6.0 EVALUATION OF ALTERNATIVES

The evaluation of the expected performance of each restoration alternative is based upon USEPA's guidance for conducting an EE/CA (USEPA 1993a) and the DOI's NRD Restoration Planning Process (43 CFR 11.81-11.82). Correspondingly, the evaluation considers a composite of the feasibility criteria identified in the EE/CA guidance and criteria identified for evaluating the appropriateness of a restoration alternative under the NRD guidance. The effectiveness of each alternative is ultimately gauged relative to its expected ability to achieve the overarching restoration objectives identified in Section 3, or more specifically, the ability to restore the resource to baseline conditions. A No Action/Natural Recovery alternative provides a point of comparison.

The alternatives developed in Section 5 are evaluated under the general criteria of implementability, effectiveness and relative cost, taking into account conditions within the 11-Mile Reach. The specific considerations for each of the general criteria are described below.

Implementability

This criterion relates to the applicability and technical and administrative feasibility associated with each alternative. Technical feasibility, or implementability, is the ability to construct and reliably operate, or maintain, the system to meet the restoration objectives, in light of the site setting. Administrative feasibility, or implementability, is the ability to procure the necessary services, land, equipment, and expertise. Anticipated regulatory and community acceptance were also considered in evaluating the administrative implementability of each alternative. An alternative that is relatively easy to construct or put into practice at the site, and is technologically reliable will be considered readily, or highly, implementable. An alternative that is based upon commercially available technologies but not widely used for the specific application, or one that presents some challenges or difficulty related to site conditions was characterized as more difficult to implement. An alternative using technology that may not be commercially available, such as innovative or emerging technologies, or that may have significant construction or operational problems for the particular site was considered to have an even lower degree of implementability.

Effectiveness

This criterion relates to the potential effectiveness of the alternative to achieve the restoration objectives, considering the physical and chemical properties of the media addressed and the site-specific conditions. The effectiveness evaluation considers how well each alternative reduces the source of injury

to specific resources and the extent to which the resource may be expected to be restored. Potential impacts to human health and the environment during the construction and implementation of the remedy, including the potential for additional injury, are effectiveness considerations. The time to achieve the restoration objectives and the short- and long-term reliability of the selected restoration action with respect to site conditions are also considered in determining the effectiveness of each alternative.

In addition to the overarching action objectives, the following specific considerations were identified:

- Reduce the potential for transport of hazardous substances to surface water;
  - Leaching
  - Erosion
- Reduce the potential for transport of hazardous substances to groundwater;
- Reduce the potential for direct exposure to hazardous substances in soil by wildlife and livestock;
  - Direct exposure to soils
  - Plant uptake
- Reduce the potential for phytotoxicity;
- Re-establish appropriate vegetation/habitat to meet land-use objectives; and
- Improve the physical condition of both riparian and in-stream habitat within the stream corridor.

Estimated Costs

The estimated costs to implement each of the alternatives include direct capital costs, or costs directly related to construction activities, and are intended to include all labor, materials and equipment costs to implement the restoration activities in 2003 dollars. Indirect capital costs are also included, such as engineering/design, construction management, and administrative costs related to the development and implementation of appropriate institutional controls. O&M costs including inspections, maintenance seeding and additional amendments are estimated on an annual basis. These O&M costs are extended over a twenty-year period and a net present value is calculated using a 5% rate of return. The total cost includes all capital costs and the net present value for the O&M costs. Per the FS criteria, these costs are

expected to fall within a –30% to +50% range of actual costs. Detailed cost estimates are included as Appendix A.

The following evaluation is organized by reach. Within each reach, the range of alternatives for each Resource Category is considered individually, relative to the above criteria. A comparison of performance is provided in Section 7.

6.1 REACH 1

Reach 1 extends from the confluence of the Upper Arkansas River with California Gulch to the tributary input from Lake Fork (1.81 miles). Reach 1 is comprised of predominantly agricultural lands.

