the Modified North Miller Creek Alternative, soil salvage and handling would be the same as under Alternative B for road construction and for interim reclamation. The effects on soils also would be the same.

For final decommissioning of access roads, the surface soil that had been in place on access roads for the life of the transmission line would be salvaged, the road prism obliterated, and then the surface soil replaced. The surface soil that had been in place for the life of the transmission line would have higher nutrient levels, higher organic matter content, and greater microbial activity than the underlying soil, and it would be a seed source for the native plants that had established over the life of the transmission line. This would shorten the amount of time for vegetation to re-establish. The depth of surface soil salvage would be determined by the lead agencies before final reclamation. Other soil handling methods would be in the same manner as under Alternative B.

At the end of operations, mycorrhizae and the agencies-approved wood-based mulch would be incorporated into the upper 4 inches of soil to raise the soil organic matter levels to 1 percent by volume in the recontoured road surfaces. This would shorten the amount of time to successfully reclaim all transmission line access roads.

In Alternatives C-R, D-R, and E-R, wooden structures would be used (wooden monopoles would be used for a 0.5-mile segment of Alternative E-R). Wooden poles would be treated to reduce decay; a typical preservative contains sodium, copper, and petroleum compounds. Typically, soil contamination surrounding a pole is minor and does not extend beyond 10 to 24 inches away from the pole (Arisi *et al*. 2006, Brooks 1998).

Alternative C-R - Vegetation Removal and Disposition

As described in section 2.5.2.6.2, *Vegetation Removal and Disposition Plan*, a Vegetation Removal and Disposition Plan would be prepared that evaluates the potential uses of vegetation removed from areas to be disturbed. This plan would result in the maximum use of native plant materials and organic debris for BMPs to enhance reclamation success.

Alternative C-R - Revegetation and Success Criteria

Trees would be planted in all areas where trees were removed for the construction of the transmission line including access roads and other disturbances such as line stringing and tensioning sites, slash burn piles, and construction pads. Trees would be planted at a density that at the end of 5 years the approximate stand density of the adjacent forest would be attained at maturity. This standard would not apply to roads placed in intermittent stored service, but would apply when the roads would be decommissioned after the transmission line was restored. Planting trees in disturbances would require less time for trees to become establish, would better match surrounding landscape features, and would meet wildlife and density recommendations provided by the agencies.

All seed mixes for both interim reclamation and final reclamation would be revised so that mixes would be composed of species native to northwestern Montana and not contain introduced species. This would reduce the spread of aggressive introduced species both in reclaimed sites and nearby sites, and enhance the conditions for re-establishment of native species. The monitoring plan, revegetation, and success criteria (except tree and shrub densities) would be the same as under Alternative 3.

3.19.4.4.8 Alternative D-R – Miller Creek Alternative

For the Miller Creek Alternative, effects and modifications to soil salvage and handling, vegetation removal and disposition, revegetation, and success criteria would be the same as for Alternative C-R.

3.19.4.4.9 Alternative E-R – West Fisher Creek Alternative

For the West Fisher Creek Alternative effects and modifications to soil salvage and handling, vegetation removal and disposition, revegetation, and success criteria would be the same as for Alternative C-R.

3.19.4.4.10 Effectiveness of Agencies' Mitigation Measures

MMC's implementation of the agencies' numerous mitigations regarding soil salvage, stockpiling, and replacement, vegetation removal and disposition, and revegetation procedures described in Chapter 2 would be effective in ensuring all lands disturbed by mining were reclaimed to a post-mine land use and to comparable stability and utility. Salvage of 3 feet of wetland soils for use at wetland mitigation sites would be effective in providing suitable soils for wetland creation.

3.19.4.5 Cumulative Effects

Cumulative effects include the combination of direct and indirect effects from past, present, and reasonably foreseeable activities. Direct, indirect, and cumulative effects on soils are measured within each activity area. Existing system roads and designated landings on National Forest transportation system are considered dedicated lands and are not part of the soils cumulative effects. The highly variable nature of soil productivity requires site-specific analyses to adequately address reclamation needs. Assessments of cumulative effects on soil productivity are retained at the site-specific boundary scale. In contrast, soil processes such as erosion regime and hydrologic functions occur at a watershed scale.

Past actions, particularly road construction, timber harvest, and mining activities have increased erosion rates in comparison to undisturbed areas in the analysis area. As vegetation in timber harvest areas return to pre-harvest conditions, erosion rates have and would continue to decrease. Cumulative effects on soils from other current and foreseeable actions would be associated primarily with potential soil loss from erosion and loss of soil productivity. Other regional current and foreseeable actions that would affect soil resources include timber harvest, mineral exploration, and new road construction. These actions would potentially occur on both public and private lands. There may also be abandoned mine waste cleanup on public and private lands, and continued commercial and residential development on private lands. The primary soil disturbance of many of these activities would be from road construction and soil removal. These actions would result in an increase in erosion and sedimentation within the Libby Creek and Fisher River watersheds, and a loss of soil productivity in areas where soil was removed, stored for prolonged periods, and then replaced.

The KNF requires the implementation of BMPs for logging, mine reclamation, and road-building operations. Private landowners are not required to use BMPs. By properly implementing and maintaining BMPs, onsite erosion and potential increases in sedimentation to creeks would be minimized, and soil erosion losses would be a minor cumulative impact.

3.19.4.6 Regulatory/Forest Plan Consistency

3.19.4.6.1 Organic Administration Act and Forest Service Locatable Minerals Regulations

36 CFR 228.8 requires that mining operators minimize, where feasible, adverse environmental impacts on National Forest surface resources; construct and maintain all roads so as to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and

other resource values; and reclaim, where practicable, the surface disturbed in operations by taking such measures as preventing or controlling onsite and off-site damage to the environment and forest surface resources.

Minimize Adverse Environmental Impact (36 CFR 228.8)

Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8 to minimize adverse environmental impacts. MMC did not propose to implement practicable measures to minimize erosion, maximize reclamation success, or minimize effect of road usage. The agencies' alternatives (Mine Alternatives 3 and 4 and Transmission Line Alternatives C-R, D-R, and E-R) would incorporate additional feasible and practicable measures to minimize adverse environmental impacts. These measures include developing and implementing a final Road Management Plan and a Vegetation Removal and Disposition Plan; increasing the salvage and replacement of suitable soil materials for reclamation; removing a majority of coniferous forest debris removed before soil removal; and salvaging disturbed wetland soils for use in constructing new wetlands.

Roads (36 CFR 228.8(f))

In all mine and transmission line alternatives, roads would be constructed and maintained to ensure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values. The Environmental Specifications describe how transmission line roads would be constructed and maintained to ensure adequate drainage and to minimize or eliminate damage to resource values. The agencies' transmission line alternatives would have less new road development in the watersheds of impaired streams, in watersheds of Class 1 streams, and on soils with severe erosion risk, high sediment delivery, and slope failure. The predicted delivery of sediment from roads to streams in the agencies' mine and transmission line alternatives would be less than in MMC's alternatives. At the end of operations, all mine and transmission line alternatives would have roads no longer needed for operations. The agencies' mitigation provides more specificity regarding management of roads no longer needed for operations. Such roads would be placed either in intermittent stored service or decommissioned. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8(f) as it relates to water quality because MMC did not propose to implement practicable measures to minimize adverse environmental impacts on soils. Mine Alternatives 3 and 4 Transmission Line Alternatives C-R, D-R, and E-R would comply with 36 CFR 228.8(f) as it relates to soils.

Compliance with 36 CFR 228.8(f) regarding roads management is discussed in section 3.6.4.11.4, *National Forest Management Act/Kootenai Forest Plan* (RF-2 through RF-5), beginning on page 477.

Reclamation (36 CFR 228.8(g))

All mine and transmission lines alternative would comply with the requirements of 36 CFR 228.8(g) regarding controlling erosion, controlling surface water runoff, and isolating toxic materials. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8(g) to implement practicable measures to prevent or control onsite and off-site damage to the environment and forest surface resources. MMC did not propose to implement practicable measures to minimize erosion and maximize reclamation success. The agencies' alternatives would include developing and implementing a final Road Management Plan and a Vegetation Removal and Disposition Plan; increasing the salvage and replacement of suitable soil materials for reclamation; removing a majority of coniferous forest debris removed before soil removal; consolidating soil stockpiles and reclaiming them incrementally; using primarily native species in revegetation and salvaging disturbed wetland soils for use in constructing new wetlands. These measures would minimize erosion and ensure reclamation success. The agencies' alternatives would comply with 36 CFR 228.(g) as it relates to soils.

3.19.4.6.2 Kootenai Forest Plan

All mine and transmission line alternatives would comply with the 2015 KFP guideline to incorporate site-specific BMPs to protect soil resources, control nonpoint pollution sources and meet soil and water goals (FW-GDL-SOIL-03 and FW-GDL-WTR-03). The agencies' alternatives would include more frequent BMP monitoring than MMC's alternatives.

3.19.4.6.3 State Requirements

Alternatives 3 and 4 would comply with the MMRA regarding disturbed lands being reclaimed to a post-mining land use with stability and utility comparable to that of the pre-mining landscape. Draft findings regarding compliance with MFSA requirements are discussed in the Summary, beginning on p. S-53.

3.19.4.7 Irreversible and Irretrievable Commitments

Some soil would be irreversibly lost under all action alternatives during soil removal, construction, and operation of the mine before the re-establishment of vegetation. Some soil would be irreversibly lost under transmission line Alternatives B through E-R, especially during construction and final reclamation of access roads. Soil productivity would be irreversibly lost in large areas under Alternative 2, along portions of access roads under Alternatives 3 and 4, and along transmission line access roads under all alternatives where single-lift salvage and replacement was used, because the soil profile would be altered and would require many years for soil productivity to return to pre-mine conditions. The time required to restore soil productivity would be shortened with the use of soil amendments. A minor amount of soil productivity would be irreversibly lost under all action alternatives along NFS road #278 due to widening of the road.

Irretrievable effects on soil productivity would result from prolonged soil stockpiling and at disturbances that would not be reclaimed until the end of mine life, such as at plant sites and most of Little Cherry Creek and Poorman Tailings Impoundment sites. Irretrievable effects on soil productivity would result along transmission line access roads where road prisms would remain until final reclamation of the transmission line. These irretrievable effects would be minimized with the use of fertilizers and mulches. Irretrievable effects on soil productivity would be limited at areas under Alternatives 3 and 4 where double-lift soil salvage and replacement was used. The replaced lift soils under Alternatives 3 and 4 also would have wood-based mulch and mycorrhizae incorporated into the upper 4 inches of soil. These measures would accelerate the rebuilding processes for respread soils to reach pre-mine productivity levels. Irretrievable effects on soil productivity would be limited on access roads of transmission line under Alternatives C-R through E-R with removal and replacement of the surface soil for final reclamation, and with the addition of wood-based mulch and mycorrhizae into the upper 4 inches of soil during final reclamation.

3.19.4.8 Short-term Uses and Long-term Productivity

Soil losses due to erosion would be long-term, but would return to natural rates Once vegetation is re-established and stabilized reclaimed areas, in about 3 to 5 years following reclamation. Over steepened and south- and west-facing cut slopes may require more than 5 years for the vegetation ground cover to reach predisturbance levels without soil amendments. Decreases in soil productivity would be long-term in all reclaimed areas. The degree of soil productivity losses would vary among the action alternatives and would be more severe under Alternative 2 and under transmission line Alternatives B through E-R in areas where single-lift soil salvage and replacement would be used. These areas primarily include the Ramsey Plant Site, the Little Cherry Creek Diversion Channel, mine roads, the Libby Adit Site, and all transmission line access roads. Due to mixing of soil horizons and prolonged storage, soil profile characteristics would be drastically changed over pre-mine conditions. Soil productivity would decrease under Alternative 2 on the top of the Little Cherry Creek Tailings Impoundment if 18 inches of soil were placed over crusted fine-grained tailings, which would restrict rooting depth.

3.19.4.9 Unavoidable Adverse Environmental Effects

Loss of soil development in the area would occur in all action alternatives. Soil erosion to some degree would occur under all action alternatives, even with implementation of proposed mitigation measures. The degree of effects of soil erosion would be more severe under Alternative 2 and less under Alternatives 3 and 4 because of the additional erosion control methods and the fewer acres of soil disturbance under Alternatives 3 and 4. Loss of soil productivity would be unavoidable under all action alternatives in all disturbances where soil was removed, stored, and replaced. The degree of effects on soil productivity would be more severe under Alternative 2 and under transmission line Alternatives B through E-R where single-lift soil salvage and replacement was used.

3.20 Sound, Electrical and Magnetic Fields, Radio and TV Effects

3.20.1 Regulatory Framework

3.20.1.1 Sound

Noise is generally defined as unwanted sound, and can be intermittent or continuous, stationary or transient. Noise levels heard by humans and animals depend on several variables, including distance and ground cover between the source and receiver and atmospheric conditions. Noise can influence humans or wildlife by interfering with normal activities or diminishing the quality of the environment. Noise levels are quantified using units of decibels (dB). The dBA scale begins at zero—the sound intensity at which sound becomes audible to a young person with normal hearing. Each 10 dBA increase in sound approximates a doubling in loudness, so that 60 dBA is twice as loud as 50 dBA. People generally have difficulty detecting sound level differences of 3 dBA or less.

No federal, KNF, or county regulations govern noise levels in the analysis area (Big Sky Acoustics 2006). The EPA identifies outdoor noise levels less than or equal to 55 dBA are sufficient to protect public health and welfare in residential areas and other places where quiet is a basis for use. The MDT determines that traffic noise impacts occur if predicted 1-hour traffic noise levels are 66 dBA or greater at a residential property during the peak traffic hour (Big Sky Acoustics 2006). Noise associated with the transmission line is required to be 50 dBA or less at the edge of the right-of-way in residential and subdivided areas unless the affected landowner waives this condition (ARM 17.20.1607.2 (a)).

3.20.1.2 Electrical and Magnetic Fields

"EMF" is an abbreviation for the electric field and magnetic field associated with electric power systems. In the United States, these systems and their associated transmission lines operate at a frequency of 60 hertz (Hz), and therefore create 60-Hz EMFs. EMFs occur in the environment naturally and as a result of human activity. Naturally occurring EMFs are created by the weather and the geomagnetic field. The electric power transmission and distribution system is the principal source of environmental 60-Hz EMFs. EMFs are weak except near power lines, substations, electrical machinery, and appliances.

Electric fields from power lines are created when a voltage is placed on the conductors, a step known as energizing the line. Electric fields exist in the space surrounding an energized object and have a strength measured by the unit "volt per meter" (V/m) or 1,000 volts per meter (kV/m). Electric field strength is determined by the voltage on the line and does not change with power flow. Electric field strength attenuates rapidly with increasing distance from the power line and can be reduced by trees with foliage and houses and greatly reduced by metal and other conducting surfaces.

Magnetic fields from power lines are created whenever current flows through power lines. The strength of the field is directly dependent on the current in amperes in the line but not the voltage. Magnetic field strength near electric power lines is typically measured in milligauss (mG). Similar to electric field strength, magnetic field strength attenuates rapidly with distance from the source, but unlike electric fields, magnetic fields are not easily shielded by ordinary objects and materials. Both electrical and magnetic fields are low energy, extremely low frequency fields, and should not be confused with high energy or ionizing radiation such as X-rays and gamma rays.

No federal, KNF or county regulations govern electrical and magnetic fields in the analysis area. Montana major facility siting regulations require that the electric field strength at the edge of the right-of-way be no greater than 1 kV/m in residential and subdivided areas unless the affected landowner waives this condition and that the electric field at road crossings be no greater than 7 kV/m (ARM 17.20.1607.2(d)). Montana has no regulation concerning 60-Hz magnetic fields of power lines.

3.20.1.3 Radio and TV Effects

Radio and television interference are collectively referred to as radio noise. Radio noise is a phenomenon produced by both corona and sparking and can vary greatly based on weather conditions. Television interference is significant only for foul weather conditions. Corona occurs when the electrical field at a particular point reaches a sufficiently high value to cause ionization of the surrounding air. Corona on transmission lines can cause power loss, radio, and television interference and audible noise near the transmission line.

No KNF, state or county regulations govern radio or television interference in the analysis area. The Federal Communications Commission (FCC) regulations pertaining to the prevention of radio and television interference vary by service. Such regulations are usually included in the operating requirements section for each service.

For transmission lines with normal conductor spacings and rights-of-way, a fair-weather radio interference level of about 40 decibel-microvolts per meter (dBμV/m) at a lateral distance of 100 feet from the outermost phase has been established as a guideline for identifying design criteria for a radio noise limit (Institute of Electrical and Electronics Engineers Standard 430-1991).

3.20.2 Analysis Area and Methods

The analysis area for direct, indirect, and cumulative effects on sound levels encompasses an area potentially affected by project facilities: along the Bear Creek Road south from US 2; the area surrounding the proposed mine facilities; and the area crossed by the four transmission line alternatives and associated access roads, and the Sedlak Park Substation site and loop line area. Mitigation activities, such as culvert removals proposed in the wetland mitigation plan, would have negligible short-term effect on sound levels and are not discussed further.

3.20.2.1 Sound

Woodward-Clyde Consultants collected ambient noise levels measurements at the Ramsey Plant Site and the Little Cherry Creek Tailings Impoundment Site in 1988 (Woodward-Clyde Consultants 1989c). Ambient noise levels in the analysis area are unlikely to have changed significantly since 1988. Big Sky Acoustics completed two, 5-minute noise level measurements in 2005 above the Troy Mine mill and portal (Big Sky Acoustics 2006). The Troy Mine is located about 20 miles northeast of the proposed Montanore Project and uses similar underground mining and milling techniques.

Big Sky Acoustics (2006) developed predicted noise level contours that would develop under various operating conditions in Alternative 2 using noise prediction software. The model uses algorithms from the International Organization for Standardization Standard 9613-2 (Big Sky

Acoustics 2006). This standard specifies the calculations to determine the reduction in noise levels due to the distance between the noise source and the receiver, the effect of the ground on the propagation of sound, and the effectiveness of natural barriers due to grade or man-made barriers, such as walls. The calculations conservatively assume that the atmospheric conditions are favorable for sound propagation. Typically, such conditions include the wind is blowing from a source to a receiver at 2 to 10 miles-per-hour, and a well-developed temperature inversion is occurring. Because atmospheric conditions can vary dramatically at large distances between a noise source and a receptor, the estimated levels should be assumed to be average noise levels, and temporary significant positive and negative deviations from the averages can occur (Big Sky Acoustics 2006). Big Sky Acoustics updated the analysis in 2015 to assess alternative fan locations in all alternatives and to model the facility locations proposed in Alternative 3 (Big Sky Acoustics 2015).

The same noise sources would be used in each alternative. Noise would be produced by heavy equipment (i.e., scrapers, bulldozers, graders, loaders, haul trucks), generators, ventilation fans and blasting (Big Sky Acoustics 2006). Because each alternative would have the same noise sources, effects of the agencies' alternatives were based on modeling completed for MMC's alternatives. The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects of noise in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

Sound is perceived differently by different people; 3-decibel change in sound is not likely to be noticed by most people and 5- to 6-decibel change is readily perceived (EPA 1974, Big Sky Acoustics 2006). A 10-dBA change in noise level is judged by most people as doubling of the sound level (Bid Sky Acoustics 2006).

The sound pressure levels of two separate sounds are not directly (that is, arithmetically) additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is a 3-decibel increase (to 73 dB), not a doubling to 140 dB (EPA 1974).

3.20.2.2 Electrical and Magnetic Fields and Radio and TV Effects

Power Engineers determined electrical and magnetic fields and radio and television interference for MMC's proposed structure configuration (Power Engineers 2005a). A steel monopole structure 90 feet in height was used in the analysis. BPA's corona and field effects program was used in the calculations. A similar calculation using BPA's corona and field effects program was made for the H-frame structures that would be used in the other three transmission line alternatives (HDR Engineering 2007).

The lead agencies completed an evaluation of the potential for environmental impacts from transmission line EMFs (Asher Sheppard Consulting 2007, 2012). The evaluation addresses the current status of scientific knowledge concerning potential health effects from exposure to transmission line EMFs. For purpose of categorizing risk of exposure of a residence to EMFs, all residences within 0.5 mile, 200 feet, and 50 feet of the centerline were identified. Residences within 0.5 miles but greater than 200 feet (as the project would be constructed) are designated as Category I homes. Category I homes would have electric field strength always less than 50 V/m and the magnetic field strength always less than 1.0 mG, regardless of the pole type. Exposures in Category I homes are characterized as having "no recognized potential for a health impact from exposure to EMFs" (Asher Sheppard Consulting 2007, 2012). Montana regulations allow the final centerline to vary by up to 250 feet of the centerline (ARM 17.20.301 (21)) unless there is a compelling reason to increase or decrease this distance. Consequently, residences within 450 feet of the mapped centerline location were considered Category I. Similarly, identification of residences within the 0.5 mile corridor requires an increased distance of 2,890 feet from the mapped right-of-way centerline. Residences within 200 feet but greater than 50 feet from the centerline (as it would be constructed) are in Category II. At lateral distances from 50 feet from the centerline) to 200 feet away, the electric field strength would be no greater than 0.75 kV/m and the magnetic field strength no greater than 5 mG. This maximum electric field strength is below the level set by the Montana regulation for electric field strength and both the electric and magnetic field strengths are below the exposure levels for the general public recommended as reference levels or maximum permissible levels. Exposures at distances of 50 to 200 feet from the centerline (as it would be constructed) are characterized as having "questionable potential for a health impact from exposure to EMFs."

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on radio and television and of EMFs in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.20.3 Affected Environment

3.20.3.1 Sound

Except for the Libby Adit Site, existing sound levels in the analysis area are low, characteristic of rural areas and wilderness (Table 173). Nighttime sound levels are 4 to 12 dB lower than daytime levels due to cessation of many human-related activities. Wind conditions during the monitoring period were low, less than 15 mph, eliminating wind as a significant sound source. Natural sound sources include wind, wildlife, water flow, thunder, and wind-induced noise such as the rustling of foliage. Other sound sources include vehicles, such as trucks or airplanes, and man. The overall contribution from human activities is small, and the predominant sound sources are natural. Wildernesses typically have very low noise levels. The Rock Creek Project Final EIS reported daytime noise levels at the CMW boundary of 25 to 27 dBA (USDA Forest Service and DEQ 2001).

Large-lot residential properties, ranches, and cabins are found along US 2 near Libby Creek Road (NFS road #231), Bear Creek Road (NFS road #278), the Fisher River, Pleasant Valley, and Schrieber Lake. Twenty residences or cabins are within 1 mile of the four transmission line alternatives. Most of these properties are within 0.5 mile of US 2. Undeveloped private land not owned by MMC is found northwest of the Little Cherry Creek Impoundment Site, east of the Poorman Impoundment Site and Libby Plant Site, along the Bear Creek and Libby Creek roads, and scattered along the transmission line alignments.

Table 173. Summary of Ambient Sound Measurements.

Measurement Period	Little Cherry Creek Impoundment Site	Ramsey Plant Site
Midweek		
Day (Ld)	39.0	41.3
Night (Ln)	35.5	28.8
Average 24-hour (Ldn)	42.6	40.5
Weekend		
Day(Ld)	28.6	40.1
Night (Ln)	22.7	31.3
Average 24-hour (Ldn)	30.6	40.6

Source: Woodward-Clyde Consultants, Inc. 1989a.

3.20.4 Environmental Consequences

3.20.4.1 Sound

3.20.4.1.1 Alternative 1 – No Mine

The analysis area would continue to have quiet sound levels characteristic of rural areas and wilderness lands. Existing noise levels would not change. Activities on private land at the Libby Adit Site would remain until reclaimed in accordance with existing permits and approvals. These activities would increase ambient noise levels near the adit.

3.20.4.1.2 Alternative 2 – MMC's Proposed Mine

Construction Phase

During final design before construction began, noise would be generated at mine facility locations where additional subsurface drilling may occur, such as the Little Cherry Creek Impoundment Site and the LAD Areas. The noise produced by diesel-powered equipment typically is 85 dBA at a distance of 50 feet from the equipment.

During the Construction Phase, noise would be produced by heavy equipment, such as scrapers, bulldozers, graders, loaders, and rock trucks. The noise produced by diesel-powered equipment typically is 85 dBA at a distance of 50 feet from the equipment. Equipment noise can vary considerably depending on age, condition, manufacturer, use during a time period, and a changing distance from the equipment to a listener location. To minimize equipment noise, MMC would supplement backup beepers on surface equipment with strobe light-type warning devices and the sound level of the backup beepers would be reduced to the minimum level necessary to comply with safety regulations.

Generators would be used to supply power as the adits were developed, and each generator is predicted to produce a noise level of about 82 dBA at 50 feet. Ventilation fans would be located outside of the adit portals, and include inlet and discharge attenuators to meet a total noise level of 85 dBA at 3 feet (Big Sky Acoustics 2006). Noise from the generators and fans would extend into the CMW, reaching about 30 dBA along the ridge between Elephant Peak and Bald Eagle Peak (Big Sky Acoustics 2006). These sound levels in the CMW would be slightly above existing levels, affecting recreational users of the ridge between Elephant Peak and Bald Eagle Peak.

Recreational access to upper Ramsey Creek would be eliminated and recreational users that used upper Ramsey Creek would not be affected by plant noise. Noise from generators would cease after 2 to 3 years when the transmission line was completed.

Highest noise levels would be generated periodically at the Ramsey Plant Site as a result of blasting. Blasting noise near the surface during the preproduction phase is predicted to be equal to 122 dBA at 0.6 mile from the Ramsey Plant Site, and equal to the existing ambient noise level at up to about 8 miles from the site. Blasting noise would be greatest during initial adit construction; as the adits go deeper, blasting noise would decrease. The Rock Lake Ventilation Adit would be constructed from the mine to the surface. Very short-term blasting would be necessary when the adit daylighted on private land east of and above Rock Lake.

Construction Phase activities also would include: hauling of waste rock to the Little Cherry Creek Impoundment Site; excavation of borrow material from the Little Cherry Creek Impoundment Site; and construction of a Starter Dam, Diversion Channel and Seepage Collection Dam at the Little Cherry Creek Impoundment Site. Noise levels between 30 and 40 dBA would be experienced in areas within 2.5 miles of the source, depending on the topography and atmospheric conditions. Some blasting may be necessary in the upper part of the diversion channel. Elevated noise levels from blasting would be short and intermittent.

Construction truck traffic over a 1-year period to and from the Plant Site and Tailings Impoundment Site would increase noise levels on the Libby Creek Road (NFS road #231) while the Bear Creek Road was reconstructed. Trucks with properly operating mufflers are expected to generate up to an estimated 86 dBA at 50 feet. Trucks using Jake brakes with straight pipe mufflers would produce sound levels of 98 dB(A) at 50 feet, and would be audible at distances of up to 1 mile. Similar noise levels would occur along the Bear Creek Road (NFS road #278) during the Operations Phase. The noise effects would be similar to those of trucks transporting logs from a timber sale. Noise from haul trucks would affect forest users and private residences adjacent to the access road.

Operations Phase

Noise at the Ramsey Plant Site would be slightly less during operations than during the Construction Phase. Ore would be processed inside the mill buildings. Noise from enclosed milling operations is typically audible as a low level hum, and was measured as 49 dBA at about 328 feet near the Troy Mine plant (Big Sky Acoustics 2006). MMC also would locate all fans a minimum of 500 feet from the portals during operations unless alternative locations would not increase noise levels in the CMW from the Libby Adit Site by 5 decibels or more. Changes smaller than 5 dB would be considered insignificant (EPA 1978). All fans would include inlet and discharge attenuators to meet a total noise level of 85 dBA at 3 feet (Big Sky Acoustics 2015). Noise levels greater than the EPA guideline of 55 dBA would occur in the immediate vicinity of the Ramsey Plant Site, but would decrease substantially with distance from the mill. For example, noise levels at the Troy Mine were 49 dBA 330 feet from the mill. Noise levels between 30 and 55 dBA would extend into the CMW to Elephant Peak and down the Ramsey Creek drainage to about the LAD Area 1 (Big Sky Acoustics 2006). Recreational access to the CMW from the Ramsey Creek drainage would be eliminated and the typical wilderness user would not hear the operation. At all project facilities, backup beepers on surface equipment would be supplemented with strobe light-type warning devices. The sound level of the backup beepers would be reduced to the minimum level necessary to comply with safety regulations. These sound levels in the CMW would be slightly above existing levels, affecting recreational users of the ridge between

Elephant Peak and Bald Eagle Peak. Recreational access to upper Ramsey Creek would be eliminated and recreational users that used upper Ramsey Creek would not be affected by plant noise.

Traffic along the Bear Creek Road and other access roads during operations would increase noise levels. Assuming a worst-case of all mine traffic traveling during the same hour at the maximum speed (45 miles per hour), predicted noise levels at 50 feet from the roads would be 61 dBA and would be audible at a level of 20 dBA for up to 1.9 miles from the roads. Forest users and private residences within about 1,000 feet of the access roads would perceive a 7 dBA increase in noise levels from ambient levels (30 dBA). Where the line of sight between the road and a listener is blocked by terrain, the traffic noise levels would be less than described (Big Sky Acoustics 2015). Concentrate hauling would be limited to daytime hours (Table 12). Evening and nighttime noise levels along the Bear Creek Road would be similar to existing levels but elevated noise levels greater than ambient levels would occur more frequently. Because the Ramsey Plant Site would be within 1.2 miles of the CMW, traffic noise may be audible in the CMW at some locations near the Ramsey Plant Site. Traffic noise in the CMW would be indistinguishable from other mine-related noises described previously.

The air-intake fan associated with the Rock Lake Ventilation Adit would be located inside the mine, and not at the portal. The walls of the raise and adit would reduce the noise from the fan at the surface. Noise level at the portal of the Rock Lake Ventilation Adit is estimated to be 16 dBA and would not be audible over ambient noise levels (Big Sky Acoustics 2006).

Noise at the Little Cherry Creek Impoundment Site and LAD Areas would be generated by heavy equipment during construction and by occasional vehicular traffic, pumps and associated equipment, and bulldozers during operations. The sound from bulldozers would be periodic. In general, the production phase noise levels are predicted to be 55 dBA within about 0.2 mile of the facility, and would be equal to the lowest measured existing ambient noise level of 30 dBA within about 2.5 miles of the sites (Big Sky Acoustics 2006).

Truck and train traffic and heavy equipment would increase noise at the Libby Loadout. Loadout activities would generate sound levels similar to other operations. The increased noise levels would be less noticeable because of higher ambient noise levels.

Closure Phase

After operations cease, MMC would remove all facilities from the plant and adit sites. Reclamation at the Ramsey Plant Site, the Libby Adit Site, and the Rock Lake Ventilation Adit Site would take several years. Noise at these locations would be generated by heavy equipment during reclamation and by occasional vehicular traffic. Heavy equipment also would be used at the tailings impoundment. The decommissioning and closure period is expected to require a minimum of 10 years, and possibly up to 25 years of monitoring (Klohn Crippen Consultants 2005). Reclamation activities would generate sound levels similar to the Operations Phase. At the end of reclamation, noise levels at all project facilities would return to pre-mine levels. Traffic and activities associated with any long-term monitoring or water treatment would generate slightly increased noise levels.

3.20.4.1.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Noise sources and general magnitude of effects during all phases of operations in Alternative 3 would be similar to Alternative 2. During final design before construction began, noise would be generated at mine facility locations where additional subsurface drilling would occur, such as the Poorman Impoundment Site and the Libby Plant Site. The noise produced by diesel-powered equipment typically is 85 dBA at a distance of 50 feet from the equipment.

Ventilation adits would be in the Libby Creek drainage and near Rock Lake. During construction of the adits, elevated noise levels would extend up and down the Libby Creek drainage in a similar manner as in Ramsey Creek in Alternative 2. Noise from the generators and fans would extend into the CMW, reaching about 30 dBA along the ridge between Elephant Peak and Ojibway Peak. Noise from generators would cease after 2 to 3 years when the transmission line was completed.

Construction of the Libby Plant Site would increase noise levels in the lower Ramsey Creek drainage and in the Libby Creek drainage east of the Libby Adit. Recreational users at the Libby Gold Panning Recreation Area would experience noise levels between 45 and 55 dBA. The Libby Plant Site would be closer to private property (along Libby Creek) than the Ramsey Plant Site. Outdoor users of the property would experience noise levels between 45 and 50 dBA. Users at both locations would perceive a substantial increase in noise levels from ambient levels shown in Table 173.

Noise at the Poorman Impoundment Site would be generated by heavy equipment during the Construction Phase and by occasional vehicular traffic, pumps and associated equipment, and bulldozers during operations. The sound from bulldozers would be periodic. The Poorman Impoundment Site would be closer to private property (along Libby Creek) than the Little Cherry Creek Impoundment Site. Outdoor users of the property would experience noise levels between 55 and 60 dBA and would perceive a substantial increase in noise levels from ambient levels shown in Table 173.

Traffic along the Bear Creek Road and other access roads during construction and operations would increase noise levels. Assuming a worst-case of all mine traffic traveling during the same hour at the maximum speed (45 miles per hour), predicted noise levels at 50 feet from the roads would be 61 dBA and would be audible at a level of 20 dBA for up to 1.9 miles from the roads. Forest users and private residences within about 1,000 feet of the access roads would perceive a 7 dBA increase in noise levels from ambient levels (30 dBA). Where the line of sight between the road and a listener is blocked by terrain, the traffic noise levels would be less than described (Big Sky Acoustics 2015). Concentrate hauling would be limited to daytime hours (Table 12). MMC would develop a Transportation Plan for life of the mine; the plan's objectives would be to minimize mine-related vehicular traffic traveling between US 2 and the plant site, which would reduce traffic noise. Evening and nighttime noise levels along the Bear Creek Road would be similar to existing levels but elevated noise levels greater than ambient levels would occur more frequently. Developing and implementing a transportation plan and a road management plan, and creating a supply staging area in Libby and consolidating shipments to the mine area would minimize project-related traffic noise on the Bear Creek Road. Traffic noise would not be audible in the CMW. The Libby Plant Site is more than 2 miles from the CWM and all access roads would be more than 1.2 miles from the CMW.

3.20.4.1.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Noise sources and general magnitude of effects during all phases of operations at the Libby Plant Site, Upper Libby Adit Site and in the CMW in Alternative 4 would be the same as in Alternative 3. Noise effects at the Little Cherry Creek Impoundment Site would be the same as Alternative 2.

3.20.4.1.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. Noise levels associated with the existing 230-kV BPA transmission line would not change. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.20.4.1.6 Alternative B – MMC's Proposed Transmission Line

Noise During Transmission Line Construction, Operations, and Decommissioning

Transmission line construction would temporarily increase daytime ambient noise levels along the transmission line corridor. During the estimated 6-month transmission line construction period, construction equipment such as bulldozers, loaders, and haul trucks would generate 100 to 120 dB(A) at 50 feet. Chain saws and logging trucks used in forest clearing for the line would generate similar noise levels. These sounds would generally occur in hilly, forested areas, which would serve to reduce sound audibility. A helicopter may be used for four activities, depending on the construction contractor, structure placement, line stringing, timber harvest, and annual inspection and maintenance. Helicopters may be used for logging steep terrain. Logging may take one to two months, depending on the area logged. Structure placement and line stringing would take a week or two each. Annual inspections may take about a week. Increased noise levels would be audible to residences along US 2 (Figure 79) and recreational users at the Libby Creek Recreation Gold Panning Area and on trails along the alignment of this alternative. Similar helicopter noise would be audible during annual inspections of the line. When the line and structures were removed at mine closure, noise from helicopters, vehicles and other heavy equipment would be audible residences along US 2 and recreational users at the Libby Creek Recreation Gold Panning Area and on trails along the alignment. Some residents may perceive air pressure changes as vibrations from the helicopter use.

Because of generally low ambient background noise levels, the transmission line clearing, road construction, and line construction activities would be generally audible for about 2.5 miles, depending on the topography and atmospheric conditions. This could include the campground at Howard Lake and homes and recreational use areas along the Fisher River valley. Equipment trucks or logging trucks could extend the audible area. All off-site truck traffic would temporarily increase noise levels at residences adjacent to travel routes to and from the construction area. The effects would be similar to logging trucks transporting logs from an active timber sale area. The increased noise levels would be short-term, and would return to ambient levels when the noise-generating activity was completed.

Transmission Line Noise

The proposed 230-kV electrical power transmission line would produce soft hissing and crackling sounds in wet weather. In fair weather, these noises are virtually inaudible. During the light rains or wet snows which occur about 10 percent of the time in the analysis area, the transmission line would produce a noise level of about 50 dB(A) at the edge of the right-of-way (Power Engineers 2005a). The closest residence to MMC's proposed centerline would be about 380 feet away; two other residences along US 2 are within 450 feet from the centerline. The proposed centerline may vary up to 250 feet from the final centerline in final design. Expected noise levels at a residence about 380 feet from the centerline during a light rain or wet snows would be between 40 and 45 dBA (Power Engineers 2005a). This sound level would be slightly above naturally occurring levels and would be faintly discernible. The sound level would be less than 20 dBA during fair weather, and would not be audible over existing sounds.

Noise During Substation Construction, Operations, and Decommissioning

Noise generated during construction of the Sedlak Park Substation would be similar to construction of the mine facilities. Typical construction equipment generates noise between 60 to 70 dBA at 400 feet from the site, which is about the distance to the nearest residence. Construction would take 12 to 18 months. Because BPA's Sedlak Park Substation would not contain a transformer, there would be no audible hum emanating from the substation. Whenever breakers were to open and close, an audible noise would be heard by those in close proximity to the substation. The noise would be infrequent, occurring no more than a few times per year, and would be no louder than the noise from a shotgun blast.

3.20.4.1.7 Transmission Line Alternatives C-R, D-R, and E-R

Noise During Transmission Line Construction, Operations, and Decommissioning

Noise sources and general magnitude of effects during all phases of construction operations, and decommissioning in Alternatives C-R, D-R and E-R would be similar to Alternative B. Noise associated with BPA's Sedlak Park Substation also would be the same as Alternative B.

Selected structures would be constructed and timber harvested with helicopter. Depending on the alternative, noise levels in the upper part of the Miller Creek tributary (Alternative C-R), Miller Creek (Alternative D-R) and along West Fisher Creek and Standard Creek (Alternative E-R) would experience noise from helicopters, heavy equipment, and chain saws between the work location and staging area during construction. Similar noise levels would be audible during annual inspections, and final line decommissioning. Helicopters would be used for five activities: logging, structure placement, line stringing, and annual inspection and maintenance, and decommissioning. Logging may take one to two months and structure placement and line stringing would take a week or two each. Annual inspections may take about a week. Increased noise levels would be audible at private residences along US 2 where the alignment crosses the Fisher River, at private residences near Howard Lake in Alternatives D-R and E-R, and at a private residence along West Fisher Creek in Alternative E-R. In Alternatives C-R, D-R and E-R, recreational users at the Libby Creek Recreation Gold Panning Area and on trails along the alignment would experience higher noise levels during construction, annual inspections, and decommissioning. The increased noise levels would be short-term, and would return to ambient levels when the noise-generating activity is completed.

The alignment in the Miller Creek and West Fisher Creek Alternatives would follow NFS road #231 east of Howard Lake. At the closest location, the alignment in these two alternatives would be about 1,300 feet east of the Howard Lake Campground and about 1,000 feet east of the eastern shore of Howard Lake. Recreational users at the campground and Howard Lake would experience higher noise levels during construction, annual inspections, and decommissioning. The increased noise levels would be short-term, and would return to ambient levels when the noise-generating activity is completed.

Transmission Line Noise

All residences are more than 450 feet of the centerline of the agencies' alternatives. As part of these alternatives, the centerline would be no closer than 200 feet from any residence during final design. Expected noise levels at a residence 200 feet from the centerline during a light rain would be about 42 dBA and less than 40 dBA at 300 feet (HDR Engineering, Inc. 2007) and probably would not be noticeable over existing noise levels.

3.20.4.1.8 Effectiveness of Agencies' Mitigation Measures

The Libby Plant Site in the agencies' mine alternatives would be about 2 miles farther from the CMW than the Ramsey Plant Site proposed by MMC. The Libby Plant Site would effectively minimize noise in the CMW, but would substantially increase noise at the Libby Gold Panning Recreation Area and on private land. Developing and implementing a transportation plan and a road management plan, and creating a supply staging area in Libby and consolidating shipments to the mine area would be effective in minimizing project-related traffic noise on the Bear Creek Road. The agencies' mitigation of placing the centerline no closer than 200 feet from any residence would be effective in minimizing transmission line noise effects.

3.20.4.2 Electrical and Magnetic Fields

3.20.4.2.1 Alternative A – No Transmission Line

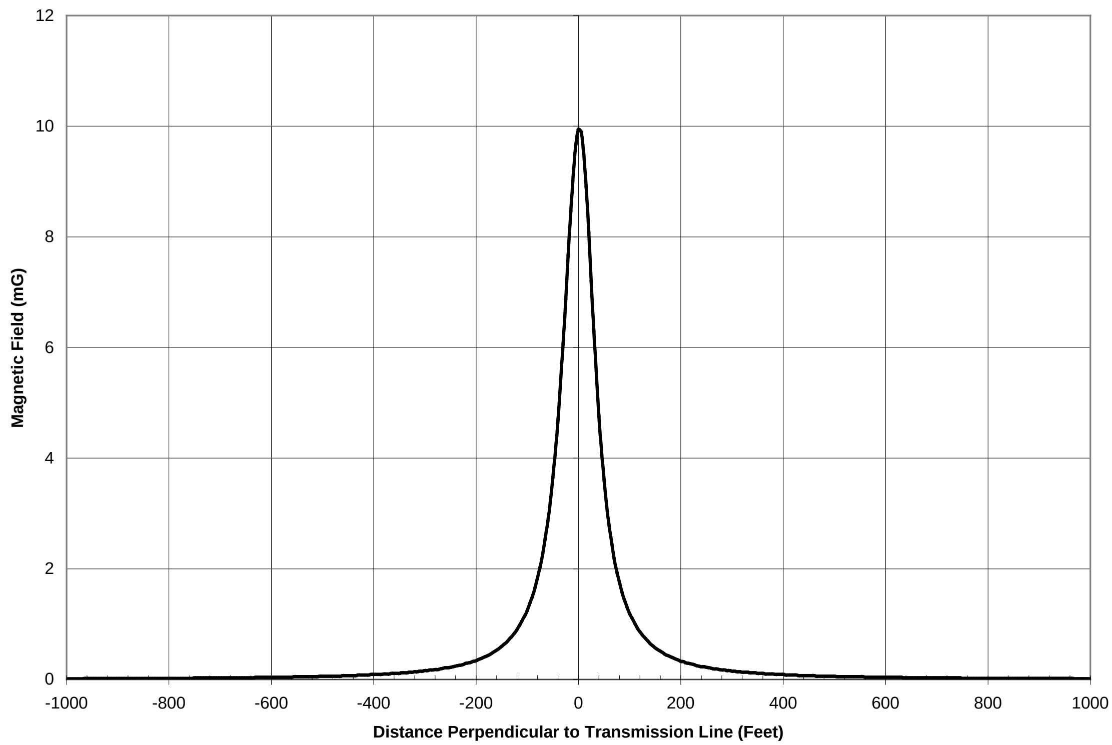
In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. Existing electrical and magnetic fields associated with the existing 230-kV BPA transmission line would not change. If existing residences are typical of others in the United States, average residential electric fields would be less than 10 V/m and magnetic fields of the order of 1 mG or less. EMFs of these levels are not known to have the potential for an adverse effect on health. In this alternative, the residences would have no recognized potential of an EMF health impact.

3.20.4.2.2 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

Within 0.5 mile of this alignment, 14 residences are present, of which 11 are greater than 450 feet from the centerline of the right-of-way and the remaining three are within 450 feet. Because the final alignment could vary by up to 250 feet of the centerline analyzed in this EIS (ARM 17.20.301 (21)), three residences may be within 200 feet of the centerline depending on final transmission line alignment. At lateral distances from the edge of the right-of-way (50 feet from the centerline) to 200 feet away, the electric field strength would range from about 0.75 kV/m at 50 feet to about 0.05 kV/m (or 50 V/m) at 200 feet. The magnetic field strength would be about 4 mG at 50 feet and less than 1 mG at 200 feet (Chart 20). This maximum electric field strength at 50 feet would be below the level set by Montana regulation for subdivided and residential areas for electric field strength and both the electric and magnetic field strengths at 50 feet would be below the exposure levels for the general public recommended as reference levels or maximum permissible levels (Asher Sheppard Consulting 2007, 2012).

The Sedlak Park Substation would the closest electrical facility to a residence in all alternatives. The substation would be about 350 feet south of BPA's existing 230-kV centerline. The edge of the substation would be 600 feet from the residence, and the electric field strength would be less than about 0.05 kV/m (or 50 V/m) and the magnetic field strength would be less than 1.0 mG. Based on the electric and magnetic field strengths recommended in guidelines as reference levels or maximum permissible levels for the general public, and the current state of scientific research on EMFs, the substation would be categorized as having no recognized potential for a health impact from exposure to EMFs.

Chart 20. Calculated Magnetic Field Strength for MMC's Proposed Monopole Structures.



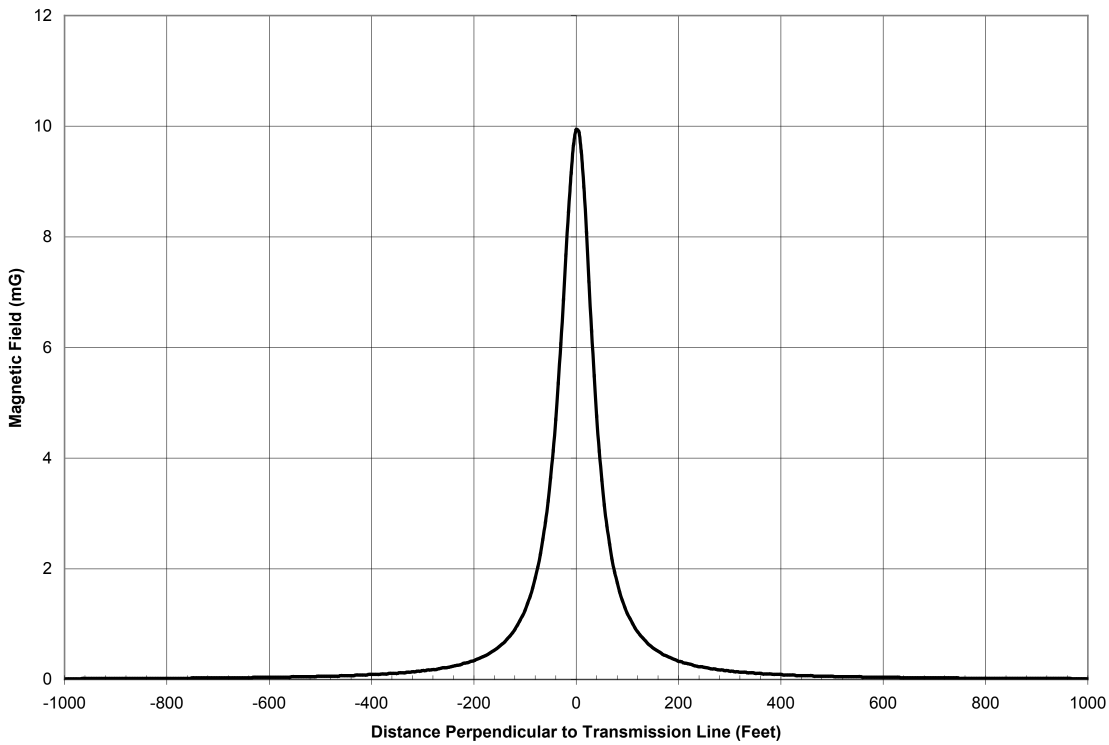
Source: POWER Engineers (2005), Fig. 5.

3.20.4.2.3 Transmission Line Alternatives C-R, D-R, and E-R

All four residences along the Modified North Miller Creek Alternative and all six residences along the Miller Creek Alternative and West Fisher Creek Alternative within 0.5 mile are greater than 450 feet from the proposed centerline. The electric field strength would be less than about 0.05 kV/m (or 50 V/m) and the magnetic field strength would be less than 1.0 mG (Chart 21). Based on the electric and magnetic field strengths recommended in guidelines as reference levels or maximum permissible levels for the general public, and the current state of scientific research on EMFs, these alternatives are categorized as having no recognized potential for a health impact from exposure to EMFs (Asher Sheppard Consulting 2007, 2012).

on EMFs, the substation would be categorized as having no recognized potential for a health impact from exposure to EMFs.

Chart 20. Calculated Magnetic Field Strength for MMC's Proposed Monopole Structures.



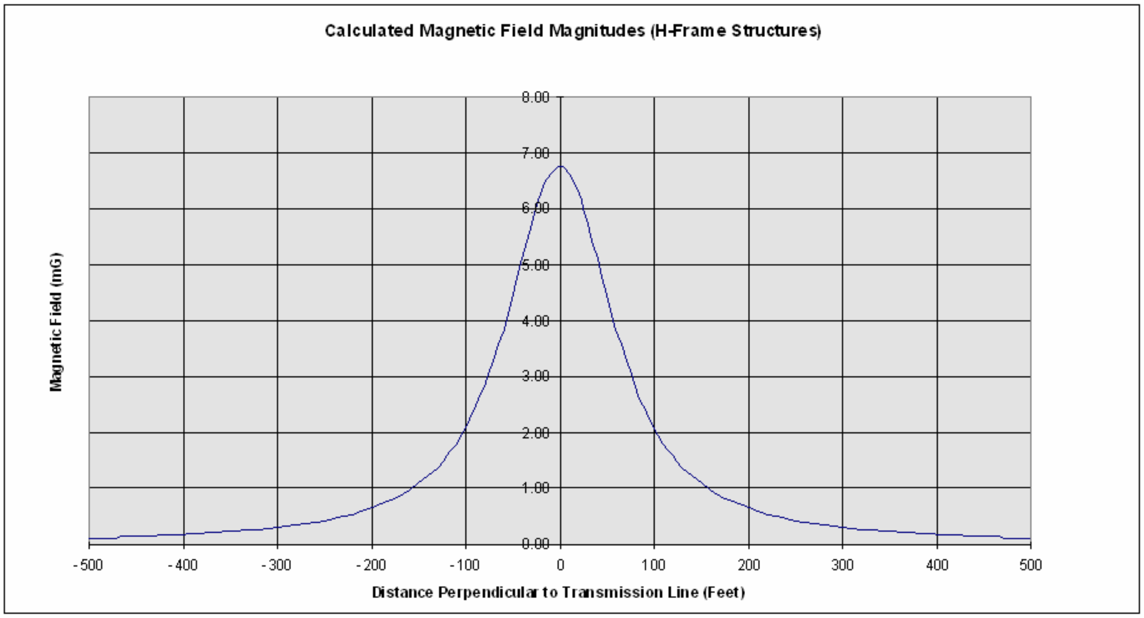
Source: POWER Engineers (2005), Fig. 5.

3.20.4.2.3 Transmission Line Alternatives C-R, D-R, and E-R

All four residences along the Modified North Miller Creek Alternative and all six residences along the Miller Creek Alternative and West Fisher Creek Alternative within 0.5 mile are greater than 450 feet from the proposed centerline. The electric field strength would be less than about 0.05 kV/m (or 50 V/m) and the magnetic field strength would be less than 1.0 mG (Chart 21). Based on the electric and magnetic field strengths recommended in guidelines as reference levels or maximum permissible levels for the general public, and the current state of scientific research on EMFs, these alternatives are categorized as having no recognized potential for a health impact from exposure to EMFs (Asher Sheppard Consulting 2007, 2012).

All residences are more than 450 feet of the proposed centerline of the agencies' alternatives. As part of these alternatives, the centerline would be no closer than 200 feet from any residence during final design. For residences 200 feet or more from the centerline, the electric field strength would be about 0.05 kV/m (or 50 V/m) and the magnetic field strength would be less than 1 mG. Based on the electric and magnetic field strengths recommended in guidelines as reference levels or maximum permissible levels for the general public, and the current state of scientific research on EMFs, all agencies' alternatives are categorized as having no recognized potential for a health impact from exposure to EMFs (Asher Sheppard Consulting 2007, 2012).

Chart 21. Calculated Magnetic Field Strength for Agencies' Proposed H-Frame Structures.



Source: HDR Engineering, Inc. 2007.

3.20.4.2.4 Effectiveness of Agencies' Mitigation Measures

The agencies' mitigation of routing the alignments in the agencies' alternatives more than 200 feet from the proposed centerline would be effective in minimizing exposure to magnetic fields. All residences are more than 450 feet of the centerline of the agencies' alternatives. As part of these alternatives, the centerline would be no closer than 200 feet from any residence during final design. All agencies' alternatives are categorized as having no recognized potential for a health impact from exposure to EMFs.

3.20.4.3 Radio and TV Effects

3.20.4.3.1 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. Radio and TV interference associated with the existing 230-kV BPA transmission line would not change.

3.20.4.5 Regulatory/Forest Plan Consistency

The applicable Montana administrative rules require that the electric field strength at the edge of the right-of-way be no greater than 1 kV/m in residential and subdivided areas and at road crossings be no greater than 7 kV/m. Calculations performed under assumptions of line operating conditions that would produce maximum strength electric and magnetic fields do not exceed these restrictions (Power Engineers 2005a, HDR Engineering, Inc. 2007). Montana has no rule or regulation concerning 60-Hz magnetic fields of power lines. Montana also requires that transmission lines be constructed in conformity with the National Electric Safety Code. All proposed transmission line alternatives would meet this requirement. In addition, MMC would be required to prevent unacceptable interference with stationary radio, television, and other communication systems as a condition of the certificate. In summary, all transmission line alternatives would comply with Montana rules concerning EMF levels and transmission line safety.

3.20.4.6 Irreversible and Irretrievable Commitments

The quiet sound levels characteristic of the analysis area would be irretrievably lost during the Construction, Operations, and Closure Phases.

3.20.4.7 Short-term Uses and Long-term Productivity

Elevated noise and EMF levels in all action alternatives would cease at mine closure and transmission line decommissioning, and would be a short-term use of the existing environment.

3.20.4.8 Unavoidable Adverse Environmental Effects

Elevated noise levels in upper Libby Creek would occur during the reclamation of the Libby Adit in the No Action Alternative. Similar noise levels would occur during construction, operations, and reclamation would occur between Libby Creek and the Cabinet Mountains in all mine action alternatives. Elevated noise from equipment and helicopter use in drainages in which the transmission line would be built would occur in all transmission line action alternatives.

3.21 Transportation

The transportation resource consists of a network of roadways that would be used during activities related to the proposed mine and transmission line. This section discusses the effects on roadway level of service and safety. Effects on public access in the analysis area are discussed in section 3.16, *Recreation*.

3.21.1 Regulatory Framework

3.21.1.1 Forest Service Requirements

The roads analysis complies with regulations governing the administration of the Forest Transportation System (36 CFR 212) and with the Forest Service Travel Management Policy FSM Chapter 7700 (2010c). The Forest Service regulations intended to help ensure that additions to the National Forest System road network are those deemed essential for resource management and use; that construction, reconstruction, and maintenance of roads minimize adverse environmental impacts; and that unneeded roads are decommissioned and restoration of ecological processes are initiated. Current Forest Service roads policy requires a science-based travel analysis ((USDA Forest Service 2009b). The Forest Service's locatable minerals regulations (36 CFR 228.8) require mine operators to construct and maintain all roads so as to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other surface resource values.

FW-DC-AR-07 of the 2015 KFP describes a transportation system "that provides safe and efficient public and administrative access to the Forest for recreation, special uses, forest resource management, and fire management activities. It is efficiently maintained, environmentally compatible, and responsive to public needs and desires. The transportation system and its use have minimal impacts on resources including threatened and endangered species, sensitive species, heritage and cultural sites, watersheds, and aquatic species. Newly constructed or reconstructed roads do not encroach into streams and riparian areas in ways that impact channel function, geometry, or sediment delivery. Roads in intermittent stored service pose minimal risks to water quality and aquatic ecosystems. Drainage structures have a minimal risk of failure, and provide adequate drainage that prevents accelerated runoff, erosion, and sediment delivery to streams. In addition, stream crossings provide for passage of aquatic organisms. Unauthorized roads and trails are no longer created." The 2015 KFP INFS standards and guidelines establish stream, wetland, and landslide-prone area protection zones called RHCAs, and set standards and guidelines for managing activities that potentially affect conditions within the RHCAs. INFS standards and guidelines applicable to roads are discussed in section 3.6, *Aquatic Life and Fisheries.*

3.21.1.2 State Requirements

US 2 is a federal highway owned and maintained by the MDT. Any modification of the existing Bear Creek Road/US 2 intersection or Libby Creek Road/US 2 intersection, and construction of an approach road to the Sedlak Park Substation would be in MDT's right of way. Approval for these activities in MDT's right of way would be under its jurisdiction.

3.21.2 Analysis Area and Methods

3.21.2.1 Analysis Area

In Alternative 2, MMC would use US 2, NFS road #278 (Bear Creek Road), 1.7 miles of new access road, and NFS road #4781 (Ramsey Creek Road) to access the plant site and tailings impoundment. About 10 miles of the Bear Creek Road (NFS road #278), from US 2 to the Bear Creek bridge, would be chip-sealed. The road width would be upgraded to 20 to 29 feet wide. US 2 would be used from Libby, Montana (US 2 milepost (MP) 32.7) to the intersection with Bear Creek Road (MP 39.7). NFS road #6210 (between Ramsey Creek and Libby Creek) would be used as an access road to the Libby Adit. While the Bear Creek Road is upgraded in the first 2 years, NFS road #231 (Libby Creek Road) would be used for access.

In Alternatives 3 and 4, MMC would use the same segment of US 2 between Libby and the intersection with Bear Creek Road, and the Bear Creek Road to the tailings impoundment site. The Bear Creek Road would be paved with hot mix asphalt, and the asphalt road surface would then be chip-sealed. The roadway width would be upgraded to two 12-foot wide travel lanes and two shoulders of 1 foot, for a total width of 26 feet. Additional widening would be necessary on curves and short segments of new road would be needed.

During transmission line construction, MMC would use US 2 from Libby to Sedlak Park (MP 58.8). Depending on the transmission line alternative selected, MMC would use other NFS roads, such as the Miller Creek Road (NFS road #385), or the Libby Creek Road (NFS road #231). Proposed road use and new road construction in each transmission line alternative is discussed in Chapter 2. None of the new roads would be open to public access; these roads would only be used by MMC for access to the transmission line.

No airports, air strips, helipads, or metal pipelines are in the analysis area; these areas are not discussed further. Ken Justice, a pilot with the ALERT Air Ambulance Service at the Kalispell Regional Medical Center indicated US 2 is not used as a corridor for helicopters and that the preferred route is the Kootenai River corridor (Justice, pers. comm. 2008). No railroads are near the mine area or transmission line corridors. Concentrate would be shipped via rail from the Libby Loadout. MMC’s concentrate shipments would be relatively small, and effects on rail traffic are not discussed further.

3.21.2.2 Methods

To establish the base traffic conditions, the amount of traffic on the roadway system during the time period of the proposed mine operations without mine-related traffic was estimated. The proposed mine traffic was then added to the base levels, and the extent to which the mine traffic affects the service level of the roadway network was then determined. Safety was analyzed by calculating the additional number of accidents that may result from the increases in mine-related traffic. Intersections within the roadway network were examined to determine if the roadways need to be modified to accommodate increased levels of traffic. Because transmission line access roads would be used most heavily during construction and line decommissioning, and traffic volumes would be relatively small and short-term, an assessment of traffic congestion and safety was not completed on them.

3.21.2.2.1 Time Period

The analysis area includes the roadways to be used by mine traffic during start up, operating, and Closure Phases. For purposes of analysis, the lead agencies assumed construction would start in 2010. Mine start up construction activities would last 3 years until 2013. The mine would operate until 2029, for 16 years. Three additional years of operation may occur.

After operations are completed, the mine would be closed. For purposes of this transportation analysis, the reclamation and monitoring activities are assumed to last 10 years, until 2039. Upon completion of mining operations, traffic volumes would be greatest during the first two years for reclamation activities. Traffic would be minimal during post-closure monitoring activities. The analyses were projected for 19 years, starting in 2010. Although actual timelines for the mine may change from the timeline proposed (for example, if construction would start in 2014 instead of 2010), the magnitude and duration of the effects of mine-related traffic on the transportation system would remain relatively the same.

3.21.2.2.2 Traffic Volumes

MMC provided estimates of mine-related daily traffic volumes and vehicle types anticipated to use the roadway system during operation of the proposed mine (MMI 2005a, MMC 2008). The MDT and the KNF provided traffic data for US 2 and National Forest System roads. Future traffic volumes on US 2 were estimated using traffic volumes in 2002 as the base year and the growth rate experienced on US 2 (1.2 percent). Future traffic volumes on NFS road #278 were estimated using traffic volumes in 1992 as the base year, calculated as the average of the traffic volumes between 1986 and 1991 (Table 176) and the growth rate experienced on US 2 (1.2 percent). MMC’s volumes and types were added to the traffic data supplied by the MDT and the KNF. In addition to traffic data, the MDT supplied design plans for the segments of US 2 from Libby to the Libby Creek Road turnoff; these design plans were used to complete the intersection safety analysis at US 2 and Bear Creek Road.

3.21.2.2.3 Traffic Congestion

The quality of service that a roadway provides is a measure of the amount of traffic congestion on a roadway for a particular volume of traffic. The quality of service is measured using the concept of levels of service (LOS). Six LOSs are as defined by the Transportation Research Board in the Highway Capacity Manual. The six LOSs are A, B, C, D, E, and F, with LOS of A being the least congested, or best condition, and LOS of F being the most congested, or worst condition. Any roadway section determined to be functioning at LOS A, B or C is considered to be operating acceptably (Highway Capacity Manual 2000).

An LOS analysis was completed for US 2 and for the intersection of US 2 and Bear Creek Road. These analyses were completed for peak hour traffic during the day and represent the maximum amount of traffic congestion expected. For most of the time, the roadways would not experience the peak hour traffic used in the analysis.

For two-lane highways, such as US 2, each LOS is defined by percent time spent following another vehicle and average travel speed, as shown in Table 174. US 2 is a class 1 highway, which is a highway where efficient mobility is paramount. For intersections without traffic lights, such as the two-way, stop-controlled (TWSC) intersection at US 2 and Bear Creek Road, each LOS is defined by a range of delay times, measured in seconds that an individual vehicle will experience completing an individual turning movement during the peak hour volume (Highway Capacity Manual 2000). The LOS criteria for TWSC intersections are also shown in Table 174.

Table 174. Level of Service Criteria Used in Congestion Analysis.

Level of Service	Criteria for Two-Lane Highways in Class 1		Criteria for TWSC Intersections
	Percent Time Spent Following	Average Travel Speed (mph)	Average Control Delay (sec/vehicle)
A	< 35	> 55	0 to 10
B	> 35 to 50	> 50-55	>10 to 15
C	> 50 to 65	> 45 to 50	>15 to 25
D	> 65 to 80	> 40 to 45	>25 to 35
E	> 80	> 40	> 35 to 50
F	Applies whenever the flow rate exceeds the segment capacity		> 50

TWSC = two-way, stop-controlled.
Source: Highway Capacity Manual 2000.

The intersection of US 2 and the Libby Loadout access road was not analyzed due to the low level of anticipated use by MMC-related vehicles, which would be about one truck per hour during day shift operating hours.

The intersections of US 2 and Libby Creek Road and US 2 and the proposed Sedlak Park Substation access did not warrant analysis because the limited amount of traffic that would use them during construction activities would not affect the operation of the intersection. MMC would submit a Traffic Impact Study Report in accordance with MDT requirements (MDT 2007) to the lead agencies and the MDT. The report would describe anticipated traffic generated by the project, anticipated impacts on capacity and level of service and traffic safety, and recommendations for road improvements. Final decisions regarding necessary road improvements would be made by the road owner (MDT, County, and Forest Service). MMC would fund all road improvements required by the project.

Congestion on Bear Creek Road and Libby Creek Road also was not analyzed because the Highway Capacity Manual analysis methods do not apply to recreational roads. A recreational road is not used for mobility, or to get from point A to point B in the fastest time, which is the basis of the two-lane highway analysis in the Highway Capacity Manual.

3.21.2.2.4 Safety

The safety of a particular section of highway is measured by the number of crashes per million vehicle miles traveled, called the accident rate. Typically, if there are no changes to a portion of highway that could affect the number of crashes and the roadway congestion is not severe, then as the amount of traffic increases, the number of accidents also increases proportionally by the accident rate. Because the proposed mine project would result in increased traffic on the area roadways, the number of accidents also may increase. The additional number of accidents that may result from the mine-related traffic was calculated for existing and future traffic conditions.

The intersection of US 2 and Bear Creek Road also was analyzed to determine if the intersection met current sight distance requirements and if turning lanes were required based on additional mine-related traffic. The sight distance and turning lane requirements for the intersection were analyzed using current MDT design criteria from the Montana Road Design Manual (MDT 2000).

3.21.2.3 Baseline Data Adequacy

The preceding sections describe the methods used to collect information about the affected environment and the approaches used by the lead agencies in analyzing potential effects. The subsequent section on the affected environment describes the best available information regarding traffic volume, congestion and safety in the analysis area. Traffic volume data on National Forest System roads in the analysis area are lacking. Traffic volume on National Forest System roads in the analysis area were estimated using an approach generally accepted in the scientific community. The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on congestion and safety in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.21.3 Affected Environment

3.21.3.1 US 2

US 2 is a Non-Interstate National Highway and the northernmost U.S. highway. It provides access for eastbound and westbound travel across the continental United States. In Montana, the MDT classifies US 2 as a principle arterial.

Average annual daily traffic volumes along US 2 near the intersection of US 2 and NFS road #278 (Bear Creek Road) from 2002 through 2011 ranged from 1,740 vehicles per day in 2002 to 1,940 vehicles per day in 2010. The data were used to develop traffic growth rates for this section of roadway in the analysis (MDT 2012).

Within the analysis area, from the city of Libby (MP 32.7) to the intersection with MT 482 in the city of White Haven (MP 36.1), US 2 is a two-way, four-lane, undivided highway with a total width of 68 feet. The road consists of 12-feet travel lanes, 10-feet shoulders, and is bounded on both edges by curb and gutter. South of the intersection with MT 482, US 2 reduces in width to a two-way, three-lane, undivided highway. The eastbound direction remains at two lanes to MP 36.6. The westbound direction is a single travel lane. The roadway edges change from a curb and gutter to a shoulder and ditch section. At MP 36.6, US 2 reduces to a two-way, two-lane highway that is a total width of 46 feet and consists of 12-feet travel lanes and 11-feet shoulders. The shoulder width remains 11 feet until MP 37.4, where it reduces to 1.5 feet. The narrow shoulder condition continues to Libby Creek Road.

Proceeding east from the city limit boundary for the town of Libby, the posted regulatory speed limit is 40 mph to MP 33.4 (0.6 mile), increases to 50 mph to the end of the three-lane roadway section at MP 36.4 (east of White Haven), and increases to 70 mph for passenger vehicles, and 65 mph for trucks on the remainder of the two-lane roadway within the analysis area. The roadway surface is asphalt. Based on roadway plans provided by MDT, the roadway geometry is curvilinear and the terrain is level between Libby and White Haven and rolling east of White

Haven. Initially constructed in the 1930s, the road was resurfaced and rehabilitated in 1998 and 1999.

Accident information including accident rates for US 2 from MP 39.0 to MP 40.5 was supplied by MDT. Accident information is presented in Table 175. The accident rate for US 2 between MP 39.0 to MP 40.5 is 2.33 accidents per million vehicle miles traveled for the 7-year period 2001 to 2007, higher than the statewide average. The accident rate for all rural non-interstate national highways in Montana from 2006 to 2010 was 1.04 accidents per million vehicle miles traveled. From 2007 to 2011, 16 accidents occurred near the intersection of US 2 and Bear Creek Road. Most of the accidents were due to improper or inattentive driving or wildlife on the road (MDT 2012). No data for crash rates on Bear Creek Road or Libby Creek Road are available.

3.21.3.2 NFS Road #278 (Bear Creek Road)

Bear Creek Road intersects US 2 at MP 39.7, 7.0 miles east of the Libby city limit boundary. It functions primarily as a recreational road, providing access to the KNF. The first 0.75 mile of Bear Creek Road is a two-way, two-lane roadway with a total width ranging from 18 to 20 feet. The remainder of the roadway is two-way, single-lane with a total width of about 14 feet. The first 9.5 miles is paved with hot mix asphalt, and the asphalt road surface is chip-sealed and in poor condition Bear Creek Road crosses Bear Creek at MP 9.5; the bridge across Bear Creek is 14 feet wide. The remainder of the road is a native (dirt) surface. The road is designed for speeds of 25 mph. The degree of intervisible turnouts is 50 percent; an intervisible turnout is an area designed to allow vehicles to pass and so spaced to provide visibility between the turnouts. The roadway geometry is curvilinear with various curves in several locations. The roadway profile is mountainous. The Bear Creek Road in its current alignment is owned by the Forest Service. The KNF holds easements for those segments that cross private land.

Table 175. US 2 Accident Data (MP 39.0 to MP 40.5).

Year	Total Number of Crashes	Total Number of Fatal Crashes	Total Number of Injury Crashes	Total Number of Property Damage Only Crashes
2007	5	0	4	1
2008	1	0	0	1
2009	8	0	2	6
2010	1	0	0	1
2011	1	0	0	1
Total	16	0	6	10

MP = milepost.
Source: MDT 2012.

Because the roadway is not an all-weather road (Stantus, pers. comm. 2006b), it is closed during spring frost break-up for vehicles weighing over 10,000 pounds. All types of vehicles can travel on the roadway except when mud and snow conditions limit use to 4-wheel drive (USDA Forest Service *et al.* 1992). There has been little maintenance to the roadway and several areas of the roadway have settled due to subsurface instability.

Yearly traffic volumes supplied by the KNF from 1986 through 1991 (Table 176) were used to develop traffic growth rates and peak hour traffic volumes. According to the KNF, the actual existing volumes may be lower than the provided volumes due to significant decreases in timber operations since 1991 (Lampton, pers. comm. 2006).

Table 176. Estimated Yearly Traffic on Bear Creek Road.

1986	1987	1988	1989	1990	1991
15,957	18,773	13,175	17,355	19,150	13,615

Source: Stantus 2006a.

3.21.3.3 NFS Road #231 (Libby Creek Road)

Libby Creek Road intersects US 2 at MP 42.0, 9.3 miles east of the Libby city limit boundary. It functions as a recreational road providing access to the KNF. Libby Creek Road has a two-way, two-lane width of 22 feet and a chip-seal paved surface for the first 0.5 mile. The road then narrows to a two-way, single-lane width varying from 14 to 16 feet with a gravel surface until the bridge at MP 9.2 (Lampton, pers. comm. 2006). This road segment is designed for speeds of 25 mph and the degree of intervisible turnouts is 75 percent. At MP 9.2 (intersection with Bear Creek Road) and proceeding until MP 10.6, the road changes to a two-way, single-lane width of 12 feet and maintains the gravel surface. This road segment is designed for speeds of 20 mph and the degree of intervisible turnouts is 50 percent. From MP 10.6 to the end of the road, the roadway surface is native and the two-way, single lane roadway width is 12 feet. This road segment is designed for speeds of 15 mph and there are no intervisible turnouts (USDA Forest Service *et al.* 1992). The roadway geometry is curvilinear with very sharp curves in several locations. The roadway profile is mountainous. The Forest Service does not post speed limits on the road.

Lincoln County owns three segments of the Libby Creek Road that would be used in all mine and transmission line alternatives: a 0.7-mile segment beginning at the northern intersection with US 2; a 2.8-mile segment from the intersection with the Bear Creek Road south to the intersection of NFS road #4779 near Howard Creek; and a 2.8-mile segment beginning at the southern intersection with US 2. The remainder of the Libby Creek Road is owed by the Forest Service. The KNF holds easements for those segments that cross private or State land.

The Libby Creek Road is not built to an all-weather standard and, like Bear Creek Road, is closed during spring frost break-up to vehicles weighing over 10,000 pounds. All vehicles can generally use the roadway except during snow and mud conditions when travel is limited to 4-wheel drive (USDA Forest Service *et al.* 1992). Some culverts and surfacing have been replaced in the last 5 years (Stantus, pers. comm. 2006b).

3.21.3.4 Other National Forest System Roads

The Forest Service manages all other National Forest System roads in the analysis area that would be used in the alternatives. Some roads on private and State lands would be used during transmission line construction and decommissioning. The access status of some National Forest System roads would be changed as a result of the wildlife mitigation. Table 28 and Table 29 provide a complete description of these road access changes.

3.21.4 Environmental Consequences

3.21.4.1 Congestion

3.21.4.1.1 Alternative 1 – No Mine

Without the proposed mine, traffic on US 2 from White Haven to Bear Creek Road would grow at an annual rate of 1.2 percent, increasing from a predicted 1,914 vehicles per day in 2010 to 2,401 vehicles in 2029. This would result in peak hour traffic of 288 vehicles per hour in 2010 and 361 vehicles per hour in 2029. For the entire 19-year period from 2010 to 2029, US 2 would function at LOS C in this two-lane section of the roadway, due to the limited passing opportunities and the percent of time vehicles spent following other vehicles. Between Libby and White Haven, traffic would grow at 1.2 percent annually with traffic increasing from 5,075 vehicles per day in 2010 to 6,370 vehicles per day in 2029. Peak hour traffic would be 760 vehicles per hour in 2010 and 960 vehicles per hour in 2029. This four-lane section would operate at LOS A through 2027.

The traffic on Bear Creek Road averaged 16,338 vehicles per year between 1986 and 1991 (Table 176). Assuming traffic on the Bear Creek Road increased at the same rate as traffic on US 2, average annual traffic would be 20,493 vehicles in 2010. Without the proposed mine, traffic would grow at an annual rate of 1.2 percent increasing to 25,707 vehicles per year in 2029. No improvements would be completed to Bear Creek Road under this alternative. A negligible increase in traffic volumes along the Bear Creek Road and NFS roads #4781 and #6210 would occur during ongoing activities at the Libby Adit.

Peak-hour traffic entering US 2 from Bear Creek Road would experience a LOS B through 2029. The increase in traffic also would not affect peak hour traffic turning left from US 2 onto Bear Creek Road. It would experience a LOS A during the entire 19-year period from 2010 to 2029.

3.21.4.1.2 Alternative 2 – MMC's Proposed Mine

The low volume of traffic generated by the proposed mine would not adversely affect the operation of US 2. The proposed mine would generate an additional 132 vehicles per day on US 2, including 52 trucks and six buses. US 2 would continue to function at LOS C during the peak hour period in the two-lane section during the entire 19-year period from 2010 to 2029. The additional mine-related traffic also would not affect the four-lane section of the roadway, which would still function at LOS A through 2027.

The US 2/Bear Creek Road intersection would remain at LOS B during operations with the addition of mine-related traffic to the existing traffic entering US 2 from Bear Creek Road. Peak hour traffic turning left from US 2 onto Bear Creek Road also would not experience a reduction in LOS due to the mine-related traffic and would still operate at a LOS A.

Traffic on Bear Creek Road (NFS road #278) would increase in all mine alternatives. Annual traffic would be about three times existing levels throughout the life of the mine (Table 177). To accommodate the increased traffic, about 10 miles of the Bear Creek Road (NFS road #278), from US 2 to the Bear Creek bridge, would be chip-and-seal paved and upgraded to 20 to 29 feet wide. Several short segments of the Bear Creek Road around the Little Cherry Creek Impoundment and Diversion Channel also would be realigned under this alternative. Reconstruction is anticipated to take 2 years. The reconstruction of Bear Creek Road would minimize future congestion because the roadway would be upgraded to a uniform width that would accommodate two-way traffic in separate lanes. Concentrate hauling would be limited to daytime hours (Table 12). When the mill ceased operations in the Closure Phase and the number of employees decreased, traffic volumes would be substantially less than shown in Table 177. Traffic on the Bear Creek Road would increase over the long term due to the loss of the Little Cherry Loop Road beneath the impoundment and the anticipated improvements.

Table 177. Estimated Traffic on Bear Creek Road (NFS road #278) with Mine, all Mine Alternatives.

Year	Estimated Annual Traffic without Mine (Vehicles per Year)	Estimated Mine Traffic (Vehicles per Year)	Estimated Traffic With Mine (Vehicles per Year)	% Increase
2010	20,493	48,048	68,541	234%
2015	21,753	48,048	69,801	221%
2020	23,090	48,048	71,138	208%
2025	24,509	48,048	72,557	196%
2029	25,707	48,048	73,755	187%

MMC would design, construct, own, operate and maintain the mill site substation. Peak demand is expected to be 50 megawatts; a transformer of the same size will be needed. A 50-MW transformer may weigh 50 tons, which would necessitate reinforcing bridges and culverts on stream crossings on the Bear Creek Road and other access roads. The method and requirements of transporting the substation transformer and other mining equipment on access roads would be considered during final road design.

MMC would continue to plow and use the Libby Creek Road (NFS road #231) and the Upper Libby Creek Road (NFS road #2316) year-round during the 2-year evaluation program and the 1-year period during reconstruction of the Bear Creek Road. The use would increase traffic on the two roads, and would keep open roads previously closed in the winter. The addition of mine-related traffic to the existing traffic entering US 2 from Libby Creek Road in 2010 would not affect the LOS and would remain LOS B during 3-year period.

The Forest Service would require MMC to include the terms of road use in its amended Plan of Operations before using Libby Creek Road during mine evaluation and construction activities. The Plan of Operations would include the requirement for a monetary deposit for gravel replacement and conditions for dust control. Approved plan requirements for road use would be determined by the level of use anticipated by MMC.

Six roads currently open, Little Cherry Loop Road (NFS road #6212), a 1.6-mile long segment of Little Cherry Bear Creek Road (NFS road #5182), NFS road #8838, a 1-mile long segment of Poorman Creek Road (NFS road #2317), 0.2 mile of NFS road #5170, and a 0.7-mile long segment of Ramsey Creek Road (NFS road #4781), would be gated and used for mine traffic only during operations. The gates on the Little Cherry Loop Road (NFS road #6212) and the Poorman Creek Road (NFS road #2317) would be near the intersection with the Bear Creek Road on the north end and the tailings impoundment permit area boundary on the south end. Gating the Little Cherry Loop Road (NFS road #6212) would restrict motorized access to NFS roads #5182 and #8838. The gate on the Poorman Creek Road (NFS road #2317) would be near its intersection with the Bear Creek Road south of Poorman Creek. Gating the Poorman Creek Road (NFS road

#2317) would restrict motorized access to the Ramsey Creek Road (NFS road #4781) and NFS road #5170 (Figure 16).

At the end of operations, gates on formerly open roads would be removed and the roads would reopen to motorized access. An exception would be a segment of the Little Cherry Loop Road (NFS road #6212) that would be covered by the tailings impoundment and would no longer provide a loop between the Bear Creek Road.

3.21.4.1.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Alternative 3 would have similar effects on congestion and level of service as Alternative 2. The US 2/Bear Creek Road intersection would remain at LOS B during operations with the addition of mine-related traffic to the existing traffic entering US 2 from Bear Creek Road. Creation of a supply staging area in Libby and consolidating shipments to the mine area would slightly reduce traffic from that estimated for Alternative 2 (Table 177).

The public and mine traffic would use the Bear Creek Road (NFS road #278) from US 2 to where a new Libby Plant Access Road would parallel it, in the center of the Poorman Impoundment Site near the intersection of NFS road #6201. MMC would surface the existing NFS road #278 (Bear Creek Road) from the junction with NFS road #6201 to NFS road #231 (Libby Creek Road) with 6 inches of gravel 16 feet wide. The Libby Plant Access road would be used solely for mine traffic except for two segments of the road where there would be mixed mine haul and public traffic (Figure 29). Mine haul traffic would be mine haul trucks carrying waste rock to the impoundment area from the mine adit and may exceed the 20-ton limit for vehicles on area highways. The bridge on NFS road #6212 across Poorman Creek would be removed during construction and the road south of Poorman Creek to the intersection of NFS road #278 would be decommissioned. A gate on the road would be installed near the tailings impoundment permit area boundary on the north end. Depending on timing of project construction, the KNF may need administrative access to NFS road #6212P to allow access to a gravel pit at the road's terminus. At the end of mine operations, the connection between the Bear Creek Road and the Libby Creek Road (NFS road #231) would exist via the new Libby Plant Access Road and the Poorman Creek Road (NFS road #2317). The bridge over Poorman creek on this new Libby Plant Access Road would remain for public access and use.

The Poorman Creek Road would remain open to motorized access from the intersection with the Bear Creek Road to its current closure location at the intersection of NFS road #2317B. A small parking area would provide parking for non-motorized access up Poorman Creek.

At the end of operations, gates on formerly open roads would be removed and the roads would reopen to motorized access. An exception would be a segment of the Little Cherry Loop Road (NFS road #6212) that would be covered by the tailings impoundment and would no longer provide a loop between the Bear Creek Road. Traffic on the segment of the Bear Creek Road between Poorman and Bear creeks would increase over the long term due to the loss of the Little Cherry Loop Road beneath the impoundment. About 3.2 miles of the Ramsey Creek Road (NFS road #4781) would be barriered and closed to administrative use for grizzly bear mitigation in Alternative 3. This change would reduce administrative access to the Ramsey Creek drainage.

3.21.4.1.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would have similar effects on congestion and level of service as Alternative 2. The public and mine traffic access for Bear Creek Road would be the same as described in Alternative

3. The US 2/Bear Creek Road intersection would remain at LOS B during operations with the addition of mine-related traffic to the existing traffic entering US 2 from Bear Creek Road.

The gates on the Little Cherry Loop Road (NFS road #6212) and the Poorman Creek Road (NFS road #2317) would be near the intersection with the Bear Creek Road on the north end and the tailings impoundment permit area boundary on the south end. Gating the Little Cherry Loop Road (NFS road #6212) would restrict motorized access to NFS roads #5182 and #8838.

The Poorman Creek Road would remain open to motorized access from the intersection with the Bear Creek Road to its current closure location at the intersection of NFS road #2317B. A small parking area would provide parking for non-motorized access up Poorman Creek.

At the end of operations, gates on formerly open roads would be removed and the roads would reopen to motorized access. An exception would be a segment of the Little Cherry Loop Road (NFS road #6212) that would be covered by the tailings impoundment and would no longer provide a loop between the Bear Creek Road. Traffic on the segment of the Bear Creek Road between Poorman and Bear creeks would increase over the long term due to the loss of the Little Cherry Loop Road beneath the impoundment. About 3.2 miles of the Ramsey Creek Road (NFS road #4781) would be barriered and closed to administrative use for grizzly bear mitigation in Alternative 4. This change would reduce administrative access to the Ramsey Creek drainage.

3.21.4.1.5 Alternative A – No Transmission Line

Without the traffic related to the transmission line initial construction and continued operations and maintenance, the LOS on US 2 and related roadways would operate at acceptable levels, similar to those experienced on US 2 without the mine-related traffic. The DEQ’s approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.21.4.1.6 All Transmission Line Alternatives

The traffic generated by the initial construction, continued operations and maintenance and final decommissioning of any of the transmission line alternatives would have no significant effect on the traffic congestion of the affected roadways and intersections due to the low volumes of traffic generated. Short, intermittent delays on US 2 would occur during transmission line stringing operations. Guard structures would be placed on either side of US 2 to prevent the line from failing across the highway. Similar delays would occur and similar procedures would be used on currently open NFS roads, such as NFS road #231 or #385, used in the construction of the transmission line. Similar short, intermittent delays on U.S. would occur during the initial months of construction of the Sedlak Park Substation Site. These delays would not adversely affect traffic congestion on US 2.

3.21.4.2 Safety

3.21.4.2.1 Alternative 1 – No Mine

By the end of 2010, between the eastern city limit of Libby to the town of White Haven, US 2 is projected to have experienced an estimated 7 accidents without mine traffic. For 2010, US 2 will have experienced 3 accidents from White Haven to Bear Creek Road. In 2029, the accidents between Libby and White Haven would increase to 9 accidents and 4 accidents between White Haven and Bear Creek Road. The increase in accidents would be due to the increase in traffic volumes during that same period.

3.21.4.2.2 Alternative 2 – MMC's Proposal

On US 2, the proposed mine would generate an additional 132 vehicles per day over the base traffic volume without the mine and would result in an additional 0.4 accidents per year from 2010 to 2029, for a total of 8 additional accidents over the 19-year life of the proposed mine. The increased number of accidents would be due to the increase in traffic volumes, would be short-term, and would return to a number without the mine at the end of the project.

The intersection of US 2 and Bear Creek Road meets current MDT sight distance requirements for left and right turning vehicles from Bear Creek Road onto US 2. The intersection also meets the stopping sight distance requirements for vehicles turning from US 2 onto Bear Creek Road. Turn lanes for eastbound US 2 traffic turning right onto Bear Creek Road and westbound US 2 traffic turning left onto Bear Creek Road would not be warranted based on the expected traffic volumes in 2010 or 2029. The Bear Creek Road is a public approach to US 2. MMC would evaluate the Bear Creek Road/US 2 and the Kootenai Business Park access road/US 2 intersections for the largest design vehicle and modify the intersections if the approach of either intersection did not meet the design requirements for that vehicle. The approach would be designed to maintain the transportation system level of service or safety in the analysis area.

On the Bear Creek Road and the Libby Creek Road, no accident data are available to calculate the anticipated number of accidents due to the increase in traffic from the proposed mine. On the Bear Creek Road, MMC would reconstruct the segment between US 2 and the Bear Creek bridge to a consistent two-lane width that is appropriate for two-way traffic to pass unobstructed. The minimal mine-related traffic on Libby Creek Road during the time period that Bear Creek Road was reconstructed would have no adverse effect on the safety of Libby Creek Road.

MMC would design the Bear Creek Road for speeds of 35 to 45 mph, an increase from the current design speed of 25 mph. Design exceptions for slower speeds may be needed on some curves. Mine Safety and Health Administration regulations (30 CFR 56, Subpart H) require that all mines establish and follow rules governing speed, right-of-way, direction of movement, and the use of headlights to assure appropriate visibility, and that equipment operating speeds be consistent with conditions of roadways, grades, clearance, visibility, traffic, and the type of equipment used. MMC would post warning signs for speed limits and other important road conditions and require all mine-related vehicles to follow all traffic control restrictions, such as speed. The effect of road improvements and higher speeds may lead to a slight increase in accidents. The minimal mine-related traffic on Libby Creek Road during the time period that Bear Creek Road was reconstructed would have no adverse effect on the safety of Libby Creek Road.

MMC would reconstruct the Bear Creek Road from US 2 to the Ramsey Access Road to a roadway width of 20 to 29 feet. MMC has not assessed if the easements across private land held by the Forest Service would allow for widening to the proposed width. Mine haul traffic and public traffic would share two segments of roads, a 2.5-mile segment of the Bear Creek Road between the Little Cherry Creek Impoundment Site to the Ramsey Access Road and a 0.6-mile segment of NFS road #2316 east of the Libby Adit Site (Figure 29). MMC's proposed widths would not safely accommodate mine haul traffic and public traffic. The Mine Safety and Health

Administration (Mine Safety and Health Administration 1999) recommends a road width of 56 feet wide to accommodate joint-use traffic safely.

MMC would inspect the Bear Creek bridge for load capacity, but expects it would be sufficient for mine use. The bridge width, which is currently 14 feet, would be inconsistent with the width of the improved Bear Creek Road. Because mine traffic and public traffic would share the Bear Creek Road north of the Little Cherry Creek Impoundment, the narrow bridge width may lead to safety concerns. (See Alternative 3 for agency-mitigated measures to address these concerns.)

The Bear Creek Road between the intersection with Libby Creek Road and the new Ramsey Plant Access Road would not be reconstructed and would remain in its current unpaved condition.

3.21.4.2.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative and Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

These alternatives would have the same effect on the number of accidents on US 2 as Alternative 2. The roadway width would be upgraded to two 12-foot wide travel lanes and two shoulders of 1 foot, for a total width of 26 feet. Additional widening would be necessary on curves and short segments of new road would be needed. A reconstructed bridge at Bear Creek widened to 26 feet would be safer than the existing bridge. The new bridges would be long enough to convey a 100-year flow event, to comply with INFS standards and guidelines and Forest Service guidance, such as fish passage or conveyance of adequate flows (USDA Forest Service 2008a, 2015b).MMC would complete a preliminary and final design of the reconstructed road. If preliminary design indicates the reconstructed road would exceed the current right-of-way width across private land, MMC will make a reasonable effort during the Evaluation Phase to secure all necessary easements to accommodate the needed road right-of-way width.

Public and mine haul traffic would share 1.8 miles of road in Alternative 3 and 3.8 miles of road in Alternative 4 (Figure 38). The joint-use road segments would be widened to widths recommended by the Mine Safety and Health Administration (Mine Safety and Health Administration 1999). For a 16-foot wide haul vehicle, the road width would be 56 feet wide to safely accommodate joint-use traffic. All bridge would be reconstructed to a width compatible with the reconstructed width of the adjacent road segment. A wider road width would safely accommodate joint-use traffic.

In Alternative 3, MMC would surface the existing NFS road #278 (Bear Creek Road) from the junction with NFS road #6201 to NFS road #231 (Libby Creek Road) with 6 inches of gravel 16 feet wide (Figure 29). Similarly, MMC would surface the Bear Creek Road from new Libby Plant access road to the Libby Creek Road in Alternative 4 (Figure 38). This surfacing would ensure the safe transition from the improved section north of the new Libby Plant Access Road and the unimproved section to the Libby Creek Road.

Modifications to the intersection of US 2 and the Bear Creek Road and to the intersection of US 2 and the Kootenai Business Park access road would be required if the approach did not meet the design requirements for the largest design vehicle. Any modification to US 2 would require the approval of the MDT. This mitigation would maintain the transportation system level of service and safety in the analysis area.

Before initiating the Construction Phase, MMC would submit a traffic impact study report to the agencies and MDT that address the requirements of MDT’s System Impact Action Process

(Montana Department of Transportation 2007). The study would identify measures necessary to maintain safe public roads and highways and acceptable operational levels of service.

3.21.4.2.4 Effectiveness of Agencies' Mitigation Measures

Widening roads, culverts, and bridges to an appropriate width would be effective in minimizing conflict between mine traffic and other road users. Graveling a section of the existing NFS road #278 (Bear Creek Road) would be effective in maintenance requirements on the Bear Creek Road. Proper design and implementation of any necessary improvements of US 2 and its intersections that would be identified in a traffic impact study would be effective in maintaining the transportation system level of service and safety on US 2. Developing and implementing a transportation plan and a road management plan would be effective in minimizing project-related traffic and indirect environmental effects. Creating a supply staging area in Libby and consolidating shipments to the mine area would effectively reduce traffic on the Bear Creek Road.

3.21.4.2.5 Alternative A – No Transmission Line

Without the traffic related to the initial construction and continued operations and maintenance of the transmission line, substation and loop line, the safety on US 2 and related roadways would be similar to those experienced on US 2 without the mine-related traffic. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.21.4.2.6 All Transmission Line Alternatives

None of transmission line alternatives, which include the Sedlak Park Substation and loop line, would result in adverse impacts on the safety of the transportation network due to the minimal volume of traffic that would be generated by the transmission line construction, continued operations and maintenance, and final decommissioning. The approach to the Sedlak Park Substation would be designed not to affect the transportation system level of service or safety in the analysis area.