6.1.1 FLUVIAL MINE-WASTE DEPOSITS

Reach 1 contains 24 fluvial mine-waste deposits with a combined volume of approximately 33,000 cu. yds. USEPA has conducted treatment on 16 of the Reach 1 deposits (Section 3). All of the mapped high priority deposits within Reach 1 have been or are being remediated by USEPA. It is assumed that with time, USEPA's activities will provide adequate stabilization and allow for establishment of good vegetation cover. Correspondingly, the treated deposits are not included in Reach 1 alternatives calling for in-place stabilization. Removal alternatives, however, consider all of the deposits regardless of prior amendments.

6.1.1.1 ALTERNATIVE 1

Alternative 1 for mine-waste deposits of all priorities (low, moderate and high) in Reach 1 is the No Action/Natural Recovery alternative. No additional work would be performed, in addition to that work already completed by the USEPA.

Implementability: No action would be taken.

Effectiveness: The majority of fluvial mine-waste deposits in Reach 1 have recently been remediated by USEPA. Only approximately 3 of the 18 acres of deposits have not been remediated. These remaining 3 acres are comprised of moderate and low priority deposits. USEPA's remediation of all high priority deposits in Reach 1 with approximately 100 tons/acre lime should be effective in terms of reducing metals mobility, thereby reducing the potential for leaching and plant uptake.

USEPA has not formally evaluated the success of their Reach 1 remediation, but has observed that moisture-holding capacity is an important consideration. However, their addition of over 100 tons of organic amendments per acre will improve moisture-holding capacity and increase plant nutrients,

thereby allowing for the near term development of adequate vegetation cover and, over time, providing suitable habitat/pasture, effectively restoring conditions within the 15 acres of deposits to conditions similar to those observed in adjacent areas. Given the initial establishment of cover and small area of deposits, vegetation consistent with surrounding communities should be achieved and maintained, thereby restoring habitat.

Although the remaining low and medium priority deposits cover a small area, pose less concern than the treated deposits, and have lesser potential to pose injury, they will not recover without restoration measures. However, the consequence of no action for these deposits is limited, because the partial loss of habitat/agricultural services provided by roughly 3 acres of unremediated deposits within the approximately 1,175 acres of Reach 1 500-year floodplain is relatively small.

Overall, given the large amount of recent remediation by USEPA, the No Action alternative could very well be effective in meeting most, if not all, restoration objectives.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.1.1.2 ALTERNATIVE 2

Alternative 2 for the previously untreated low and moderate priority fluvial mine-waste deposits within Reach 1 consists of the combination of lime addition, deep tilling, and reseeding of the amended deposits, with mulch addition.

Implementability: The 3 acres of unremediated mine-waste deposits are accessible for lime addition, deep tilling and reseeding activities, although the incorporation of amendments to a depth of 18 inches may require special construction equipment and/or techniques to achieve adequate mixing. Incorporation to this depth may require the use of a "Roto-mill", a self-contained soil stabilization/mixing machine, or a specialty pull-behind attachment known as a modified Baker plow. This alternative is considered to be implementable with the use of appropriate equipment. With respect to administrative implementability, access and consent of the landowners will be required to implement this alternative. However, given the extent of work previously performed within this reach and the fact that most of the reach is under the control of a single landowner, access is not considered to be difficult to obtain.

Effectiveness: Alternative 2 will effectively reduce the availability of metals and, with the addition of lime and deep tilling to a depth of 18-inches, will potentially reduce surficial metals concentrations. Revegetation activities under Alternative 2 should meet the objectives of establishing cover/habitat with low potential for metals exposure within 3 to 5 years of implementation. Institutional controls addressing future land-use practices may be required for long-term effectiveness.

Cost: The total estimated cost for Alternative 2 is approximately $85,000 (Table A-1). The largest portion of the costs for this alternative is related to the procurement and incorporation of agricultural lime. Costs have also been included in this estimate to develop access to the deposits and to restore access routes following implementation. Because many of the deposits within this reach have previously been accessed without the construction of access roads, and the quantity of amendments to be delivered is relatively small, these costs are minor.