3.21.4.3 Cumulative Effects

The KNF's Miller-West Fisher Vegetation Management Project will consist of vegetative treatments including timber harvest, slash treatment, site preparation, prescribed burning, tree planting, precommercial thinning, construction of new roads, road storage and decommissioning activities, road reconstruction, and implementation of BMPs. Depending on the timing of these activities and construction of the transmission line, traffic volumes may be cumulatively greater in the Miller Creek and West Fisher Creek drainages. Many of the other reasonably foreseeable actions would use the same roads as the Montanore Project. The reasonably foreseeable actions and the Montanore Project would cumulatively increase traffic volumes near access roads. The additional traffic would not adversely affect the level of service on US 2 or lead to adverse congestion.

3.21.4.4 Regulatory/Forest Plan Consistency

All action alternatives would make progress toward the 2015 KFP FW-DC-AR-07 and comply with regulations governing the administration of the forest transportation system (36 CFR 212).

All roads to be built for the project would be constructed, maintained, and decommissioned to minimize adverse environmental impact, in accordance with the Forest Service locatable minerals regulations (36 CFR 228.8). Only the minimum number of roads would be constructed to the minimum standard necessary. Unneeded roads used during construction would be decommissioned. Compliance with 36 CFR 228.8(f) regarding roads management is discussed in section 3.6.4.11.4 *National Forest Management Act/Kootenai Forest Plan* (RF-2 through RF-5), beginning on page 477.

3.21.4.5 Irreversible and Irretrievable Commitments

All mine alternatives would increase traffic on the roadways, thereby increasing the fuel used by vehicles beyond the no-mine alternative. Fuel is a non-renewable resource; thus, an increase in traffic related to the mine alternative would result in an irreversible commitment of resources. All mine alternatives would increase the number of accidents during the mine's operation and closure. Increased accidents would be an irreversible commitment of resources.

3.21.4.6 Short-term Uses and Long-term Productivity

During the mine's and transmission line construction, operation and closure, increased traffic congestion and accidents could occur on roads and highways used in the project, and would cease at the end of the closure period.

3.21.4.7 Unavoidable Adverse Environmental Effects

During the mine's operation and closure, traffic congestion and accidents would occur on roads and highways used in the project. Increased congestion and accidents would cease at the end of the closure period.

3.22 Vegetation

3.22.1 Vegetation Communities

3.22.1.1 Regulatory Framework

The Organic Administration Act authorizes the Forest Service to regulate the occupancy and use of National Forest System lands. The Forest Service's locatable minerals regulations are promulgated at 36 CFR 228, Subpart A. The regulations apply to operations conducted under the U.S. mining laws as they affect surface resources on National Forest System lands under the jurisdiction of the Secretary of Agriculture. One of these regulations (36 CFR 228.8) requires that mining activity be conducted, where feasible, to minimize adverse environmental impacts on National Forest surface resources.

The National Forest Management Act requires the development, maintenance, and, as appropriate, the revision of land and resource management plans (forest plans) for units of the National Forest System. These forest plans provide for the multiple use and sustained yield of renewable resources in accordance with the Multiple-Use Sustained-Yield Act of 1960. The vegetation management approach in the 2015 KFP is one that provides ecological components, patterns, and processes at multiple scales on the landscape, and thereby provides the full spectrum of habitats and conditions needed for all of the biological organisms associated with the various ecosystems (USDA Forest Service 2013c).

The Montanore Project would clear forested lands for mineral development. Vegetation standards and guidelines in the 2015 KFP applicable to vegetation management activities do not apply to intensively developed sites such as mines, developed recreation sites, administrative sites, or rock where lands have been or will be converted to non-forest sites.

2015 KFP vegetation direction for old growth is discussed in section 3.22.2, *Old Growth Ecosystems*; vegetation direction for peatland and bogs is discussed in section 3.23, *Wetlands and Other Waters of the U.S.;* and direction for INFS and RHCA is discussed in section 3.6, *Aquatic Life and Fisheries*.

Sensitive species are designated by the Regional Forester (FSM 2670.5). FSM 2672.42 directs the Forest Service to conduct a biological evaluation (BE) to analyze impacts on sensitive species. The sensitive species analysis in this document meets the requirements for a BE as outlined in FSM 2672.42. FSM 2670.22 requires that the Forest Service develop and implement management practices to ensure that sensitive species do not become threatened or endangered because of Forest Service actions and maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Any decision on the Montanore Project cannot result in loss of sensitive species viability or create significant trends toward federal listing (FSM 2670.32). Sensitive plant species identified within the analysis area are the northern beechfern or the crenulated moonwort.

For lands affected by the transmission line, the MFSA directs the DEQ to approve a facility if, in conjunction with other findings, the DEQ finds and determines that the facility would minimize adverse environmental impacts, considering the state of available technology and the nature and economics of the various alternatives. If approved, DEQ would require that disturbances from the transmission line would be reclaimed to standards set by administrative rule (ARM 17.20.1902 (10)(b)).

The MMRA requires that lands affected by mining must meet the post-mine land uses. The DEQ evaluates in its environmental documents whether the revegetation plans for mine facilities would adequately meet the post-mine land uses.

3.22.1.2 Analysis Area and Methods

3.22.1.2.1 Analysis Area

The analysis area for direct, indirect, and cumulative effects on vegetation consists of all areas that would be disturbed by construction of the mine, transmission line, substation and loop line under any alternative (Figure 85) and streams that may be indirectly affected by changes in hydrology. The vegetation at the Libby Loadout Site is completely disturbed and the loadout site is not discussed further.

3.22.1.2.2 Baseline Data Collection

Vegetation mapping for the analysis area was obtained from baseline inventories (Western Resource Development Corp. 1989d, 1989e; Westech 2005d, 2005e; Geomatrix 2009b; Hydrometrics, Inc. in MMI 2005a). Coniferous forest includes old growth forest. Old growth and previously harvested coniferous forest mapping for National Forest System lands was provided by the KNF as GIS data layers. Old growth and previously harvested coniferous forest on non-National Forest System lands was mapped based on aerial photography and field verified by KNF biologists. Where they overlapped, community types were determined in the following priority order: wetland/riparian, old growth forest, which was mapped as coniferous forest, and previously harvested coniferous forest. All areas that were not previously harvested coniferous forest or wetland/riparian were mapped as coniferous forest vegetation community.

Timber suitability was based on the determination of suitability developed for the 2015 KFP. In the 2015 KFP, the KNF determined timber suitability using various resource data and GIS to apply criteria and identify lands suitable for timber production. Criteria for suitability are defined in the 1982 Planning Rule procedures at 36 CFR 219.14.

3.22.1.2.3 Impact Analysis Methods

Impacts of the mine alternatives on vegetation communities were determined by calculating the number of acres that would be disturbed. The mine reclamation plans of the alternatives also were compared. The analysis of transmission line, substation, and loop line effects calculated the total acreage within the clearing width of each alternative. Actual acreage cleared would be less and would depend on tree height, slope, and line clearance above the ground. Vegetation communities affected by road construction for transmission line access were calculated for each alternative. For analysis purposes, it is assumed that minor disturbances of vegetation from staging and yarding areas and stringing, and tensioning sites would occur within the clearing width.

Because mine and adit dewatering, the pumpback well system operation around the impoundment, and other project activities may result in streamflow changes, indirect effects on riparian vegetation were assessed. Representative cross sections at important aquatic habitat locations were selected on Libby Creek (1 mile upstream of Little Cherry Creek), East Fork Rock Creek (1 mile upstream of the confluence with the West Fork Rock Creek), and East Fork Bull River (at the confluence with Isabella Creek) to collect data on vegetation communities, stream cross section widths, and velocity. Using baseline data and changes in streamflow predicted from the 3D groundwater model, changes in wetted perimeter were predicted (section 3.11.4, *Surface Water Hydrology*) to assess effects on riparian vegetation.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on vegetation communities in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.22.1.3 Affected Environment

Vegetation communities have developed across the landscape in response to climate, disturbance, and other environmental factors. The success of fire suppression efforts and resource management activities over the last 100 years has had a large influence on the structure and composition of forest conditions. These changes include an increase in shade-tolerant species, decrease in fire-tolerant species, increased vertical stand structure, increased canopy closure, increased vertical fuel ladders, greater biomass, greater fire intensities and severities, and increased insect and disease epidemics. Over the last 15 years, silvicultural prescriptions have largely been designed to emulate forest composition and structures created by historic fire regimes (USDA Forest Service 2013). Historically, dominant forest species were a mix of long-lived species such as white pine, western larch, ponderosa pine, and whitebark pine and short-lived species such as lodgepole pine, and alpine fir. Currently, the forest stands in the analysis area are dominated by Douglas-fir, lodgepole pine, alpine fir, grand fir, and western hemlock, with lodgepole pine abundant on the higher-elevation, steeper slopes as a result of stand-replacing fire in the late 1800s and 1910. Three dominant vegetation communities, mature coniferous forest; previously harvested young coniferous forest; and wetlands including riparian areas, are found in the analysis area; a total of 410 plant species were observed (Westech 2005d). Vegetation communities in the analysis area are shown in Figure 85 and summarized below.

3.22.1.3.1 Coniferous Forest

About 50 percent of the analysis area is composed of mature coniferous forest vegetation communities including unlogged areas. Mature coniferous forests have large economic potential associated with timber harvesting and provide habitat for a variety of wildlife and plant species. Timber harvesting generally occurs mainly where the dominant tree species are lodgepole pine, western hemlock, western redcedar, grand fir, Engelmann spruce, Douglas-fir, and western larch (Westech 2005d).

Stand structure within the KNF varies from new growth to old growth managed areas. Within the mature coniferous forest vegetation communities, the KNF has identified stands of old growth that are managed to maintain diversity and habitat for wildlife and plant species. Old growth ecosystems and the habitat they provide for wildlife species are described in section 3.22.2, *Old Growth Ecosystems*.

The KNF has established Vegetative Response Units (VRUs) to aggregate lands having similar capabilities and management potential and to assist the KNF in preparation of site-specific prescriptions. The VRU system can help managers interpret vegetation community response to management or natural disturbance and project future landscapes based on current conditions.

The major VRUs in the analysis area are VRU5S and VRU5N, which are moderately cool and moist ecosystems (USDA Forest Service 1999b).

3.22.1.3.2 Previously Harvested Coniferous Forest

The previously harvested coniferous forest vegetation community includes all areas where trees were harvested, both intermediate harvest that maintained the existing stand or regeneration harvest that initiated a new stand. Most previously harvested areas have well-established conifer regeneration with western larch, western white pine, grand fir, and lodgepole pine. Higher-elevation areas are dominated by lodgepole pine, Engelmann spruce and subalpine fir; while mid to lower-elevation areas are dominated by western larch, Douglas-fir, lodgepole pine, and ponderosa pine. As with the mature coniferous forest vegetation type, understory composition and cover varies considerably with site conditions, elevation, tree cover, and stand age. In younger previously harvested coniferous forest areas, more introduced species and noxious weeds are present than in older harvested areas (Westech 2005d).

3.22.1.3.3 Wetlands and Riparian Areas

Within the analysis area, wetlands and riparian vegetation communities are present along most streams and rivers. Wetlands are also found in depressions at both tailings impoundment sites, and along the transmission line alternatives. Wetlands and wetland vegetation are discussed in section 3.23, *Wetlands and Other Waters of the U.S.*

Riparian areas along Fisher River, Libby Creek, and Miller Creek support several riparian/wetland vegetation communities including riparian coniferous forest, cottonwood forest, shrub thickets, and herbaceous fringes. Riparian coniferous forest includes western redcedar, western hemlock, and Engelmann spruce with understory species of ladyfern, devil’s club, oakfern, common horsetail, clintonia, common snowberry, thimbleberry, Sitka alder, and Rocky Mountain maple. Riparian cottonwood forests are present along Fisher River, where black cottonwood, Douglas-fir, and ponderosa pine are the dominant tree species with common snowberry, alder buckthorn, willow, and Wood’s rose making up the understory. Other herbaceous species include introduced reed canarygrass, native fowl bluegrass, and introduced common tansy, a noxious weed. Shrub thickets are present along the Fisher River, Miller Creek, and upper elevation streams with stands of Douglas spirea, thinleaf or Sitka alder, willow, and alder buckthorn.

Riparian vegetation along the banks of Libby Creek at the cross section is mostly dominated by black cottonwood, Douglas-fir, spruce, Western red cedar, alder, and willow. At the cross sections of the East Fork Bull River and East Fork Rock Creek, the vegetation is dominated by Western red cedar, mountain maple, black cottonwood, Western hemlock, Pacific yew, and grand fir with Devil’s club in the understory. These streams are fairly entrenched and are characterized by medium to large cobble.

3.22.1.3.4 Other Vegetation Communities

Other vegetation communities in the analysis area are present in small quantities (Westech 2005d). Mapping of the vegetation communities has been consolidated with more dominant vegetation communities in the analysis area. These small vegetation communities are described below.

The shrub-field vegetation community is found in avalanche chutes where rock outcrops, talus, or scree are present. The shrub-fields are periodically disturbed by avalanche and have low cover and low tree density. Shrub species include Rocky Mountain maple, Sitka alder, common snowberry, white spirea, pachistima, serviceberry, and bristly Nootka rose. For analysis purposes, the shrub-field vegetation community is included in the coniferous forest community.

The grassland community is found on steep convex ridges or slopes. Dominant grass species are natives including Idaho fescue, purple reedgrass, and elk sedge. Other common native herbaceous species are clubmoss, fescue sandwort, yellow buckwheat, Sandberg's lomatium, Alberta penstemon, and western groundsel. For analysis purposes, the grassland community is included in the previously harvested coniferous forest community.

The Libby Adit Site, which is private land, was revegetated, reclaimed, and subsequently has been redisturbed by MMC. The disturbed mining area is dominated by introduced forbs such as birdsfoot trefoil and Dutch clover. Grasses such as introduced red fescue and native big bluegrass also are present. Some native forbs and noxious weeds such as spotted knapweed have established as well as some native tree species. For analysis purposes, the area disturbed at the Libby Adit Site is included in the previously harvested coniferous forest community.

3.22.1.3.5 Agricultural Land

Agricultural land used for livestock grazing is located along the Fisher River and along the Bear Creek Access Road. Dominant species include introduced timothy, Kentucky bluegrass, orchard grass, white Dutch clover, and red clover. For purposes of analysis, agricultural land areas are combined with previously harvested coniferous forest community.

3.22.1.4 Environmental Consequences

3.22.1.4.1 Alternative 1 – No Mine

The No Mine Alternative would not remove or affect any vegetation communities or individual species. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Monitoring wells and other devices installed for monitoring would be removed and the area reclaimed. Disturbances on private land at the Libby Adit Site would remain until reclaimed in accordance with existing permits and approvals. Introduced species would continue to increase from current disturbance areas.

3.22.1.4.2 Alternative 2 – MMC's Proposed Mine

Alternative 2 would result in the removal and loss of vegetation communities on up to 2,582 acres during mine operations (Table 178). The mature coniferous forests vegetation community would be most affected, with up to 1,617 acres disturbed. The mature coniferous forest vegetation communities include old growth stands, which are discussed in section 3.22.2, *Old Growth Ecosystems*. Previously harvested coniferous forest would be the second largest vegetation community impacted, with a disturbance of 925 acres. About 40 acres of riparian and wetland areas would be affected by Alternative 2. Alternative 2 would affect more mature coniferous forest communities and riparian areas than the other alternatives. Effects on other vegetation communities would be minor. Indirect effect on riparian vegetation along Libby Creek, East Fork Bull River, and East Fork Rock Creek would be negligible. The change in wetted perimeter would be greatest during the post-closure (year 38) with a 26 percent change in wetted perimeter on East Fork Bull River and a 9 percent change in wetted perimeter on East Fork Rock Creek. With mitigation, no detectible change in wetted perimeter is expected on Libby Creek. The species that occur along these streams are mostly woody and have a wide moisture tolerance, some of which can be found in uplands with a similar or higher frequency as in riparian zones. Although cottonwood and willow have greater soil moisture requirements, the changes in wetted perimeter would occur during low flow, which would be a small percentage of the growing season during most years. During dry years, the low flows and reduction in wetted perimeter may extend for a longer portion of the growing season and cause stress and possibly dieback in cottonwoods and willows.

Table 178. Vegetation Communities within Mine Alternative Disturbance Areas.

Vegetation Community	Alternative 2 MMC's Proposed Mine	Alternative 3 Agency Mitigated Poorman Impoundment Alternative	Alternative 4 Agency Mitigated Little Cherry Creek Impoundment Alternative
Mature Coniferous Forest	1,617	865	1,143
Previously Harvested Coniferous Forest	925	683	740
Wetland/Riparian Areas	40	17	41
Total	2,582	1,565	1,924

All units are acres, rounded to the nearest acre.
Source: GIS analysis by ERO Resources Corp. using vegetation mapping in Westech 2005d.

Areas in Alternative 2 that require vegetation clearing and removal would be subject to an overall loss of biodiversity and a change in species composition during mine operations. Reclamation would re-establish plant communities but the biodiversity would be less, introduced species would be more common, species composition would not be the same, and timber production would be lost until the seral forest re-established after several decades. Westech (2005d) documented 410 different plant species in the analysis area. After reclamation of mine disturbances, a forest can take many years to re-establish a community with a diversity of plants similar to but less than the original plant community. Competitive introduced species may limit the ability of native grasses and especially forbs to re-establish after the disturbance. A loss of timber production on 1,575 acres of National Forest System lands suitable for timber production and 294 acres of private lands would occur throughout mining (Table 179). The loss would exist until timber regenerated and reached merchantable size. The tailings impoundment areas, which would disturb about 600 acres in each mine alternative, would be managed for mineral development following operations, and would no longer be managed for timber production. The area covered by asphalt and gravel by widening the Bear Creek Road would not be returned to pre-mine timber production.

Table 179. Lands Suitable for Timber Production within Mine Alternative Disturbance Areas.

Type	Alternative 2 MMC's Proposed Mine	Alternative 3 Agency Mitigated Poorman Impoundment Alternative	Alternative 4 Agency Mitigated Little Cherry Creek Impoundment Alternative
National Forest System Lands Suitable for Timber Harvest			
Tailings Impoundment (footprint)	349	421	345
Tailings Impoundment (other)	865	572	741
Bear Creek Road (US 2 to impoundment)	46	52	46
Other Disturbances	315	101	118
Private Lands			
Tailings Impoundment (footprint)	88	0	88
Tailings Impoundment (other)	182	0	172
Other Disturbances	24	24	24
Total	1,869	1,170	1,534

All units are acres, rounded to the nearest acre.
Source: GIS analysis by ERO Resources Corp. using KNF 2015 KFP timber suitability data (National Forest System lands) and vegetation mapping in Westech 2005d (private lands).

The LAD Areas would experience a change in species composition during water application and may change again after Closure when water application was discontinued. The LAD Areas may become dominated by species that favor seasonally saturated conditions, especially introduced species.

Interim reclamation would be used to revegetate disturbances from activities such as road cut-and-fill slopes and other temporary disturbances. In these locations, vegetation cover would return more quickly than those disturbed by mine operations. Some of the species in the interim mixture are introduced annual species. Upon completion of mining, disturbed areas would be reclaimed and revegetated. MMC's reclamation goal is to establish a post-mining environment comparable with existing conditions. The reclamation plan includes areas designated for reforestation, shrubs, or grasslands.

The permanent seed mix for Alternative 2 would be dominated by native species but quick establishing, more aggressive, non-native annual species are included in the seed mix. Over the long-term, reclaimed areas would likely have fewer native species than existing communities. MMC's monitoring plan, 3 consecutive years of revegetation success would be achieved before bond release would be requested. Loss of native species and some increase in introduced species is an unavoidable impact of allowing the mine disturbance.

3.22.1.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Alternative 3 would disturb up to 1,565 acres of vegetation (Table 178). The largest effect would be to the previously harvested coniferous forest vegetation communities (683 acres) and mature coniferous forest vegetation communities (865 acres). The impact on riparian and wetland areas would be about 17 acres and effects on other vegetation communities would be a small percentage of the disturbance. Effects on vegetation communities would be about 1,017 acres less than Alternative 2 because of a smaller Poorman Impoundment disturbance area. A loss of timber production on 1,146 acres of National Forest System lands suitable for timber production and 24 acres of private lands would occur throughout mining (Table 179). The loss of biodiversity, increase in introduced species, change in species composition, and loss of timber production on disturbed lands until forest regeneration would be similar to Alternative 2. Changes to MMC's reclamation plan, such as longer revegetation monitoring, elimination of non-native species and modification of soil salvage, handling, and replacement would facilitate revegetation of disturbed areas, minimize introduced species, and ensure long-term reclamation success. Indirect effects on riparian vegetation would be the same as Alternative 2.

3.22.1.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would disturb up to 1,924 acres of vegetation, including 1,143 acres of coniferous forests and 740 acres of previously harvested coniferous forest (Table 178). The impact on riparian and wetland areas would be about 41 acres. Effects on vegetation communities would be about 696 acres less than Alternative 2 because LAD Areas would not be used to treat excess water and the disturbance surrounding the Little Cherry Creek Impoundment would be less. A loss of timber production on 1,250 acres of National Forest System lands suitable for timber production and 284 acres of private lands would occur throughout mining (Table 179). Effects, including loss of biodiversity, an increase in introduced species, and a change in species composition, would be similar to Alternative 2. Indirect effects on riparian vegetation would be the same as Alternative 2.

3.22.1.4.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001 would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.22.1.4.6 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

Alternative B would have the least effect on vegetation communities compared to the other transmission line alternatives because of a narrower clearing width (150 feet compared to 200 feet). The mature coniferous forest vegetation communities would be most affected by Alternative B. About 136 acres of mature coniferous forests, 133 acres of previously harvested coniferous forest, and 28 acres of wetland and riparian areas could be cleared (Table 180). Actual clearing would likely be less than that shown in Table 180 depending on tree height, slope, and line distance above the ground. Construction of new access roads for transmission line installation and maintenance are estimated to affect about 10 acres of mature coniferous forest, 5 acres of previously harvested coniferous forest, and less than 1 acre of wetland and riparian areas. A loss of timber production on 93 acres of National Forest System lands suitable for timber production and 130 acres of private lands would occur throughout the project until the transmission line was decommissioned and timber reached merchantable size (Table 181).

Table 180. Vegetation Communities along Transmission Line Alternatives.

Type†	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
Transmission Line Clearing Area				
Coniferous Forest	136	166	182	93
Previously Harvested Coniferous Forest	133	136	131	235
Wetland/Riparian	28	15	18	35
Subtotal	297	317	331	363
Areas Disturbed by New or Upgraded Roads				
Coniferous Forest	10	2	3	2
Previously Harvested Coniferous Forest	5	1	1	2
Wetland/Riparian	1	<1	<1	0
Subtotal	16	3	4	4
Sedlak Park Substation and Loop Line				
Coniferous Forest	<1	<1	<1	<1
Previously Harvested Coniferous Forest	4	4	4	4
Subtotal	4	4	4	4
Total	317	323	338	365

All units are acres, rounded to the nearest acre.
†Acreage is based on a 150-foot clearing width for monopoles (Alternative B) and 200-foot width for H-frame structures (other alternatives except for a short segment of the West Fisher Creek Alternative that has monopoles). Actual acreage cleared would be less than listed and would depend on tree height, slope, and line clearance above the ground.
Source: GIS analysis by ERO Resources Corp. using KNF data, and vegetation mapping in Westech 2005d and MMI 2005b.

In 2003, Plum Creek sold a conservation easement (Thompson-Fisher Conservation Easement) to the FWP on 142,000 acres in northwest Montana, some of it within the analysis area (Figure 78). The conservation easement was partially funded by the Forest Legacy Program for the purpose of preventing the land from being converted to non-forest uses. One of the stated purposes of the conservation easement is to “preserve and protect in perpetuity the right to practice commercial forest and resource management.” Vegetation communities within the area covered by conservation are shown in Table 181. MMC did not propose to mitigation for the loss of timber production on lands covered by the conservation easement.

All disturbed areas would be interim seeded with native and introduced annual grass and native shrub species when construction of the transmission line and loop line was completed. Areas where trees would be trimmed, but otherwise not disturbed, would be allowed to establish naturally as grassland or shrubland. In accordance with BPA’s health and safety policy, vegetation would be prevented from growing in the Sedlak Park Substation or within 5 feet of the substation fence. Within and outside the 100-foot right of way and within the 300-foot clearing width of the substation loop line, trees that pose a risk of falling on the transmission line would be cleared over the life of the line. Roads opened or constructed for transmission line access would be closed after transmission line construction was completed. The road surface would be reseeded as an interim reclamation measure designed to stabilize the surface. Where soil was salvaged from new roads, the road surface would be covered with soil and then reseeded. The new road prism would remain during transmission line operations. Introduced species would increase during mine life from the disturbance as well as from introduced species in the interim seed mix.

The BPA would clear all trees from its proposed 4-acre Sedlak Park Substation, including the access road between US 2 and the substation. It also would clear the woody vegetation within the 300-foot-wide right-of-way for the loop line that would connect the substation to the Noxon-Libby transmission line, in order to construct, operate, and maintain the substation and loop line. When the transmission line was decommissioned, the BPA would dismantle the substation, remove the loop line, and revegetate the area assuming it had no need for the facilities.

During the final Closure Phase following mining, the transmission line would be removed, roads recontoured to match existing topography, trees along the line allowed to grow, and all disturbed areas revegetated. Grassland and shrub communities would be the quickest to establish; the coniferous forest community and riparian forest would take many years to establish because many species are relatively slow growing.

3.22.1.4.7 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

The use of a 200-foot clearing width for wooden H-frame structures for Alternative C-R would result in greater vegetation disturbance than Alternative B. About 166 acres of coniferous forest, 136 acres of previously harvested coniferous forest, and 15 acres of wetland/riparian areas would be cleared and would remain cleared over the life of the transmission line (Table 180). In Alternatives C-R, D-R, and E-R, a Vegetation Clearing Plan would be developed to minimize vegetation clearing in sensitive areas, such as RHCAs. Use of a helicopter to clear timber and construct structures in areas near core grizzly bear habitat would minimize effects on vegetation communities in these areas. Road construction would affect about 2 acres of mature coniferous forest, about 1 acre of previously harvested coniferous forest, and less than 1 acre of wetlands, and riparian areas. Timber production would be eliminated on 141 acres of National Forest System lands suitable for timber production and on 105 acres of private lands until the transmission line was decommissioned and timber reached merchantable size (Table 181). MMC would convey a conservation easement to the FWP on up to 86 acres (Table 181) of private land adjacent to the Thompson/Fisher conservation easement that have similar conservation values. Acquired lands or easements would be added to the existing conservation easement

Table 181. Vegetation Communities along Transmission Line Alternatives Covered by Thompson-Fisher Conservation Easement.

Type	Alternative B – North Miller Creek		Alternative C-R – Modified North Miller Creek		Alternative D-R – Miller Creek		Alternative E-R – West Fisher Creek	
	Total	Covered by Thompson-Fisher Conservation Easement	Total	Covered by Thompson-Fisher Conservation Easement	Total	Covered by Thompson-Fisher Conservation Easement	Total	Covered by Thompson-Fisher Conservation Easement
National Forest System Lands Suitable for Timber Harvest	93	0	141	0	170	0	164	0
Private Lands	130	97	105	86	105	86	138	89
Total	223	97	246	86	275	86	302	89

All units are acres, rounded to the nearest acre.
†Acreage is based on a 150-foot clearing width for monopoles (Alternative B) and 200-foot width for H-frame structures (other alternatives except for a short segment of the West Fisher Creek Alternative that has monopoles). Actual acreage cleared would be less than listed and would depend on tree height, slope, and line clearance above the ground.
Source: GIS analysis by ERO Resources Corp. using KNF 2015 KFP timber suitability data and FWP data (National Forest System lands), and vegetation mapping in Westech 2005d and MMI 2005b (private lands).

New roads on National Forest System lands would be placed into intermittent stored service by using a variety of treatment methods after transmission line construction was completed. Trees would be planted in all areas where trees were removed for the construction of the transmission line including access roads and other disturbances such as line stringing and tensioning sites, slash burn piles, and construction pads. Trees would be planted at a density such that at the end of 5 years the approximate stand density of the adjacent forest would be attained at maturity. This standard would not apply to roads placed in intermittent stored service, but would apply when the roads would be decommissioned after the transmission line was restored. Planting trees in disturbances would require less time for trees to become established, would better match surrounding landscape features, and would meet wildlife and density recommendations provided by the agencies.

Effects, including loss of biodiversity, an increase in introduced species, a change in species composition, and timber production on disturbed lands, would be similar to but less than mine Alternatives 2, 3, and 4, and similar to transmission line Alternatives B and D-R, and E-R.

3.22.1.4.8 Alternative D-R – Miller Creek Transmission Line Alternative

Alternative D-R, with a clearing width of 200 feet would affect up to about 182 acres of mature coniferous forest and 131 acres of previously harvested coniferous forest, and about 18 acres of wetland/riparian areas (Table 180). Road construction would affect about 3 acres of mature coniferous forest, about 1 acre of previously harvested coniferous forest, and less than 1 acre of wetlands and riparian areas. Timber production would be eliminated on 170 acres of National Forest System lands suitable for timber production and on 105 acres of private lands until the transmission line was decommissioned and timber reached merchantable size (Table 181). MMC would convey a conservation easement to the FWP on up to 86 acres (Table 181) of private land adjacent to the Thompson/Fisher conservation easement that have similar conservation values that would be added to the existing conservation easement. Reclamation and transmission line decommissioning at the end of mining operations would be the same as Alternative C-R.

Effects, including loss of biodiversity, an increase in introduced species, a change in species composition, and timber production on disturbed lands, would be similar to but less than mine Alternatives 2, 3, and 4, and similar to transmission line Alternatives B, C-R, and E-R.

3.22.1.4.9 Alternative E-R – West Fisher Creek Transmission Line Alternative

Alternative E-R would include tree clearing widths of 150 to 200 feet, depending on location. Clearing could affect about 93 acres of mature coniferous forest and 35 acres of wetland/riparian vegetation over the life of the transmission line. This alternative would make the best use of previously harvested coniferous forest (235 acres) to reduce the amount of new tree clearing. Road construction would disturb about 2 acres of coniferous forest and 2 acres of previously harvested coniferous forest. Timber production would be eliminated on 164 acres of National Forest System lands suitable for timber production and on 138 acres of private lands until the transmission line was decommissioned and timber reached merchantable size (Table 181). MMC would convey a conservation easement to the FWP on up to 89 acres (Table 181) of private land adjacent to the Thompson/Fisher conservation easement that have similar conservation values that would be added to the existing conservation easement. Reclamation at the end mining operations would be similar to Alternatives B, C-R, and D-R.

Effects, including loss of biodiversity, increase in introduced species, a change in species composition, and timber production on disturbed lands, would be similar to but less than mine Alternatives 2, 3, and 4, and similar to transmission line Alternatives B, C-R, and D-R.

3.22.1.4.10 Effectiveness of Agencies' Proposed Mitigation

Changes to MMC's reclamation plan, such as longer revegetation monitoring, elimination of non-native species and modification of soil salvage, handling, and replacement would be effective in facilitating revegetation of disturbed areas, minimizing introduced species, and ensuring long-term reclamation success. Revegetation success and recovery time of affected vegetation communities would depend on reclamation stage (interim or post-closure), vegetation community type, proper implementation, and environmental factors such as climate and soil conditions. Implementation of the agencies' Weed Control Plan would reduce impacts on native vegetation caused by increased weed infestation due to disturbance caused by the Proposed Action and its alternatives. The reclamation monitoring plan in Appendix C describes measures that would be implemented to assess the effectiveness of reclamation and actions that would be taken if reclamation success criteria were not met. MMC's bond would not be released unless the specified reclamation objectives were met.

Implementation of the Vegetation Removal and Disposition Plan would be effective in reducing impacts on vegetation from transmission line construction by minimizing clearing of trees and destruction of ground cover through the use of monopoles, where appropriate, and other measures.

3.22.1.4.11 Cumulative Effects

Past actions, particularly timber harvest, road construction, wildfires, and fire suppression activities, have altered the vegetation communities in the analysis area. Vegetation cover and diversity in disturbed areas have decreased. Disturbances have increased the distribution of noxious weeds and other introduced species. In the areas surrounding the proposed Montanore Project, several projects would contribute to the cumulative effect on vegetation communities such as the Libby Creek Ventures Drilling Plan and the Miller-West Fisher Vegetation Management Project. These projects would result in various degrees of vegetation clearing, disturbance, and subsequent revegetation. The primary effects would include an incremental change in species composition and seral stage from converting mature forests to an early successional stage or to grasslands and shrubland. These changes would cumulatively affect species biodiversity and productivity in the analysis area.

3.22.1.4.12 Regulatory/Forest Plan Consistency

Organic Administration Act and Forest Service Locatable Minerals Regulations

36 CFR 228.8 requires that mining operators minimize, where feasible, adverse environmental impacts on National Forest surface resources. Mine Alternative 2 and Transmission Line Alternative B would not fully comply with 36 CFR 228.8 to minimize adverse environmental impacts. MMC did not propose to implement feasible measures to minimize the disturbance area, maximize reclamation success, or minimize vegetation clearing. The agencies' alternatives (Mine Alternatives 3 and 4 and Transmission Line Alternatives C-R, D-R, and E-R) would incorporate additional feasible and practicable measures to minimize adverse environmental impacts. These measures include minimizing the disturbance area of Alternatives 3 and 4; developing and implementing a final Road Management Plan and a Vegetation Removal and Disposition Plan; increasing the salvage and replacement of suitable soil materials for reclamation; using primarily

native species in revegetation; and salvaging disturbed wetland soils for use in constructing new wetlands.

As a minerals development project, 2015 KFP vegetation management standards and guidelines do not apply. Where the land was being cleared for mine facility development, there would be no site-specific movement toward forestwide vegetation goals and desired conditions. The transmission line activities would change species size class (creating seedling/sap and early seral size classes) and patterns. Considering the footprint of the project in comparison to forestwide vegetation management practices and natural disturbance processes, all action alternatives would generally be neutral in regard to progress toward forestwide 2015 KFP vegetation desired conditions

Over the long-term, reclaimed plant communities would eventually be re-established. Planting would follow silvicultural prescriptions designed to address forestwide desired conditions for species composition. Although initial vegetation diversity would be less than the original plant communities, use of local native seed mixes and other agency mitigation would aid in facility reclamation consistent with 2015 KFP goals and desired conditions. Long-term, plant communities in the analysis area would trend toward the forestwide desired conditions for composition, structure, patterns, and processes.

3.22.1.4.13 Irreversible and Irretrievable Commitments

All of the mine alternative and transmission line alternatives would disturb native species-dominated vegetation communities, most of which would be subsequently mitigated by revegetation. Revegetated areas would eventually return to pre-disturbance productivity, but vegetation diversity would be lower than existing conditions. Decreased production of timber during mine and transmission line operations and for several decades after reclamation would be an irretrievable commitment of resources. The tailings impoundment areas, which would disturb 400 to 500 acres in each mine alternative would no longer be suitable for timber production. The area covered by asphalt and gravel by widening the Bear Creek Road would not be returned to pre-mine uses. These effects would be an irretrievable commitment of resources. The loss of native plant species and increase in introduced species in all mine and transmission line alternatives would be an irreversible resource commitment.

3.22.1.4.14 Short-term Uses and Long-term Productivity

Mining operations and transmission line construction, operations, and decommissioning for all action alternatives would result in long-term impacts on vegetation communities and productivity. Productivity for forested areas would remain low following reclamation until new timber stands are established. A long-term loss of vegetation diversity from loss of native species would occur for each of the mine alternatives. Introduced species cover and production would increase on the disturbed areas.

3.22.1.4.15 Unavoidable Adverse Environmental Effects

An unavoidable loss of native species and species composition would occur during mining operations. Reclamation of disturbed areas following mining would revegetate most areas to pre-mining forested vegetation production over the long term; vegetation communities would be altered and not all native species would re-establish. Introduced species would increase. This loss of some native species and increase in introduced species would be unavoidable impacts of development.

3.22.2 Old Growth Ecosystems

This section describes vegetative characteristics of old growth forests and features particularly important to wildlife. The KNF has adopted the definitions of old growth developed by the Regional Old Growth Task Force and documented in Green *et al*. 1992. Reference to Green *et al*. (1992) in this EIS is to the most recent version that was corrected via an errata in December 2011. Old growth is recognized for its unique ecological characteristics that serve as important habitat for both wildlife and some species of rare plants on the KNF. Although there are many wildlife species on the KNF that use habitat in old growth forest for breeding and/or feeding, there are no old growth obligate wildlife species that are solely dependent on this habitat on the KNF (Castaneda 2004), although there are species that use old growth if available.

3.22.2.1 Regulatory Framework

As described in section 3.22.1.1, vegetation management standards and guidelines, including those applying to old growth, are not applicable to the Montanore Project. Applicable 2015 KFP old growth direction is:

FW-DC-VEG-03. The 2015 KFP old growth desired condition is that "the amount of old growth increases at the forestwide scale. At the finer scale of the biophysical setting, old growth amounts increase for the Warm/Dry and Warm/Moist settings while staying close to the current level for the Subalpine setting. Relative to other tree species, there is a greater increase in old growth stands that contain substantial amounts (*i.e.*, 30% or more of the total species composition) of one or more of the following tree species: ponderosa pine, western larch, western white pine, and whitebark pine. Old growth stands are more resistant and resilient to disturbances and stressors such as wildfires, droughts, insects and disease, and potential climate change effects. The size of old growth stands (or patches of multiple contiguous old growth stands) increase and they are well- distributed across the five Geographic Areas on the Forest.

FW-GDL-VEG-02. Road construction (permanent or temporary) or other developments should generally be avoided in old growth stands unless access is needed to implement vegetation management activities for the purpose of increasing the resistance and resilience of the stands to disturbances.

The MFSA directs DEQ to approve a facility if, in conjunction with other findings, DEQ finds and determines that the facility would minimize adverse environmental impact, considering the state of available technology and the nature and economics of the various alternatives. The MMRA does not specifically address effects on old growth. The MMRA requires that lands affected by mining meet the post-mine land uses. DEQ evaluates in its environmental documents whether the revegetation plans for mine facilities would adequately meet the post-mine land uses.

3.22.2.2 Analysis Area and Methods

3.22.2.2.1 Analysis Area

The analysis area for evaluating direct, indirect, and cumulative impacts on old growth in the KNF includes the Crazy and Silverfish PSUs, which are planning areas generally based on watersheds that encompass project facilities for all alternatives (Figure 86). The analysis area for evaluating direct and indirect impacts of the transmission line on old growth on private and State land consists of all lands that would be disturbed by any of the alternative transmission line alignments, substation or loop line (Figure 86).

3.22.2.2.2 Baseline Data Collection

Management and characteristics of old growth are discussed and summarized in the following documents that are incorporated by reference: Green *et al.* (1992), Pfister *et al.* (2000), Kootenai Supplement No. 85 to FSM 2432.22 (USDA Forest Service 1991), and Castaneda (2004). The 2015 KFP provides a description of old growth by habitat group (warm-dry, cool-moist, warm-moist). Pfister *et al.* (2000) conducted a peer review of documents that provide old-growth descriptions and attributes, and concluded that Green *et al.* (1992) provides the best available source for identifying old growth. As a result, the KNF currently applies Green *et al.* (1992) as the definition of effective old growth. Old growth stands are defined as those that meet the definitions in Green *et al*. 1992. Recruitment potential old growth includes forest stands that do not meet the definition of old growth in Green *et al.* 1992 but are being managed with the goal of meeting that definition in the future under the 2015 KFP.

Old growth stands on National Forest System lands were identified based on data from Ranger District files and surveys and the KNF old growth GIS layer. As specified in the KNF Supplement No. 85 to FSM 2432.22, old growth stands were field-verified for the Crazy and Silverfish PSUs. Changes in old growth mapping resulting from recent field verification were incorporated into effects analysis for this Final EIS. Field verification of old growth stands was completed using both walk-through and common stand exam methods, as described in the Vegetation Update Report (Westech 2005d).

Old growth mapping for private and State lands along the transmission line was based on photo-interpretation of 2006 aerial imagery and field verification conducted by a Forest Service biologist in 2008. Private land in the Little Cherry Creek impoundment disturbance area has been mostly harvested and was not surveyed for old growth. Impacts on old growth on private lands were evaluated based on the extent of mapped old growth affected.

3.22.2.2.3 Impact Analysis

Impacts of the mine alternatives on old growth were based on the area that would be disturbed by the mine features and associated roads. Transmission line impacts were based on the clearing width and new and improved roads associated with each alternative. Actual acreage cleared would be less and would depend on tree height, slope, and line clearance above the ground. Impacts of the alternatives on old growth on National Forest System lands were evaluated according to the following criteria:

- Acres of cleared effective and recruitment potential old growth
- Acres affected by edge in effective and recruitment old growth
- Acres of interior habitat remaining in effective and recruitment old growth
- Road length built adjacent to or through effective and recruitment old growth

Research has indicated that certain activities, in particular regeneration harvest, within or adjacent to old growth stands may influence vegetative characteristics and wildlife use of those stands (Harris 1984; Ripple *et al.* 1991; Morrison *et al.* 1992; Province of British Columbia 1995; Russell *et al.* 2000; Russell and Jones 2001). Although the width of old growth shown to be influenced by edge varies depending on the study (Chen *et al.* 1995), research supports a three-tree height rule of thumb as the distance to which effects occur (Harris 1984; Ripple *et al.* 1991; Morrison *et al.* 1992; Province of British Columbia 1995; Russell *et al.* 2000). On the KNF, the average old growth tree height is 100 feet, based on data from the KNF Timber Stand

Management Record System (TSMRS) database. Existing edge effects were estimated by applying a 300-foot buffer to harvested forest habitat (activity codes 4111-4117, 4131, 4132, 4175-4177, 4193, and 4194 or old TSMRS activity codes 4100-4134) less than 30 years old and bordering old growth stands. Effects of alternatives were estimated by applying the same buffer to any resulting old growth edge. Old growth areas 50 acres in size and greater not affected by edge effects provide interior habitat.

3.22.2.3 Affected Environment

According to Green *et al.* (1992) old growth "…encompasses the later stages of stand development that typically differ from earlier stages in characteristics such as tree age, tree size, number of large trees per acre, and basal area. In addition, attributes such as decadence, dead trees, the number of canopy layers, and canopy gaps are important but more difficult to describe because of high variability." Old growth definition criteria are specific to forest type (the dominant tree species) and habitat type group.

3.22.2.3.1 Existing Old Growth Inventory

Existing conditions of old growth forest in the KNF portion of the analysis area are a result of past disturbance processes, primarily historical timber harvest and wildfires (USDA Forest Service 2003b). Old growth stands occupying mesic sites in the analysis area are dominated by western hemlock and western redcedar. Common subdominant conifers at these sites include grand fir, Engelmann spruce, Douglas-fir, and western larch. While western white pine is present at these sites, the majority occur as dead snags, having succumbed to whitepine blister rust disease. Lower elevation old growth stands are mainly composed of Douglas-fir, ponderosa pine, western larch, grand fir, or lodgepole pine. Mid to upper elevation old growth sites support subalpine fir, western hemlock, western redcedar, grand fir, and Engelmann spruce (Westech 2005d). Mapped old growth stands in the Crazy and Silverfish PSUs are shown on Figure 86. The characteristics of KNF's mapped inventory of effective old growth and recruitment potential old growth on National Forest System lands in the Crazy and Silverfish PSUs is shown in Table 182.

Attributes of Old Growth within the Landscape

As elements of dynamic landscapes, other attributes of old growth stands such as the size of old growth blocks, their juxtaposition and connectivity with other old growth stands, their topographic position, their shapes, their edge, and their stand structure compared to neighboring stands are important to evaluate. To maintain healthy and diverse ecosystems, the full range of natural variation should be represented and landscape mosaics should be managed as a whole (Green *et al.* 1992). Management activities, such as timber harvest, road construction, or mining, have the potential to impact the function of old growth or specific components of old growth, such as quantity of interior habitat, habitat patch sizes, and vertical structure.

Larger blocks (more than 50 acres) of old growth forest provide interior habitat and connectivity within National Forest System lands. Stands smaller than 50 acres also provide attributes unique to old growth (Morrison *et al.* 1992). Smaller patches of older, forested vegetation may be important stepping stones for dispersal of wildlife species, especially in heavily fragmented landscapes. Although these patches may not meet criteria for interior conditions, their removal could prevent dispersal of some species across a larger landscape (Morrison *et al.* 1992). In the KNF, small patches of old growth are largely surrounded by multi-aged stands, which also provide corridor links to larger blocks of old growth.

Table 182. Old Growth Inventory and Characteristics on National Forest System Lands in the Crazy and Silverfish PSUs.

Old Growth Type	Crazy PSU (Acres)	Silverfish PSU (Acres)
Effective		
Existing Inventory	8,350	5,298
Existing Edge Influence	1,170	336
Existing Interior Habitat	7,312	5,413
Recruitment		
Existing Inventory	465	1,491
Existing Edge Influence	98	179
Existing Interior Habitat	373	1,300

Source: KNF 2012.

Stand Structure

Green *et al.* (1992) identifies three structural stages useful in describing old growth: late seral single-story (*e.g.*, ponderosa pine, Douglas-fir, or lodgepole pine sites); late seral multi-story (*e.g.*, larch or western white pine sites); and near-climax (*e.g.*, cedar, grand fir, or subalpine fir sites). Old growth stands in the Crazy and Silverfish PSUs can be characterized as predominately multi-story or near-climax (Westech 2005d).

Disturbance

Many roads and trails in the Crazy and Silverfish PSUs either bisect or are adjacent to old growth stands. Roads facilitate pedestrian and motorized access to old growth forest habitats, resulting in increased disturbance to vegetation and wildlife. Roads also increase access for firewood cutters who may remove standing snags and down logs that are important components of old growth forests. Within existing designated old growth in the Crazy and Silverfish PSUs, 41 miles of local roads comprise 13 miles of seasonally restricted roads, 6 miles of roads closed year-round, and 22 miles of roads open year-round. Timber harvesting can affect adjacent old growth stands by altering six microclimatic factors: solar radiation, soil temperature, soil moisture, air temperature, relative humidity, and wind speed (Chen *et al.* 1995). Microclimatic changes lead to vegetation changes such as species richness, diversity, composition, and structure (Russell and Jones 2001). Changes in vegetative conditions may, in turn, affect wildlife, resulting in changes in associated wildlife communities and influencing other factors such as predation and competition (Askins 2000). Effects of timber harvesting extend varying distances into the uncut stands depending on a number of variables, such as aspect, slope, elevation, wind speed, and direction. The depth of influence is also related to time since harvest, with effects dissipating within 20 to 50 years, depending on the factor (Russell and Jones 2001; Ripple *et al.* 1991; Russell *et al.* 2000). In the Crazy and Silverfish PSUs, average tree growth in stands where regeneration has occurred result in tree heights (20 to 50 feet) and densities (fully stocked stands) that reduce the depth of influence from edge effects after 30 years. Table 182 shows the amount of old growth currently influenced by edge effects, including the number of existing harvested stands (stands less than 30 years old) adjacent to old growth stands. These stands create an edge influence on about 1,268 acres of old growth in the Crazy PSU and about 515 acres of old growth in the Silverfish PSU. While edge areas may result in changes in vegetation and wildlife use, the edge areas remain functional as old growth for some species. Old growth areas not impacted by edge effects provide interior habitat.

3.22.2.3.2 Existing Old Growth on Private and State Lands

Old growth on private and State lands within the analysis area consists primarily of riparian old growth and occurs mainly in the Fisher River, West Fisher Creek, and Hunter Creek riparian corridors (Figure 86). No old growth stands were identified at the Sedlak Park Substation Site. The majority of private or state-owned land within the analysis area has been harvested in the past 20 to 30 years (Figure 85) and is heavily roaded. Although most previously harvested areas have well-established conifer regeneration, as described in section 3.22.1, *Vegetation Communities*, these areas do not provide effective old growth. Coniferous forest on private lands is primarily dominated by dry, ponderosa pine/Douglas-fir communities that do not have old growth characteristics.

3.22.2.4 Environmental Consequences

The following section discusses the direct, indirect, and cumulative effects on old growth for each of the mine alternatives, transmission line alternatives, and combined mine-transmission line alternatives. The mine alternatives would have no effect on old growth in the Silverfish PSU. Impacts on old growth in the Crazy PSU from the mine alternatives are summarized in Table 183. Impacts on old growth in the Crazy and Silverfish PSUs and on State and private land from the transmission line alternatives are summarized in Table 184.

Table 183. Summary of Impacts on Old Growth from the Mine Alternatives in the Crazy PSU.

Measurement Criteria	No Mine	MMC's Proposed Mine	Agency Mitigated Poorman Impound-ment Alternative	Agency Mitigated Little Cherry Creek Impound-ment Area
Effective Old Growth				
Cleared old growth (acres)	0	360	245	216
Change in edge influence (acres)	0	+236	+241	+220
Change in interior habitat (acres)	0	-596	-486	-437
New road length adjacent or through old growth (feet)	0	973	1,241	1,743
Recruitment Old Growth				
Cleared old growth (acres)	0	54	11	61
Change in edge influence (acres)	0	-15	+35	-7
Change in interior habitat (acres)	0	-39	-46	-54
New road length adjacent or through old growth (feet)	0	0	0	0
Effective or Recruitment Old Growth				
Areas of vegetation removed adjacent to old growth (#)	0	5	4	4

Source: Clearing and road GIS analysis by ERO Resources Corp. using KNF data GIS analysis by KNF.

3.22.2.4.1 Alternative 1–- No Mine

Alternative 1 would have no direct effect on designated old growth. The conditions for all measurement criteria would remain unchanged (Table 183). All old growth areas would maintain their existing conditions and continue to provide habitat for those species that use the area over a long term. The most recent forest-wide old growth analysis concluded that 201,577 acres of National Forest lands below 5,500 feet in elevation were effective old growth and an additional 97,717 acres were recruitment old growth (USDA Forest Service 2014a). In the Crazy PSU, 8,350 acres of effective old growth and 465 acres of recruitment old growth would remain. In the Silverfish PSU, 5,298 acres of effective old growth and 1,491 acres of recruitment old growth would remain (Table 182). This alternative would not affect the current proportion of old growth (Table 183) at either the PSU or forestwide scale.

3.22.2.4.2 Alternative 2 – MMC's Proposed Mine

Alternative 2 would have the greatest effect on effective old growth of the mine alternatives, affecting 360 acres of effective old growth in the Crazy PSU (Table 183). Old growth in the Silverfish PSU and in private or State land outside the Silverfish PSU would not be affected. Alternative 2 would increase edge effects on 236 acres of effective old growth and reduce interior old growth by 596 acres. The majority of impacts on effective old growth would occur in the LAD Area 2 at the mouth of Ramsey and Poorman creeks and at the Little Cherry Creek Impoundment Site. Trees would be selectively thinned in 200 acres of the LAD Areas where spray irrigation would occur. Although these irrigated areas would likely continue to provide suitable habitat for some old growth-associated species, old growth connectivity would be reduced between the Ramsey Creek and Poorman Creek drainages for other species. Construction of the Little Cherry Creek Impoundment would eliminate 133 acres of a 193-acre old growth block. Reducing the size of old growth blocks would decrease the availability of interior habitat for those species that use it. At the PSU scale, Alternative 2 would result in a 0.7 percent loss of effective old growth in the Crazy PSU. Alternative 2 would affect 54 acres of recruitment old growth, decrease edge influence by 15 acres, and reduce recruitment interior habitat by 39 acres in the Crazy PSU (Table 183).

Alternative 2 would include the construction of an estimated 973 feet of new road through effective old growth on National Forest System lands. As a result, 2 acres of old growth would be lost. These impacts are included in the impacts on old growth shown in Table 183. The new road to the Ramsey Plant Site connecting NFS roads #278 and #4781 would cross old growth along Poorman Creek. Because new roads would not be open to the public and would be reclaimed at mine closure, they would not likely reduce snag levels from firewood gathering.

3.22.2.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Alternative 3 would affect 245 acres of effective old growth in the Crazy PSU. Old growth in the Silverfish PSU and in private or State land outside the Silverfish PSU would not be affected. Relative to other alternatives, Alternative 3 would result in the most edge effects (241 acres) to effective old growth. Alternative 3 would reduce 486 acres of interior old growth (Table 183). The majority of impacts on old growth would occur as a result of impoundment construction, reducing old growth connectivity in the Poorman Creek drainage. Reducing the size of old growth blocks would decrease the availability of interior habitat for those species that use it. At the PSU scale, Alternative 3 would result in a 0.7 percent loss of effective old growth in the Crazy PSU. Alternative 3 would affect 11 acres of recruitment old growth, increase edge influence by 35 acres, and reduce recruitment interior habitat by 46 acres in the Crazy PSU (Table 183).

Alternative 3 would include the construction of an estimated 1,231 feet of new road parallel to an existing road (NFS road #278) through effective old growth across Poorman Creek on National

Forest System lands. As a result, about 3 acres of old growth would be lost. These impacts are included in the impacts on old growth shown in Table 183. The construction of a new road across Poorman Creek parallel to an existing road would be unavoidable. Other impacts of new roads constructed for Alternative 3 would be the same as Alternative 2. Losses and degradation of old growth may be offset by private land acquisition associated with grizzly bear habitat mitigation, if old growth characteristics were present on the acquired parcels.

3.22.2.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would have the least effect on old growth of the mine alternatives, affecting 216 acres of effective old growth in the Crazy PSU. Old growth in the Silverfish PSU and in private or State land outside the Silverfish PSU would not be affected. Alternative 4 would increase edge effects on about 220 acres of effective old growth. Relative to the other mine alternatives, the least amount of interior old growth (437 acres) would be lost as a result of Alternative 4. Alternative 4 would include the construction of about 1,231 feet of new road parallel to an existing road (NFS road #278) through effective old growth across Little Cherry Creek and Poorman Creek on National Forest System lands. As a result, about 3 acres of old growth would be lost. These impacts are included in the impacts on old growth shown in Table 183. The construction of a new road across Little Cherry Creek and Poorman Creek parallel to an existing road would be unavoidable. Losses and degradation of old growth may be offset by private land acquisition associated with grizzly bear habitat mitigation, if old growth characteristics were present on the acquired parcels. At the PSU scale, Alternative 4 would result in a 0.5 percent loss of effective old growth in the Crazy PSU. Alternative 4 would affect 61 acres of recruitment old growth, decrease edge influence by 7 acres, and reduce recruitment interior habitat by 54 acres in the Crazy PSU (Table 183).

3.22.2.4.5 Alternative A – No Transmission Line

Alternative A would have no direct effect on old growth or associated plant and wildlife species The conditions for all measurement criteria (Table 184) would remain unchanged. All old growth areas would maintain their existing conditions, and continue to provide habitat for those species that use the area over a long term. The most recent forest-wide old growth analysis concludes that 10.8 percent of the KNF is effective old growth. This alternative would not affect the current proportion of old growth (Table 184) at either the PSU or KNF scale.

3.22.2.4.6 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

Alternative B would have the greatest impact on old growth of the transmission line alternatives, affecting 27 acres of effective old growth in the Crazy PSU and no acres in the Silverfish PSU (Table 184). Alternative B would increase edge effects on 98 acres of effective old growth and reduce interior old growth in the Crazy PSU by 125 acres and by 3 acres in the Silverfish PSU. The majority of impacts on old growth would occur in the Ramsey Creek corridor and at the confluence of Libby and Howard creeks, reducing old growth connectivity in these drainages. Reducing the size of old growth blocks would decrease the availability of interior habitat for those species that use it. At the PSU scale, the loss of old growth would have negligible effects on the proportion of old growth in either PSU. Alternative B would not affect recruitment interior habitat in the Crazy PSU (Table 184). In the Silverfish PSU, Alternative B would affect 7 acres of recruitment old growth, increase edge influence by 20 acres, and reduce recruitment interior habitat by 25 acres (Table 184). Alternative B would remove about 4 acres of old growth on private land along the Fisher River and a short portion of Miller Creek. The substation and loop line would not affect old growth. Loss of old growth and edge effect may be offset by private land acquisition associated with grizzly bear habitat mitigation, if old growth characteristics were present on the acquired parcels.

Alternative B would include the construction of an estimated 4,081 feet of new roads through effective old growth and an estimated, 2,052 feet of new road of recruitment old growth. New road construction would affect 4 acres of old growth on National Forest System lands. These impacts are included in the impacts on old growth shown in Table 184. Because new roads would not be open to the public, would undergo interim reclamation after construction, and would be bladed and recontoured to match existing topography at transmission line decommissioning, the roads would not likely reduce the amount of snag levels from firewood gathering. Use of new roads associated with transmission line construction would result in short-term disturbance to vegetation and wildlife.

3.22.2.4.7 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

For Alternative C-R, acreage, edge influences, and interior habitat of effective or recruitment old growth would not be affected in the Crazy PSU. One area of vegetation removal would be adjacent to old growth. Ten acres of effective old growth would be removed and 8 acres of interior habitat would be lost in the Silverfish PSU (Table 184). In the Silverfish PSU, Alternative C-R would affect 11 acres of recruitment old growth, increase edge influence by 20 acres, and reduce recruitment interior habitat by 31 acres (Table 184). Alternative C-R would not affect old growth on private land (Figure 86). The substation and loop line would not affect old growth. Alternative C-R would include the construction of an estimated 92 feet of new roads through effective old growth, affecting less than 0.1 acre of old growth on National Forest System lands. These impacts are included in the impacts on old growth shown in Table 184. The majority of impacts on old growth would occur on the ridge between Miller and West Fisher creeks and upslope of the unnamed tributary to Miller Creek. Reducing the size of old growth blocks would decrease the availability of interior habitat for those species that use it. At the PSU scale, the loss of old growth would have a negligible effect on the proportion of old growth composition and would not measurably impact old growth characteristics and attributes in the Crazy or Silverfish PSU.

Impacts on old growth on all lands would be minimized through implementation of the Environmental Specifications (Appendix D) and Vegetation Removal and Disposition Plan. Also, the use of monopoles in old growth, if incorporated into the Vegetation Removal and Disposition Plan, would require less clearing. Loss of old growth and edge effect may be offset by private land acquisition associated with grizzly bear habitat mitigation, if old growth characteristics were present on the acquired parcels.

Table 184. Summary of Impacts on Old Growth from the Transmission Line Alternatives in the Crazy and Silverfish PSUs and on State and Private Land.

Measurement Criteria	Alternative A – No Trans-mission Line	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
Crazy					
Effective Old Growth					
Cleared old growth (acres)	0	27	0	0	0
Change in edge influence (acres)	0	+98	0	+4	+4
Change in interior habitat (acres)	0	-125	0	-4	-4
New road length adjacent or through old growth (feet)	0	2,852	0	0	0
Recruitment Old Growth					
Cleared old growth (acres)	0	0	0	0	0
Change in edge influence (acres)	0	0	0	0	0
Change in interior habitat (acres)	0	0	0	0	0
New road length adjacent or through old growth (feet)	0	0	0	0	0
Effective or Recruitment Old Growth					
Areas of vegetation removed adjacent to old growth (#)	0	3	1	2	2
Silverfish					
Effective Old Growth					
Cleared old growth (acres)	0	0	10	8	0
Change in edge influence (acres)	0	+3	-3	-4	0
Change in interior habitat (acres)	0	-3	-8	-5	0
New road length adjacent or through old growth (feet)	0	1,229	92	92	0
Recruitment Old Growth					
Cleared old growth (acres)	0	7	11	0	0
Change in edge influence (acres)	0	+20	+20	0	+2
Change in interior habitat (acres)	0	-25	-31	0	-2
New road length adjacent or through old growth (feet)	0	2,052	0	0	0
Effective or Recruitment Old Growth					
Areas of vegetation removed adjacent to old growth (#)	0	3	4	1	1
State and Private Land Old Growth					
Cleared old growth (acres)	0	4	0	0	7

Source: Clearing and road GIS analysis by ERO Resources Corp. using KNF data; edge and interior GIS analysis by KNF.

3.22.2.4.8 Alternative D-R – Miller Creek Transmission Line Alternative

Alternative D-R in the Crazy PSU would increase edge effects on 4 acres of effective old growth and decrease interior habitat by 4 acres (Table 184). In the Silverfish PSU, Alternative D-R would affect 8 acres of effective old growth, decrease edge effects on 4 acres of effective old growth, and decrease interior habitat by 5 acres (Table 184). Recruitment old growth would not be affected. Alternative D-R would not affect old growth on private land (Figure 86). The substation and loop line would not affect old growth. Alternative D-R would include the construction of an estimated 92 feet of new roads through effective old growth, affecting less than 0.1 acre of effective old growth on National Forest System lands. These impacts are included in the impacts on old growth shown in Table 184. The effect of the agencies' mitigation would be the same as Alternative C-R.

3.22.2.4.9 Alternative E-R – West Fisher Creek Transmission Line Alternative

Effects on old growth from Alternative E-R in the Crazy PSU would be the same as Alternative D-R. In the Silverfish PSU, effective old growth would not be affected by Alternative E-R. Alternative E-R would increase edge effects on 2 acres and reduce 2 acres of recruitment interior old growth (Table 184). Alternative E-R would directly impact 7 acres of old growth on private and State land where the transmission line would cross the Fisher River and parallel West Fisher Creek (Figure 86). The substation and loop line would not affect old growth. Alternative E-R would not require new road construction in old growth on National Forest System lands. The effect of the agencies' mitigation would be the same as Alternative C-R.

3.22.2.4.10 Combined Mine-Transmission Line Effects

Direct impacts of the mine alternatives in combination with the transmission line alternatives are shown in Table 185. Impacts on effective old growth from combined mine and transmission line alternatives would be the greatest (723 acres of interior old growth removed in the Crazy and Silverfish PSUs) for MMC's proposed alternative (Alternative 2B). Loss of interior old growth in the Crazy and Silverfish PSUs for the agencies' alternatives (Alternatives 3C-R, 3D-R, 3E-R, 4C-R, 4D-R, and 4E-R), including private and State land, would range from 440 acres for Alternative 4E-R to 489 acres for Alternatives 3C-R. For the agencies' alternatives, impacts on old growth on private land would be minimized through implementation of the Environmental Specifications and Vegetation Removal and Disposition Plan. The use of monopoles in old growth, if incorporated into the Vegetation Removal and Disposition Plan, would require less clearing. For all combined alternatives, losses and degradation of old growth may be offset by private land acquisition associated with grizzly bear habitat mitigation, if old growth characteristics were present on the acquired parcels.

3.22.2.4.11 Effectiveness of Agencies' Proposed Mitigation

Implementation of Environmental Specifications and Vegetation Removal and Disposition Plan would help reduce clearing of old growth. Designation of old growth would not replace old growth lost, and given the recovery time of old growth forest (200 to 250 years), mitigation of effects after stand-replacing disturbance would likely require centuries.

Table 185. Summary of Impacts on Old Growth from Combined Mine and Transmission Line Alternatives.

Measurement Criteria	No Mine	MMC's Proposed Mine	Agency Mitigated Poorman Impoundment Alternative			Agency Mitigated Little Cherry Creek Impoundment Area		
		TL-B	TL-C-R	TL-D-R	TL-E-R	TL-C-R	TL-D-R	TL-E-R
Crazy PSU								
Effective Old Growth								
Cleared old growth (acres)	0	386	229	229	229	207	207	207
Change in edge influence (acres)	0	+288	+242	+238	+238	+179	+175	+175
Change in interior habitat (acres)	0	-720	-486	-482	-482	-437	-433	-433
Recruitment Old Growth								
Cleared old growth (acres)	0	54	7	7	7	54	54	54
Change in edge influence (acres)	0	+35	+35	+35	+35	+35	+35	+35
Change in interior habitat (acres)	0	-40	-46	-46	-46	-54	-54	-54
Silverfish PSU								
Effective Old Growth								
Cleared old growth (acres)	0	2	6	4	0	6	4	0
Change in edge influence (acres)	0	+3	-3	-4	0	-3	-4	0
Change in interior habitat (acres)	0	-3	-8	+5	0	-8	+5	0
Recruitment Old Growth								
Cleared old growth (acres)	0	7	11	0	0	11	0	0
Change in edge influence (acres)	0	+20	+20	0	+2	+20	0	+2
Change in interior habitat (acres)	0	-25	-31	0	-2	-31	0	-2
State and Private Land								
Old Growth								
Cleared old growth (acres)	0	4	0	0	7	0	0	7

Source: Clearing and road GIS analysis by ERO Resources Corp. using KNF data; edge and interior GIS analysis by KNF.

3.22.2.4.12 Cumulative Effects

Past actions, particularly timber harvest, road construction, and fire suppression activities, have altered the old growth ecosystems in the analysis area, resulting in reductions in early and late succession habitats; conditions favoring shade-tolerant, fire-intolerant species; loss of large snags and down wood; and increases in tree density and a shift to a largely mid-seral structural stage (USDA Forest Service 2003b). Firewood cutting would continue to occur where open roads provide access to old growth, contributing to snag removal. Continuing development of private lands, including timber harvest, home construction, and land clearing would contribute to losses of old growth in the analysis area, but would not affect the proportion of old growth on National Forest System lands. In addition, it is likely that limited amounts of old growth occur on private and State lands, based on past and current harvest practices. The No Action Alternatives (Alternative 1 and Alternative A) would not contribute to cumulative impacts on old growth. The amount of old growth that is predicted to occur across the Forest in the future increases substantially during the next 50 years. In the absence of large scale dramatic disturbances over the Forest, old growth amounts should increase in the future due to the large number of acres of forest stands on the KNF that currently meet every old growth criteria except age, but that will meet the age criteria relatively soon (USDA Forest Service 2013c).Regeneration harvest included in the Miller-West Fisher Vegetation Management Project, which will occur in the Silverfish PSU, would not directly affect old growth. The Miller-West Fisher Vegetation Management Project will result in minor increased edge effects where regeneration harvest is proposed adjacent to old growth. While the action alternatives would result in some losses and degradation of old growth, the Montanore Project and all reasonably foreseeable action would not substantially reduce the amount of old growth in the PSU or across the KNF.

3.22.2.4.13 Regulatory/Forest Plan Consistency

The 2015 KFP desired condition is to increase old growth at the forestwide scale (FW-DC-VEG-03). Although there would be site-specific reductions of old growth within the land clearing for mine and transmission line facilities, none of the alternatives would preclude achievement of the forestwide desired condition over the long term. The amount of old growth that is predicted to occur across the Forest in the future increases substantially during the next 50 years. In the absence of large-scale dramatic disturbances over the Forest, old growth amounts should increase in the future due to the large number of acres of forest stands on the KNF that currently meet every old growth criteria except age, but that will meet the age criteria relatively soon (USDA Forest Service 2013c). As described in section 3.22.1.1, the Montanore Project would clear forested lands for mineral development. Vegetation standards and guidelines in the 2015 KFP applicable to vegetation management activities do not apply to intensively developed sites such as mines, developed recreation sites, administrative sites, or rock quarries where lands have been or will be converted to non-forest sites.

Mine Alternative 2 and Transmission Line Alternative B would not be designed in accordance with guideline FW-GDL-VEG-02. Road construction or other developments in old growth stands would not generally be avoided. The agencies' mine and transmission line would comply with FW-GDL-VEG-02. Although road construction or other developments in old growth stands would be minimized in the agencies' alternatives, none of the mine and transmission line alternatives would be designed in accordance with guideline FW-GDL-VEG-02 for generally avoiding effects on old growth. Section 2.12, *Forest Plan Amendment* describes the project-specific amendment to the 2015 KFP that the KNF would adopt in all mine and transmission line alternatives. The amendment would allow all mine and transmission line facilities to unavoidably affect old growth stands. Design features cannot be applied to the project to generally avoid effects on old growth stands. The amendment would apply to National Forest System lands affected by the Montanore Project facilities, and would not apply to State or private lands. No old growth regulatory requirements apply to BPA's Sedlak Park Substation and loop line, which would be on private land. A significance determination of the amendments will be in the ROD and is available in the project record.

3.22.2.4.14 Irreversible and Irretrievable Commitments

All action alternatives would result in an irreversible commitment of old growth forest in the Crazy PSU and, except for Alternative E-R, the Silverfish PSU. Transmission line alternatives B and E-R would result in an irreversible commitment of old growth forest in small areas of private land along the transmission line corridor near US 2. Irretrievable commitments of old growth resources in the Silverfish PSU would occur due to the direct impacts of old growth removal and the indirect impacts from minor edge effects. The recovery time of old growth forest would preclude restoration for centuries following disturbance (200 to 250 years).

3.22.2.4.15 Short-term Uses and Long-term Productivity

Losses of old growth resulting from implementation of the action alternatives would be long term, and would be primarily in the Crazy PSU, small areas in the Silverfish PSU, and in small areas of old growth on private land along the transmission line corridor. All alternatives would result in minor edge effects, which would continue beyond the Closure Phase. If reclamation were successful and successional processes were allowed to take place, edge effects would eventually dissipate. Given the recovery time of old growth forest, direct elimination of effects after disturbance would likely require centuries (200 to 250 years).

3.22.2.4.16 Unavoidable Adverse Environmental Effects

Unavoidable adverse effects would occur from all action alternatives in the Crazy and Silverfish PSUs and small areas of private land along the transmission line corridor where old growth would be directly removed.

3.22.3 Threatened, Endangered, and Sensitive Plant Species

The KNF monitors plant species considered to be of concern. Plant species of concern are characterized as threatened, endangered, sensitive, or Category 4 watch species. T&E species include species listed by the USFWS and protected under the ESA. Forest Service sensitive species are those species the Regional Forester determines to be a concern on National Forest System lands in the Region due to declining numbers. The KNF works closely with the MNHP, which maintains records of plant species of concern. State-listed plant species of concern are also discussed in the following sections.

3.22.3.1 Regulatory Framework

Section 3.6, *Aquatic Life and Fisheries* discusses the regulatory framework for federal-listed threatened or endangered plant species, and Forest sensitive plant species. Applicable 2015 KFP direction is:

FW-DC-VEG-09. Habitat for plant species listed under the Endangered Species Act (ESA) is maintained or restored on NFS lands, thus contributing to species recovery or delisting. Ecological conditions and processes that sustain the habitats currently or potentially occupied by sensitive plant species are retained or restored. The geographic distributions of sensitive plant species in the Forest Plan area are maintained.

FW-GDL-VEG-07. Evaluate proposed management activities and project areas for the presence of occupied or suitable habitat for any plant species listed under the Endangered Species Act or on the regional sensitive species list. If needed, based on pre-field review, conduct field surveys and provide mitigation or protection to maintain occurrences or habitats that are important for species sustainability.

Two Forest sensitive plant species of concern were found in the analysis area, the northern beechfern (*Phegopteris connectilis)* and crenulated moonwort *(Botrychium crenulatum)*.

There are no regulatory requirements to protect Forest sensitive or state plant species of concern on private land. The DEQ strives to work with proponents of mine development to voluntarily limit impacts on Forest sensitive or state plant species of concern. The MFSA directs the DEQ to approve a facility if, in conjunction with other findings, the DEQ finds and determines that the facility would minimize adverse environmental impacts, considering the state of available technology and the nature and economics of the various alternatives.

3.22.3.2 Analysis Area and Methods

The analysis area for direct, indirect, and cumulative effects on threatened, endangered, and sensitive plant species consists of all areas that would be disturbed by construction of the mine, transmission line, substation and loop line under any alternative (Figure 85). The Libby Loadout site is disturbed and is not discussed further.

Potential habitat for sensitive plants was surveyed in areas surrounding facilities as proposed in 1989. Sensitive plant surveys followed KNF guidelines and procedures and were conducted during the summers of 1988 and 1989 (Western Resource Development Corp. 1989d, 1989e), with additional updates in the summer of 2005 (Westech 2005c). During the sensitive plant survey, habitats for sensitive plants were thoroughly examined and the remainder of the analysis area was less thoroughly examined (Westech 2005c). Additional sensitive plant inventories of the Poorman Tailings Impoundment Site, the Libby Plant Site, and the Upper Libby Adit Site were conducted in June and August of 2007 (Geomatrix 2009b). Information from these surveys was used to determine effects on plant species of concern. MNHP records are used in this summary to describe the characteristics of plant species of concern found during surveys of the analysis area. No surveys specifically for Category 4 watch species were conducted in the analysis area. Category 4 watch species were identified and recorded during surveys and are included in vascular plant species lists identified in the analysis area (Westech 2005c) and are not discussed further. Surveys for sensitive plants were not completed for all segments of all transmission line alternatives because a final alignment has not been selected and suitable habitat for sensitive plants could be avoided through design and placement of the transmission line structures. Surveys for sensitive plants were not completed for the segment in Alternatives C-R, D-R, and E-R from the Sedlak Park Substation north to where the alignment crosses Alternative B segments of Alternative C-R where they differ from Alternative B, a segment of Alternative D-R, and the entire alignment of Alternative E-R. The loop line at the Sedlak Park Substation site also was not surveyed. The remaining segments of the alternatives were surveyed for sensitive plants.

The Regional Forester updated the Forest Service sensitive species list for Region 1 in 2011 (USDA Forest Service 2011f). MMC would update surveys for plant species of concern before any ground-disturbing activities in the agencies' mine and transmission line alternatives. The survey results would be submitted to the agencies for approval. If sensitive plants were identified and adverse effects could not be avoided, MMC would develop appropriate mitigation plans for the agencies' approval. The mitigation would be implemented before any ground-disturbing activities. To the extent feasible, MMC would make adjustments to structure and road locations, and other disturbing activities to reduce impacts.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on threatened, endangered, and sensitive plant species in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.22.3.3 Affected Environment

One federal-listed threatened plant species was identified to potentially occur in the analysis area: Spalding's campion (*Silene spaldingii*). Suitable habitat for federal-listed or candidate species was evaluated and determined to be limited in the analysis area (Westech 2005c). No federal-listed T&E plant species were found in the analysis area and T&E plant species are not discussed further.

Two Forest Service sensitive plant species were found in the analysis area: the northern beechfern (*Phegopteris connectilis*) and crenulated moonwort (*Botrychium crenulatum*). Northern beechfern is found at 22 locations in scattered populations in northwestern Montana in Flathead, Glacier, Lincoln, and Sanders counties (MNHP and FWP 2014). Three of the occurrences are on the Libby Ranger District of the KNF. Northern beechfern is found in populations ranging from 10 to 100 individuals on benches above Little Cherry Creek in the analysis area (Westech 2005c). Past timber harvesting likely led to declines in the species' abundance and distribution (MNHP and FWP 2014). The MNHP and FWP classified the northern beechfern as secure globally, but imperiled in Montana because of rarity within the state. Habitat characteristics for the northern beechfern include old growth and mature western redcedar and western hemlock, which occur in the coniferous forest community. Understory plants found with northern beechfern are queencup beadlily, devil's club and lady fern. Management goals for northern beechfern population and genetic viability associated with each are discussed in the KNF Conservation Assessment Report prepared as a result of the 1992 Montanore Project EIS (KNF 1993).

The crenulated moonwort is a small, perennial fern that has been found at several locations in western Montana. Habitat for the crenulated moonwort is mesic areas associated with streams, seeps and western red cedar and western hemlock forests but also includes roadsides and other disturbed areas. During surveys in 2005 for the Montanore Project, two populations were found in riparian areas along Libby Creek and Little Cherry Creek (Westech 2005c). Suitable habitat is present within the Poorman Impoundment Site, but crenulated moonworts were not found during 2007 surveys (Geomatrix 2007d).

Dryland forests along the transmission line corridors have potentially suitable habitat for three Forest sensitive species: taper-tipped onion (*Allium acuminatum*), common clarkia (*Clarkia rhomboidea*), and bank monkeyflower (*Mimulus clivovola*). Limited plant surveys have been done along the transmission line corridor and the presence of these species is unknown.

3.22.3.4 Environmental Consequences

3.22.3.4.1 Alternative 1 – No Mine

The No Mine Alternative would not affect any Forest sensitive or other state-listed plant species of concern. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.22.3.4.2 Alternative 2 – MMC's Proposed Mine

In Alternative 2, two Forest sensitive and state-listed plant species of concern would be affected, the northern beechfern and the crenulated moonwort. Northern beechfern and the crenulated moonwort populations are located along Little Cherry Creek in the Tailings Impoundment Site (Westech 2005c). A population of northern beechfern and a population of crenulated moonwort would be eliminated in the Little Cherry Creek tailings impoundment site. Northern beechfern is found in 22 other locations across northwestern Montana with (MNHP and FWP 2014). The crenulated moonwort has 139 observations at more than 50 locations in Montana. The other populations of both the northern beechfern and the crenulated moonwort are currently secure so viability would not be threatened with the loss of populations in Little Cherry Creek. The KNF's Conservation Assessment (KNF1993) provides additional information on the northern beechfern. An increase in noxious weeds from disturbed ground could reduce habitat for forest sensitive and state-listed plant species of concern.

3.22.3.4.3 Alternative 3 – Agency-Mitigated Poorman Impoundment Alternative

Alternative 3 would not affect any Forest sensitive and state-listed plant species of concern since no sensitive species were identified during field surveys. MMC would update surveys for plant species of concern before any ground-disturbing activities in the agencies' alternatives. If a species of concern was identified and adverse effects could not be avoided, MMC would develop appropriate mitigation plans for the agencies' approval. The mitigation would be implemented before any ground-disturbing activities.

3.22.3.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

The effect on Forest sensitive and state-listed plant species of concern for Alternative 4 would be the same as Alternative 2. MMC would update surveys for plant species of concern before any ground-disturbing activities in the agencies' alternatives. If a species of concern was identified and adverse effects could not be avoided, MMC would develop appropriate mitigation plans for the agencies' approval. The mitigation would be implemented before any ground-disturbing activities.

3.22.3.4.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001 would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby

Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.22.3.4.6 Alternatives B

All of Alternative B was surveyed for Forest sensitive or other state-listed plant species of concern, and none were identified. Taper-tipped onion, common clarkia, and bank monkeyflower have been added as Forest sensitive species since the previous survey was conducted, and surveys would be updated before construction.

3.22.3.4.7 Alternatives C-R, D-R, and E-R

No Forest sensitive or other state-listed plant species of concern were identified along the transmission line corridors surveyed. Surveys for sensitive plants were not completed for all segments of all transmission line alternatives because a final alignment has not been selected and suitable habitat for sensitive plants could be avoided through design and placement of the transmission line structures. Surveys for sensitive plants were not completed for the segment in Alternatives C-R, D-R, and E-R from the Sedlak Park Substation north to where the alignment crosses Alternative B segments of Alternative C-R where they differ from Alternative B, a segment of Alternative D-R, and the entire alignment of Alternative E-R. The loop line alignment at the Sedlak Park Substation site also was not surveyed. The remaining segments of the alternatives were surveyed for sensitive plants.

MMC would update surveys for plant species of concern, including newly listed species, before any ground-disturbing activities in the agencies' alternatives. If a species of concern was identified and adverse effects could not be avoided, MMC would develop appropriate mitigation plans for the agencies' approval. The mitigation would be implemented before any ground-disturbing activities. To the extent feasible, MMC would make adjustments to structure and road locations, and other ground-disturbing activities to reduce impacts.

3.22.3.4.8 Effectiveness of Agencies' Proposed Mitigation

Updating surveys and developing avoidance and mitigation measures would effectively minimize effects on Forest sensitive or other state-listed plant species of concern.

3.22.3.4.9 Cumulative Effects

No other reasonably foreseeable projects in the region, including the Miller-West Fisher Vegetation Management Project, would directly impact federal-listed, Forest sensitive, or state-listed plant species of concern.

3.22.3.4.10 Regulatory/Forest Plan Consistency

The No Action alternatives would not impact any sensitive plant species or their habitat. Alternatives 2 and 4 would impact individuals and habitat but would not likely contribute to a trend toward federal listing or cause a loss of viability for Northern beechfern and crenulated moonwort. Alternative 3 may impact individuals or habitat but would not likely contribute to a trend toward federal listing or cause a loss of viability to the population or species. All alternatives transmission line locations may impact individuals of or habitat for taper-tipped onion, common clarkia, and bank monkeyflower but would not likely contribute to a trend toward federal listing or cause a loss of viability to the population or species.

3.22.3.4.11 Irreversible and Irretrievable Commitments

An irretrievable commitment of resources would occur in Alternatives 2 and 4 from the loss of two populations of Forest sensitive and state-listed plant species of concern. Reclamation of habitat upon completion of mining would not recreate the habitat or necessarily provide conditions suitable for establishment of affected species. Increases in populations of introduced species after disturbance may limit the potential for re-establishment of these species.

3.22.3.4.12 Short-term Uses and Long-term Productivity

Mine operations would result in the long-term loss of one population of northern beechfern and one population of crenulated moonwort in Alternatives 2 and 4.Reclamation of habitat following mining would not recreate the habitat for affected species. Increases in populations of introduced species after disturbance may limit the potential for re-establishment of these species.

3.22.3.4.13 Unavoidable Adverse Environmental Effects

Long-term loss of one population of northern beechfern and one population of crenulated moonwort would occur in Alternatives 2 and 4. It is currently unknown whether any populations of taper-tipped onion, common clarkia, and bank monkeyflower would be lost. Surveys for these species would occur prior to ground-disturbing activities along the selected transmission line corridor. Preconstruction surveys and development of mitigation for unavoidable impacts are discussed in section 2.5.2.6, *Final Design Process.*

3.22.4 Noxious Weeds

3.22.4.1 Regulatory Framework

The term “noxious weed” is defined in the Federal Plant Protection Act and in some individual State statutes. The term “noxious weed” means any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment. The term typically describes species of plants that have been determined to be undesirable or injurious in some capacity (USDA Forest Service 2011g). Executive Order 13112 directs federal agencies to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause.

The Montana County Weed Control Act (7-22-2101 *et seq.,* MCA) defines noxious weeds as “any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated a state noxious weed by rule of the Department of Agriculture; or a noxious weed by a county board.” It also states that it is unlawful for any person to permit any noxious weed to propagate or go to seed on his land. The KNF has signed a memorandum with Lincoln County and has agreed to assist and cooperate with the Lincoln County Weed District in managing noxious weeds. The Forest Service’s guidelines for controlling noxious weeds are provided in the FSM 2900 Invasive Species Management (USDA Forest Service 2011g) and Appendix A of the KNF Invasive Plant Management Final EIS (KNF 2007a). The Lincoln County Weed District has identified several species of noxious weeds that occur or potentially occur in Lincoln County (Lincoln County 2014). The DEQ requires that mine operations have a weed control plan approved by the local county weed control board.

As described in section 3.22.1.1, vegetation management standards and guidelines, including those applying to old growth, are not applicable to the Montanore Project. Applicable 2015 KFP old growth direction is:.

FW-DC-VEG-10. Newly invading, non-native invasive plant species are treated and populations are contained or eradicated. The weed program on the Forest uses integrated pest management approaches, including prevention and control measures that limit introduction, intensification, and spread due to management activities. Agreements with cooperative weed management areas assist control efforts across jurisdictional boundaries.

GA-DC-VEG-LIB-03. Populations of new noxious weed species are treated promptly and eradicated. Established noxious weed infestations are reduced and habitat conditions are improved for native grasses, forbs, and shrubs. Private, county, state, and federal organizations work cooperatively to prevent, control, and manage noxious weed infestations. Weed infestations on big game winter range and in the Cabinet Mountains Wilderness area are emphasized. Established rush skeltonweed sites in the Quartz Creek area are eradicated.

3.22.4.2 Analysis Area and Methods

The analysis area for direct, indirect, and cumulative effects on noxious weeds consists of all areas that would be disturbed by construction of the mine, transmission line, substation and loop line and Libby Loadout under any alternative (Figure 85).

Noxious weed baseline surveys for the Montanore Project facilities as proposed in 1989 were conducted during the summers of 1988 and 1989 (Western Resource Development Corp. 1989d, 1989e). Noxious weed surveys were updated in 2005 to determine if the weed species or distribution had changed (Westech 2005b). Most proposed mine facility locations and transmission line alternatives were surveyed for noxious weeds. The areas not surveyed for threatened, endangered, or sensitive species also were not surveyed for noxious weeds. Areas not evaluated for noxious weeds are believed to have similar noxious weed infestations and would require similar control methods. The potential for noxious weed introduction and establishment for the alternatives evaluated was determined based on existing weed populations, total amount of disturbance, and plans to control weeds and revegetate disturbed areas. The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on noxious weeds in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.22.4.3 Affected Environment

Noxious weeds are categorized by the state, county, and Forest Service for management and control. Lincoln County categorizes noxious weeds in Categories I through IIIb (Lincoln County 2014). Lincoln County Category I species are weeds that cover extensive areas, Category II are well established, IIIa are potential invaders, and IIIb are new invaders. Potential invaders include noxious weeds that do not currently exist in Lincoln County but have a high probability of causing severe environmental or economic degradation. (Lincoln County 2014).

The State of Montana identifies Priority 1A, 1B, 2A, 2B, and 3. IA includes weeds not present in Montana, 1B have limited presence, 2A are common in isolated areas of Montana, 2B are abundant in Montana and widespread in many counties and Priority 3 species are regulated plants, but are not listed as Noxious Weeds in Montana. The KNF noxious weed plans (KNF Noxious Weed Handbook, Spring 2008, Edition 5.0) categorize noxious weeds into three categories; Category 1 are well established, Category 2 are new invaders and Category 3 are potential invader species, groupings that are similar to Lincoln County but have different priorities. Noxious weed categories are listed in Table 186.

Table 186. Noxious Weeds Found in the Analysis Area.

Weed Species	Scientific Name[†]	State Category	Lincoln County Weed Category	KNF Weed Category
Canada thistle	*Cirsium arvense*	2B	II	1
Common tansy	*Tanacetum vulgare*	2B	II	1
Meadow hawkweed	*Hieracium caespitosum*	2A	I	1
Orange hawkweed	*Hieracium aurantiacum*	2A	I	1
Ox-eye daisy	*Leucanthemum vulgare*	2B	I	1
Spotted knapweed	*Centaurea stoebe*	2B	I	1
St. Johnswort	*Hypericum perforatum*	2B	I	1
Sulphur cinquefoil	*Potentilla recta*	2B	I	1
Tall buttercup	*Ranunculus acris*	2A	IIIa	2

[†]Scientific name from USDA Natural Resources Conservation Service 2008.

Canada thistle is a deep-rooted, creeping perennial that is native to Eurasia. In the analysis area, Canada thistle is common in disturbed swales, mesic areas, and in wetlands where logging has occurred. Monocultures characterized by a high density of Canada thistle are present as scattered plants with low concentrations (Westech 2005b).

KNF Category 1 and 2, State Category 2A and B and 2, and Lincoln County Category I, II, and IIIa species were observed in several locations in the analysis area. Nine species of noxious weeds were found in the analysis area during the 2005 baseline vegetation studies: Canada thistle; spotted knapweed; ox-eye daisy; orange hawkweed; meadow hawkweed; St. Johnswort; sulfur cinquefoil; tall buttercup; and common tansy (Westech 2005b). In addition, Dalmatian toadflax has been found in the Miller Creek drainage, and rush skeletonweed has been found in the Miller Creek and West Fisher Creek drainages. The 1988 vegetation baseline inventory (Western Resource Development Corp. 1989d, 1989e) documented three listed noxious weeds in the analysis area as well as three noxious weeds yet to be officially listed: Canada thistle, spotted knapweed, St. Johnswort, orange hawkweed, ox-eye daisy, and tall buttercup. Meadow hawkweed, sulfur cinquefoil, and common tansy were not recorded in the initial mine analysis area in 1988 but were recorded in 2005.

Common tansy is a perennial forb that is poisonous if ingested. It is not as dominant as the other listed noxious weeds in the analysis area. This species is found most frequently along roads and in disturbed areas, and along riparian corridors. It is common in patches along the Fisher River (Westech 2005b).

Orange hawkweed is a perennial with a fibrous, creeping root system. It has clusters of orange dandelion-like heads and is the most abundant and problematic noxious weed in the Montanore analysis area. It is found mostly in logged and disturbed areas in western hemlock/western redcedar forest types. Most roadsides are dominated by orange hawkweed (Westech 2005b).

Meadow hawkweed has almost identical vegetative growth characteristics to orange hawkweed and is difficult to distinguish without flowering heads. Meadow hawkweed is less common in the analysis area than orange hawkweed, and is found primarily along roads (Westech 2005b).

Once a cultivated species, ox-eye daisy is an invasive weed that is becoming an increasing problem in the western states. Ox-eye daisy is most common along roads and in recently logged areas in the Montanore analysis area (Westech 2005b). It is invading many meadows in northwestern Montana.

Spotted knapweed is an aggressive invader that generally occurs in disturbed areas. Spotted knapweed is a perennial, taprooted Eurasian weed species that invades range and harvested forestland throughout the West. It can reduce biodiversity, wildlife and livestock forage production, and can also increase soil erosion (Montana Noxious Weed Summit Advisory Council 2008). Spotted knapweed grows best in well-drained soils. Spotted knapweed occurs throughout the analysis area, particularly along roads, on disturbed areas, and in areas where timber has been harvested and tree canopy cover is relatively open. Undisturbed areas typically do not have large infestations of spotted knapweed (Westech 2005b).

St. Johnswort is a perennial species that was introduced because of its medicinal properties. Montana's Department of Agriculture reports that St. Johnswort covers an area of about 68,000 acres in Montana (Montana Noxious Weed Summit Advisory Council 2008). This plant is unpalatable and mildly poisonous to livestock. It is observed along roads and in recent previously harvested coniferous forests but coverage was spotty or minor (Westech 2005b).

Sulfur cinquefoil is a perennial species with well-developed creeping woody roots. Sulfur cinquefoil was recorded in Sedlak Park and along US 2 near the analysis area (Westech 2005b).

Tall buttercup is a perennial species that grows up to 3 feet tall and is poisonous to livestock if ingested. Tall buttercup was present in the 1988 baseline vegetation inventory but was not located during the 2005 baseline vegetation survey (Westech 2005b).

3.22.4.4 Environmental Consequences

3.22.4.4.1 Alternative 1 – No Mine

Introduced species such as cheatgrass and noxious weeds have increased in the analysis area between the time the baseline vegetation surveys were conducted in 1988 and 1989 and the time they were updated in 2005. This increase would continue in the future with or without the mine because of the competitiveness of the introduced species. The No Mine Alternative would not involve new land-disturbing activities and would minimize the increase in number and distribution of introduced species and noxious weeds. Noxious weeds currently present in the analysis area would continue to be subject to existing Forest Service, state, and county-wide noxious weed management practices. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001 would remain in effect. Noxious weeds at the Libby Adit Site would continue to be controlled in accordance with existing permits and approvals. Noxious weed control using herbicides can cause an indirect effect on adjacent native species ranging from minimal to severe depending on the type of herbicide and quality of application. Inadequate reseeding efforts to replace native species after treatment cause additional indirect effects on native plant species. The Forest Service and other land managers and owners are not required to control introduced species that are not classified as noxious weeds.