6.1.1.3 ALTERNATIVE 3

Alternative 3 for the previously untreated low and moderate priority deposits within Reach 1 consists of the combination of lime and biosolids addition, deep tilling, and reseeding of the amended deposits.

Implementability: The 3 acres of unremediated mine-waste deposits are accessible for lime and biosolids addition, deep tilling and reseeding activities, although the incorporation of amendments to a depth of 18 inches may require special construction equipment and/or techniques to achieve adequate mixing. Incorporation to this depth may require the use of a "Roto-mill", a self-contained soil stabilization/mixing machine, or a specialty pull-behind attachment known as a modified Baker plow. This alternative is considered to be implementable with the use of appropriate equipment. The implementability of this treatment option for near bank deposits could be limited because USEPA regulations prohibit the use of non-composted biosolids within 10 feet of the river channel. It is assumed that suitably composted biosolids can be obtained. With respect to administrative implementability, access and consent of the landowners will be required to implement this alternative. However, given the extent of work previously performed within this reach and the fact that most of the reach is under the control of a single landowner, access is not considered to be difficult to obtain.

Effectiveness: Alternative 3 will effectively reduce the availability of metals and, with the addition of lime and deep tilling to a depth of 18-inches, will potentially reduce surficial metals concentrations prior to revegetation. The inclusion of biosolids will improve moisture-holding capacity and increase plant nutrients, thereby improving growth and restoring habitat. Alternative 3 should meet the objectives of establishing cover/habitat with low potential for metals exposure within 2-3 years after implementation. Institutional controls addressing future land-use practices may be required for long-term effectiveness.

Cost: The total estimated cost for Alternative 3 is approximately $89,000 (Table A-2). The largest portion of the costs for this alternative is related to the procurement and incorporation of agricultural lime. It is assumed that biosolids may be obtained from a municipality within 50 miles of the site at no cost, other than loading and transportation. Costs have also been included in this estimate to develop access to the deposits and to restore access routes following implementation. Because many of the deposits within this reach have previously been accessed without the construction of access roads, and the quantity of amendments to be delivered is relatively small, these costs are minor.

6.1.1.4 ALTERNATIVE 4

Alternative 4 for the fluvial mine-waste deposits of all priorities (low, moderate and high) within Reach 1 is complete removal, backfilling the excavation with replacement soil to match the surrounding grade and revegetation. Although the vast majority of fluvial deposits within Reach 1 have been treated in place, Alternative 4 includes removal of the treated deposits. As a matter of course and to ensure the complete removal of mine waste, an additional six inches of underlying soil will also be excavated beyond the waste-soil interface. The remaining subgrade soils beneath the high priority deposits will be amended with lime prior to backfilling. Banks will be stabilized where removals pose the potential for instability.

Excavated material will be transported to the California Gulch NPL Site repository to be established at the Black Cloud Mine site. For the purposes of this evaluation the capacity of the Black Cloud repository is assumed to be adequate to accommodate the volume of waste and soil removed.

Implementability: Excavation of the mine-waste deposits and underlying soil, to an average depth of 18 inches, is not anticipated to be difficult and can be accomplished with common earthmoving

construction equipment. Appropriate control measures will be required when excavating along the riverbank to avoid release of waste material into the river, including the installation of silt fence and other sediment and erosion control BMPs. The Black Cloud Mine repository is located approximately nine miles from the confluence of California Gulch and the Arkansas River, near the headwaters of Iowa Gulch. This is a reasonable haul distance and although some steep grades exist, the roads are generally in good condition. The implementation of this alternative may also require the improvement of access routes to facilitate truck access from either US Highway 24, Colorado Highway 300, or from existing gravel access roads within the reach. While the majority of the deposits within this reach have been accessed previously, additional work may be required to better prepare the access routes to accommodate the larger volume of truck traffic. Dust control will be required to mitigate dust on temporary haul roads and gravel access roads. The implementation of this remedy will present some short-term risks associated with potential transport of contaminants, either as dust emissions or as releases to the river during excavation along the riverbank. Both potential release mechanisms may be mitigated through the implementation of appropriate engineering controls. In addition, increased truck traffic along the haul routes may create minor disruptions to residents and businesses along the haul route, through Stringtown and the southern end of Leadville, as well as an increased potential for traffic accidents.