3.22.4.4.2 Alternative 2 – MMC's Proposed Mine

Alternative 2 would increase the spread and establishment of noxious weeds and other introduced species associated with ground-disturbing activities. Weeds invade disturbed ground where they easily establish and out-compete native species even with a weed control program. Weed establishment would more likely occur along roads, cut-and-fill slopes, the margins of mine facilities, soil stockpiles, and other disturbed areas. The distribution of noxious weeds and other introduced species would probably be greatest under Alternative 2 because it includes the largest area of potential disturbance (2,582 acres).

MMC's weed control program would minimize weed infestations on lands disturbed by the proposed facilities. All off-highway vehicles and earth moving equipment entering Lincoln County would be washed at a commercial facility. Special emphasis would be taken to remove soil and other plant material from the vehicle or equipment. MMC would notify KNF at least 24 hours in advance of equipment delivering to the site to provide an opportunity to inspect the equipment. Weed control during operations would primarily be through the use of herbicides. Additionally, a 3-year continuous monitoring and treatment program would be implemented (MMC 2008). Criteria in the reclamation plan for Alternative 2 require that vegetation composition would have less than 10 percent cover of noxious weeds. MMC would not be required to control other introduced species.

3.22.4.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

With 2,011 acres of disturbance, Alternative 3 would have similar potential to increase the infestation and spread of noxious weeds and other introduced species as Alternative 2, although distribution would likely be less. All weed BMPs discussed under *Noxious Weed Mitigation Measures* (p. 144) for Alternative 3 would be implemented, and would reduce the establishment and spread of noxious weeds, compared to Alternative 2. Weed BMPs would address the treatment and control of noxious weeds throughout all mine facilities.

The reclamation plan for reclaimed areas under Alternative 3 differs from Alternative 2 and would require that noxious weeds would have less than 10 percent cover of species listed as Category 1 (established infestations), and 0 percent cover of categories 2 and 3 (potential invaders and new invaders, as described in the KNF Noxious Weed Handbook, Spring 2008, Edition 5.0). Category 1 noxious weeds would not dominate any location greater than 400 square feet. The goal of Alternative 3 would be to use a native seed mix, if commercially available, that would reduce the spread of invasive or noxious species. In Alternative 3, shrubs and trees would be planted by hand in random patterns to prevent the spread or infestation of noxious weeds by limiting disturbance from machinery. MMC would not be required to control other introduced species.

3.22.4.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Alternative 4 would have the same potential to result in the establishment and spread of noxious weeds and other introduced species as described for Alternatives 2 and 3. The reclamation and weed management plans for Alternative 4 would be the same as Alternative 3. MMC would not be required to control other introduced species.

3.22.4.4.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001 would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Effects associated with activities at the Libby Adit Site would remain until the site was reclaimed in accordance with existing permits and approvals.

3.22.4.4.6 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

Alternative B would have the largest area of surface disturbance associated with new or upgraded road construction and timber clearing of the four alternatives (Table 180). New roads would be reseeded as an interim measure, but used for maintenance activities, as necessary. Surface disturbances and continued road use would increase the risk of spread of noxious weed and other introduced species and would require more monitoring and control of noxious weeds. Alternative B would have the least area of vegetation clearing, which would minimize disturbance and potential weed spreading. MMC's weed control program described in Alternative 2 would be implemented for Alternative B, and is designed to minimize weed infestations on lands disturbed by the proposed facilities. Vehicles would be cleaned before entering the area and following work in weed infested areas. BPA's plan to conduct a noxious weed survey at the proposed Sedlak Park Substation Site before and after construction of the substation and its weed control program would minimize noxious weeds at the site. MMC and the BPA would not be required to control other introduced species that are not classified as noxious weeds.

3.22.4.4.7 Effects Common to Transmission Line Alternatives C-R, D-R, and E-R

These alternatives would use a helicopter to construct between 16 and 32 structures, which would minimize new road construction or reconstruction. A helicopter would be used to clear timber in areas adjacent to core grizzly bear habitat. Roads decommissioned or placed in intermittent stored service would not be used for routine maintenance of the transmission line, but could be used for emergency repairs, such as a damaged insulator. These modifications would reduce the risk of noxious weed spread. Because these alternatives would require greater vegetation clearing along the transmission line corridor, weed spread associated with such clearing would be greater in these alternatives than Alternative B. MMC's weed control program described in Alternative 2 and modified in Alternative 3 would minimize weed infestations on lands disturbed by the transmission line facilities. BPA's plan to conduct a noxious weed survey at the proposed Sedlak Park Substation Site before and after construction of the substation and its weed control program would minimize noxious weeds at the site. MMC would coordinate with the Forest Service Weed Specialist for use of biocontrol agents as they become available. MMC and BPA would not be required to control other introduced species.

3.22.4.4.8 Effectiveness of Agencies' Proposed Mitigation

The agencies' modifications to MCC's weed control program would be effective in minimizing weed infestations on lands disturbed by the mine and transmission line facilities.

3.22.4.4.9 Cumulative Effects

Past actions, particularly timber harvest, road construction, and fire suppression, coupled with human activity have resulted in the establishment of the existing noxious weed and other introduced species populations in the analysis area. All reasonably foreseeable future projects in the area that involve ground disturbances have the potential to spread and increase the number of noxious weeds and other introduced species. Any ground-disturbing activities, activities that involve large equipment, livestock grazing, or activities that increase motor access could increase spread of noxious weeds or introduce new invaders to the area. Noxious weed and other introduced species infestations could impact sensitive plant species. The construction of both the Montanore Project and the Rock Creek Project would increase the opportunity for noxious weeds to invade the CMW from the east and west. All reasonably foreseeable actions would be subject to existing Forest Service, state, and county-wide management practices, which have proven effective in slowing the spread of targeted noxious weeds. Native species are also affected by chemical weed control programs. The Forest Service and other land managers and owners are not required to control other introduced species.

3.22.4.4.10 Regulatory/Forest Plan Consistency

Mine Alternative 2 and transmission line Alternative B would not fully comply with the 2015 KFP and Executive Order 13112. MMC did not propose to implement all weed BMPs identified in Appendix A of the KNF Invasive Plant Management Final EIS (KNF 2007a). In the agencies' mine and transmission line alternatives, all weed BMPs discussed under *Noxious Weed Mitigation Measures* (p. 144) would be implemented, and would reduce the establishment and spread of noxious weeds on all mine and transmission line facilities, compared to Alternatives 2 and B. The agencies' mine and transmission line alternatives would improve the trend toward the forestwide and Libby Geographic Area desired conditions.

3.22.4.4.11 Irreversible and Irretrievable Commitments

All alternatives have the potential to increase noxious weed and other introduced species populations, which would displace native species, and result in an irreversible loss of plant species. Chemical weed control programs would also limit native species.

3.22.4.4.12 Short-term Uses and Long-term Productivity

All alternatives have the potential to increase noxious weed and other introduced species populations, which would displace native species, and reduce their long-term productivity. Chemical weed control programs would also limit native species' productivity.

3.22.4.4.13 Unavoidable Adverse Environmental Effects

A potential unavoidable increase in noxious weed and other introduced species populations would occur under all alternatives. Invasion of noxious weeds and other introduced species as well as spraying of noxious weeds with chemicals would result in the loss of some native plant species.

3.23 Wetlands and Other Waters of the U.S.

3.23.1 Regulatory Framework

Discharges of dredged or fill material into waters of the U.S. are regulated under Section 404 of the Clean Water Act by the Corps of Engineers. Waters of the U.S. are defined broadly in the Corps' regulations to include a wide variety of waters and wetlands. All water bodies in the analysis area are State waters. The Corps defines "wetlands" as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR 328.3 (b)). Under natural conditions, waters of the U.S. provide food and habitat for fish and wildlife, flood protection, erosion control, water quality improvement, and opportunities for recreation (Adamus *et al.* 1991). The term "wetlands and other wetland waters of the U.S." includes both deep-water habitats (non-wetland) and special aquatic sites, which include wetlands (Environmental Laboratory 1987).

This section discusses wetlands and other waters of the U.S. found within the analysis area. In Montana, surface water is any water of the State at the surface of the ground, including but not limited to any river, stream, creek, ravine, coulee, undeveloped spring, lake, and other natural surface source of water regardless of its character or manner of occurrence (ARM 36.12.101). The Corps determines a water to be subject to its jurisdiction if the water body is a traditionally navigable water, relatively permanent water, or a wetland that directly abuts a traditionally navigable or relatively permanent water body, or, in combination with all wetlands adjacent to that water body, has a significant nexus with traditionally navigable waters (Corps and EPA 2007). In 2015, the EPA and Corps jointly issued a final Clean Water rule that strives to better define waters of the U.S. subject to Corps' jurisdiction. Before the rule became effective, a Federal District Court in North Dakota granted a preliminary injunction blocking implementation of the new rule in 13 states that joined the suit, including Montana. After the rule became effective, the Sixth Circuit Court of Appeals issued an order granting states' request to stay the rule nationwide while the court considers its legality. With the injunction in place, the Omaha District is basing permit decisions on the prior regulations. If the rule is in place for Montana in the future, the Corps will be responsible for implementing the final rule.

The Corps defines springs as "any location where there is artesian flow emanating from a distinct point at any time during the growing season" (Corps 2012). In Montana, a spring is defined as a hydrologic occurrence of water involving the natural flow of water originating from beneath the land surface and arising to the surface of the ground. Any disturbances within 100 feet of a spring are regulated by the Corps (Corps 2012).

All activities that result in the discharge of fill material into wetlands or other waters of the U.S. are regulated by the Corps. Based on a Supreme Court 2001 ruling, wetlands that are isolated from other waters of the U.S., and whose only connection to interstate commerce is use by migratory birds, do not fall under Corps' jurisdiction. Such wetlands are "isolated" or "non-jurisdictional" and these terms are used synonymously.

Projects subject to the Corps' jurisdiction also must comply with the 404(b)(1) Guidelines for discharge of dredged and fill material into wetlands and other waters of the U.S. (40 CFR 230). It is anticipated that one or more Montanore Project facilities would need a 404 permit from the Corps. The 404(b)(1) Guidelines specify "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse effect on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." An alternative is considered practicable if "it is capable of being done after taking into consideration cost, existing technology, and logistics in the light of overall project purposes." Practicable alternatives under the Guidelines assume that "alternatives that do not involve special aquatic sites are available, unless clearly demonstrated otherwise." The Guidelines also assume that "all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse effect on the aquatic ecosystem, unless clearly demonstrated otherwise" (40 CFR 230).

Federal agencies have responsibilities to avoid, minimize, and mitigate unavoidable impacts on wetlands under Executive Order 11990. Executive Order 11990 requires federal agencies to "consider factors relevant to a proposal's effect on the survival and quality of the wetlands." Federal agencies must find that there is no practicable alternative to new construction located in wetlands, and that the Proposed Action includes all practicable measures to minimize harm to wetlands. Agencies may take into account economic, environmental and other pertinent factors in making this finding.

In 2008, the Corps and the EPA issued regulations (33 CFR 332 and 40 CFR 230 Subpart J) regarding compensatory mitigation requirements for losses of aquatic resources, such as wetlands. These regulations require, in cases where appropriate functional or condition assessment methods or other suitable metrics are available, that these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used. Before issuance of the 2008 regulations, the Corps in Montana used ratios for various mitigation types in determining compensation requirements (Corps 2005a). The Corps developed a stream mitigation procedure for projects adversely affected streams in 2010 and revised it in 2013 (Corps 2013a).

The 2015 KFP includes the INFS that establishes management direction for wetlands. INFS standards and guidelines apply to an area within 150 feet of a wetland greater than 1 acre in size. For a wetland less than 1 acre, INFS standards and guidelines apply to an area within 100 feet of a wetland.

3.23.2 Analysis Area and Methods

3.23.2.1 Analysis Area

The analysis area is where potential direct, indirect, or cumulative effects on wetlands and other waters of the U.S. by any of the alternatives would occur. The analysis area is the same as the analysis area used for surface water hydrology (discussed in section 3.11.2, *Analysis Area and Methods*) and shown on Figure 76.

3.23.2.2 Baseline Data Collection

3.23.2.2.1 Wetland Delineation and Functional Assessment

Wetlands and other waters were delineated within the analysis areas between 2005 and 2009 (Westech 2005e, Geomatrix 2008b; Geomatrix 2009b) following Corps methods (Environmental

Laboratory 1987). Wetland boundaries were flagged and delineated using a Global Positioning System (GPS) device. Waters of the U.S. not likely to be filled with dredged or fill material, or sites where GPS coverage was lacking, were delineated from aerial photo interpretation. This included wetlands along access roads and the transmission line corridor, and on private lands. In 2011, MMC completed an inventory of the physical, chemical and biological characteristics of headwater drainages that would be directly affected by the Poorman Impoundment (Kline Environmental Research 2012). Modifications to the location of some of the drainages mapped from 2005 to 2009 were made based on the Kline inventory. Wetlands mapped along the previous drainage alignments are considered riparian corridor wetlands (Figure 87) and were used in the impact calculation.

Wetland delineations were not completed for Alternative E-R - West Fisher Creek Alternative, a segment of Alternative D-R - Miller Creek Alternative in upper Miller Creek, segments of Alternative C-R - Modified North Miller Creek Alternative where they differ from Alternative B, and the segment in Alternatives C-R, D-R, and E-R from the Sedlak Park Substation north to where the alignment crosses Alternative B. Wetland delineations also would be needed at sites proposed in the agencies' fisheries and wildlife mitigation measures, such as road crossings where culverts would be removed.

Wetlands near the Sedlak Park Substation site were not delineated according to the 1987 Corps of Engineers Wetlands Delineation Manual. Instead, BPA environmental staff identified wetland boundaries based on the presence of hydric soil boundaries, secondary hydrologic indicators, and wetland vegetation. Wetland boundaries were recorded using a GPS device. GPS data were used by BPA to develop a substation design that would avoid and minimize impacts on wetlands and waters of the U.S. (BPA 2008).

An assessment of the jurisdictional status of each wetland was made during the wetland delineations. Wetlands and other waters were assigned as either jurisdictional wetlands, jurisdictional non-wetland waters of the U.S., or isolated wetlands. Isolated wetlands are not connected by surface flow to jurisdictional waters of the U.S. Non-wetland waters of the U.S. were delineated to the ordinary high water mark where stream channels had a defined bed and bank during the 2005 delineation (Westech 2005e). Non-wetland waters of the U.S. in the Poorman Impoundment Site were updated based on the 2011 stream survey (Kline Environmental Research 2012). The 2005 wetland delineation (Westech 2005e) and the 2009 wetland delineation (Geomatrix 2009b) have been subject to a preliminary jurisdictional determination by the Corps (Corps 2005b, 2008b). An approved jurisdictional determination of isolated wetlands in the Poorman Impoundment Site has been completed (Corps 2008c, 2014). In 2013, the Corps issued an updated preliminary jurisdictional determination of wetlands and non-wetland waters within the Poorman Impoundment Site (Corps 2013b). The Corps determined that short reaches of four drainages in the Poorman Impoundment Site lacked a defined channel and were non-jurisdictional. Other reaches were determined to be relatively permanent waters, which are subject to Corps jurisdiction (Figure 87). In the effects analysis, the lead agencies used the Corps' preliminary and approved jurisdictional determinations of the sites. The jurisdictional status of the wetlands and other waters of the U.S. is preliminary and impacts may change during the 404 permitting process.

Between 2005 and 2008, functions and services for wetlands within the analysis area were evaluated using the 1999 MDT Montana Wetland Assessment Method (Berglund 1999). In 2010, wetland functional assessments were revised following the 2008 MDT Montana Wetland

Assessment Method (MDT method) (Berglund and McEldowney 2008; Geomatrix 2010d). The MDT method uses a classification system that combines the USFWS classification system (Cowardin *et al.* 1979) with a hydrogeomorphic (landscape position) approach (Brinson 1993). The MDT method provides a landscape context to the USFWS classification. The MDT method classifies wetlands as Category I, II, III, or IV. Category I wetlands are exceptionally high quality wetlands and are generally rare to uncommon. Category II wetlands are more common than Category I wetlands, and provide habitat for sensitive plants and animals. Category III wetlands are more common than Category II or I wetlands, generally less diverse, and are often smaller than Category II or I wetlands. Category IV wetlands are generally small, isolated, and lack vegetative diversity. These wetlands provide minor wildlife habitat.

3.23.2.2.2 Hydrologic Assessment

Groundwater Levels – Poorman Impoundment Site

MMC collected groundwater data from several piezometers installed in wetlands within the Poorman Impoundment Site to provide information on seasonal and yearly variations and insight into hydrologic support of wetlands. In 2011, MMC installed three shallow piezometers in wetland WUS-15 and one nested pair in WUS-17. The three piezometers installed in the WUS-15 wetland area are not adjacent to each other because groundwater was below the maximum depth that could be augered or driven by the piezometers after initial installation. The three piezometers in wetland WUS-15 were spaced apart to assess depth to groundwater at different locations. One shallow piezometer was also installed in isolated wetland WUS-30 to a depth of 3.0 feet. In 2012, two additional piezometers were installed in WUS-17; one to a depth of 6 feet and the other to a depth of 11.8 feet. One piezometer was installed in WUS-1 (5.2 feet deep) and WUS-2 (6.3 feet deep). Water levels in each piezometer were measured periodically. To identify the source of the water, sampling and analysis of stable water isotopes (oxygen 18 and deuterium) of some of the piezometers was conducted.

Wetland Landscape Position Assessment

To determine the potential hydrologic support for wetlands without groundwater wells in the Poorman and Little Cherry Creek Impoundment sites and to assist in determining indirect effects on wetlands, ERO reviewed the topographic position of wetlands in relation to light detection and ranging (LiDAR) optical remote sensing data from which topographic maps were produced in 2012 (ERO Resources Corp. 2013). MMC’s LiDAR mapping has elevation contours of 2 feet. Wetland mapping used in this assessment was completed by Westech Environmental Services, Inc. (2005) and Geomatrix (2008) for the Little Cherry Creek Impoundment Site and by Geomatrix (2009) for the Poorman Impoundment Site, with supplemental stream mapping in the Poorman Impoundment Site provided by Kline Environmental Research (2012). ERO assumed that wetlands located in topographic depressions and closed basins are primarily surface water supported. These wetlands collect and hold precipitation, snow melt, and surface water drainage into the basin. Wetlands on a slope that are either isolated, associated with a channel, or associated with a spring are assumed to be primarily groundwater supported. These wetlands are constantly draining downslope and will not retain hydrologic support without additional groundwater.

3.23.2.2.3 Libby Creek, East Fork Bull River, and East Fork Rock Creek

Cross sections on Libby Creek (1 mile upstream of Little Cherry Creek), East Fork Rock Creek (1 mile upstream of the confluence with the West Fork Rock Creek), and East Fork Bull River (at the confluence with Isabella Creek) were established to assess indirect effects on wetland vegetation from changes in stream flow (ERO Resources Corp. 2012a). Presence of wetland or riparian vegetation and the width of the vegetation zone along each stream at the cross sections were noted. The relationship between wetted perimeter and flow was determined to estimate changes to wetland vegetation.

3.23.2.2.4 Baseline Data Adequacy

The preceding section summarizes the baseline information collected for wetland resources and the affected environment, and the following sections describe the approaches used by the lead agencies in analyzing potential effects. The subsequent section on the affected environment describes the best available information regarding wetland resources in the analysis area. The KNF and the DEQ determined that the baseline data and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on wetland resources in the analysis area, and to enable the decision makers to make a reasoned choice among alternatives. Section 3.10.2.4, *Additional Data Collection* and Appendix C describe the additional wetland resources data that would be collected during all phases of the project, including the Evaluation Phase and for final design. The agencies did not identify any incomplete or unavailable information, as described in section 3.1.3, *Incomplete and Unavailable Information*.

3.23.2.3 Impact Analysis

3.23.2.3.1 Direct Effects

Impacts of the mine alternatives on wetlands and streams were determined by calculating the number of acres that would be disturbed. For analysis purposes, the lead agencies used a disturbance area to assess effects on surface resources. The disturbance area surrounding both impoundment areas encompassed most of the wetlands and streams downstream of the impoundment areas. Within the disturbance areas are facility boundaries that include the footprint of the impoundment, dam, seepage collection pond, diversion channel, borrow area, soil stockpiles, and roads. Wetlands within the facility boundary would be filled by project activities while some wetlands and other waters in the disturbance area that are not within the facility boundary may be avoided during final design. The effects within the disturbance area boundary are presented as the total potential effects for this EIS.

Wetland mapping did not distinguish open water channels from adjacent wetlands along stream channels. For example, wetlands along Little Cherry Creek as well as the Little Cherry Creek channel were mapped as riverine wetlands. To differentiate effects on wetlands from open water, open water and channel width were subtracted from the wetland information provided by Westech and Geomatrix and incorporated into the impact analysis. An average channel width of 5.5 feet was used for Little Cherry Creek and an average width of 3 feet was used to calculate riparian corridor wetlands for the four drainages within the Poorman Impoundment Site (Geomatrix and Kline Environmental Research 2011).

As a basis for comparing transmission line alternatives, acreage of all wetlands and streams within the transmission line clearing area was calculated. Direct effects on wetlands and streams are expected to be mostly avoided by placement and location of the substation, loop line, and transmission structures outside of wetlands and streams. Unavoidable direct effects on wetlands would be determined during final design.

3.23.2.3.2 Indirect Effects

Indirect effects on wetlands near the impoundment sites from a pumpback well system were assessed by determining the primary supportive hydrology of wetlands (groundwater or surface water) (ERO Resources Corp. 2013b) and determining which groundwater-supported wetlands would be potentially affected by groundwater drawdown from a pumpback well system. In its analysis, ERO assumed that wetlands located in topographic depressions and closed basins were primarily surface water supported. These wetlands collect and hold precipitation, snow melt, and surface water drainage into the basin. Wetlands on a slope that are either isolated, associated with a channel, or associated with a spring were assumed to be primarily groundwater supported. These wetlands are constantly draining downslope and will not retain hydrologic support without additional groundwater.

MMC evaluated a pumpback well system for the Poorman Impoundment in Alternative 3 using a 3D groundwater model (Geomatrix 2010c). The lead agencies assumed any wetland within the 1-foot drawdown contour was potentially at risk of losing hydrologic support. The drawdown from the Poorman Impoundment would extend to Little Cherry Creek on the north and 5,000 feet to the south of the dam crest (Figure 73). A pumpback well system for the Little Cherry Creek impoundment in Alternatives 2 and 4 was not modeled. The lead agencies assumed drawdown from a pumpback well system in the Little Cherry Creek impoundment in Alternatives 2 and 4, if installed, 4 would extend from Bear Creek to 5,000 feet to the south of the dam crest.

The *Geology and Geochemistry and Groundwater Hydrology* sections discuss the geology of the impoundment sites. A low permeability bedrock ridge separates groundwater flow between the watershed of Little Cherry Creek and those of Drainages 5 and 10 in the Poorman Impoundment Site (Figure 66). NewFields (2014a) concluded that the bedrock ridge would limit drawdown in the Little Cherry Creek watershed, but drawdown could still extend between watersheds unless the bedrock ridge provided a complete barrier to cross-boundary groundwater flow. Wetland impacts were distinguished based on the separation of the wetland by the bedrock ridge from the impoundment. All available geologic and hydrogeologic data from the Little Cherry Creek and in the Poorman Impoundment areas were reviewed and discussed in detail by NewFields (2014a).

In 2009, MMC completed a GDE inventory focusing on areas at or below about 5,600 feet on the north side of the Libby Creek watershed (Geomatrix 2009). Additional inventory in the Libby Creek drainage was conducted in 2010. The additional inventory consisted of inventorying GDEs identified in 2009 (Geomatrix 2010). An inventory of other mine areas, such as the Ramsey Creek, East Fork Rock Creek and East Fork Bull River drainages, was conducted in 2012. Additional areas were inventoried by MMC in 2013, including upper Libby Creek, upper Ramsey Creek and Ramsey Lake, upper East Fork Bull River at and above St. Paul Lake, upper East Fork Rock Creek at and above Rock Lake, and the Libby Lakes basin (MMC 2014d). In 2013, MMC surveyed GDEs, measured flows, collected water quality samples and stable isotope samples, measured groundwater levels in piezometers, and completed vegetation surveys at upper watershed area springs, seeps, streams and lakes, mostly within the CMW. MMC provided data collected in 2013 and 2014 from GDE sites in the CMW (Klepfer Mining Services 2015a). GDE monitoring completed through 2014 in the CMW is summarized in Appendix C.

3.23.3 Affected Environment

3.23.3.1 Wetlands and Streams

In the analysis area, wetlands are primarily located adjacent to low terraces, overflow channels, and scoured depressions along perennial streams. Wetlands are also found in depressions and low gradient swales in the two tailings impoundment sites (Figure 87). Fisher River, Libby Creek, Ramsey Creek, Poorman Creek, Little Cherry Creek, Bear Creek, Howard Creek, Miller Creek, West Fisher Creek, Hunter Creek, Sedlak Creek, and other unnamed drainages are likely waters of the U.S. Section 3.11.3.2.1, *Watershed Descriptions* provides additional descriptions of these drainages. Springs, seeps, and runoff from snowmelt and precipitation result in soil saturation or inundation during spring and early summer. Sidehill and toeslope seeps are present along portions of Little Cherry Creek. These seeps range from small discrete trickles to more extensive zones of saturation along slopes where the seepage zone may extend for more than 100 feet. Sidehill and toeslope seeps are generally saturated late into the growing season.

3.23.3.1.1 Wetland Types

Forest-dominated wetland types (riverine palustrine forested, slope palustrine forested, and depressional palustrine forested) are primarily found along stream corridors and seeps, mostly in the Little Cherry Creek drainage. This wetland type is dominated by western redcedar, western hemlock, and Engelmann spruce. Understory species include devil's club, lady fern, oakfern, arrowleaf groundsel, and common horsetail (Westech 2005e and Geomatrix 2009b).

Scrub-shrub dominated wetlands (slope palustrine scrub-shrub, depressional palustrine scrub-shrub, and riverine palustrine scrub-shrub) support Douglas spirea, thinleaf alder, alder buckthorn, and common snowberry. Understory species include inflated sedge, brown bog sedge, bluejoint reedgrass and common horsetail. Scrub-shrub-dominated wetlands are found along drainages where trees have been removed by logging, around depressions, in logged swales with poor drainage, and in oxbows of the Fisher River (Westech 2005e; Geomatrix 2009b). Scrub-shrub wetlands are found in the Little Cherry Creek, Bear Creek, and Rock Creek drainages.

Herbaceous-dominated wetlands (slope palustrine emergent and depressional palustrine emergent) are wet depressions or slope areas with poorly drained soils. Sedges such as inflated sedge, beaked sedge, and knot-sheath sedge are typically the dominant species with horsetails, rushes, and other graminoids being co-dominants (Westech 2005e; Geomatrix 2009b). Herbaceous-dominated wetlands occur within the Little Cherry Creek and Poorman Impoundment Sites.

3.23.3.1.2 Wetland and Stream Functional Assessment

Category II and III wetlands are the most common functional category and are found throughout the analysis areas. Category I, II, III, and IV wetlands are found along Little Cherry Creek in the Little Cherry Creek Impoundment Site. Category IV wetlands are uncommon and are associated with Little Cherry Creek. Category II and III wetlands are found in the Poorman Impoundment Site (Geomatrix 2010d).

Category II wetlands in the analysis area had high functional ratings for structural diversity, general wildlife habitat, known or potential habitat for special-status wildlife species, and sediment/toxicant removal. Category III wetlands are most common in the analysis area and are present in areas that previously have been logged, and usually are seasonally flooded due to spring snow melt and precipitation.

The Poorman Impoundment streams provide aquatic and riparian habitat to support aquatic, semi-aquatic, and terrestrial biota along the riparian corridor of each drainage. The capacity to provide aquatic and riparian habitat for aquatic, semiaquatic and terrestrial biota is low because the channels are not dynamic. The aquatic habitat is fragmented and riparian vegetation is generally indistinguishable from upland areas. Relative to Libby Creek, the streams moderate streamflow; sequester, degrade, or volatilize pollutants that may occur in the drainages; and retain sediment. These functions are the result of storage, infiltration or evaporation in wetlands, low-gradient swales, and possibly minor contributions from the hyporheic zone alongside and beneath the stream channels.

3.23.3.1.3 Springs

Numerous springs are located in the analysis area. Spring types and locations are described in section 3.10.3, *Affected Environment* in the *Groundwater Hydrology* section. Spring 26 is located at the upper end of a large slope wetland in the Poorman Impoundment Site. Based on a review of data collected on tritium and stable isotopes of oxygen and hydrogen for Spring 26 (Gurrieri 2013; NewFields 2013a), the water from Spring 26 appears to be older than 1950, suggesting the water source is likely a deep aquifer. The location of the spring and wetland on a slope provides further evidence that the water source of the wetland is groundwater (Gurrieri 2013; ERO Resources Corp. 2013). Data from other springs within the Poorman Impoundment Site were not collected.

3.23.3.1.4 Libby Creek, East Fork Bull River, and East Fork Rock Creek

Data collected by KNF on cross sections on Libby Creek, East Fork Bull River, and East Fork Rock Creek indicate these streams are dominated by medium to large cobble and are slightly to moderately entrenched. Vegetation along the banks of Libby Creek is mostly dominated by cottonwood, Douglas-fir, spruce, cedar, alder, and willow. At the cross sections of the East Fork Bull River and East Fork Rock Creek, the vegetation is dominated by western red cedar, mountain maple, black cottonwood, Western hemlock, Pacific yew and grand fir with Devil's club in the understory. The dominant species and the cobbly soils are more characteristic of riparian vegetation. Due to the lack of soil and dominance of species that have a wide moisture tolerance, wetlands that meet the criteria of the Corps are likely absent from the banks of the streams. Because vegetation along these major streams is more characteristic of riparian vegetation, these streams are discussed in section 3.22, *Vegetation* and no further discussion is provided in this section.

3.23.3.1.5 Groundwater Dependent Ecosystems

During the 2013 inventory, MMC identified wetlands, mostly associated with springs or seeps, near lower Libby Lake, upper East Fork Bull River Tributary drainage above Saint Paul Lake, upper East Fork Rock Creek drainage, and upper Libby Creek drainage (MMC 2014d). Wetlands near lower Libby Lake are supported by four separate seeps and have distinctive wetland vegetation including moss and algae. In the upper East Fork Bull River tributary drainage the GDE is a large seep/pond/wetland complex. The upper East fork Rock Creek drainage, a series of seeps run over bedrock and limited wetland vegetation to establish. In the upper Libby Creek drainage, springs and seeps provide the supportive hydrology for wetland with diverse wetland vegetation. Additional wetlands, seeps, and springs may be identified in future inventories if they were required to meet the agencies' requirements described in Appendix C. Effects on these resources would be identified through monitoring described in Appendix C.

3.23.4 Environmental Consequences

3.23.4.1 Alternative 1 – No Mine

The No Mine Alternative would not disturb or affect any wetlands or other waters of the U.S.

3.23.4.2 Alternative 2 – MMC's Proposed Mine

3.23.4.2.1 Direct Effects

Mine Facilities

Alternative 2 would have 35.6 acres of jurisdictional wetlands within the disturbance area, which includes 25.0 acres within the facility boundary (Table 187). Most of these wetlands would be forested wetlands located in the proposed Little Cherry Creek Tailings Impoundment Site. Functional Category I, II, III, and IV wetland types in the Little Cherry Creek Tailings Impoundment Site would be affected. About 1.1 acre of isolated wetlands found in small scattered locations in the Little Cherry Creek Tailings Impoundment Site would be within the disturbance area. These isolated wetlands are generally small depressions resulting from logging activity (Westech 2005e). About 28,355 linear feet of streams would be within the disturbance area of Alternative 2, while 19,700 linear feet would be within the facility boundary (Table 187). Streams and wetlands in Ramsey Creek would be bridged for access to the Ramsey Plant site and would not be affected.

Effects of Mitigation Measures

This section describes the effects of MMC's mitigation measures on wetlands and other waters of the U.S. The agencies' evaluation of MMC's mitigation plan for wetlands and other waters of the U.S. is discussed in 3.23.4.10, *Proposed Mitigation and Monitoring Plans*. As part of Alternative 2, one of the possible fisheries mitigation projects proposed by MMC would be to conduct a sediment-source inventory in the watershed, and stabilize, recontour, and revegetate priority source areas, which are typically roadcuts in Libby, Hoodoo, Poorman, Midas, and Crazyman creeks. Wetland delineations at these sediment source areas have not been completed. Any wetlands and waters of the U.S. disturbed during the implementation of this mitigation are not listed in Table 187. If implemented, this mitigation in the short term would increase sedimentation in area streams and adjacent wetlands and waters of the U.S. Over the long term, this mitigation may increase the function and services of any associated wetlands and would decrease sediment delivery to waters of the U.S.

Table 187. Wetlands and Streams within Mine Alternative Disturbance Areas.

Facility†	Alternative 2 – MMC's Proposed Mine		Alternative 3 – Agency Mitigated Poorman Impoundment		Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment	
	Disturbance Area	Facility Boundary	Disturbance Area	Facility Boundary	Disturbance Area	Facility Boundary
	Area of Jurisdictional Wetlands (acres)§					
Impoundment Site*	35.2	24.6	9.0	8.6	36.5	22.3
Plant Site	0.2	0.2	0.0	0.0	0.0	0.0
Roads	0.2	0.2	0.2	0.2	0.2	0.2
Subtotal	**35.6**	**25.0**	**9.2**	**8.8**	**36.7**	**22.5**
	Area of Isolated Wetlands (acres)§					
Impoundment Site*	1.1	0.5	3.3	2.9	1.1	0.5
Plant Site	0.0	0.0	0.1	0.1	0.1	0.1
Roads	<0.1	<0.1	0.1	0.1	<0.1	<0.1
Libby Adit Site	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Subtotal	**1.3**	**0.7**	**3.5**	**3.1**	**1.2**	**0.6**
Total Area	**36.9**	**25.7**	**12.7**	**11.9**	**37.9**	**23.1**
	Stream Length (linear feet)					
Impoundment Site*	27,715	19,700	13,272	9,787	26,694	17,481
Roads	640	0	1,059	0	1,059	0
Total	**28,355**	**19,700**	**14,331**	**9,787**	**27,753**	**17,481**

The jurisdictional status of the wetlands and streams is based on the Corps' preliminary and approved jurisdictional determinations (Corps 2008c, 2013b, 2014). Impacts by jurisdictional status may change during the 404 permitting process.

Units for areas are rounded to the nearest 0.1 acre; units for stream length are rounded to the nearest whole number; subtotals may vary by 0.1 acre due to rounding.

†The adits would not affect any wetlands or streams in any alternative; although bridges would be constructed for road crossings on Ramsey, Poorman, and Bear creeks and would likely not affect wetlands or streams Effects are included under the disturbance area boundary effects.

§Area of streams has been subtracted from the area of wetlands.

*Impoundment site includes the impoundment footprint, dam, seepage collection pond, diversion channel, borrow area, soil stockpiles, and some roads.

Source: GIS analysis by ERO Resources Corp. using wetland data in Westech 2005e, Geomatrix 2009b, Kline Environmental Research 2012.

3.23.4.2.2 Indirect Effects

NEPA regulations define indirect effects as "…effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." (40 CFR 1508.8). The discussion of indirect effects on wetlands in Alternatives 2, 3, and 4 is consistent with the NEPA definition. Under the 404(b)(1) Guidelines (40 CFR 230.11(h)(1)), "secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered before the time final section 404 action is taken by permitting authorities." The Corps indicated to the KNF that mine dewatering and operation of a pumpback well system are not within its scope of analysis and the effects of these activities will not be considered in its 404 permit decision. Consequently, the Corps will not require mitigation for indirect effects of mine dewatering and operation of a pumpback well system.

Mine Dewatering

Indirect effects on wetlands, springs, and seeps may occur during mine dewatering. The indirect effect on wetlands, spring, and seep habitat overlying the mine would be similar in all mine action alternatives and difficult to predict (see section 3.10.4.2.1, *Evaluation through Operations Phases*). The effect on plant species, functions, and services associated with the affected wetlands, springs, or seeps by a change in water level would be best determined by relating plant species with water abundance and quality for monitoring and evaluation. Alternative 2 does not include a survey of plant species abundance (all species) before activity and subsequent plant species abundance and water monitoring of GDEs overlying the mine. Without this type of monitoring, mining-induced changes in water level or quality may result in an unidentified loss of species, functions, and services associated with the affected wetlands, springs, or seeps.

In the upper watershed, wetlands at Rock Creek Meadows are not expected to be indirectly affected by mining or dewatering. The 3D model predicted the greatest surface flow reduction of 0.43 cfs on East Fork Rock Creek where it enters Rock Creek Meadows 16 years after mine closure (Klepfer Mining Service 2012). Although this would be a 20 percent reduction in baseflow, a perennially high water table and other tributaries that flow into Rock Creek Meadows that would not be affected by mining provide the primary hydrologic support for wetlands at Rock Creek Meadows.

Watershed Modification and Seepage Control Systems

Several wetlands and springs are present between the proposed Little Cherry Creek Tailings Impoundment and Libby Creek. Precipitation and runoff captured by the tailings impoundment and the Seepage Collection Dam would no longer flow to the former Little Cherry Creek. The pumpback well system if installed to collect seepage not collected by the underdrain system would likely lower groundwater levels and reduce groundwater discharge to springs, seeps, and wetlands downgradient of the impoundment. Flow below the Seepage Collection Dam in the former Little Cherry Creek channel would be substantially reduced. The agencies estimated the following indirect effects on streams and wetlands below the disturbance area boundary:

- Reduced flow to 2,757 linear feet of Little Cherry Creek below the Seepage Collection Dam to Libby Creek all on private land. 290 linear feet occur within the disturbance area boundary and are accounted for in Table 187. The 2,467 linear feet of Little Cherry Creek that would be indirectly affected are not accounted for in Table 187 or Table 188.

- Reduced flow to 1,395 linear feet of a small tributary to Little Cherry Creek below the disturbance area boundary all on private land. This indirect effect has not been accounted for in Table 187 or Table 188.

- Reduced flow to 987 linear feet of a tributary to Libby Creek below the disturbance area boundary on National Forest System land and 549 linear feet on private land. These indirect effects have not been accounted for in Table 187 or Table 188.

- The combined total of indirect effects on the drainages that occur outside of the disturbance area boundary not accounted for in Table 187 or Table 188 would be 5,398 linear feet, of which 987 linear feet would be on National Forest System land.

- Reduced flow to 0.4 acre of wetland associated with the drainages below the disturbance area boundary that occur on National Forest System lands. Another 1.3 acre of wetlands associated with the drainages below the disturbance area boundary are on private land. These indirect wetland effects have not been accounted for in in Table 187 or Table 188.

In Alternative 2, MMC committed to implementing seepage control measures at the impoundment, such as pumpback recovery wells, if required to comply with applicable standards. Seepage pumpback wells could be installed along the downstream toe of the tailings dam. The wells may require active pumping, depending on the artesian pressures within the wells (Klohn Crippen 2005). A subsurface bedrock ridge occurs south of the impoundment dam (see discussion in the *Groundwater Hydrology* section). If MMC installed a pumpback well system, the effects on groundwater from pumping may be reduced or eliminated south of the bedrock ridge. Based on the assessment of groundwater-supported wetlands within a potential drawdown area north of the bedrock ridge from the disturbance area boundary to Bear Creek, no jurisdictional wetlands on National Forest System land would be indirectly affected (Table 188). About 1.2 acres of jurisdictional wetland north of the ridge on National Forest System land would require more data to determine supportive hydrology. South of the ridge, an additional 0.6 acre of jurisdictional groundwater-supported wetland occurs on National Forest System land. Disregarding the bedrock ridge, a total of 1.8 acres of jurisdictional wetlands and 0.2 acre of isolated wetland on National Forest System land would be potentially indirectly affected. Wetlands north of the Little Cherry Creek Impoundment Site and south of Bear Creek have not been delineated for Alternative 2; therefore, the number of wetland acres potentially indirectly affected may be greater than what is shown in Table 188.

MMC would monitor effects on existing wetlands downstream of the tailings impoundment. Monitoring of the downstream wetland areas would be completed annually for the first 5 years of mine operation. If functions and services of downstream wetlands were adversely affected, MMC, in cooperation with the lead agencies and the Corps, would develop additional wetland mitigation. MMC did not propose monitoring wetlands north or south of the impoundment. MMC's proposed monitoring would not adequately detect potential changes to wetlands from the operation of the impoundment and pumpback well system.

Temporary indirect effects on wetlands and streams may occur during construction of the proposed Little Cherry Creek Tailings Impoundment and associated facilities due to increased sediment contributions to wetlands and streams Proposed BMPs would reduce or eliminate sediment contributions to wetlands and streams.

The flow in the unnamed drainages into which upper Little Cherry Creek would be diverted (Drainages 5 and 10) would increase and would change to perennial flow throughout their length. The drainages are not large enough to handle the expected flow volumes and downcutting and increased sediment delivery to Libby Creek would occur as the channel stabilized. Where possible, MMC would construct some bioengineering and structural features in the two drainage channels to reduce flow velocities, stabilize the channels, and create fish habitat. Short sections of these two channels are very steep, and it may be difficult to access such sections to complete any channel stabilization work. In addition, some sections of these two channels have very thick vegetation that may require clearing, which may create erosion and increase sediment delivery to the channels. Over time, the channels would stabilize and provide increased water for wetlands adjacent to the channels. The section that is currently intermittent probably would support wetlands where flow became perennial.

Table 188. Potential Indirect Wetland Effects from Groundwater Drawdown in the Tailings Impoundment Area.

Primary Hydrologic Support	Alternative 2 – MMC's Proposed Mine				Alternative 3 – Agency Mitigated Poorman Impoundment				Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment			
	North of Bedrock Ridge§ (ac)		South of Bedrock Ridge† (ac)		South of Bedrock Ridge§ (ac)		North of Bedrock Ridge† (ac)		North of Bedrock Ridge§ (ac)		South of Bedrock Ridge† (ac)	
	NFS	Private	NFS	Private	NFS	Private	NFS	Private	NFS	Private	NFS	Private
Jurisdictional Wetlands												
Groundwater-supported	0.0	0.0	0.6	0.0	2.5	0.0	1.2	0.6	0.0	0.0	0.2	0.0
Surface water-supported	0.0	0.0	1.6	0.0	0.0	0.0	1.6	0.0	0.0	0.0	1.6	0.0
Needs more data	1.2	0.0	0.0	0.0	0.0	0.0	5.8	6.2	1.2	0.0	0.0	0.0
Subtotal	*1.2*	*0.0*	*2.2*	*0.0*	*2.5*	*0.0*	*8.6*	*6.8*	*1.2*	*0.0*	*1.8*	*0.0*
Isolated Wetlands												
Groundwater-supported	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.2	0.0	<0.1	0.2	0.0
Surface water-supported	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	<0.1	0.0
Subtotal	*0.0*	*0.0*	*0.2*	*0.0*	*0.0*	*0.0*	*0.1*	*0.2*	*0.0*	*<0.1*	*0.2*	*0.0*
Total	**1.2**	**0.0**	**2.4**	**0.0**	**2.5**	**0.0**	**8.7**	**7.0**	**1.2**	**0.3**	**2.0**	**0.0**

§Wetlands have not been delineated for Alternatives 2 and 4 north of the Little Cherry Creek Impoundment Site and south of Bear Creek or for Alternative 3 south of Poorman Creek; the number of wetland acres could potentially increase after more thorough wetland mapping.
†These wetlands may not be affected if a bedrock ridge and hydrologic divide separates the impoundment from the wetlands
Source: GIS analysis by ERO Resources Corp. using data from ERO Resources Corp. (2013).

3.23.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

3.23.4.3.1 Direct Effects

Mine Facilities

Alternative 3 would have 9.2 acres of jurisdictional wetlands, 3.5 acres of isolated wetlands, and 14,331 linear feet of streams within the disturbance area (Table 187). Functional Category II and III wetland types would be affected in the Poorman Impoundment Site. Because the Poorman Impoundment would not require diversion of a perennial stream, Alternative 3 would affect fewer wetlands compared to Alternatives 2 and 4 (Figure 87). Effects on wetlands within the facility boundary only, including additional access roads, would be 8.8 acres. These wetlands would not be filled by the tailings but are within the disturbance area and likely would be filled by access roads or other project facilities. During final design, MMC would avoid wetlands to the extent practicable.

Effects of Mitigation Measures

This section describes the effects of the agencies' mitigation measures on wetlands and other waters of the U.S. The agencies' evaluation of the agencies' mitigation plan for wetlands and other waters of the U.S. is discussed in 3.23.4.10, *Proposed Mitigation and Monitoring Plans*. MMC would continue to plow the Libby Creek Road (NFS road #231) and the Upper Libby Creek Road (NFS road #2316) year-round during the 2-year evaluation program and the 1-year period during reconstruction of the Bear Creek Road. Culverts along all access roads that pose a substantial risk to riparian conditions would be replaced as necessary to comply with INFS standards and guidelines and Forest Service guidance, such as fish passage or conveyance of adequate flows (USDA Forest Service 2008a, 2015b). Any work in a RHCA along an access road would be completed in compliance with INFS standards and guidelines. The mitigation would increase sedimentation in area streams and adjacent wetlands and waters of the U.S. in the short term. Over the long term, the mitigation may increase the function and services of any associated wetlands and would decrease sediment delivery to waters of the U.S.

The Grizzly Bear Mitigation Plan for Alternative 3 would include 20.3 miles of proposed access changes during the Evaluation Phase and up to 20.1 miles of proposed access changes during the Construction Phase in the Rock Creek, Libby Creek, and Miller Creek watersheds (Figure 35). The Plan also would require MMC to acquire 5,387 acres of land for habitat replacement. Habitat enhancement, such as access changes and trail conversions, may be implemented on the acquired lands. Wetland delineations along the roads and trails proposed for access changes have not been completed. MMC would build and maintain gates or barriers on the roads, and complete other activities so that the roads would either be removed from service or cause little resource risk if maintenance were not performed on them during the operation period of the mine and before their future need. In most cases, culverts would be removed; such removals would occur in active stream channels requiring instream work, structure placement, and fill removal. The effect would be the same as described for road improvements along the Libby Creek Road and the Upper Libby Creek Road.