With respect to administrative implementability, access and consent of the landowners will be required for temporary construction and removal activities. However, given the extent of work previously performed within this reach and the fact that most of the reach containing mine-waste deposits is under the control of a single landowner, access is not considered to be difficult to obtain. Because Asarco and Resurrection are developing the Black Cloud repository, with cooperation from the USEPA and the State of Colorado (all MOUP), authorization to use this repository is not considered to be an impediment to implementation. It is expected that USEPA would view transport of the mine wastes to the Black Cloud Repository as consolidation within the same general area of contamination. Excavation along the banks of the river and bank stabilization activities may hold permitting considerations, however, they would not prohibit the work.

Effectiveness: Complete removal of all mapped deposits to the Black Cloud repository within Reach 1 allows for all Restoration Objectives to be fulfilled. Liming of underlying soil and soil replacement eliminates concerns for plant uptake of any residual metals and allows for establishment of any desired cover type. Alternative 4 should meet the objectives of establishing cover/habitat with low potential for metals exposure within 2 years after implementation. The only potential limitations on effectiveness are related to plant access to moisture and grazing impacts, prior to full establishment of vegetation.

Complete removal also provides additional long-term effectiveness, in that no reliance on institutional controls (access control) would be required.

Cost: The total estimated cost for Alternative 4 is approximately $1,521,000 (Table A-3). The largest costs associated with this alternative are related to the removal of the deposits, the import of replacement soil, and lime amendment of the underlying soils. Transportation costs for transport of mine wastes and incoming clean soils make up a substantial portion of the overall cost. Costs are also included for the improvement of access routes, the restoration following construction of approximately 4,000 linear feet of temporary access/haul roads, and the implementation of engineering controls/BMPs. Costs for streambank stabilization are included, assuming that approximately 300 feet, or 15%, of bank associated with removals would require some specific stabilization measures. While the specific actions to be taken within these areas will require additional evaluation, the cost estimates included are representative of the average cost that may be associated with a range of options. Costs specifically related to developing or preparing, or related to the closure of, the repository at the Black Cloud Mine have not been included, however a $2.00 per cubic yard tipping fee has been included in the cost estimate.

6.1.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

6.1.2.1 ALTERNATIVE 1

Alternative 1 for Channel Morphology/In-Stream Habitat/Riparian Area in Reach 1 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: The relative role of habitat versus water quality in determining the quality of the fishery in Reach 1 is unknown. However, the in-stream physical habitat in Reach 1 could be improved. It is thought that improvements in physical in-stream habitat will off-set, to some degree, the current impacts of poor water quality. Without improvements in water quality and/or habitat, the quality of the fishery in Reach 1 is not expected to change significantly over time.

With regard to stream morphology and riparian zone habitat, rapid significant changes in channel morphology are not expected. USEPA has conducted some limited bank stabilization measures in Reach 1. It is thought that with no action, limited erosion of mine waste, loss of riparian habitat and agricultural impacts would not change from their current level. Impact from grazing is expected to be the ongoing primary factor that influences riparian zone habitat conditions, as well as bank stability.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.1.2.2 ALTERNATIVE 2

Alternative 2 identified for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 1 includes a combination of fencing paired with a 20-year conservation lease (a 25 foot offset, or setback, from the banks encompassing the fenced areas). This alternative may be coupled with any of the restoration alternatives for the fluvial mine-waste deposits, identified above.

Implementability: From a technical perspective, fencing of sensitive riparian zones to restrict and limit cattle access is readily implementable, but requires the cooperation and consent of the landowner. Administratively, the implementation of this alternative will require coordination with the landowners, to negotiate acceptable conservation leases that meet the requirements for restoration and address landowner concerns. This restriction would not significantly reduce the area currently available for grazing within the 500-year floodplain. Given the narrow width of the easement, it would not preclude the landowner from land uses other than grazing (e.g., development within 25 feet of the bank is unlikely), and should therefore be acceptable. Conservation easements/leases are quite often established in environmentally sensitive areas on private lands.