Post-Closure, a channel would be excavated through the tailings and Saddle Dam abutment to route runoff from the site toward a tributary of Little Cherry Creek. The increased flow would provide support to wetlands adjacent to Little Cherry Creek. Wetlands may develop in the unnamed tributary of Little Cherry Creek below the Saddle Dam abutment.

3.23.4.3.2 Indirect Effects

Mine Dewatering

Indirect effects on wetlands, springs, and seeps may occur during mine dewatering and would be similar in all alternatives. Based on preliminary estimates of hydraulic properties of the bedrock and Rock Lake Fault, Evaluation Phase mining activities in Alternatives 3 and 4 would be limited to within 300 feet of the Rock Lake Fault and 1,000 feet of Rock Lake to minimize the risk of high water inflow rates and resulting reduction in groundwater levels and surface resources. In Alternative 3, MMC would complete a GDE inventory and conduct GDE monitoring in an area overlying the proposed mine and adits to evaluate indirect wetland effects (see section C.10, *Water Resources* of Appendix C). The inventory, which began in 2009, includes a vegetation survey to describe and document existing vegetation characteristics and establish a prevalence index used by the Corps to determine wetland vegetation (Corps 2008d). The prevalence index would be used to assess changes in vegetation composition and if a loss of wetland species was occurring. The monitoring would not alter the effect of Alternative 3 but would assist in determining if an impact was occurring and the scale of any impact. Other temporary indirect effects of construction would be the same as Alternative 2.

Watershed Modification and Seepage Control Systems

About 0.2 acres of riparian corridor wetlands occur below the disturbance area boundary on Drainages 3 and 14. These riparian corridor wetlands would be indirectly affected by changes in hydrology related to a change in their watershed and filling of perennial springs. The 0.2-acre of indirect wetland effect would be mitigated at the Swamp Creek site.

Segments of Drainages 3, 5, 10, and 14 are found below the impoundment (Figure 87). Intermittent and/or perennial flow in the channels would likely be either reduced or eliminated. The agencies estimated the following indirect effects to streams in the Poorman Impoundment Site:

- Reduced flow to 2,326 linear feet of Drainage 3 between the Tailings Impoundment and Libby Creek. 1,164 linear feet are within the disturbance area boundary and have been accounted for in Table 187; 1,162 linear feet of Drainage 3 are outside of the disturbance area boundary and not accounted for in Table 187.
- Reduced flow to 559 linear feet of Drainage 5 between the Tailings Impoundment and the Seepage Collection Pond. All of this effect is accounted for in the disturbance area impacts shown in Table 187.
- Reduced flow in 1,364 linear feet of Drainage 10. Of the 1,364 feet, 235 linear feet are below the disturbance area boundary and have not been accounted for in Table 187. 1,129 linear feet are within the disturbance area boundary and have been accounted for in Table 187.
- Reduced flow in 3,963 linear feet of Drainage 14 between the Tailings Impoundment and Libby Creek. The disturbance area impacts shown in Table 187 accounts for 633 linear feet of this effect.
- The combined total of indirect effects on the four drainages that occur outside of the disturbance area boundary would be 4,727 linear feet.

MMC used a 3D model to predict the effect of the pumpback wells on the impoundment site's hydrology. To the north, the model predicted that the drawdown from the wells would extend to

Little Cherry Creek, potentially affecting wetlands between the Poorman Impoundment Site and Little Cherry Creek. NewFields concluded that the bedrock ridge would limit drawdown in the Little Cherry Creek watershed, but drawdown could still extend between watersheds unless the bedrock ridge provided a complete barrier to cross-boundary groundwater flow. According to NewFields (2014a), perched groundwater conditions occur beneath most wetlands in Little Cherry Creek and in the Poorman Impoundment areas and the hydrologic support for the wetlands appears to be direct precipitation and upgradient runoff water that infiltrates into the subsurface. NewFields concluded the operation of the pumpback wells would have little or no effect on most wetlands in the Little Cherry Creek watershed.

Section 3.10.4.2 indicates operation of a pumpback well system may not affect groundwater levels and five of the springs south of Little Cherry Creek because of an apparent subsurface bedrock ridge that separates groundwater flow between the watershed of Little Cherry Creek from those of Drainages 5 and 10 in the Poorman Impoundment Site (Chen Northern 1989). Because geologic and hydrologic data from the area between the Little Cherry Creek and Poorman drainages are limited, they are not sufficient to eliminate the possibility of the pumpback well system adversely affecting surface resources, particularly groundwater-supported wetlands. The agencies are not proposing mitigation for indirect wetland effects from the pumpback wells until more investigation indicates that they would be adversely affected. The rationale for not proposing mitigation for indirect wetland effects from the pumpback wells is discussed in a following section (*Mitigation for Other Potential Indirect Effects*).

In 2012, MMC installed shallow piezometers in each of four wetlands (LCC-29, LCC-35A, LCC-36, and LCC-39A) south of Little Cherry Creek. One piezometer was installed in wetlands LLC-29 and LLC-36, two piezometers were installed in wetland LLC-35A, and three piezometers were installed in wetland LLC-39A. Water levels for five of the piezometers were measured in November 2012, two of which were dry. Water levels in the piezometers would continue to be measured monthly April through September. The purpose of the monitoring would be to assess effects on wetlands. Vegetation in these four wetlands also would be monitored, following the methods used for the GDE monitoring (see section C.10.4.2, *Groundwater Dependent Ecosystem Monitoring* in Appendix C). The monitoring would continue through the Closure Phase as long as the pumpback well system operated.

Springs SP-14 and SP-15 (Figure 70) adjacent to the impoundment site would be monitored for flow. The flow of each spring would be measured twice, once in early June or when the area was initially accessible, and once between mid-August and mid-September during a time of little or no precipitation. The monitoring would begin 1 year before construction and continue through the Closure Phase as long as the pumpback well system operated. The most accurate site-specific method for measuring spring flow would be used.

3.23.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

3.23.4.4.1 Direct Effects

Mine Facilities

Alternative 4 would directly affect 36.7 acres of jurisdictional wetlands, 1.2 acres of isolated wetlands, and 27,753 linear feet of streams within the disturbance area (Table 187). Most effects would be in the Little Cherry Creek Impoundment Site. Functional Category I, II, III, and IV wetlands would be affected in the Little Cherry Creek Impoundment site.

Effects of Mitigation Measures

The same mitigation measures described in Alternative 3 would be implemented in Alternative 4, except for the post-closure development of a channel to route runoff from the site toward a tributary of Little Cherry Creek. Any wetlands and streams disturbed during the implementation of the mitigation measures are not shown in Table 187. In the short term, these activities would increase sedimentation in area streams and adjacent wetlands and streams. After the activities were completed, and the roads became stabilized, these mitigation measures would increase the function and services of any associated wetlands and would decrease sediment delivery to streams. Access changes for grizzly bear mitigation would be the same as Alternative 3; MMC would acquire 6,151 acres of land for mitigation. The agencies' mitigation plan for wetlands and other waters of the U.S. is discussed in section 3.23.4.10, *Proposed Mitigation and Monitoring Plans*.

3.23.4.4.2 Indirect Effects

Mine Dewatering

To account for indirect effects on wetlands, springs, and seeps from mine dewatering, a GDE inventory of an area overlying the mine area, subsequent monitoring of GDEs, and implementation of any mitigation would be completed in Alternative 4, as described in Alternative 3.

Watershed Modification and Seepage Control Systems

Flow from springs SP-02, SP-10, S-12, SP-14, SP-15, and SP-29 (shown on (Figure 40) would be measured twice, once in early June when the area was initially accessible, and once between mid-August and mid-September 1 year before construction began. Springs SP-02 and SP-15 would not be monitored if they were covered by impoundment facilities. Samples from these springs would be collected 1 year before construction and analyzed for selected water quality parameters. Sampling would be repeated every 2 years until tailings disposal ceased. At each spring, a vegetation survey would be completed 1 year before construction; the use of a prevalence index to monitor changes in plant species would be the same as Alternative 3.

MMC would monitor three wetlands, LCC-24, LCC-25, and LCC-39 (shown on Figure 40), if these wetlands were not filled by project activities. MMC would use the procedures established for monitoring wetland mitigation sites described in Alternative 3 to assess vegetation characteristics and establish a prevalence index. A prevalence index would be used to assess changes in vegetation composition and to detect a loss of wetland species. Samples from any standing water in these three wetlands would be collected in mid-summer 1 year before construction began and analyzed for selected parameters. Sampling would be repeated in mid-summer every 2 years until tailings disposal ceased. The mitigation would not alter the effect of Alternative 4, but would assist in determining if an impact were occurring and the scale of any impact.

Other indirect effects would be similar to Alternative 2 but less than 0.1 acre of isolated groundwater-supported wetlands would potentially be affected by groundwater drawdown north of the ridge on National Forest System land. An additional 1.2 acres of wetlands would require additional data before determining if groundwater is the primary hydrologic support and would potentially be affected. Effects on stream channels and associated wetlands on National Forest System land below the Seepage Collection Pond would be the same as Alternative 2 except that 1,244 linear feet of channel (257 linear feet more than in Alternative 2) and 0.7 acre of wetland (0.3 acre more than in Alternative 2) would be indirectly affected below the disturbance area boundary. On private land, the total linear feet of channel that would be indirectly affected would be 4,464 linear feet (53 linear feet more than in Alternative 2) and the total acres of wetland would be 1.3 (same as Alternative 2).

3.23.4.5 Alternative A – No Transmission Line

Because construction of the transmission line, substation and loop line would not occur, the No Transmission Line Alternative would have no direct or indirect effects on wetlands or streams.

3.23.4.6 Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

A total of 3.6 acres of wetlands and 4,822 linear feet of streams would be within the Alternative B transmission line clearing area (Table 189). Less than 0.1 acre of wetlands and 289 linear feet of streams would be affected by new or upgraded road construction. The need for culverts or other crossing types at streams would be determined during final design. Indirect effects on wetlands from road construction would be minimized by use of drive-through dips, open-top box culverts, waterbars or crossdrains, and implementation of BMPs. After an alignment was selected and the final wetland surveys were completed, any wetlands affected by the transmission line and access roads may be subject to conditions of the 318 authorization, and, where significant impacts occur, MFSA certification requirements if not covered by other mitigations. MMC would follow its proposed Environmental Specifications (MMI 2005b) and use BMPs during construction to minimize impacts. The BPA would avoid all wetlands at the Sedlak Park Substation Site.

3.23.4.7 Alternative C-R – Modified North Miller Creek Transmission Line Alternative

A total of 2.0 acres of wetlands and 1,922 linear feet of streams would be within the clearing area of Alternative C-R (Table 189). The amount of wetlands in the clearing area of Alternative C-R is the same as Alternatives D-R and E-R; Alternative C-R would have the least effect on streams compared to the other alignments. Indirect and direct effects on wetlands and streams would be avoided where practicable during structure placement. Less than 0.1 acre of wetlands would be affected by new or upgraded road construction. Indirect effects would be minimized through BMPs and appropriate stream crossings, described in the agencies' Environmental Specifications (Appendix D).

Table 189. Wetlands and Streams within Clearing Area of the Transmission Line Alternatives.

Project Component	Alternative B – North Miller Creek	Alternative C-R – Modified North Miller Creek	Alternative D-R – Miller Creek	Alternative E-R – West Fisher Creek
Area of Jurisdictional Wetlands (acres) †				
Transmission Line Clearing	3.6	2.0	2.0	2.0
New or Upgraded Roads	0.1	0.1	0.1	0.1
Total Area	3.7	2.1	2.1	2.1
Area of Isolated Wetlands (acres)				
Transmission Line Clearing	<0.1	0.0	0.0	0.0
New or Upgraded Roads	0.0	0.0	0.0	0.0
Total Area	<0.1	0.0	0.0	0.0
Stream Length (linear feet)				
Transmission Line Clearing	4,822	1,922	2,935	3,380
New or Upgraded Roads	289	0	0	0
Total Linear Feet	5,111	1,922	2,935	3,380

The jurisdictional status of the wetlands and streams is preliminary and impacts may change during the 404 permitting process.
Units for areas are rounded to the nearest 0.1 acre; units for stream length are rounded to the nearest whole number
†Acreage is based on a 150-foot clearing width for monopoles (Alternative B) and 200-foot width for H-frame structures (all other alternatives except for a short segment of the West Fisher Creek Alternative E-R that has monopoles). Actual acreage cleared would be less than listed and would depend on tree height, slope, and line clearance above the ground.
Source: GIS analysis by ERO Resources Corp. using MMC data.

3.23.4.8 Alternative D-R – Miller Creek Transmission Line Alternative

A total of 2.0 acres of wetlands and 2,935 linear feet of streams would be within the clearing area of Alternative D-R (Table 189). No wetlands or streams would be affected by new or upgraded road construction. Indirect effects would be minimized through BMPs and appropriate stream crossings, described in the agencies' Environmental Specifications (Appendix D).

3.23.4.9 Alternative E-R – West Fisher Creek Transmission Line Alternative

A total of 2.0 acres of wetlands, and 3,380 linear feet of streams would be within the clearing area of Alternative E-R (Table 189). No wetlands or streams would be affected by new or upgraded road construction. Indirect effects would be minimized through BMPs and appropriate stream crossings, described in the agencies' Environmental Specifications (Appendix D).

3.23.4.10 Proposed Mitigation and Monitoring Plans

A variety of measures would be used to avoid, minimize, or mitigate wetland effects during construction and operation. These measures would include BMPs, such as silt fence, revegetation of disturbed areas, and restoration of temporary wetland effects. Transmission line structures would be placed to avoid wetlands.

The Corps would be responsible for developing final mitigation requirements for jurisdictional waters of the U.S. including wetlands, depending on the functions and services of the affected wetlands and streams. MMC used the MDT functional units method, the Corps' acreage ratio method, the MDT and hydrogeomorphic functions/services assessment, and the Montana Stream Mitigation Procedure to evaluate the amount of compensation needed for direct effects on wetlands and other waters of U.S. (MMC 2014a). Projects that implement mitigation before project losses would have a lower mitigation requirement than projects that implement mitigation concurrently or after wetland losses have occurred. The Corps typically does not establish mitigation requirements for non-jurisdictional wetlands. The agencies require mitigation for non-jurisdictional wetlands in Alternatives 3 and 4.

Proposed mitigation is considered either on-site or off-site. According to the compensatory mitigation regulations, on-site means an area located on the same parcel of land as the impact site, or on a parcel of land contiguous to the impact site. Off-site means an area that is neither located on the same parcel of land as the impact site, nor on a parcel of land contiguous to the parcel containing the impact site. The Corps is responsible for determining if a mitigation site is considered on-site or off-site.

3.23.4.10.1 Alternative 2 – MMC's Proposed Mine

MMC wetland mitigation plan would involve on-site and off-site locations. MMC proposes to replace forested and herbaceous wetlands at a 2:1 ratio and herbaceous/shrub wetlands at a 1:1 ratio. Annual monitoring of mitigation sites would ensure mitigation sites were dominated by hydrophytic vegetation and had comparable functions and services to the affected wetlands although no forested wetlands are proposed to replace the affected forested wetlands. Vegetation, soils, and hydrology data would be collected annually until the Corps has determined that wetland mitigation success was achieved. On-site mitigation opportunities would involve wetland restoration and wetland creation. Opportunities for wetland mitigation include sites along Little Cherry Creek. A total of 8.8 acres of on-site mitigation is proposed for Alternative 2 (Table 190) (Figure 20). Off-site mitigation would occur outside the permit area boundary. A total of 35.8 acres of off-site mitigation is proposed mitigate for effects associated with Alternative 2 (Table 190). Acreages shown in Table 190 for Alternative 2 are those presented in MMC's Plan of Operations and Hard Rock Operating Permit Application, and do not include those at the Swamp Creek site that MMC could use if acquired by MMC. Most of the mitigation sites would be located in the Poorman Creek area.

NMC's 1993 404 permit included more detailed designs for the North Poorman, South Poorman, and Ramsey creek sites (Corps 1993). The Poorman Weather Station mitigation site was not included in NMC's 1993 404 permit and the feasibility of creating 14 acres that replaced the lost functions of the wetlands affected by Alternative 2 is uncertain.

In all alternatives, the Corps would develop final mitigation requirements for jurisdictional wetlands and other waters of the U.S. In 2008, the Corps and the EPA issued regulations (33 CFR 332 and 40 CFR 230 Subpart J) regarding compensatory mitigation requirements for losses of aquatic resources, such as wetlands. These regulations require in cases where appropriate functional or condition assessment methods or other suitable metrics are available, these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used. Before issuance of the 2008 regulations, the Corps in Montana used ratios for various mitigation types in determining compensation requirements (Corps 2005a). The Corps developed a stream mitigation procedure for projects adversely affected streams in 2010 and revised it in 2013 (Corps 2013a). MMC's plan is conceptual and would be refined during the 404 permitting process. MMC did not update its mitigation plan for Alternative 2 to reflect the new regulations and stream mitigation procedure.

Table 190. Jurisdictional Wetland Mitigation Opportunities by Alternative.

Mitigation Type and Site Name	Alternative 2 – MMC's Proposed Mine	Alternative 3 – Agency Mitigated Poorman Impoundment	Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment
On-Site			
Little Cherry Creek	2.2	0.0	0.0
Little Cherry Creek Diversion Channel	1.6	0.0	0.0
Unspecified Little Cherry Creek Site	5.0	0.0	0.0
Total On-Site	**8.8**	**0.0**	**0.0**
Off-Site			
North Poorman Creek	3.4	0.0	3.4
South Poorman Creek	9.7	0.0	9.7
Poorman Weather Station	14.0	0.0	14.0
Libby Creek Recreational Gold Panning Area	2.0	0.0	0.0
Ramsey Creek	6.7	0.0	6.7
Swamp Creek	0.0	15.0	15.0
Total Off-Site	**35.8**	**15.0**	**48.8**
Total Mitigation	**44.6**	**15.0**	**48.8**

All units are rounded to the nearest 0.1 acre.
Wetlands mitigation sites are shown for Alternative 2 on Figure 20 and for Alternatives 3 and 4 on Figure 33 and Figure 34.
The Corps is responsible for determining if a mitigation site is considered on-site or off-site.
Source: GIS analysis by ERO Resources Corp. using MMC data.

3.23.4.10.2 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

The agencies' Wetland Mitigation Plan for Alternative 3 is described in section 2.5.7.1, *Jurisdictional Wetlands and Other Waters of the U.S.* MMC would implement the following mitigation as part of the wetland mitigation for 9.2 acres of direct effects and 0.2 acre of indirect effects (downgradient of the disturbance area boundary) on wetlands from Alternative 3 (MMC 2014a):

- Rehabilitate 15 acres of wetland at the Swamp Creek site (Figure 34)
- Preserve 3 acres of upland vegetated buffer at the Swamp Creek site

MMC would implement the following stream mitigation (MMC 2014a):

- Reconstruct three existing channels at the Swamp Creek site to add meanders and to raise the channel bottom, adding 6,500 linear feet of stream
- Replace a culvert on Little Cherry Creek with a bottomless, arched culvert

- Replace a culvert on Poorman Creek with a bottomless arched culvert
- Stabilize 400 feet of erosion on NFS road #6212
- Remove a bridge across Poorman Creek and re-establish floodplain
- Remove 21 culverts and restore adjacent riparian habitat on lands acquired for grizzly bear mitigation

The Corps will determine the final mitigation requirements with the objective of replacing lost functions and services of the affected wetlands. The Corps will determine if the mitigation sites would be sufficient to meet the mitigation requirements for 9.2 acres of direct effects and 0.2 acre of indirect effect on jurisdictional wetlands, and the KNF will make the same determination for non-jurisdictional wetlands. MMC would submit more detailed plans for the selected jurisdictional mitigation sites for final approval by the Corps. Similar more detailed plans would be submitted to the KNF for isolated wetland mitigation sites.

The following sections briefly describe the wetland and stream mitigation proposed for Alternative 3, the basis for the anticipated hydrologic support for the mitigation site, the anticipated improvement in function and services that would be provided by the mitigation sites, and the anticipated credits associated with each site. A longer description of the proposed mitigation is found in section 2.5.7.1, *Jurisdictional Wetlands and Other Waters of the U.S.* in Chapter 2, with a full description provided in MMC's revised Mitigation Design Report (MMC 2014a). The anticipated improvement in function and services is based on MMC's revised Mitigation Design Report (MMC 2014a). The Corps is responsible for determining the amount of required compensatory mitigation necessary to replace lost jurisdictional wetland and stream functions and services. The Corps will determine compliance of the proposed discharges of fill with the 404(b)(1) Guidelines. The Corps will discuss compliance with the 404(b)(1) Guidelines in its ROD or Statement of Findings on the Section 404 permit. The Corps' findings regarding the least environmentally damaging practicable alternative and compliance with the 404(b)(1) Guidelines are subject to EPA's review.

Jurisdictional Wetland Mitigation

Swamp Creek Site

The Swamp Creek site is about 4 miles east of the Montanore Project site near US 2. Swamp Creek is a potential off-site wetland mitigation site where MMC has conducted hydrologic monitoring. In August 2011, MMC installed four piezometers at the site at depths that ranged from 5 to about 9 feet below ground surface. MMC collected data twice in 2011 and four times in 2012 and 2013 (NewFields Companies and Kline Environmental Research 2014). During the growing season, groundwater levels at one piezometer within the middle of the existing wetland ranged from 0.7 feet in August 2011 to 2 feet below the ground surface in September 2012. Groundwater levels at two piezometers on the west side of the exiting wetland were greater than 2 feet below the ground surface from August to September. Early growing season (May and June) measurements of groundwater were not taken at any of the piezometers and groundwater levels are not known.

About 15 acres of wetland would be rehabilitated at the Swamp Creek site. Three acres would become woody riparian habitat and 3 acres would be preserved for an vegetated upland buffer. The site is currently a wetland, and the rehabilitation has a high likelihood of success because the supportive hydrology is present.

The site has high cover of reed canarygrass, which can form dense stands and out compete other species. MMC plans to burn the grass, followed by plowing the soil and seeding the area with wetland vegetation. The performance standards developed by MMC for Alternatives 3 and 4 include having 30 percent cover or less of reed canarygrass (see section C.4 in Appendix C). Reed canarygrass is difficult to control because it has vigorous, rapidly spreading rhizomes and forms a large seed bank. Control of reed canarygrass is most effective when it includes an integrated approach implemented in a sequential and timely order. Ongoing maintenance to control sprouting and seedling establishment may be necessary to maintain long-term reed canarygrass control (Waggy 2010). If mitigation efforts created soils conditions that were more frequently saturated or inundated, the ecological conditions would be more favorable for species with higher moisture tolerances such as sedges and bulrushes.

The Swamp Creek mitigation site would increase the capacity for the area to perform all 15 functions and three services, in comparison to existing conditions at the Swamp Creek site. In addition, the Swamp Creek site would have similar functions and services as the affected wetlands. All but three of the functions would have high ratings at the rehabilitating wetland site, and all three services would also have high ratings (MMC 2014a). Mitigation credit would accrue from rehabilitating 15 acres of wetlands at a 1.5:1 ratio and protecting an upland buffer zone of 3 acres around the new wetland areas at a 5:1 ratio. MMC estimates total credits would be 10.6 acres.

Stream Mitigation

Swamp Creek Site

Stream mitigation at the Swamp Creek site would consist of constructing about 6,500 linear feet of new meandering channels, planting a 10-foot wide riparian zone on each side of the channels totaling about 3 acres, and removal of cattle on the property to prevent grazing along the channels. Three primary drainage channels located on the Swamp Creek site would be subject to channel restoration: main Swamp Creek channel and two tributary channels from Spring #2 and Spring #3.

Proposed mitigation would have direct benefits to the functions and services of the stream reaches on the Swamp Creek mitigation site, with benefits that would extend downstream in Swamp Creek and into Libby Creek. The Swamp Creek stream mitigation sites would raise the functions from low and medium ratings to mostly high ratings. All services at the Swamp Creek site currently have a low rating, but would be increased to mostly high ratings due to the planned future public access to the site (MMC 2014a). Mitigation credit would accrue from constructing about 6,500 linear feet of new meandering channels, improving 580 feet of existing channel (Spring #1), planting a 10-foot wide riparian zone on each side of the channels totaling about 3 acres, and restricting cattle from grazing along the stream channels.

Little Cherry Creek Site

Stream mitigation at the Little Cherry Creek sites would consist of replacing a culvert on NFS road #6212 with an arched culvert, following Forest Service stream simulation techniques (USDA Forest Service 2008a). The culvert replacement would improve passage for aquatic, semi-aquatic, and terrestrial biota and increase recreational potential.

Poorman Creek Sites

Stream mitigation at the Poorman Creek sites would consist of replacing one culvert across the creek at NFS road #278, removing one bridge on a decommissioned NFS road #6212 and stabilizing 400 feet of eroding cut slope adjacent to NFS road #6212. The bridge on NFS road #6212 across Poorman Creek would be removed during construction. Replacement of the road #278 culvert would improve passage for fish possibly up to the first natural barrier and improve passage for an indefinite distance for semi-aquatic biota, including amphibians and mammals that are associated with water. Removal of the NFS road #6212 bridge and creation of a floodplain, and restored stream and riparian habitat would add surface water storage capacity during flood conditions, which would include associated nutrient cycling and sediment retention in the reestablished floodplain. Aquatic and semi-aquatic habitat and biota would benefit from reduced sediment downstream of the removed NFS road #6212 bridge due to reduced inputs from the road crossing and stabilization of erosion along the road. Benefits of increased organic inputs, nutrient cycling, fish production, and flood and erosion protection from the restored floodplain, and benefits of reduced sediment inputs would extend into Libby Creek (MMC 2014a). This reach would also be more appealing for recreation.

Lands Acquired for Grizzly Bear Mitigation

MMC would convey the title to or a perpetual conservation easement on 5,387 acres of land to the Forest Service or private conservation organization independent of MMC for grizzly bear mitigation. All lands would be acquired before the start of the Construction Phase. The Forest Service would ensure that the specified acres of mitigation properties were managed for grizzly bear habitat in perpetuity. The grizzly bear mitigation plan also would require MMC to implement access management improvements, such as road decommissioning and culvert removal, on mitigation lands. MMC would conduct a survey to assess all mitigation lands for opportunities to improve aquatic resources. Some of the types of activities that would be conducted to mitigate streams include: culvert removal and floodplain restoration, restoration of disturbed riparian buffer areas by removing roads and revegetating, addition of woody debris to the floodplain, removal of riprap and bridge abutments below the ordinary high water mark, removal of berms and other impervious fill material, and installation of instream habitat features to increase the value to aquatic life. MMC would use the Corps' Montana Stream Mitigation Procedure and the Corps' compensatory mitigation regulations (33 CFR 332) in assessing mitigation opportunities. For the purposes of assessing stream mitigation credits, MMC identified 21 culverts that would be removed and adjacent riparian habitat would be restored on 908 linear feet of stream on potential grizzly bear mitigation lands (MMC 2014a). The culvert removal would improve passage for aquatic, semi-aquatic, and terrestrial biota and increase recreational potential.

Summary of MMC's Proposed Jurisdictional Mitigation and Associated Credits and Debits

MMC's estimated wetland credits would be 10.6 acres. In its revised Mitigation Design Report (MMC 2014a), MMC did not include all wetlands and streams outside of the disturbance area or streams indirectly affected below the impoundment in determining mitigation debits. Assuming all wetlands within the Alternative 3 disturbance area boundary would be filled or otherwise indirectly affected by the project and that wetlands below the disturbance area boundary would be indirectly affected, total impact would be 9.4 acres, which would consist of 9.2 acres of and 0.2 acre of indirectly-affected jurisdictional wetlands downgradient of the disturbance area boundary. MMC did not apply for a 404 permit to fill all jurisdictional wetlands within the disturbance boundary. If jurisdictional wetlands within the disturbance area boundary could not be avoided during final design, MMC would have to modify its 404 permit, if issued for the project.

Mitigation for isolated wetlands is described in the next section. While MMC has demonstrated that adequate jurisdictional wetland mitigation credits are available for debits determined by MMC, final jurisdictional wetland debits and credits will be determined by the Corps during the 404 permitting process.

Total direct and indirect steam impacts associated with construction of the impoundment would be 19,058 linear feet, which includes 13,272 linear feet direct effect within the disturbance area boundary, 1,059 linear feet of direct effect from roads, and 4,727 linear feet of indirect effect below the disturbance area boundary to Libby Creek. The effects on streams may be reduced during final design through avoidance and minimization efforts. While MMC has demonstrated that adequate stream mitigation credits are available for debits determined by MMC, the Corps would determine if the mitigation proposed by MMC for Alternative 3 would be adequate to offset unavoidable impacts to waters of the U. S. during the 404 permitting process. The above sections describe some of the possible opportunities to meet the required mitigation credits.

Isolated Wetland Mitigation

Little Cherry Creek Sites LCM-1, LCM-2, and LCM-3

As part of the planning process, MMC identified six potential mitigation sites adjacent to wetlands in the Little Cherry Creek Impoundment area. From 2010 to 2012, a total of eleven piezometers were installed at the six potential wetland mitigation sites at depths ranging from 3.2 to 5.1 feet. Depth to groundwater in the piezometers was measured once in 2010 and four times in 2011, 2012, and 2013, although often depth to groundwater was greater than the well depth (NewFields Companies and Kline Environmental Research 2014). Based on groundwater data, MMC identified Little Cherry Creek Mitigation Sites LCM-1, LCM-2, and LCM-3 with a combined total of 4.5 acres to meet a portion of its mitigation requirements. Groundwater levels measured in the piezometers show the water table is typically less than 2 feet below the ground surface in the spring and early summer and then declines until late summer.

Numerous small depressions would be excavated and lined with low permeability soil at the Little Cherry Creek sites LCM-1, LCM-2, and LCM-3 to create areas with palustrine emergent wetlands and seasonal open water areas. Surface water from snowmelt and direct rainfall would be the primary water source. If the title to or a perpetual conservation easement on Little Cherry Creek mitigation sites had not already been conveyed as part of the grizzly bear mitigation plan, MMC would convey the title to or a perpetual conservation easement on the Little Cherry Creek mitigation sites to the Forest Service after the Forest Service has determined the sites' performance standards had been met. Conveyed lands would be the isolated wetland mitigation sites, upland buffers, and adjacent existing wetlands contiguous to National Forest System lands. If a perpetual conservation easement was conveyed, the easement would allow for public access to the property. The proposed Little Cherry Creek wetland mitigation sites would improve the capacity of the area to perform all 15 functions and three services, in comparison to the existing upland conditions. The new wetlands generally would have similar or improved functions and services as the affected wetlands. Two of the functions (short- and long-term surface water storage; general wildlife habitat) would have high ratings for the new wetland sites, while all of the other functions and services except general fish habitat would have a medium rating (MMC 2014a). Mitigation credit would accrue from creating 4.5 acres of wetlands in uplands near the existing wetlands at a 2:1 ratio, and protecting an upland buffer zone of 2.5 acres around the new wetland areas at a 5:1 ratio. The agencies estimate credits would be 2.75 acres (Table 191).

Gravel Pit Site

The proposed Gravel Pit mitigation site was previously disturbed by gravel mining and remains unvegetated. In 2011, one piezometer was installed at the proposed Gravel Pit wetland mitigation site to a depth of 8.5 feet. Three monthly measurements were collected in 2011 and four monthly measurements were collected in 2012. During the growing season, groundwater levels ranged from 1.6 feet below ground surface in June 2012 to about 8 feet below ground surface in September 2011 (NewFields Companies and Kline Environmental Research 2014). Because the depth to groundwater would require extensive excavation, this mitigation site would be designed for precipitation as the supportive hydrology. Several small depressions would be excavated and lined with low permeability wetland soil to collect and hold precipitation, providing seasonal supportive hydrology. The success of this mitigation site would depend on proper construction and placement of the low permeability soil and adequate annual precipitation. Typically, groundwater-supported mitigation wetlands have a greater chance of success.

The Gravel Pit mitigation site would improve the capacity of the area to perform all 15 functions and three services, in comparison to existing conditions at the gravel pit. In addition, the new wetland site would have similar functions and services as the affected wetlands. Three of the functions (short- and long-term surface water storage; general wildlife habitat; and uniqueness) would have high ratings for the new wetland site, while all of the other functions and services except general fish habitat would have a medium rating (MMC 2014a). Mitigation credit would accrue from creating 3 acres of wetlands at a 2:1 ratio and protecting an upland buffer zone of 2 acres around the new wetland areas at a 5:1 ratio. The agencies estimate total credits would be 1.9 acres (Table 191).

MMC would convey the title or a perpetual conservation easement to the Forest Service for the following lands: lands contiguous with existing wetlands, the isolated wetland mitigation sites and National Forest System lands owned by MMC along Little Cherry.

MMC would acquire a water right for the created wetlands if the DNRC determined water use for creating wetlands was a beneficial use. If water use for creating wetlands was not a beneficial use, MMC could use water for wetland creation without a beneficial water use permit protecting its right to do so. Water to create wetlands would come from precipitation on MMC and National Forest System lands and the legal availability of that water would not be at risk of appropriation by another user. Any water rights used for wetland mitigation would be conveyed to the Forest Service when the mitigation sites were conveyed.

Table 191. Summary of Isolated Wetland Mitigation and the Agencies' Estimated Credits, Alternative 3.

Mitigation Location	Mitigation Type	Mitigation Areas or Estimated Credit
Wetlands		
Three sites (LCM-1, LCM-2, LCM-3) near Little Cherry Creek	Wetland creation of 4.5 acres	2.25 acres wetlands (2:1 ratio); 0.5 acre upland buffer (5:1 ratio)
Former Gravel Pit near Poorman Creek	Wetland creation of 3.0 acres	1.5 acres wetlands (2:1 ratio); 0.4 acre upland buffer (5:1 ratio)
Total	7.5 acres	4.65 acres

Source: Agencies' analysis.

Mitigation for Other Potential Indirect Effects

The agencies did not require MMC to identify mitigation for three potential indirect effects of the project: affecting the hydrologic support for wetlands north of the Poorman Impoundment Site by the pumpback well system, reducing the flow in Poorman and Little Cherry creeks by the pumpback well system, and affecting the hydrologic support for wetlands and other aquatic resources in the upper watersheds of the East Fork Rock Creek and the East Fork Bull River. The agencies' approach for assessing and monitoring these potential effects and developing appropriate mitigation based on monitoring is described in the following sections.

Indirect Effects of the Pumpback Wells. MMC used a 3D model to predict the effect of the pumpback wells on the impoundment site's hydrology. In Alternative 3, the model predicted that the drawdown from the wells would extend to Little Cherry Creek, potentially affecting wetlands between the Poorman Impoundment Site and Little Cherry Creek. Alternatives 2 and 4 would have similar potential to affect wetlands indirectly (Table 188). Potential effects on streamflow in Libby Creek, Little Cherry Creek, and Poorman Creek from the pumpback wells were discussed in section 3.11.4.4. Streamflow was predicted by the model to be reduced by 0.55 cfs in Libby Creek, 0.04 cfs in Little Cherry Creek, and 0.18 cfs in Poorman Creek.

Section 3.10.4.2 indicates operation of a pumpback well system may not affect groundwater levels, surface resources, or five of the springs south of Little Cherry Creek because of an apparent subsurface bedrock ridge that separates groundwater flow between the watershed of Little Cherry Creek from those of Drainages 5 and 10 in the Poorman Impoundment Site (Chen Northern 1989). Because geologic and hydrologic data from the area between the Little Cherry Creek and Poorman drainages are limited, they are not sufficient to eliminate the possibility of the pumpback well system adversely affecting surface resources, particularly groundwater-supported wetlands. Additional subsurface data, such as aquifer pumping tests, from this area would be collected during the final design process of the Poorman Impoundment (see section 2.5.2.6, *Final Design Process* in Chapter 2 and Appendix C). These data would be used to confirm the geophysical results and the MMC's hydrogeologic interpretation. The 3D model would be rerun to evaluate the site conditions with the new data.

Section C.10 of Appendix C also describes wetland monitoring before operations began. One year before mill operation started, MMC would measure water levels in the piezometers in wetlands LCC-35 and LCC-39 four times over the annual hydrograph. The purpose of the monitoring would be to assess the potential effects of the pumpback well system. Vegetation in these two wetlands also would be monitored, following the methods used for the GDE monitoring. The monitoring would continue through the Closure Phase as long as the pumpback well system operated or until agreed upon by the agencies that it was no longer necessary. Streamflow in Libby Creek, Little Cherry Creek, and Poorman Creek also would be monitored. Should the updated tailings impoundment 3D model indicate streamflow or aquatic resources may be adversely affected by groundwater pumping, MMC would develop appropriate mitigation for the adverse effect. Mitigation would be identified and implemented before the pumpback well system began operation. Monitoring data collected during operations also would be used to assess effect. Conceptual mitigation options include providing hydrology support from groundwater wells or surface water, creating new wetlands on either National Forest System lands or private land north of Little Cherry Creek or creating, restoring or rehabilitating wetlands on 5,341 acres of private land in Alternative 3 or 6,151 acres in Alternative 4 acquired for grizzly bear mitigation.

Indirect Effects of Mine Dewatering. Similar to the assessment of the Poorman Impoundment Site's hydrology, the agencies used 2D and 3D models to evaluate the site hydrogeology and analyze potential impacts due to mining. Although the results of the two models were similar, the 3D model provides a more detailed analysis, by incorporating known or suspected fault behavior with respect to hydrology; more recent underground hydraulic testing results; a more comprehensive calibration process, and better simulation of vertical hydraulic characteristics of the geologic formations to be encountered during the mining process. The effect on streamflow was discussed in section 3.11.4, *Surface Water Hydrology*. Section 3.10.4.3.5, *Groundwater Model Uncertainty* discusses model uncertainty. There is uncertainty associated with the hydraulic properties of the bedrock and faults; predictions of mine inflows and impacts on water resources are sensitive to permeability of major fault zones. With the data currently available, the model results provide a potential range of mine dewatering and pumping (in the case of the tailings impoundment model) rates and streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using currently available data in the groundwater models. The mine 3D groundwater model would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see section C.10.4, *Evaluation Phase* in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease.

Section C.10 of Appendix C also describes GDE inventory and monitoring and streamflow monitoring of in the mine area. The inventory area may change if the 3D groundwater model used to assess effects was updated and predicted greater or lesser effects. An inventory would help identify and rank GDEs based on their importance in sustaining critical habitats or species. The inventory would be conducted in accordance with the most current version of the Forest Service's *Groundwater Dependent Ecosystems: Level II Inventory Field Guide* (USDA Forest Service 2012b). The inventory, which began in 2009, includes a vegetation survey to describe and document existing vegetation characteristics and establish a prevalence index used by the Corps to determine wetland vegetation (Corps 2008d). The prevalence index would be used to assess changes in vegetation composition and if a loss of wetland species was occurring. The monitoring would continue through the Closure Phase as long as mine dewatering occurred or until agreed upon by the agencies that it was no longer necessary. Should the updated mine area 3D model indicate aquatic resources may be adversely affected by mine dewatering, MMC would develop appropriate mitigation for the adverse effect. Mitigation would be identified and implemented before the mill began operation. Monitoring data collected during operations also would be used to assess effect. Conceptual mitigation options include mitigation on lands acquired for grizzly bear mitigation. Some of the types of activities that would be conducted for mitigation include: remove culverts and restore the floodplain, restore disturbed riparian buffer areas by removing roads and revegetating, add woody debris to the floodplain, remove riprap and bridge abutments below the ordinary high water mark, remove berms and other impervious fill material, and install instream habitat features to increase the value to aquatic life.

3.23.4.10.3 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

The agencies' Wetland Mitigation Plan for Alternative 4 is described in section 2.6.7.1, *Wetlands Mitigation*. Jurisdictional wetlands would be replaced at a ratio determined by the Corps while isolated wetlands would be replaced using the Corps' 2005 ratios. A total of 48.8 acres of off-site mitigation were identified for Alternative 4. If the KNF selected Alternative 4 in the ROD, MMC would develop a mitigation design report for unavoidable effects on jurisdictional waters of the

U.S. MMC would implement the wetland rehabilitation and stream restoration at Swamp Creek, the culvert replacement and the bridge replacement on NFS road #278 at Poorman Creek, and culvert removal on lands acquired for grizzly bear mitigation. Other possible wetland mitigation sites may include the North Poorman Creek, South Poorman Creek, Poorman Weather Station and Ramsey Creek sites shown in Table 190 and Figure 33. Insufficient mitigation sites were identified to achieve the Corps' minimum ratios for effects on jurisdictional wetlands, and additional mitigation sites would be necessary if this alternative were permitted. MMC would implement the mitigation described for the Gravel Pit site in Alternative 3 for mitigation for isolated wetlands.

In Alternative 4, the diversion channel for Little Cherry Creek would be a geomorphic-type diversion that would incorporate habitat components. Several mitigation measures would be implemented along the channel to ensure that erosion and sedimentation resulting from heavy rainfall and from high flow events would be minimized. Wetland soil, sod, and shrubs would be excavated from existing wetlands before filling during construction, and placed in the wetland mitigation areas. Use of existing wetland soils in mitigation would improve mitigation success.

As proposed in Alternative 3, 1 year of groundwater monitoring at the mitigation sites would be implemented in Alternative 4. Only sites with adequate existing groundwater available to support wetlands would be used for mitigation.

NMC's 1993 404 permit included more detailed designs for the North Poorman, South Poorman, and Ramsey creek sites (Corps 1993). The Poorman Weather Station mitigation site was not included in NMC's 1993 404 permit and the feasibility of creating 14 acres that replaced the lost functions of the wetlands affected by Alternative 4 is uncertain. According to MMC, the Poorman Weather Station mitigation site (Figure 33) is not within an area of existing wetlands and has no well-defined drainage. Wetlands created at this site may not be jurisdictional if the site does not have a hydrologic connection to a jurisdictional water. The discussion found on page 116 regarding mitigation requirements and on-site and off-site mitigation also applies to Alternative 4. Insufficient mitigation sites were identified to achieve the Corps' minimum ratios, and additional mitigation sites would be necessary if this alternative were permitted.

The agencies' wetland monitoring plan for Alternative 4 is similar to Alternative 3. In Alternative 4, flow from springs SP-02, SP-10, S-12, SP-14, SP-15, and SP-29 (Figure 40) would be measured and sampled for selected water quality parameters. MMC would monitor three wetlands if not filled by project activities: LCC-24, LCC-25, and LCC-39 (Figure 40). MMC would use the procedures established for monitoring of wetland mitigation sites described in Alternative 3 to describe and document existing vegetation characteristics and a prevalence index. A prevalence index would be used to assess changes in vegetation composition. Samples from any standing water in these three wetlands would be collected and analyzed for selected water quality parameters. Sampling would be repeated in mid-summer every 2 years until tailings disposal ceased. The revised monitoring plan would better evaluate the functions and services of the mitigation sites and the effects on downstream springs and wetlands.

3.23.4.11 Cumulative Effects

Past actions in the analysis area, particularly road construction, has resulted in the placement of culverts and other fill material in streams and adjacent wetlands. Past actions after the passage of the Clean Water Act in 1977 were subject to Section 404 permitting and mitigation requirements. Cumulative direct and indirect effects on waters of the U.S. may result from other reasonably foreseeable actions in the analysis area such as other mining operations and road construction. All present and reasonably foreseeable future actions regulated under Section 404 of the Clean Water Act would be subject to Corps' permitting and mitigation requirements. Some activities that may result in future effects on waters of the U.S. are exempt from Corps review under Section 404(f), and other activities with minimal effects do not require notification to the Corps for authorization. With appropriate mitigation, cumulative direct wetland effects would be negligible. Vegetation management projects, such the Flower Creek Vegetation Management project and the Miller-West Fisher Vegetation Management project, would avoid direct effects on waters of the U.S. by maintaining a RHCA buffer around wetlands and other waters. Typically, proposed activities on National Forest Systems lands are designed to meet standards prescribed by INFS. These design features would prohibit timber harvest, including firewood cutting, in RHCAs, thus limiting effects on waters of the U.S. Any activities within the KNF that are not subject to Corps review and that contribute to cumulative effects on waters of the U.S. would be mitigated under Executive Order 11990. Wetland effects from KNF-approved access projects were not identified, and it would be the responsibility of the landowner to comply with the Clean Water Act. Cumulative indirect effects from reasonably foreseeable future actions in the area may include small amounts of increased sedimentation in wetlands from new roads associated with construction and ground-disturbing activities such as Miller-West Fisher Vegetation Management Project, and projects on private land such as housing development, roads, and logging.

3.23.4.12 Regulatory/Forest Plan Consistency

All of the action alternatives would involve the discharge of fill material or excavation into wetlands or waters of the U.S. MMC would apply for a permit and be required to follow conditions in the Section 404 permit. Plans for avoidance, minimization, and mitigation of effects on wetlands would be required before permit issuance. The agencies prepared a 404(b)(1) analysis that discusses compliance with the 404(b)(1) Guidelines (Appendix L). The lead agencies identified the Poorman Impoundment Site as the least environmentally damaging alternative for surface tailings disposal because it would have the least impacts on wetlands and waters of the U.S., and would not have other significant adverse environmental consequences (40 CFR 230.10(a)). As the permitting authority, the Corps will determine if mine Alternative 3 and transmission line Alternative D-R are the least environmentally damaging practicable alternatives. The Corps also will determine if the proposed project complies with the 404(b)(1) Guidelines. The Corps will discuss compliance with the 404(b)(1) Guidelines in its ROD or Statement of Findings on the Section 404 permit. The Corps' findings regarding the least environmentally damaging practicable alternative and compliance with the 404(b)(1) Guidelines are subject to EPA's review. Any alternative permitted by the Corps would comply with the 2015 KFP and Section 404 of the Clean Water Act.

In compliance with Executive Order 11990, the KNF finds that there is no practicable alternative to new construction located in wetlands, and that Alternative 3 would include all practicable measures to minimize harm to wetlands. Section 2.5.2.6.3, *Final Tailings Impoundment Design Process* describes the agencies' requirements for the impoundment design before construction would begin. One mitigation measure would require MMC to avoid or minimize, to the extent practicable, filling wetlands and streams, such as described in Glasgow Engineering Group, Inc. (2010). This mitigation would ensure adverse effects on National Forest System lands would be minimized before considering compensatory mitigation and would comply with 36 CFR 228 Subpart A.

The Corps' wetland mitigation requirements would fulfill the Executive Order's requirements to minimize harm to jurisdictional wetlands. To minimize harm to isolated wetlands and comply with Executive Order 11990 and with 36 CFR 228 Subpart A regulations for locatable minerals operations on National Forest System lands, the KNF would require MMC to develop compensatory mitigation that would create 7.5 acres of wetlands and 4.5 acres of upland buffers. MMC would submit a final isolated wetland mitigation plan to the KNF for its approval and for incorporation into MMC's amended Plan of Operations.

3.23.4.13 Irreversible and Irretrievable Commitments

All action alternatives would result in an irretrievable commitment of wetlands and streams Successful mitigation would restore lost wetlands and provide similar functions and services to altered wetlands at another location. All action alternatives would affect wetlands and create changes in wetland functions and services. Some biodiversity in wetlands may ultimately be lost from invasion of introduced species and be irreversible under all action alternatives. Any differences in the function and services of the existing Little Cherry Creek channel and the proposed diversion channel in Alternatives 2 and 4 would be an irretrievable commitment.

3.23.4.14 Short-term Uses and Long-term Productivity

Potential short-term effects would result from time delays between the loss of existing wetlands resources and the development of the viable wetlands with similar functions and services. Proposed BMPs would minimize sedimentation. Other potential short-term effects would result from time delays between the loss of existing wetlands resources and the development of the viable wetlands with similar functions and services.

3.23.4.15 Unavoidable Adverse Environmental Effects

A loss of wetland functions and services, biodiversity, and species composition would occur in all action alternatives where wetlands are affected. The agencies anticipate effects on wetlands and streams would be mitigated and wetland functions and services would return to the area in time. The Corps would be responsible for establishing mitigation requirements for jurisdictional wetlands and other waters of the U.S. The KNF would be responsible for establishing and approving any wetland mitigation requirements for non-jurisdictional wetlands associated with the project on National Forest System lands. Any non-jurisdictional wetland affected by the transmission line and access roads may be subject to conditions of the 318 authorization, and, where significant impacts occur, MFSA certification requirements if not covered by other mitigations. The agencies' proposed mitigation would mitigate for direct effects on jurisdictional and isolated wetlands. Created wetlands biodiversity and species composition of forested wetlands would not return to pre-disturbance levels until decades after establishment. The diversity and species composition of herbaceous wetlands would likely be restored within 5 years.

3.24 Wilderness, Roadless Areas and Wild and Scenic Rivers

3.24.1 Cabinet Mountains Wilderness

3.24.1.1 Regulatory Framework

The CMW became a unit of the National Forest Wilderness Preservation System with the passage of the Wilderness Act on September 3, 1964. The Wilderness Act applies to the 94,272 acres of land within the CMW that were designated as part of the wilderness preservation system, not to activities and land outside the CMW boundary. The Wilderness Act directs the Forest Service to protect the natural character of the wilderness and to provide for recreational, scenic, scientific, educational, cultural, and historical uses of wilderness areas. Based on the Wilderness Act's definition of wilderness, the Forest Service uses four qualities to broadly describe all wilderness character in the National Forest System:

- Untrammeled – wilderness is essentially unhindered and free from modern human control or manipulation
- Undeveloped – wilderness is essentially without permanent improvements or modern human occupation
- Natural – wilderness ecological systems are substantially free from the effects of modern civilization
- Outstanding opportunities for solitude or a primitive and unconfined type of recreation – wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge

More specific descriptions of these wilderness character qualities are described below under *Affected Environment*.

Section 4(d)(3) of the Wilderness Act pertains to mining claims within the wilderness and states that holders of unpatented mining claims validly established as of December 31, 1983 on National Forest System lands designated by the Act as a wilderness area will be accorded rights under the 1872 General Mining Law. The same section states that all patents issued on National Forest System lands designated as a wilderness area will convey only title to the mineral deposits within the claims and the United States reserves all title to the surface and surface resources of the claims. The Secretary of Agriculture may prescribe reasonable stipulations "for the protection of the wilderness character of the land consistent with the use of the land for the purposes for which they are leased, permitted, or licensed." The Secretary of Agriculture also may regulate ingress and egress consistent with the use of the land for mineral location and development. Consequently, mining operations can occur within the wilderness but may be subject to management requirements that are above and beyond those normally imposed on operations outside of a wilderness, provided those requirements do not prevent the operator from exercising due rights under United States mining laws. Forest Service mineral regulations (36 CFR 228, Subpart A) provide direction for administering locatable minerals operations on National Forest System lands. Specifically, 36 CFR 228.15 provides direction for operations within the National Forest Wilderness. Holders of validly existing mining claims within the National Forest

Wilderness are accorded the rights provided by the U.S. mining laws and must comply with the Forest Service mineral regulations (36 CFR 228, Subpart A). Mineral operations in the National Forest Wilderness are to be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and to preserve the wilderness character consistent with the use of the land for mineral development and production.

In 2009, the KNF completed the Cabinet Mountains Wilderness Management Plan. The goal statement for the plan directs that the CMW "will be managed according to the Wilderness Act to allow natural processes to operate freely where the evidence of man's activity is substantially unnoticeable" (USDA Forest Service 2009a). Management direction in the plan is derived from the Wilderness Act and subsequent legislation which sought to protect these special areas and preserve wilderness character. The management plan identifies that valid existing rights for the Montanore ore deposit have been established in the CMW.

The 2015 KFP allocates the CMW to MA 1a. MA 1a is managed to protect wilderness character as defined in the Wilderness Act and as outlined in the Cabinet Mountains Wilderness Management Plan. Desired conditions are: to allow natural processes act as the primary forces affecting the composition, structure, and pattern of vegetation; provide non-motorized and non-mechanized opportunities for exploration, solitude, risk, challenge, and primitive recreation; and provide large remote areas with little human disturbance to contribute habitats for species with large home ranges such as grizzly bear and mountain goats. The 2015 KFP has no specific locatable minerals direction for MA 1a, but management direction in the 2015 KFP as a whole is subject to valid existing rights and defers to overarching applicable laws and regulations.

3.24.1.2 Analysis Area and Methods

The analysis area for direct, indirect, and cumulative effects on wilderness encompasses the CMW south of the ridge separating Big Cherry Creek from Bear Creek (Figure 88). The CMW north of the ridge would not be affected, and, consequently, is outside of the analysis area. Potential effects on the CMW were qualitatively evaluated based on potential effects on wilderness attributes from the proposed project.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on wilderness character in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in Section 3.1.3, *Incomplete and Unavailable Information*.

3.24.1.3 Affected Environment

The CMW is a 94,272-acre unit of the National Forest Wilderness Preservation System. It is about 34 miles long and varies from 0.5 to 7 miles wide (Figure 88). The wilderness occupies the upper elevations of the Cabinet Mountains, with elevations from 2,500 to 8,700 feet. The Cabinet Mountains are a north/northwest trending, extensively glaciated mountain range. This glaciation produced spectacular features such as high craggy peaks, vertical cliffs, knife-edge ridges, amphitheater-like basins, and filled valley bottoms. These land-building processes also have created many streams and about 85 lakes within the wilderness. MMC's mineral rights in the CMW are discussed in section 1.3.1, *Mineral Rights.*

3.24.1.3.1 Wilderness Character

The Forest Service's national framework for wilderness character was based on Section 2(c) of the Wilderness Act (Landres *et al*. 2008). These qualities of wilderness character provide the basis for the effects analysis.

- Untrammeled – The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature." Wilderness is essentially unhindered and free from modern human control or manipulation. This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness.
- Natural – The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." Wilderness ecological systems are substantially free from the effects of modern civilization. This quality is degraded by intended or unintended effects of modern people on the ecological systems inside the wilderness since the area was designated.
- Undeveloped – The Wilderness Act states that wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport that increases people's ability to occupy or modify the environment.
- Solitude or a primitive and unconfined type of recreation – The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality is about the opportunity for people to experience wilderness; it is not directly about visitor experiences per se. This quality is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

Untrammeled and natural are closely related, emphasizing natural ecological processes and an absence of modern disturbances. Both may be altered by the same activities. Undeveloped focuses on how the wilderness is perceived by the general public, while solitude or a primitive and unconfined type of recreation focuses on how visitors experience wilderness.

The CMW has a high degree of untrammeled, natural, and undeveloped qualities. Vegetation in the CMW is abundant and varied, ranging from delicate harebells growing in rock fissures to the lush, valley bottom stands of old growth cedar and hemlock. Thirteen species of conifer trees, 130 species of wildflowers, and numerous shrub species are known to grow in the wilderness. Many wildlife species inhabit the area within and adjacent to the wilderness. These include the grizzly bear, black bear, elk, bighorn sheep, mountain goats, lynx, mule deer, white-tailed deer, and various small mammals and birds.

Primitive recreation provides opportunities for isolation from the evidence of man. Visitors may enjoy a high degree of challenge and risk, and use of outdoor skills. The CMW offers opportunities for primitive recreational activities in a pristine setting. Hiking is the most popular activity in the wilderness. Fishing, photography, and hunting are the next most common activities pursued by wilderness visitors. The wilderness is split between Sanders and Lincoln counties. Access from the Lincoln County side is provided by 12 trails that are maintained on 1- to 2-year intervals and 19 trails are maintained on 3- to 4-year intervals. Access from the Sanders County side is provided by nine maintained trails and six trails not regularly maintained.

Solitude is isolation from sights, sounds, and the presence of others. The developments and evidence of man do not appear. Features that contribute to solitude include size of area and distance from perimeter to center. Vegetation and topographic screening are also related to solitude. The narrow configuration of the CMW (less than a mile wide at its narrowest point) has caused some pressures to occur at some of the more popular destination sites. The relatively easy access has also resulted in some sites receiving heavy use and visitor impacts.

3.24.1.3.2 Management

Management of the portion of the CMW in the analysis area is shared by two Ranger Districts of the KNF. To determine the type and extent of management actions appropriate for different portions of the wilderness, the Forest Service has identified two distinct opportunity classes for wilderness. The opportunity classes are delineated according to the biological, social, and managerial setting within the wilderness.

Opportunity Class I includes pristine areas without developed trails. The opportunity for solitude is high and one would not expect to see other groups or much evidence of recreation use. Dispersion of visitors is the management intention. Generally, no trails or other structures will be developed within the class. Existing travelways will be left in place and not maintained or marked. Existing facilities will be removed. Requests for research or other mineral development facilities will be evaluated on a case-by-case basis. Fish stocking does not currently occur and is not desirable in this area.

Opportunity Class II includes a delineation of trail corridors and more heavily used lake basins, such as Rock Lake and the trail along the East Fork Bull River to St. Paul Lake. Many lakes in this class are stocked with fish and have relatively easy access. These basins are very scenic, wildlife is often seen, and flowering plants are abundant. The lake basins and the trail corridors accessing them total less than 15 percent of the wilderness acres but account for most of the recreation use. Hiker use is steadily expanding in terms of geographical dispersion. Use has resulted in creation of new sites, expansion of camp areas, vegetation loss, tree damage, and human waste problems. To prevent resource impacts, recreation use should generally be concentrated in these areas.

General use of the CMW will not be promoted. Management activities that maintain or enhance the wilderness character, resource, solitude, or primitive and unconfined forms of recreation will be implemented (KNF 2009).

Identified camp site areas are located around St. Paul Lake and Rock Lake (Opportunity Class II) and at the base of Chicago Peak near Cliff Lake (Opportunity Class I). At these locations, the average visitor would camp in one of the identified sites, as few other areas are desirable due to the topography and availability of water.

3.24.1.4 Environmental Consequences

3.24.1.4.1 Alternative 1 – No Mine

The CMW would not be directly affected by additional mine facilities. The analysis area would continue to have quiet sound levels characteristic of rural areas and wilderness lands (estimated to be between 30 and 41 dBA or equivalent to a whisper in a quiet library). Sounds associated with existing activities at the Libby Adit Site would be audible (at a level below a whisper) within a small portion of the CMW in the upper Libby Creek drainage. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Such activities on private land at the Libby Adit Site would remain until reclaimed in accordance with existing permits and approvals. Noise levels in the CMW would return to low, ambient levels when reclamation was completed.

3.24.1.4.2 Alternative 2 – MMC's Mine Proposal

All proposed surface disturbances associated with the mine facilities would occur outside the CMW boundary. None of the mine alternatives would physically disturb any lands within the CMW directly and none of the four wilderness qualities would be directly affected. None of the alternatives would directly affect wilderness character.

The experience of wilderness visitors may be affected by mining-related activities occurring outside the CMW boundary. Because the wilderness experience is highly personal and individual, the perceived effect would differ among individuals. It is likely that the visual and noise effects of the project outside the CMW would reduce the natural quality of the wilderness experience for some individuals in portions of the wilderness. Visitation in the portions of the CMW exposed to sound and visual effects may decrease. Other qualities such as untrammeled, undeveloped, and outstanding opportunities for solitude or a primitive and unconfined type of recreation may also be diminished at some locations within the CMW for visitors while the project was in operation. These effects would occur throughout the duration of project operations and diminish following mining and reclamation. General indirect effects on wilderness character from Alternative 2 are described below.

Untrammeled

Effects on the untrammeled qualities of the CMW would stem primarily from effects on ecological systems, primarily wildlife and hydrology, within or adjacent to the wilderness. Short-term disturbances to wildlife in and adjacent to the CMW such as grizzly bear, mountain goat, and wolverine would occur from operation of the Ramsey Plant (see section 3.25, *Wildlife*). For all alternatives, blasting during construction of the adit openings would result in very short-term disturbances to wildlife in the CMW. Additional temporary disturbances to wildlife in the CMW would occur for Alternative 2 from helicopters used during construction of the transmission line to the Ramsey Plant Site. These impacts would be short term and would not impact the untrammeled quality of the CMW over the long term.

The CMW is part of a narrow, northwest trending corridor that provides the grizzly bear with a north-south movement corridor. The Cabinet Mountains are a rugged, glaciated mountain range of high relief. The topography of Cabinet Mountains and human development on the east and west sides constrict the width of effective grizzly bear habitat that is critical to grizzly bear movement between the southern Cabinet Mountains and the rest of the CYE (USFWS 2003a).

The characteristics and importance of the north-south movement corridor are described in detail in the BA (USDA Forest Service 2013b). Long-term displacement effects from mine activities could inhibit grizzly bear movement in the north-south movement corridor in the Cabinet Mountains. Alternative 2 would have the greatest displacement effects in the north-south movement corridor, affecting 3,597 acres.

Direct effects on wildlife and habitat resources outside of CMW may have indirect effects on ecological processes within the CMW, due to long-term impacts on populations of wide-ranging species such as grizzly bear and wolverine. The extent to which the direct effect on wildlife and habitat outside of wilderness affects ecological processes within the CMW is uncertain; while some species may adapt to mine disturbance, others may avoid areas of mine activity and spend more time in the CMW (see *Wildlife* section 3.25).

Groundwater drawdown during all mine phases may indirectly impact aquatic habitat and associated ecological processes within the CMW. Changes in streamflow in Alternative 2 are discussed in section 3.10.4.2, *Alternative 2 – MMC Proposed Mine* in the *Groundwater Hydrology* section and section 3.11.4.3, *Alternative 2 – MMC Proposed Mine* in the *Surface Water Hydrology* section. The 3D model predicted flow in the East Fork Bull River, the East Fork Rock Creek, and Libby Creek would be reduced in all mine phases, reaching a maximum reduction of 0.40 cfs in the East Fork Bull River, 0.29 cfs in the East Fork Rock Creek, and 0.07 cfs in Libby Creek at the CMW boundary during the Post-Closure Phase without mitigation (Table 101). At steady state conditions, streamflow in Libby Creek at the CMW boundary is predicted to return to pre-mine conditions (Table 103). A permanent decrease of 0.01 cfs in the East Fork Bull River (EFBR-500) and 0.03 cfs in the East Fork Rock Creek (EFRC-200 at the outlet to Rock Lake) is predicted at the CMW boundary (Table 103). Within the CMW, a permanent decrease of 0.02 cfs in the East Fork Bull River (EFBR-300) and -0.02 cfs in the East Fork Rock Creek (EFCR-50) is predicted Table 103. These locations used by the Agencies to summarize streamflow effects are shown on Figure 76.The discussion of measurability and nondegradation discussed under Alternative 3 would apply to Alternative 2. A professional hydrologist or person highly familiar with these creeks may notice reductions in flow; however, the average wilderness user would not notice reductions in flows or be able to distinguish changes from natural variability. Permanent decreases in baseflow may result in permanent indirect effects to the untrammeled and natural qualities of wilderness character for some wilderness users, but these effects would be minor.

Aquatic habitat for bull trout and other salmonids would be adversely affected at flow changes predicted by the model. Low flows in the East Fork Bull River at the CMW boundary are estimated to decrease by 4 percent and 11 percent during the Closure Phase and Post-Closure Phases, respectively, without mitigation. Decreases in bull trout habitat availability would be similar for the reach near the Isabella Creek confluence and the reach near the CMW boundary with decreases of 4 to 5 percent predicted in both reaches for adult and juvenile bull trout habitat and 11 percent in spawning habitat (Table 77). Available habitat in the East Fork Bull River would essentially return to pre-mine conditions when the mine void filled and the potentiometric surface reached steady state conditions (Table 114), with a 1 percent or less predicted reduction in low flow. Macroinvertebrate populations are present throughout the reaches potentially affect by mine dewatering, and would be affected by the reduction or elimination of flow that would occur during low flow periods. Headwater streams also perform important ecological functions in terms of transport of organic matter, invertebrates, nutrients, and woody debris to downstream waters (Kline Environmental Research and NewFields 2012). Reductions in flow could adversely impact the ability of these headwater reaches to perform such functions. Effects on aquatic life are discussed in section 3.6.4, *Aquatic Life and Fisheries.*

Rock Lake and St. Paul Lake are popular recreation sites in the CMW and are an Opportunity Class 2 area. In Alternative 2, the project would reduce the level and volume of Rock Lake during periods in which bedrock groundwater is the only source of supply to Rock Lake (Table 115). Reductions in lake levels and volume would probably not have a detectable effect on the aquatic biota of Rock Lake. While the lake volume is projected to be decreased by 2 percent post closure with mitigation and up to 5 percent without mitigation, aquatic habitat changes would likely be difficult to separate from those caused by natural variability in lake levels that occur in part due to large influxes of surface water into the lake during snowmelt and storm events (see *Aquatic Life and Fisheries*, section 3.6.4). St. Paul Lake can become completely dry during extended periods of little to no precipitation. St. Paul Lake may be affected by mining, but effects may be difficult to separate from the large, natural lake level variations. If deep groundwater was a component of the inflow to St. Paul Lake, mine dewatering would unavoidably reduce this source of water to the lake, and the lake level may lower more quickly during dry years when the only source of water to the lake was bedrock groundwater. The average wilderness user likely would not perceive predicted reductions in Rock Lake or St. Paul Lake levels. Alternative 2 would not affect water levels or streamflow at the base of Chicago Peak near Cliff Lake (Opportunity Class I).

These direct and indirect impacts on ecological processes inside and adjacent to the wilderness, as described above, would not affect the untrammeled quality of the wilderness. The untrammeled quality would continue to appear to have been affected primarily by the forces of nature.

Natural

In Alternative 2, maximum modeled nitrogen deposition rates from the mine were greater than the Federal Land Manager (FLM) deposition analysis thresholds at Upper Libby Lake, Lower Libby Lake and Rock Lake; maximum modeled sulfur deposition rates were less than the deposition analysis thresholds at Lower Libby Lake and Rock Lake and greater than the deposition thresholds at Upper Libby Lake (Table 55). Increased nitrogen could cause changes in lake chemistry, leading to an increase of some aquatic vegetation species, such as phytoplankton or algae (USDA Forest Service *et al.* 2010). These changes may be noticeable to lake users. These changes at Upper Libby Lake or Lower Libby Lake would not be noticeable to the average wilderness user because of their remote location. Nitrogen and sulfur emissions from the mine would substantially decrease when underground mining ceased and would end after the adits were plugged. Effects of nitrogen and sulfur deposition in Alternative 2 on CMW lakes are discussed in section 3.4.4.2.6, *Cabinet Mountain Wilderness Impact Assessment* in the *Air Quality* section and in section 3.13.4 in the *Water Quality* section.

The lead agencies' analysis concluded that chimney subsidence breaching the surface to form sinkholes is unlikely given the geotechnical setting (thickness of the overlying rock above the mine workings, and the strength of the overlying rock) and the mine plan proposed by MMC (see section 3.14.3.1, *Subsidence* and Agapito Associates, Inc. 2007b). Isolated roof failure and chimney subsidence to some height above the workings is likely, and could lead to increased rock fracturing and higher groundwater hydraulic conductivity within the overlying strata. The evaluation also estimated that chimney subsidence impacts on groundwater may occur up to about 400 feet above the mine workings. The agencies' evaluation concluded that trough subsidence, while not likely, cannot be entirely dismissed at the current level of design. Without the agencies' mitigation described in section 2.5.2.6., *Final Design Process* and the agencies' monitoring described in Appendix C, Alternative 2 would have greater risks associated with subsidence than Alternatives 3 and 4.

Noise levels between 30 and 45 dBA (equivalent to a whisper in a quiet library) would extend into the CMW in the upper Ramsey Creek drainage to the crest of the Cabinet Mountains (Big Sky Acoustics 2006). Recreational access to the CMW from the Ramsey Creek drainage would be eliminated and the typical wilderness user would not hear the operation. The predicted noise level on Elephant Peak is between 25 and 30 dBA; a typical quiet bedroom at night has a noise level of 30 dBA. The occasional climber of Elephant Peak and other areas along the crest of the Cabinet Mountains west of the Ramsey Creek drainage may be able to hear the operation on a quiet day.

Undeveloped

Under Alternative 2, mine construction or operation activities would not affect the undeveloped quality of the CMW because these activities are not proposed within the CMW. The undeveloped quality would not be affected because the wilderness would remain essentially without permanent improvements or modern human occupation.

Baseline studies for the mine, such as water resources monitoring, have required the installation of some types of measuring equipment, such as dataloggers, in the CMW. Data loggers currently are located in Rock Lake (not visible) and Lower Libby Lake (PVC pipe is visible).

Solitude or a Primitive and Unconfined Type of Recreation

Solitude within the CMW may be affected by the increased visibility of mine disturbances outside of the wilderness, as well as increased noise from mining facilities. Portions of the Montanore Project would be visible from at least one key viewpoint within the CMW at Elephant Peak. The Libby Adit Site, the Ramsey Plant Site, and the Little Cherry Creek Tailings Impoundment would potentially be visible from the CMW locations west of the facilities. The surface features of proposed Rock Lake Ventilation Adit, located adjacent to Rock Lake on a small parcel of private land outside the CMW would be minimal, but may be visible from some areas within the CMW. Night lighting of the mine facilities would be visible from portions of the CMW west of the facilities. Areas cleared of timber for mine facilities would be visible from some locations within the CMW. The visual effects of mining operations would be noticeable during construction and operations and would diminish following facility reclamation and closure.

Noise from mining facilities would be higher than existing levels in the CMW, potentially reducing solitude. During construction, operations, and reclamation, noise from generators, fans, equipment, traffic, and plant operations would extend westward into the CMW, with noise levels of 55 dBA at the CMW boundary diminishing to 30 dBA along the ridge between Elephant Peak and Bald Eagle Peak. Noise level associated with the Rock Lake Ventilation Adit is unlikely to be audible over ambient noise levels. Following mine closure and reclamation, noise levels and solitude in this portion of the CMW would return to pre-mine levels. Noise levels are discussed in section 3.20.4.

Alternative 2 would not affect opportunities for a primitive and unconfined type of recreation within the CMW. Any trails or access routes that are directly affected by mine facilities would be replaced with new routes and would not affect access to the wilderness. Increased access and familiarity with the area due to mine construction and operations and road improvements may increase recreational use within the wilderness. While increased use may diminish primitive recreation opportunities in some areas (particularly near the CMW boundary), it would not substantially affect the ability of some visitors to find high-quality opportunities for primitive recreation within the wilderness.

No resource monitoring within the CMW is proposed in Alternative 2 after baseline data collection ceases. Currently, some baseline data collection is occurring, so increased opportunities for solitude or a primitive and unconfined type of recreation over present conditions would occur under Alternative 2.

3.24.1.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Site

Impacts on the qualities of wilderness character and qualities would be similar to Alternative 2. Some mine facilities and roads would be visible from locations within the CMW. Noise levels in CMW would reach 30 dBA along the ridge between Elephant Peak and Ojibway Peak. Night lighting also would be visible from portions of the CMW. In Alternatives 3 and 4, MMC would shield or baffle night lighting at all facilities, minimizing effects on night sky.

Effects on visual quality and increased levels of noise would diminish wilderness qualities related to solitude from some locations in the CMW under Alternative 3. These effects would occur throughout the duration of project operations and diminish following mining and reclamation.

Untrammeled

Temporary disturbances to wildlife in the CMW would occur for Alternatives 3 and 4 from blasting during construction of the upper Libby Adit. MMC would not conduct any blasting at the entrance to any adit portals during May 15 to June 15 to avoid disturbance to the potential goat kidding area on Shaw Mountain.

Displacement effects on the grizzly bear in the north-south movement corridor would be comparable for the agencies' alternatives, with displacement effects in the north-south movement corridor about 1,700 acres less than Alternative 2. In the agencies' alternatives, long-term displacement effects in the north-south movement corridor would be mitigated through protection of an equal amount of grizzly bear habitat in the north-south movement corridor, where possible. To mitigate for displacement effects due to evaluation adit activities, the first 500 acres acquired or put into conservation easement would be within the north-south corridor in BMUs 2, 5, and 6 (Table 30).

Changes in streamflow in Alternative 3 are discussed in section 3.10.4.3, *Agency Mitigated Poorman Impoundment Site* in the *Groundwater Hydrology* section and section 3.11.4.4, *Agency Mitigated Poorman Impoundment Site* in the *Surface Water Hydrology* section. Effects on flow of CMW streams would be less in Alternative 3 with MMC's modeled mitigation and the agencies' mitigation. In Alternatives 3 and 4, the agencies have required additional mitigation, such as increasing the buffer zones near Rock Lake and the Rock Lake Fault, which was not modeled, and leaving one or more barrier pillars inside the mine. The mitigation is designed to minimize effects on East Fork Rock Creek and East Fork Bull River streamflow and water quality. With MMC's modeled mitigation, the 3D model predicted flow in upper Libby Creek would be slightly reduced in all mine phases and in the East Fork Bull River, the East Fork Rock Creek, and other drainages in the Operations, Closure, and Post-Closure Phases. Reaches within the CMW where the 3D model predicts permanent flow reductions (EFRC-50 and EFBR-300) are located away from trails and campsites. Although a professional hydrologist or person highly familiar with these stream reaches may notice reductions in flow, the average wilderness user would not notice reductions in flows or be able to distinguish changes from natural variability.

The numerical models predict baseflow changes at various locations along streams draining the mine area, but the models do not consider what is possible to detect or measure. For example, baseflow at any one location along a stream may not be easily defined within the range of the model-predicted changes. Impacts from dewatering the mine and adits may be expressed in other ways, such as changing the elevation at which streams began to flow. Mine dewatering (and resultant groundwater drawdown) may cause this elevation to be lower in a drainage. Section 3.11.4.4.6. *Uncertainties Associated with Detecting Streamflow Changes due to Mine Activities* discusses streamflow variability and measurability. Reaches where the 3D model predicts flow reductions are located away from trails and campsites.

Surface water in the CMW overlying the ore body, such as the headwaters of the East Fork Rock Creek, Rock Lake, and East Fork Bull River, are considered outstanding resource waters under the Montana Water Quality Act. Section 3.13.1.2.1, *Nondegradation Rules*, discusses that the DEQ cannot authorize degradation of outstanding resource waters. Degradation does not include changes that the DEQ determine to be not significant. Current nondegradation rules provide that if an activity increases or decreases the mean monthly flow of a stream by less than 15 percent or the 7-day, 10-year ($7Q_{10}$) low flow of a stream by less than 10 percent such changes are not significant for purposes of the statute prohibiting degradation of state waters (ARM 17.30.715(1)(a)).

With MMC's modeled mitigation, decreases in bull trout habitat availability would be similar to Alternative 2 for the reach near the Isabella Creek confluence and the reach near the CMW boundary with decreases of 4 to 5 percent predicted in both reaches for adult and juvenile bull trout habitat and 11 percent in spawning habitat (Table 77). In Libby Creek at the CMW boundary would be 8 to 10 percent for adult and juvenile bull trout habitat and 20 percent in spawning habitat. Bull trout habitat availability would return to pre-mine conditions at steady state conditions. Mitigation projects planned to offset the risk of the population declines estimated to occur from the project in the Kootenai and Lower Clark Fork Core areas are described in more detail in the BA (USDA Forest Service 2013a) and in section 2.5.7.3, *Bull Trout.*

With MMC's modeled mitigation, the 3D model predicted less of a reduction in the potentiometric surface at Rock Lake. During operations, the effect on Rock Lake would be slightly less with MMC's modeled mitigation than without (Table 115). The agencies' mitigation, leaving barrier pillars with access-opening bulkheads, would be designed, based on hydrologic data collected during mining, to minimize post-mining changes in East Fork Rock Creek and East Fork Bull River streamflow and water quality. The agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault, may eliminate effects on Rock Lake during and after mining. Reductions in lake levels and volume would probably not have a detectable effect on the aquatic biota of Rock Lake. The average wilderness user likely would not perceive predicted reductions in Rock Lake or St. Paul Lake levels.

These direct and indirect impacts on ecological processes inside and adjacent to the wilderness, as described above, would not affect the untrammeled quality of the wilderness. The untrammeled quality would continue to appear to have been affected primarily by the forces of nature.

Natural

Modeled maximum nitrogen deposition rates from the mine were less than the FLM deposition analysis threshold at Upper Libby Lake, Lower Libby Lake, and Rock Lake (Table 60). Sulfur deposition rates are expected to be below the sulfur deposition analysis threshold (Klepfer Mining Services 2013a). The agencies' mitigation, such as limiting generator use at the mill after power was available from a transmission line to 16 hours during any rolling 12-month time period and using Tier 4 engines, if available on underground mobile equipment and generators and ultra-low diesel fuel in underground mobile equipment and in generator engines, during all phases of the project would substantially reduce emissions compared to Alternative 2. Nitrogen and sulfur emissions from the mine would substantially decrease when underground mining ceased and would end after the adits were plugged. Effects of nitrogen and sulfur deposition in Alternatives 3 and 4 on CMW lakes are discussed in section 3.4.4.3.3, *Cabinet Mountain Wilderness Impact Assessment* and in section 3.13.4 in the *Water Quality* section.

In Alternatives 3 and 4, MMC would monitor nitrogen and sulfur emissions at the Libby Adit for a minimum of 2 years. Using the monitoring data, MMC would update the nitrogen and sulfur deposition analysis and compare the updated model results to the current FLM deposition analysis thresholds. MMC would also assess potential effects on lake ANC if appropriate methods were available. If modeled results using the Libby Adit monitoring data were greater than current FLM deposition analysis thresholds, MMC would develop a plan for agencies' review that evaluated all available control technologies to reduce pollutant emissions.

Potential risk of subsidence would be less Alternative 2. The agencies' mitigation for subsidence, described in section 2.5.2.6.4, *Final Underground Mine Design Process*, the agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring, described in Appendix C, coupled with final design criteria submitted for the agencies' approval, would minimize the risk of subsidence and associated effects on surface resources in the CMW. Impacts from subsidence, if they were to occur, would not likely affect or be noticed by the average wilderness user recreating in Opportunity Class II areas.

As part of the Alternative 3 grizzly bear mitigation plan, MMC would fund access changes on five roads leading providing access to the CMW in the Bear, Poorman, Ramsey, Libby, and Standard creek drainages. These roads would be barriered and converted into trails. These access changes would improve the manageability and boundaries of the Cabinet Face East IRA, Rock Lake Trail #935, which currently provides access to Rock Lake and St. Paul Pass in the CMW, would change from being open to snow vehicles December 1 through April 30 to being restricted to all motorized vehicles, including over-snow vehicles. These access changes would improve the wilderness quality of natural. The opportunities for solitude or a primitive and unconfined type of recreation also would improve.

Noise levels would be similar to those described for Alternative 2, but instead of affecting the CMW in the upper Ramsey Creek drainage, the CMW in the upper Libby Creek drainage would be affected. The typical wilderness user would not hear the operation.

Undeveloped

Baseline studies for the mine, such as water resources monitoring, have required the installation of some types of measuring equipment, such as dataloggers, in the CMW. The agencies' proposed monitoring would continue to use such equipment and would require the installation of additional similar pieces of equipment. In addition, some surveying would need to occur in the CMW and monuments would be established. Most equipment and monuments would not be noticeable to the average wilderness user, who stays on trails and camps in identified campsites; however, some installations may be visible. Before any monitoring would occur, the Forest Service would use the Minimum Requirement Decision Guide (MRDG) process to ensure that adverse effects on wilderness character are minimized. The MRDG is a tool to complete a minimum requirement analysis, which is required under the Wilderness Act (see Appendix C, Section C.12 for a description of the MRDG process). The following equipment currently is used, would continue to be used, or would be used in the CMW:

- Data loggers: currently located in Rock Lake (not visible) and Lower Libby Lake (PVC pipe is visible). An additional data logger would be installed at Wanless Lake.
- Water level datum locations (rock bolts)
- Permanent stream flow recorders (depending on the type of recorder used, these could be slightly visible or not visible) at three stream sites (See Figure C-2 in Appendix C).
- Survey monuments (ex. elevation monuments for LiDAR)
- Ground-based reflectors (if needed, for InSAR)
- Piezometers in critical GDE locations (locations to be determined)

Solitude or a Primitive and Unconfined Type of Recreation

The agencies' conceptual monitoring (see Appendix C) would require the following activities in the CMW:

- Completing a pre-mining baseline topographic survey during the Evaluation Phase over the ore body and GDE inventory/monitoring area (Figure C-3) using aerial methods
- Completing a detailed surficial geologic survey of lands overlying the mine area during the Evaluation Phase
- Monitoring of mountain goats
- Monitoring of migratory birds
- Monitoring of wilderness water resources in wilderness lakes (Rock Lake, Lower Libby Lake, and Wanless Lake) and in the East Fork Rock Creek, East Fork Bull River, and Swamp Creek drainages
- Completing an Evaluation Phase Level II GDE inventory
- Completing GDE monitoring according to an agency-approved plan (Appendix C)

Increased use of the CMW by project personnel conducting monitoring would decrease opportunities for solitude or a primitive and unconfined type of recreation in Opportunity Class II areas around Rock Lake, Lower Libby Lake, and Wanless Lake and in Opportunity Class I areas in the East Fork Rock Creek, East Fork Bull River, and Swamp Creek drainages. Before any monitoring would occur, the Forest Service would use the MRDG process to ensure that adverse effects on wilderness character are minimized (see Appendix C, Section C.12 for a description of the MRDG process). Most work in the wilderness would be confined to Mondays-Wednesdays due to the logistics of delivering water quality samples to a laboratory. It is unlikely that much work would occur on Friday or Saturday, although an occasional Sunday start may facilitate personnel staging and earlier start times on Mondays (Klepfer Mining Services 2015b). At times, an additional person or guide with a horse may be necessary to minimize the hold time for samples. The frequency, duration, camp locations, and types of surveys are discussed in greater detail below.

Subsidence

Aerial Topographic Survey
The activities associated with the topographic survey would depend on the technology approved by the agencies in the final monitoring plan. If LiDAR (light detection and ranging) was the approved technology, MMC would complete the topographic survey using either a helicopter or a small, fixed-winged airplane. The survey would take 2 or 3 days to complete. Satellite data would be used if InSAR was the approved technology.

Before any aerial survey work could be done, elevation monuments would need to be established in the CMW over the ore body (from Rock Lake north towards the East Fork Bull River) if LiDAR is the approved technology. For InSAR monitoring, ground-based reflectors would be required to increase the number of months per year that InSAR monitoring may be performed, allow coverage in areas with thick vegetation, and increase the accuracy of all surveys. The number, location and size of the reflectors would be determined during final design should InSAR be the approved technology. For the ground support work needed for aerial surveys, it is assumed that a two-person crew would enter the CMW for a four-day period one time per year for three years. Camp locations for the survey crew would likely be at Rock Lake and somewhere along the East Fork Bull River (not necessarily in an identified camp site) (Klepfer Mining Services 2015b).

Surficial Geologic Surveys
The detailed surficial geologic survey would be completed by ground-based personnel in the area between Rock Lake and the headwaters of the East Fork Bull River, north of St. Paul Lake. The duration of the survey would depend on the complexity of the geology and may take 2 to 3 weeks.

Wildlife

MMC would fund surveys by the FWP to monitor mountain goats. The FWP would conduct the aerial surveys three times annually (winter-late spring-fall) along the east front of the Cabinet Mountains from the Bear Creek drainage south to the West Fisher drainage. Currently, the FWP conducts one aerial survey of the east Cabinet Mountains every other year. Surveys would be conducted for 2 consecutive years prior to construction, and every year during construction activities. Surveys would be conducted by helicopter over 2 to 3 days in the early morning and late evening.

MMC would conduct annual migratory bird in coordination with the KNF and Forest Service Region 1 bird monitoring specialist. One of the transects is in the CMW east of Rock Lake. One or more additional transects in the CMW may be used for comparison with the influence zone transects. Transects typically are completed on foot by 1 to 2 people over a 1- to 2-day period during June or July.

Water Resources

Lakes
As discussed above under, *Undeveloped,* data loggers are currently installed in Rock Lake and Lower Libby Lake. A datalogger also would be installed in Wanless Lake;.

Currently, Lower Libby Lake is monitored one time per year by a Forest Service crew that typically downloads data from the datalogger and collects other monitoring data during a day trip. Future monitoring work may require an overnight trip with a camp at the lake.

Rock Lake monitoring has occurred several times per year and in the future would include more extensive monitoring. Specifically, it is assumed that the following activities would occur in the wilderness:

- Continuous lake monitoring: a two-person crew on foot would visit the lake and download data from the datalogger and take water samples twice each summer. A camp would not be required as the work could be completed in a day or combined with other monitoring work (Klepfer Mining Services 2015b).
- Lake profile monitoring: a four-person crew on foot and at least 3 horses and a guide (to haul equipment) would visit the lake four times per year. The duration of each monitoring trip would be two days and would require a camp at Rock Lake (Klepfer Mining Services 2015b). Boats would be used on Rock Lake as part of this work.
- Flow monitoring: a two-person crew would monitor flow four times each summer (monthly). The duration of each trip would be one or two days with a camp (if needed) at Rock Lake (Klepfer Mining Services 2015b). This monitoring trip would likely be combined with lake profile monitoring.

Wanless Lake monitoring would also be for lake level, profile, and flow and would require a similar sized crew and frequency as monitoring for Rock Lake. The duration of each trip may be one day longer than those for Rock Lake due to the location. Camps would be made at Wanless Lake (Klepfer Mining Services 2015b).

Stream Flow
Water resource monitoring locations in the CMW are shown on Figure C-2 in Appendix C. Twenty sites in the Libby Creek, East Fork Rock Creek, East Fork Bull River, and Swamp Creek drainages in the CMW have been identified for monitoring. Streamflow measurements at three sites would require installing a streamflow measuring device to take continuous electronic recordings of stream stage.

It is assumed the following stream flow monitoring activities would occur in the wilderness:

- Libby Creek monitoring: a two-person crew on foot would monitor Libby Creek every two weeks from July – October. A camp would not be required as the work could be completed in a day or combined with other monitoring work (Klepfer Mining Services 2015b).
- East Fork Rock Creek monitoring: covered above under the discussion of the Rock Lake monitoring effort.

- East Fork Bull River monitoring: a two-person crew on foot would monitor the East Fork Bull River five times from mid-July to mid-October. A camp would not be required as the work could be completed in a day or combined with other monitoring work (Klepfer Mining Services 2015b).
- Swamp Creek monitoring (Wanless Lake area): a two person crew on foot would monitor Swamp Creek five times per summer (monthly). The duration of each trip would be two days with a camp along the Swamp Creek trail (Klepfer Mining Services 2015b).
- Bear Creek (BC-50): a one or two-person crew on foot would monitor BC-50 four times per summer (monthly). The duration of each trip would be 1-2 hours since the site can be accessed by an open road during most monitoring events (Klepfer Mining Services 2015b).

GDE Area

As part of water resources monitoring, MMC would continue and expand its GDE monitoring in CMW as described in Appendix C, Section C.10.3.2. The GDE monitoring inventory and monitoring area is shown on Figure C-3 in Appendix C and is based on areas of groundwater drawdown predicted by the 3D groundwater model. In addition to the surface water monitoring describe above, MMC would continue to monitor the spring/seep complex in upper Libby Creek (located at the GDE 4 site), collecting vegetation information annually at transects and quadrants using the Forest Service Level 2 monitoring protocol as a basis for a project specific protocol, and measuring groundwater levels at two nested piezometer sites.

Additional GDE monitoring would have locations and frequency specified based on inventory data and on the local hydrogeology and proximity to the mine or adit void. Before completing any additional GDE inventory, MMC would conduct a review of aerial photography and (LiDAR) maps of the GDE inventory area (Figure C-3). Should the review of the maps and photos identify isolated wetlands or springs, MMC would include them in a Level 2 GDE inventory focusing on areas potentially affected by mine or adit inflows during the Evaluation Phase. MMC would submit to the agencies for approval a GDE Monitoring Plan for important GDEs found during the inventory. The plan would include piezometers in critical locations, a monitoring schedule, potential mitigation measures, and identification of possible mitigation implementation triggers if stress to flora and fauna is detected and determined to be a result of mine dewatering.

GDE monitoring is currently occurring in the CMW and in the future would include more extensive monitoring as described above. It is assumed the following GDE monitoring activities would occur in the wilderness:

- Headwaters areas (Libby Lake Area; above St. Paul Lake near the water divide between Libby Creek and the East Fork Bull River; and the Rock Lake Area just below St. Paul Pass): a minimum two-person crew on foot would conduct vegetation surveys and spring flow measurements once per season. The duration of each trip would be three days. Camps would be at the St. Paul Pass area and at one of the GDE sites (Klepfer Mining Services 2015b).

- Lower Libby Creek: a two-person crew on foot would conduct vegetation surveys and take piezometer measurements four times per summer (monthly). The duration of each trip would be approximately four hours and would not require a camp (Klepfer Mining Services 2015b).

Effectiveness of Agencies' Proposed Mitigation

In the context of KNF's protection of the CMW as a wilderness area, the agencies' mitigation would be effective in minimizing adverse effects on surface resources in the CMW. Mitigation measures such as increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring coupled with final design plans submitted for the agencies' approval, would reduce the risk of subsidence and measurable hydrological indirect effects on the surface within the wilderness. In Alternative 3 and 4, potential air quality indirect impacts on wilderness lakes and wilderness character would be effectively minimized by the agencies' mitigation measures such as limiting generator use, and using Tier 4 engines and ultra-low sulfur diesel fuel in underground mobile equipment and in generators during all phases of the project by reducing emissions in the CMW Before any monitoring would occur, the Forest Service would use the MRDG process to ensure that adverse effects on wilderness character during monitoring were also minimized.. The mitigation and monitoring requirements in Alternative 3 would protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and preserving the wilderness character consistent with the use of the land for mineral development and production in compliance with 36 CFR 228.15 and the Wilderness Act.

3.24.1.4.4 Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Site

Impacts on the qualities of wilderness character from the plant and adit sites and from the agencies' proposed mitigations and monitoring would be the same as Alternative 3; the impoundment would have the same effects as Alternative 2. Some mine facilities and roads would be visible from some viewpoints within the CMW. Noise levels would be similar to Alternative 3, and night lighting also would be visible from portions of the CMW. Effects on visual quality and increased levels of noise would diminish wilderness attributes related to solitude from some locations in the CMW under Alternative 4.

3.24.1.4.5 Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built and CMW would not be affected.

3.24.1.4.6 Effects Common to Alternatives B, C-R, D-R and E-R

The alternative transmission lines alignments, substation, or loop line would not encroach on CMW. Views from within the CMW would be affected by a new transmission line, particularly from high, open vistas such as Elephant Peak within the CMW. None of the transmission line alternatives, substation, or loop line would affect wilderness character.

3.24.2 Roadless Areas

3.24.2.1 Regulatory Framework

The 2015 KFP allocated most of the 43 IRAs on the KNF to MA 5 (backcountry). Within IRAs in the Montanore Project analysis area, MA 5b direction defers to the requirements of the 2001 Roadless Area Conservation Rule (Roadless Rule) (USDA Forest Service 2001).

The Roadless Rule established prohibitions on road construction, road reconstruction, and timber harvesting on inventoried roadless areas (IRA) on National Forest System lands In 2001, with certain exceptions. One of the exceptions was for locatable mining activities, such as the Montanore Project, for which reasonable access and disturbance for mineral entry within an IRA is allowed. The intent of the Roadless Rule is to provide lasting protection for inventoried roadless areas within the National Forest System in the context of multiple-use management. IRAs are identified in the set of inventoried roadless area maps contained in the Forest Service Roadless Area Conservation, Final Environmental Impact Statement Volume 2 dated November 2000 and in Appendix C of the 2013 FEIS for the 2015 KFP (USDA Forest Service 2013c). Roadless areas provide opportunities for restoration of ecosystem function and improvement of threatened, endangered, proposed, and sensitive species habitat (Tidwell 2012).

The 2015 KFP direction considered in the analysis of IRAs is:

> **GOAL-IRA-01.** Inventoried roadless areas will be managed to protect values and benefits of roadless areas.
>
> FW-STD-IRA-01. Within inventoried roadless areas, outside of the state of Idaho, the 2001 Roadless Area Conservation Rule (36 CFR 294 Subpart B, published at 66 Fed Reg. 3244-3273) shall apply. IRAs are identified in a set of inventoried roadless area maps, contained in the Forest Service Roadless Area Conservation, Volume 2, dated November 2000, which are held at the national headquarters office of the Forest Service, or any subsequent update or revisions of those maps (36 CFR 294.11). Maps of the IRAs are also found in appendix C of the Forest Plan FEIS.

3.24.2.2 Analysis Area and Methods

The analysis area for direct, indirect, and cumulative effects on IRAs encompasses the Cabinet Face East IRA east of the CMW and south of the ridge between Big Cherry Creek and Bear Creek, the Rock Creek IRA on the west side of the CMW, and that portion of the McKay Creek IRA adjacent to the East Fork Rock Creek (Figure 88). Although other IRAs are shown on Figure 88, they would not be affected by any of the alternatives, and are not discussed further.

The five basic characteristics identified in FSH 1909.12, Chapter 70 to evaluate the capability of an IRA are: natural, undeveloped, outstanding opportunities for solitude or primitive and unconfined recreation, special features and values, and manageability. The analysis of effects on IRAs was quantitatively based on direct effects within an IRA and qualitatively based on indirect effects on IRA capabilities. Data on the IRA capabilities were taken from the 2015 KFP’s 2013 Final EIS (USDA Forest Service 2013c). The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on IRAs in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in Section 3.1.3, *Incomplete and Unavailable Information*.

3.24.2.3 Affected Environment

The Cabinet Face East IRA lies just east of the CMW and extends about 36 miles south from Libby (Figure 88). The entire IRA consists of 50,200 acres of National Forest System lands and 800 acres of private lands. The average width is about 2 miles. This IRA provides attributes and recreational opportunity similar to those found in the CMW. Its wilderness capability rating is high. It was determined to be suitable for designated wilderness because of its adjacency to the CMW and it includes areas of underrepresented plant communities, although the south half is recognized to have high value mineral deposits. The 2015 KFP allocated the Cabinet Face East IRA to MA 5b–Backcountry Motorized Year-round.

The McKay Creek IRA includes sidehill and ridgetop features and steep-sided stream bottoms. The wilderness capability rating of the McKay Creek IRA is moderate to high. The McKay Creek IRA was determined to be unsuitable for wilderness designation because of existing over-snow use, the need for vegetation restoration, the adjacent powerline, and high value mineral deposits. The 2015 KFP allocated the McKay Creek IRA in upper East Fork Rock Creek (excluding Rock Creek Trail #935) to MA 1b–Recommended Wilderness, in lower East Fork Rock Creek to MA 5a–Backcountry Non-motorized Year-round, and Rock Creek Trail #935 in upper East Fork Rock Creek to MA 5b–Backcountry Motorized Year-round.

The Rock Creek IRA is a steep and rugged area that is surrounded by the CMW on three sides. The wilderness capability rating of the Rock Creek IRA is high. It was determined to be suitable for wilderness designation. The 2015 KFP allocated the Rock Creek IRA to MA 1b–Recommended Wilderness, MA 5a–Backcountry Non-motorized Year-round, and MA 5b–Backcountry Motorized Year-round.

3.24.2.3.1 Inventoried Roadless Area Capabilities

The KNF (USDA Forest Service 2013c) identified the following capabilities of the IRAs in the analysis area considered during 2015 KFP planning process.

Natural and Undeveloped

The Cabinet Face East IRA excludes most improvements and all roads, leaving it appearing very natural and undeveloped. Man-made features within the IRA include trails and evidence of historical mining activity. The McKay Creek IRA has medium natural and undeveloped capability. The natural integrity of the Rock Creek IRA is high with no man-made features to detract from the area’s natural and undeveloped appearance.

Opportunities for Solitude

The Cabinet Face East IRA opportunity for solitude is high. The Rock Creek IRA had high opportunities for solitude along East Fork Rock Creek. The McKay IRA had medium opportunities for solitude.

Primitive and Unconfined Recreation Opportunities

Primitive recreation opportunities available in the Cabinet Face East IRA, which include hiking, hunting, stream fishing, and horseback riding, were rated medium to high. Primitive recreation opportunities in the McKay Creek IRA, which include hunting, hiking, and fishing, were rated medium to high. Opportunities in the Rock Creek IRA, which include hiking, viewing, and wildlife observation, were rated low to medium.

Special Features and Values

The Cabinet Face East IRA's special features included a variety and abundance of wildlife and views of historical mining activity. Ramsey Lake, a very small lake surrounded by old growth, is also a special scenic feature within the analysis area. The lake receives very little recreational use. Special features within the Rock Creek and McKay Creek IRAs included a variety and abundance of wildlife.

Manageability and Boundaries

Cabinet Face East IRA is a long, linear roadless area with boundaries easily defined in some places and less so in others. Less definable boundaries are due to the exclusion of some narrow drainage corridors in Bear, Cable, Poorman, Ramsey, and Libby Creeks where roads exist. The IRA spans the length of the CMW on its east side and provides a buffer zone to it, making the CMW more manageable for wilderness characteristics. The McKay Creek IRA boundary was updated in the 2015 KFP to follow identifiable features on ground and the IRA was rated as medium for manageability. The Rock Creek IRA is well-defined by a closed road (Rock Creek Trail #935) and the CMW, making for an easily managed boundary.

3.24.2.3.2 Other Unroaded Areas

The analysis area contains several areas of unroaded National Forest System lands that are adjacent or contiguous to IRAs. Five tracts of unroaded lands were identified (ERO Resources Corp. 2010b), with two larger areas, adjacent to but separated by roads from an IRA: 1) a 3,500-acre area in the Miller Creek drainage, and 2) a 900-acre area west of the Bear Creek Road in the Upper Little Cherry Creek drainage. The other three areas are smaller (64 to 200 acres) tracts that are contiguous to an IRA between Libby and Poorman Creeks. Unroaded areas analyzed in this document are those with criteria such as proximity to existing Wilderness or IRAs, larger size, overlap with protective Management Area or Recreation Opportunity Spectrum designations, or wildlife habitat. The analysis included unroaded areas that are adjacent to but separated from an IRA by road systems and unroaded areas that are contiguous to an IRA.

3.24.2.4 Environmental Consequences

3.24.2.4.1 Inventoried Roadless Areas

Alternative 1 – No Mine

Alternative 1 would not directly affect the Cabinet Face East IRA. Sounds associated with the activities at the Libby Adit Site would be audible within portions of the Cabinet Face East IRA in the Libby Creek drainage. The DEQ's approval of the mine, as permitted by DEQ Operating Permit #00150 and revised in revisions 06-001, 06-002, and 08-001, would remain in effect. MMC could continue with the permitted activities on private land associated with the Libby Adit evaluation program that did not affect National Forest System lands. Noise levels in the IRA would return to low, ambient levels when closure and reclamation was completed at the site. Noise levels are discussed in section 3.20.4.

Alternative 2 – MMC's Mine Proposal

Mine facilities in Alternative 2 would directly affect about 44 acres, or about 0.1 percent, of the Cabinet Face East IRA in the Ramsey Creek drainage. Timber harvest in the IRA would occur at the Ramsey Plant Site and a portion of LAD Area 1, and a road to the Ramsey Adits and LAD Area 1 would be built in the IRA. The Libby Adit Site, the Ramsey Plant Site, and the Little Cherry Creek Tailings Impoundment also would be visible from portions of the IRA. Night lighting at some mine facilities would be visible from the IRA. Roads and clearing areas may be visible from locations with high or open vantage points. Visual effects would be noticeable during construction and operations, and diminish following facility reclamation and closure. The visual effects of Alternative 2 are discussed in section 3.17.4.

Sound levels between 30 and 45 dBAs would be audible for distances up to 1 mile from the eastern boundary of the IRA (Big Sky Acoustics 2006). The Cabinet Face East IRA boundary is segmented on the eastern edge by narrow corridors that exclude the roads in several drainages including Ramsey Creek (Figure 88). These narrow corridors will allow for some non-conforming uses adjacent to the IRA. The project would have no direct effect on Ramsey Lake, but would restrict access to it. The plant site would be located about 1,000 feet northeast of the lake. The noise level at Ramsey Lake would increase to about 55 dBA during construction and would be slightly lower during operations. Noise levels are discussed in section 3.20.4.

Natural and Undeveloped

Alternative 2 would not change the overall appearance of the Cabinet Face East IRA, but would affect the appearance of the IRA in locations nearest the direct impact. Changes in natural integrity and apparent naturalness would occur at the edges of the Cabinet Face East IRA in the Ramsey Creek drainage by the Ramsey Plant site and LAD Area 1. Emissions from the mill and adits would increase concentrations of priority air pollutants in the IRA adjacent to Ramsey Creek; concentrations of all pollutants would be below applicable standards (Table 50). The increased concentrations would reduce the natural integrity of the IRA adjacent to Ramsey Creek. Effects on air quality are discussed in section 3.6.4, *Air Quality.* The indirect effect on baseflow described in section 3.24.1.4.2, *Alternative 2 – MMC's Mine Proposal* in the wilderness section would reduce the natural integrity of the Rock Creek and McKay Creek IRAs.

Opportunities for Solitude

Alternative 2 would not affect the opportunities for solitude in the Rock Creek and McKay Creek IRAs. Proposed facilities in Ramsey Creek and Little Cherry Creek drainages would reduce the opportunity for solitude on the east side of the Cabinet Face East IRA from Libby Creek watershed north to Bear Creek watershed because of the increased sound levels that would be generated by mine operations. Following mine closure and reclamation, noise levels and opportunities for solitude in the IRA would return to pre-mine conditions.

MMC would fund access changes on the Bear Creek Road (NFS road #4784) that leads into the Cabinet Face East IRA in the Bear Creek drainage if it was not already closed by the Rock Creek Project. This road is currently open from July 1 to October 14 to motor vehicles, and gated with motorized access restricted to administrative uses other times of the year. It is open to snow vehicles December 1 through April 30 (Table 28). In MMC's grizzly bear mitigation plan, all motorized use including administrative uses, along with wintertime use, would be eliminated for the life of the project. This access change would improve the opportunities for solitude and primitive recreation in the Cabinet Face East IRA for the life of the project. The road would return to existing conditions after the project ceased operations and completed closure and the improved opportunities for solitude and primitive recreation would cease.

Primitive and Unconfined Recreation Opportunities

Views of the Libby Adit Site, the Ramsey Plant Site, and the Little Cherry Creek Tailings Impoundment from high or open locations in the IRA may affect some visitors' primitive recreational experience. Alternative 2 would restrict access to portions of the Ramsey Creek drainage beyond LAD Area 1, eliminating recreational opportunities in those portions of the IRA. Access to Poorman Creek also would be restricted under Alternative 2. The access restriction would continue for the life of the project. Due to the restricted access and noise levels, visitors to the area also would likely no longer make Ramsey Lake a destination under this alternative during the project's life. Primitive recreation opportunities would not be affected in the rest of the roadless area. Primitive recreation opportunities would return to pre-mine levels after mine closure and reclamation. Alternative 2 would not affect the primitive recreational opportunities in the Rock Creek and McKay Creek IRAs.

Special Features

Access to Ramsey Lake would be restricted and noise levels would be high enough to deter visitation during the life of the project. Alternative 2 would not affect the special features of the Rock Creek and McKay Creek IRAs. The effects on the special feature of a variety and abundance of wildlife in the Cabinet Face East IRA are described in the section 3.25, *Wildlife*. None of the mine alternatives would affect views of historical mining activity.

Manageability and Boundaries

The Cabinet East Face IRA would be affected by the Ramsey Plant Site and LAD Area 1 in the Ramsey Creek drainage, which could prevent the expansion or establishment of a future CMW boundary in Ramsey Creek drainage. Manageability and boundaries would return to pre-mine conditions after mine closure and reclamation. Alternative 2 would not affect the manageability and boundaries of the Rock Creek or McKay Creek IRAs.

Alternative 3 – Agency Mitigated Poorman Impoundment Alternative

Cabinet Face East IRA

Alternative 3 would avoid all surface disturbance in the IRA. No road construction or timber harvest would occur in the IRA west of LAD Area 1 or at the Ramsey Plant Site. Increased noise levels from the Libby Plant Site would be audible from within the IRA between Libby and Ramsey creeks. Similar noise levels would be audible from within the IRA adjacent to the Libby Adit Site and Libby Plant Site. MMC-funded mountain goat monitoring three times annually by helicopter over 2 to 3 days in the early morning and late evening would increase noise in the Cabinet Face East IRA from the Bear Creek drainage south to the West Fisher drainage. Adverse visual impacts from activities occurring outside the IRA would be similar to Alternative 2.

Alternative 3 would not change the overall appearance of the Cabinet Face East IRA, but would affect the appearance of the IRA in locations nearest the direct impact. Changes in natural integrity and apparent naturalness would occur at the edges of the Cabinet Face East IRA in the Libby Creek drainage by the Libby Plant Site and Libby adits. Opportunities for solitude and primitive recreation would be eliminated in the IRA near the Libby Plant Site and Libby adits. The agencies' proposed water resources monitoring would require monitoring of water resources in the Libby Creek, Ramsey Creek, and Poorman Creek drainages (see Appendix C). Although the IRA excludes roads along these creeks, increased use by project personnel conducting the monitoring for 3 to 5 days between July and October would decrease opportunities for solitude or a primitive and unconfined type of recreation in the IRA adjacent to these creeks.

Emissions from the mill and adits would increase concentrations of priority air pollutants in the IRA adjacent to Libby and Ramsey creeks; concentrations of all pollutants would be below applicable standards (Table 56 and Table 57). The increased concentrations would reduce the natural integrity of the IRA adjacent to Libby and Ramsey creeks. The agencies' mitigation, such as limiting generator use at the mill after power was available from a transmission line to 16 hours during any rolling 12-month time period and using Tier 4 engines, if available on underground mobile equipment and generators and ultra-low diesel fuel in underground mobile equipment and in generator engines, during all phases of the project would substantially reduce emissions compared to Alternative 2. Effects on air quality are discussed in section 3.4.4, *Air Quality*. IRA attributes would return to pre-mine conditions after mine closure and reclamation. IRA attributes would return to pre-mine conditions after mine closure and reclamation.

The effect of closing the Bear Creek Road (NFS road #4784) on the Cabinet Face East IRA would be the same as Alternative 2. MMC would fund access changes on four roads leading into the Cabinet Face East IRA in the Poorman, Ramsey, Libby, and Standard creek drainages. These roads are currently restricted yearlong to motor vehicles, but open to snow vehicles December 1 through April 30 (Table 28). These roads are gated with motorized access restricted to administrative uses, access to private property, and access to mining claims. Such motorized uses are limited and are unlikely to be experienced by most wilderness users of the seven roads. In the agencies' grizzly bear mitigation plan, all motorized use including these uses, along with wintertime use, would be eliminated. Motorized on-road uses on the roads are limited and are unlikely to be experienced by most wilderness users of the roads. These access changes would improve the winter-time opportunities for solitude and primitive recreation in the Cabinet Face East IRA.

Rock Creek and McKay IRAs

The indirect effect on baseflow described in section 3.24.1.4.2, *Alternative 2 – MMC's Mine Proposal* in the wilderness section and in section 3.10.4, *Groundwater* would reduce the natural integrity of the Rock Creek and McKay Creek IRAs. The agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault which was not modeled, and leaving one or more barrier pillars inside the mine, is designed to minimize effects on East Fork Rock Creek streamflow.

The agencies' proposed migratory bird and water resources monitoring would require monitoring of avian and water resources in the IRAs East Fork Rock Creek, East Fork Bull River, and Swamp Creek drainages (see Appendix C). Increased use by project personnel conducting the monitoring would decrease opportunities for solitude or a primitive and unconfined type of recreation in these drainages.

Access on Rock Lake Trail #935, which currently separates the Rock Creek IRA from the McKay IRA would change from being open to snow vehicles December 1 through April 30 to being restricted to all motorized vehicles, including over-snow vehicles. The change would improve the wintertime opportunities for solitude and primitive recreation in the Rock Creek IRA.

Effectiveness of Agencies' Proposed Mitigation

The agencies alternatives would not require and would effectively eliminate road construction and timber harvest within an IRA. In the context of KNF's protection of inventoried roadless areas within the National Forest System, the agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault which was not modeled, and leaving one or more barrier pillars inside the mine, would be effective in minimizing changes in East Fork Rock Creek streamflow and water quality in the IRAs. The agencies' mitigation, such as limiting generator use at the mill after power was available from a transmission line to 16 hours during any rolling 12-month time period and using Tier 4 engines, if available on underground mobile equipment and generators and ultra-low diesel fuel in underground mobile equipment and in generator engines, during all phases of the project would be effective in minimizing emissions in the IRAs.

Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

No road construction or timber harvest would occur in any IRA. Effects on the Cabinet Face East IRA would be similar to Alternative 3 due to similar positioning of the facilities in and near Libby Creek. Predicted changes to the Rock Creek and McKay Creek IRAs would be the same as Alternative 3.

Alternative A – No Transmission Line

In Alternative A, the transmission line, substation, and loop line for the Montanore Project would not be built and the Cabinet Face East IRA would not be affected.

Alternative B – MMC's Proposed Transmission Line (North Miller Creek Alternative)

MMC's proposed North Miller Creek transmission line alignment would physically disturb about 2 acres of the Cabinet Face East IRA in the Ramsey Creek drainage. Timber harvest for line clearing would occur in the IRA. The small area disturbed in the IRA would not directly affect the primitive recreation opportunities and other features, opportunities for solitude, roadless area manageability and boundaries, or special features and special values. The steel monopoles, new roads and associated timber harvest, which would be required under Alternative B, would parallel the IRA boundary along most of Ramsey Creek, and would be visible from some viewpoints within the IRA, particularly high, open vistas. These views also may contribute to a loss of opportunities for solitude for some visitors to the IRA. Noise from transmission line construction would be audible in the IRA adjacent to Ramsey Creek. Noise levels are discussed in section 3.20.4. IRA attributes would return to pre-transmission line conditions after transmission line decommissioning. The substation and loop line would not affect the Cabinet Face East IRA in any alternative.

Effects Common to Alternatives C-R, D-R, and E-R

The other three transmission line alternatives would avoid physical disturbance in the IRAs. No road construction or timber harvest would occur in the IRAs. Transmission line construction to the Libby Plant Site would be audible in the Cabinet Face East IRA between Libby and Ramsey creeks. Views from the IRA would be affected by new H-frame transmission lines, particularly from high, open vistas. Cabinet Face East IRA attributes would return to pre-transmission line conditions after transmission line decommissioning. Attributes of the Rock Creek and McKay Creek IRAs would not be affected.

3.24.2.4.2 Other Unroaded Areas

Mine Alternatives

The mine facilities proposed in Alternatives 2, 3, and 4 would adversely affect an unroaded area, adjacent to but separated by roads from an IRA, in the upper Little Cherry Creek drainage by the various tailings impoundment and road configurations. While the impacts of the alternatives would be similar, Alternative 2 would have the greatest effect on this area by reducing the acres of unroaded area. These impacts would reduce the size of unroaded area (ERO Resources Corp. 2010b).

The impacts of the proposed mine alternatives on the other, smaller unroaded areas, contiguous to an IRA, between Libby Creek and Poorman Creek, would vary. Alternative 2 would have the greatest impact, fragmenting or eliminating two of these three areas while leaving the smallest (north of Libby Creek) intact. Alternatives 3 and 4 would eliminate the smallest area, but would not impact the other two, including the larger area north of Ramsey Creek. Overall, Alternative 2 would have the greatest impacts on unroaded areas, followed by Alternatives 4 and 3.

Transmission Line Alternatives

All of the transmission line alternatives would cross over the outer edge of the unroaded area in the Miller Creek drainage. Alternatives B and C-R would cross the northeastern edge of the unroaded area, Alternative D-R would cross along the southern edge, and Alternative E-R would cross small portions of the southwestern edge. Alternatives B and C-R would have the greatest impact, requiring vegetation clearing of 15,000 feet of centerline, further fragmenting the outer edge of this unroaded area, and reducing its overall size.

Alternative B would construct roads in the unroaded area (Figure 41), while use of helicopter for clearing in Alternative C-R would eliminate the need for road construction (Figure 44). Alternatives B and C-R would not impact the area’s overall resource values and character. Alternative D-R would require vegetation clearing of 7,000 feet of centerline and Alternative E-R would require vegetation clearing of 4,000 feet of centerline on the edges of this unroaded area (ERO Resources Corp. 2010b). Alternatives D-R and E-R would not impact this area’s overall size, character, or resource value. The Sedlak Park Substation and loop line would not affect unroaded areas.

3.24.3 Wild and Scenic Rivers

3.24.3.1 Regulatory Framework

Section 7 of the 1968 Wild and Scenic Rivers Act provides for the protection of the free-flowing, scenic, and natural values of rivers designated as components or potential components of the National Wild and Scenic Rivers System from the effects of construction of any water resources project. A water resources project under the Wild and Scenic Rivers Act is any activity that may affect the free-flowing characteristics of a designated or study river. The Wild and Scenic Rivers Act affords protection to two types of rivers: designated rivers, or Congressionally-authorized study rivers. The analysis area has no designated rivers or Congressionally-authorized study rivers.

The Forest Service’s land management policies require a comprehensive evaluation of the potential for rivers to be eligible for inclusion in the Wild and Scenic River System (USDA Forest Service 2015a, Appendix E). The 2015 KFP includes a desired condition that eligible wild, scenic, or recreational rivers and their adjacent areas retain their free-flowing status and preliminary classification, and conserve or enhance their outstandingly remarkable values (MA2-DC-AR-0). The 2015 KFP does not have any standard or guidelines specific to locatable mineral activities in MA 2.

River segments eligible for potential inclusion are not afforded protection under the Wild and Scenic Rivers Act. Forest Service policy for eligible river segments directs that "water resources projects proposed on a section 5(d)(1) study river [eligible river] are not subject to section 7(b), but will be analyzed as to their effect on a river's free-flow, water quality, and outstandingly remarkable values, with adverse effects prevented to the extent of existing agency authorities (such as special-use authority)" (USDA Forest Service 2006a).

The Bull River was listed on the Nationwide Rivers Inventory in 1993 (National Park Service 2009). The Nationwide Rivers Inventory is a listing of more than 3,400 free-flowing river segments in the United States that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. A 1979 Presidential Directive requires federal agencies to protect and manage rivers on the Nationwide Rivers Inventory and the surrounding area in a fashion comparable to rivers already included in the Wild and Scenic Rivers System. The U.S. Council on Environmental Quality issued a 1980 Memorandum that stated: "Although the President's directive does not prohibit an agency from taking, supporting or allowing an action which would adversely affect wild and scenic values of a river in the Inventory, each agency is responsible for studying, developing and describing all reasonable alternatives before acting, and for avoiding and mitigating adverse effects on rivers identified in the Inventory" (Council on Environmental Quality 1980).

3.24.3.2 Analysis Area and Methods

The eligible segments of the East Fork Bull River and the Bull River below the confluence with the East Fork Bull River are part of the analysis area for wild and scenic rivers (Figure 88). Other eligible segments of the Bull River system would not be affected. The analysis of effects on wild and scenic rivers was qualitatively based on direct effects on the free-flowing characteristics, water quantity, water quality, and outstandingly remarkable values of the eligible wild and scenic segments.

Data on the outstandingly remarkable values of the eligible wild and scenic segments were taken from the KNF's 2014 process to identify and classify potentially eligible wild and scenic rivers (USDA Forest Service 2015a, Appendix E). None of the transmission line alternatives would affect free-flowing characteristics, water quantity, water quality, or outstandingly remarkable values of the eligible wild and scenic segments. Disclosure of effects on eligible segments is limited to the mine alternatives.

The data available and methods used are adequate to evaluate and disclose reasonably foreseeable significant adverse effects on wild and scenic rivers in the analysis area and to enable the decision makers to make a reasoned choice among alternatives. The agencies did not identify any incomplete or unavailable information, as described in Section 3.1.3, *Incomplete and Unavailable Information*.

3.24.3.3 Affected Environment

Three eligible river segments of the Bull River are eligible for addition to the Wild and Scenic River System. A 3-mile segment of the East Fork Bull River in the CMW was identified as a Wild River. A 4.5-mile segment of the East Fork Bull River outside the CMW and a 9.1-mile eligible segment of the Bull River in the analysis area were identified as Recreational Rivers (Figure 88). The Outstandingly Remarkable Value of the three segments is scenery.

A wild river is a river or section of rivers free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America. A recreation river is a river or section of rivers readily accessible by roads or railroad, which may have some development along their shoreline and which may have undergone some impoundments or diversions in the past. The qualities that contribute to each of the three segments' eligibility are scenic values.

3.24.3.4 Environmental Consequences

3.24.3.4.1 Alternative 1 – No Mine

The three eligible river segments would not be affected by mining activities.

3.24.3.4.2 Alternative 2 – MMC Proposed Mine

Free-Flowing Characteristics

Alternative 2 would not alter the free-flowing character of the East Fork Bull River or Bull River. Flow would remain in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the stream.

Water Quantity

Changes in streamflow in Alternative 2 are discussed in section 3.11.4.3, *Alternative 2 – MMC Proposed Mine* in the *Surface Water Hydrology* section. The 3D model predicted flow in the East Fork Bull River and Bull River would be reduced in all mine phases, reaching a maximum reduction of 0.40 cfs in the East Fork Bull River at the CMW boundary and 0.33 cfs at the mouth of the East Fork Bull River and in the Bull River during the Post-Closure Phase. A permanent decrease of 0.01 cfs is predicted in the East Fork Bull River at the CMW boundary, and a flow increase of 0.05 cfs is predicted at the mouth of the East Fork Bull River and in the Bull River.

With the data currently available, the 3D model results provide a potential range of streamflow impacts. They are the best currently available estimates of impacts and associated uncertainty that can be obtained using groundwater models. The 3D groundwater flow model would be refined and rerun after data from the Evaluation Phase were incorporated into the models (see section C.10.4, Evaluation Phase in Appendix C). Following additional data collection and modeling, the predicted impacts on surface water resources in the analysis area, including simulation of mitigation measures, may change and the model uncertainty would decrease. See section 3.10.4.3.5, *Groundwater Model Uncertainty* in the *Groundwater Hydrology* section for more discussion of uncertainty.

Water Quality

Changes in water quality in Alternative 2 are discussed in section 3.13.4.3, *Alternative 2 – MMC Proposed Mine* in the *Water Quality* section. During all phases except post-closure, mine dewatering and the resulting drawdown of bedrock groundwater may reduce the flow of bedrock groundwater to surface water. East Fork Bull River may have lower concentrations of dissolved solids and metals. If such a water quality change occurred, it would be detectable only during low flow periods when bedrock groundwater is the major source of supply to surface water. Even at low flows, the changes in water quality may be difficult to measure.

Post-closure, groundwater levels would begin to recover, but water would continue to flow toward the mine void for hundreds of years. Eventually, water may begin to flow out of the underground mine workings and may mix with groundwater in saturated fractures, react with iron oxide and clay minerals along an estimated 0.5-mile or greater flow path, undergo changes in chemistry, and flow, without mitigation in Alternative 2 at a low rate as baseflow to the East Fork Bull River. The effect cannot be accurately quantified without additional information from the underground setting. It is likely that cadmium, lead, and copper minerals exist within bedrock fractures at low concentrations. To develop a quantitative estimate of the actual effect, MMC would monitor the chemistry within the underground workings, evaluate downgradient groundwater flow and chemistry within bedrock fracture systems, and monitor baseflow in the East Fork Bull River (see Appendix C, *Water Resources Monitoring*).

Outstandingly Remarkable Values

Reductions in streamflow or changes in water quality would have no effect on the scenic values of the East Fork Bull River or Bull River. Historic resources in the three segments, such as trails or the Bull River Guard Station, would not be affected. The scenic quality of the three segments would not be affected by a reduction in baseflow.

3.24.3.4.3 Alternative 3 – Agency Mitigated Poorman Impoundment Alternative and Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative

Free Flowing Characteristics

Alternatives 3 and 4 would not alter the free-flowing character of the East Fork Bull River or Bull River. Flow would remain in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the stream.

Water Quantity

Changes in streamflow in Alternative 3 and 4 are discussed in section 3.11.4.4, Alternative 3 – *Agency Mitigated Poorman Impoundment Alternative* and section 3.11.4.5, Alternative 4 – *Agency Mitigated Little Cherry Creek Impoundment Alternative* in the *Surface Water Hydrology* section. The 3D model predicted flow in the East Fork Bull River and Bull River would be reduced in all mine phases, reaching a maximum reduction of 0.39 cfs in the East Fork Bull River at the CMW boundary and 0.32 cfs at the mouth of the East Fork Bull River and in the Bull River during the Post-Closure Phase. A permanent decrease of 0.01 cfs is predicted in all three stream segments. The agencies' mitigation of increasing the buffer zones near Rock Lake and the Rock Lake Fault which was not modeled, and leaving one or more barrier pillars inside the mine, is designed to minimize effects on East Fork Bull River streamflow and water quality.

Water Quality

Changes in water quality in Alternatives 3 and 4 are discussed in section 3.13.4.4, *Alternative 3 – Agency Mitigated Poorman Impoundment Alternative* and section 3.13.4.5, *Alternative 4 – Agency Mitigated Little Cherry Creek Impoundment Alternative* in the *Water Quality* section. The effects on the three eligible segments in all phases except post-closure would be the same as Alternative 2. With the agencies' mitigation of barrier pillars if required in Alternatives 3 and 4, the flow would be toward East Fork Rock Creek and the post-mining changes in streamflow in the three eligible river segments would be minimized, and the water quality of the three segments would not be affected.

Outstandingly Remarkable Values

Reductions in streamflow or changes in water quality would have no effect on the scenic values of the East Fork Bull River or Bull River. The historic resources in the three eligible river segments, such as trails or the Bull River Guard Station, would not be affected. The scenic quality of the three segments would not be affected by a reduction in baseflow.

Effectiveness of Agencies' Proposed Mitigation

The mitigation in Alternative 3 and Alternative 4 would minimize effects on East Fork Bull River streamflowand water quality.

3.24.3.4.4 Transmission Line Alternatives

None of the transmission line alternatives, substation or loop line would affect the free-flowing characteristics, water quantity, water quality, or the outstandingly remarkable values of any of the three eligible segments.

3.24.4 Other Disclosures

3.24.4.1 Cumulative Effects

A list of past and current projects used for cumulative effects analysis is located in Section 3.2. Past actions have not substantially altered the attributes of the CMW since the passage of the Wilderness Act or the establishment of the Cabinet Face East IRA. The existing Libby Adit is visible from some locations in the CMW and the Cabinet Face East IRA.

Reasonably foreseeable projects used for cumulative effects analysis are described in Section 3.3. Of the projects listed, the proposed Rock Creek Project is the only one with the potential to contribute cumulative effects to wilderness. Development of the Rock Creek Project likely would have similar effects on wilderness and roadless areas as those described for development of the Montanore Project. The cumulative effects of the Rock Creek Project and the Montanore Project might contribute to a loss of wilderness character (described below) desired by some individuals.

3.24.4.1.1 Cabinet Mountains Wilderness

Untrammeled

The direct and indirect impacts of the proposed Rock Creek Project on ecological processes inside and adjacent to the wilderness, would be similar to those described above for the Montanore Project and would not affect the untrammeled quality of the wilderness. The untrammeled quality would continue to appear to have been affected primarily by the forces of nature.

Wildlife

The Montanore and Rock Creek Projects, assuming they occurred concurrently, would cumulatively impact grizzly bear habitat parameters of core and road densities within the southern Cabinet Mountains. Within BMU 4, mitigation (habitat compensation and road access mitigation) required of both projects would result in improvement to the baseline and would provide more secure habitat for grizzly bears. In BMU 5, where the majority of impacts would occur, mitigation for both projects (primarily habitat compensation and road access mitigation) implemented before the Evaluation and Construction Phases would contribute to the cumulative improvement of OMRD, TMRD and core.

Water Resources

The Montanore and Rock Creek Projects, assuming they occurred concurrently, would cumulatively reduce flow in the East Fork Bull River in the CMW. No other aspects of the two projects would have cumulative effects on surface water resources in the CMW or an IRA. The maximum effects on the East Fork Bull River would occur after both mines ceased operations (assumed to be operating and closing simultaneously). Compared to direct effects, cumulative flow reductions would be 0.08 cfs greater in the East Fork Bull River at the CMW boundary (Table 118). As the mine void filled and groundwater levels above the mines and adits reached steady state conditions, the effects on streamflow would decrease. Cumulative effects at steady state conditions were not quantified.

RCR prepared a 3D numerical hydrogeological model of the Rock Creek mine area to assist in defining potential impacts on groundwater and surface water resources (Hydrometrics 2014). For the Rock Creek Mine SEIS, the predicted cumulative effects were estimated by adding the results from the Montanore and Rock Creek 3D models for the respective periods of greatest groundwater drawdown. RCR's model predicted effects were slightly greater than estimated by MMC's 3D model (Table 118). Reaches where predicted cumulative flow reductions would occur are located away from trails and campsites. Although a professional hydrologist or person highly familiar with these stream reaches may notice reductions in flow, the average wilderness user, who remains on trails and uses identified campsites, would not notice reductions in flows. Cumulative streamflow effects of the Rock Creek and Montanore projects are discussed in section 3.11.4.9, *Cumulative Effects* in the *Surface Water Hydrology* section; cumulative water quality effects are discussed in section 3.13.4.9, *Cumulative Effects* in the *Water Quality* section.

Fisheries and Other Aquatic Resources

Assuming the Montanore and Rock Creek projects occur concurrently, they would cumulatively reduce streamflow and aquatic habitat in the Rock Creek, East Fork Bull River, and Bull River watersheds. Maximum effects would occur after both mines ceased operations, assuming they operated and closed simultaneously. Sediment increases in the Rock Creek watershed could occur in the short-term as a result of the Rock Creek Project, but, as with the Montanore Project, long-term sediment decreases are predicted to occur (USDA Forest Service and DEQ 2001). No other cumulative effects would occur within these watersheds that would affect aquatic resources. Additional discussion on cumulative effects to aquatic life and fisheries are in section 3.6.4.10.

Natural

The proposed Rock Creek Project on the west side of the Cabinet Mountains in the Rock Creek drainage would contribute to the cumulative effect on air quality; however, the effect would be minor and compliance with the Class I and Class II increments at the CMW border is predicted. The Montanore Mine NO_x with the corresponding emissions from the existing Troy Mine and proposed Rock Creek Project would not cause or contribute to a 1-hour NO_2 NAAQS. Furthermore, the daily and annual $PM_{2.5}$ and PM_{10} Montanore Mine Production Phase emissions with the corresponding particulate emissions from the Troy and Rock Creek Mines would not violate the corresponding NAAQS/MAAQS (DEQ 2015a).

The Forest Service has monitored Libby Lakes for many years because of their high quality waters and sensitivity to change. There is concern that emissions from regional mining projects could increase acid deposition to the lakes, with acidification of the lake watershed and lake chemistry and associated adverse aquatic effects. The Forest Service conducted a MAGIC (Model of Acidification of Groundwater in Catchments) model screen analysis for CMW watersheds to determine the risk of both projects on Libby Lakes (Story 1997). The modeling results concluded the estimated changes in acid anions and base cations are not sufficient to project any changes in pH or alkalinity in Libby Lakes from either project directly, and cumulatively.

Other effects that could alter the natural character of wilderness include operational noise and the possibility of subsidence. The effects for the Rock Creek Project would be similar to those for the Montanore Project, but likely would not affect locations on the east side of the Cabinet Mountains.

Undeveloped

As with the Montanore project, some types of equipment or markers, such as dataloggers or survey monuments, may be installed in the CMW as part of monitoring effort for the Rock Creek Project. The cumulative effects would be minor and not perceivable to the average wilderness user recreating on established trails and camping at identified campsites.

Solitude or a Primitive and Unconfined Type of Recreation

Solitude within the CMW may be cumulatively affected by the increased visibility of mine disturbances outside of the wilderness. The Rock Creek Project would not be visible from key viewpoints identified for the Montanore Project scenery analysis, but some components of both projects would be visible from some locations (see section 3.17.4.11, *Cumulative Effects,* in the *Scenery* section. Other viewpoints within the CMW would be affected by the Rock Creek Project. Wilderness visitors at some locations also may be affected by the clearing of timber for any of these future project facilities.

Population increases due to the development of both projects would slightly increase demand for recreational opportunities in the region. Increased recreational use of popular CMW sites, such as Rock Lake, may cumulatively decrease opportunity for solitude or a primitive and unconfined type of recreation.

Increased use of the CMW by personnel from both the Rock Creek and Montanore projects conducting monitoring (i.e. water resources monitoring) would cumulatively decrease opportunities for solitude or a primitive and unconfined type of recreation. Although lake, stream, and GDE monitoring would focus on different areas of the CMW, there may be an overall perception of loss of solitude. Other monitoring activities common to both projects, such as aerial surveys (for GDEs, wildlife, or subsidence), would also cumulatively decrease opportunities for solitude or a primitive and unconfined type of recreation.

3.24.4.1.2 Inventoried Roadless Areas

The Rock Creek Project would not directly affect the Cabinet Face East IRA, the Rock Creek IRA, or the McKay IRA and would not contribute to the cumulative effects on Cabinet Face East IRA. Libby Creek Ventures plans to drill three boring holes in the Libby Creek drainage outside of the Cabinet Face East IRA, which may increase activity and noise in the drainage and in nearby parts of the IRA for up to one week. About 1 acre of land is planned for clearing. This activity in combination with the Montanore Project may have a short-term adverse cumulative effect upon visitors to the IRA and the CMW.

3.24.4.1.3 Eligible Wild and Scenic River Segments

Cumulative reductions in streamflow would have no effect on the scenic values of the East Fork Bull River or Bull River.

3.24.4.2 Regulatory/Forest Plan Consistency

3.24.4.2.1 Wilderness

Valid existing rights were established to patents were issued to lode mining claims HR 133 and HR 134 in the CMW in 2001. None of the mine and transmission line alternatives would directly physically disturb any lands within the CMW and none of the four wilderness qualities would be directly affected. None of the alternatives would directly affect wilderness character. Under all alternatives, the undeveloped quality would not be affected because the wilderness would remain essentially without permanent improvements or modern human occupation.

The Wilderness Act does not regulate activities outside the wilderness that may affect wilderness character. None of the alternatives would indirectly affect the wilderness quality of undeveloped. The undeveloped quality would not be affected because the wilderness would remain essentially without permanent improvements or modern human occupation.

All mine alternatives have the potential to indirectly affect wilderness qualities of untrammeled, natural, and solitude or a primitive and unconfined type of recreation. Mitigation measures identified in Chapter 2 for Alternatives 3 and 4 and monitoring required for Alternatives 3 and 4 (Appendix C), including a minimum requirements analysis (as described in Section C.12.2.1 in Appendix C) and wilderness stewardship performance monitoring (Section C.12.2.2), would be implemented to minimize changes in wilderness character. Mitigation measures such as increasing the buffer zones near Rock Lake and the Rock Lake Fault, and the agencies' monitoring coupled with final design criteria submitted for the agencies' approval, would reduce the risk of subsidence and measurable hydrological indirect effects to the surface within the wilderness. In Alternative 3 and 4, potential air quality indirect impacts on wilderness lakes and wilderness character would be minimized by mitigation measures such as limiting generator use, and using Tier 4 engines and ultra-low sulfur diesel fuel in underground mobile equipment and generator engines in all phases of the project by reducing emissions as compared to Alternative 2.

Mitigation measures and monitoring requirements in Alternatives 3 and 4 are reasonable stipulations for protection of the wilderness character and are consistent with the use of the land for mineral development. Alternatives 3 and 4 would be conducted to protect the surface resources in accordance with the general purpose of maintaining the wilderness unimpaired for future use and enjoyment as wilderness and preserving the wilderness character consistent with the use of the land for mineral development and production in compliance with 36 CFR 228.15 and the Wilderness Act. All mine and transmission line alternatives would comply with the Wilderness Act, meet the 2015 KFP MA 1b-Wilderness desired conditions, standards, and guidelines, and comply with the 2009 Cabinet Mountains Wilderness Management Plan. Alternatives 3 and 4 would further minimize adverse environmental impacts on surface resources within the wilderness, and thereby comply with the regulations (36 CFR 228, Subpart A) for locatable mineral operations on National Forest System lands.

The KNF 2015-2025 Wilderness Stewardship Performance (2015) includes the element Other Special Provisions. In addition to monitoring required for all resources (Appendix C), the KNF would develop a special provisions plan, covering both management and monitoring in the CMW (See Section C.12.2.2).

3.24.4.2.2 Inventoried Roadless Areas

Mine Alternative 2 and transmission line Alternative B would directly impact 44 acres of the Cabinet Face IRA thru road construction and timber harvest. The roadless characteristics of the 44 acres of surface disturbance would not be preserved in Mine Alternative 2 and Transmission Line Alternative B. MMC has valid existing rights to access the minerals proposed for mining with the Montanore Project, and road construction and timber harvest in the Cabinet Face East IRA could be authorized by the Chief of the Forest Service. MMC's alternatives would maintain progress toward the goal GOAL-IRA-01 over the long term, even if the alternatives would adversely affect progress toward the goal in a minor way over the long term. MMC's alternatives are not designed in exact accordance with the standard FW-STD-IRA-01.

Mine Alternatives 3 and 4 and Transmission Line Alternatives C-R, D-R and E-R would not require road construction and timber harvest within an IRA. Effects of these alternatives would be from activities outside of the IRAs. Mine Alternative 3 and 4 and Transmission Line Alternatives C-R, D-R and E-R would comply with the 2015 KFP regarding management of affected IRAs. Alternatives 3 and 4 would minimize adverse environmental impacts on surface resources within the IRAs, and thereby comply with the regulations (36 CFR 228, Subpart A) for locatable mineral operations on National Forest System lands. The agencies' alternatives would maintain progress toward the goal GOAL-IRA-01. Inventoried roadless areas would be managed to protect values and benefits of roadless areas. The agencies' alternatives are designed in exact accordance with the standard FW-STD-IRA-01.

3.24.4.2.3 Eligible Wild and Scenic River Segments

None of the mine or transmission line alternatives would affect the free-flowing characteristics of the eligible portions of the Wild and Scenic River segments. Flow in the three eligible segments would remain in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the stream. Mitigation measures identified in Chapter 2 for Alternatives 3 and 4 and monitoring required for Alternatives 3 and 4 (Appendix C) would be implemented to minimize changes in the water quality of the three eligible segments. Reductions in streamflow or changes in water quality would have no effect on the scenic values of the East Fork Bull River or Bull River and the free-flowing status of the rivers would remain. All alternatives would comply with the Wild and Scenic Rivers Act, Forest Service policy, and the 2015 KFP regarding eligible Wild and Scenic River segments.

3.24.4.3 Irreversible and Irretrievable Commitments

Any changes to baseflow in the East Fork Rock Creek and East Fork Bull River within the CMW during and after mining, as well as associated loss of bull trout habitat, would be an irreversible commitment of resources. Wilderness experiences for some visitors may be irretrievably affected from specific viewpoints within the CMW under any of the alternatives. Alternative 2 and MMC's proposed North Miller Creek transmission line alternative would irretrievably devote small portions of the Cabinet Face East IRA to mining uses over the life of the project. Roadless area attributes would be irretrievably affected in the Libby Creek and Ramsey Creek drainages in all alternatives. All alternatives would irreversibly reduce streamflow in the eligible East Fork Bull River and Bull River Wild and Scenic River segments.

3.24.4.4 Short-term Uses and Long-term Productivity

In the short term, development of the project under Alternative 2 would affect the consideration of a small portion of the Cabinet Face East IRA in the Ramsey Creek drainage for permanent designation as wilderness during the project's life due to the project facilities' direct disturbance of the IRA. In the long term, areas that were cleared of timber for facilities would be visible from a number of key viewpoints, both in the CMW and the Cabinet Face East IRA, resulting a long-term impact on the visual quality of some visitor's experience.

3.24.4.5 Unavoidable Adverse Environmental Effects

Under Alternative 2, noise levels would increase from the Ramsey Plant Site up to the ridge between Elephant Peak and Bald Eagle Peak in the CMW. Under Alternatives 3 and 4, noise levels would increase from the Libby Plant Site up to the ridge between Elephant Peak and Ojibway Peak. Under all alternatives, night lighting would be visible from some locations of the CMW. All mine and transmission line action alternatives would indirectly reduce the opportunities for solitude in both the CMW and the Cabinet Mountains East IRA. The three wilderness qualities of untrammeled, natural, and solitude or a primitive and unconfined type of recreation in certain areas also would be indirectly affected in all action alternatives. Under Alternative 2, primitive recreation opportunities would no longer exist in the Ramsey Creek drainage within the IRA due to the unavoidable physical impacts, presence of facilities, increased noise levels, and night lighting.