Effectiveness: Based on observations between reaches and experience in other watersheds, fencing of the riparian zone to limit grazing will provide the largest single benefit to the quality of riparian habitat, stream bank stability and overall channel stability within Reach 1.

Re-establishment of diminished woody vegetation, potentially including larger trees, will provide improved riparian habitat for wildlife. The increased woody vegetation and the absence of livestock traffic will reduce active erosion and strengthen streambanks. Over time, as larger woody vegetation

reestablishes, there should be benefits to the in-stream habitat. Larger near bank woody vegetation should contribute woody debris, further improving in-stream habitat. Under Alternative 2, riparian vegetation is expected to improve substantially in the first five years. The benefits to bank stability and in-stream habitat would mature over the 20-year lease period. A potential landowner consideration is that the restored riparian vegetation may be more attractive to beavers, which often attempt to dam irrigation ditches.

Alternative 2 would be effective with or without companion actions for fluvial mine-waste deposits. The benefits to the brown trout fishery from Alternative 2 within Reach 1 cannot be quantified. However, the restoration of riparian vegetation is expected to provide benefits to the fishery with or without improvements in water quality.

Cost: The total estimated cost for Alternative 2 is approximately $66,000 (Table A-4). This cost estimate includes costs related to the installation of approximately 18,800 linear feet of three-strand solar-electric fence and maintenance of the fence. In addition, $350/acre has also been included, as a one-time capital cost, for the acreage included within the 20-year conservation lease boundaries on private property to compensate landowners for the loss of use to these areas.

6.1.2.3 ALTERNATIVE 3

Alternative 3 for Channel Morphology/In-Stream Habitat/Riparian Areas within Reach 1 is a combination of technologies in addition to the grazing control measures from Alternative 2. Within subreaches 1A and 1C, Alternative 3 includes soft treatments for bank protection, channel stabilization and in-stream habitat improvements. This alternative is intended to be paired with fluvial mine-waste deposit alternatives 2 and 3, involving in-place stabilization of deposits. Soft treatments would occur at locations where fluvial deposits are intersected by the active channel.

Implementability: As with Alternative 2, fencing of sensitive riparian zones is readily implementable, from a technical perspective, but requires the cooperation and consent of the landowner. Administratively, the implementation of this alternative will require coordination with the landowners, to obtain access to perform the bank protection and channel stabilization activities and address landowner concerns. The implementation of soft treatments for bank stabilization and in-stream habitat restoration is technically feasible applying commonly used procedures for stream restoration projects. Materials such

as logs, large roots and willow cuttings are readily available. BMPs for construction in and along an active channel would be required. The design, permitting and implementation of such restoration activities will require additional evaluation and specialized expertise, although this is not considered to be an impediment to implementation. Actions addressing streambank stability adjacent to fluvial mine-waste deposits would best be conducted prior to any in-place stabilization restoration actions at a deposit to avoid disturbance of the restored deposit.

Effectiveness: Alternative 3 will provide accelerated improvements in riparian zone habitat associated with grazing restrictions (i.e., increased woody vegetation) as described for Alternative 2. Additional measures combining bank stabilization and near bank stream habitat will be effective in improving the overall quality of in-stream habitat, thereby providing additional benefits to the objectives of improving the brown trout fishery. The identified bank stabilization measures have proven to be effective in reducing areas of active erosion in other watersheds.

Alternative 3 offers additional short-term effectiveness relative to Alternative 2 in terms of bank stability, but over time, there will not likely be a significant difference. Riparian vegetation is expected to improve substantially in the first five years and should generally be fully recovered. The benefits to bank stability and in-stream habitat would mature over the 20-year lease period.

Cost: The total estimated cost for Alternative 3 is approximately $241,000 (Table A-5). Costs for streambank stabilization and in-stream habitat restoration are included, assuming that approximately 3,000 feet, or 150% of the total feet of bank intercepting mine-waste deposits, would require some specific stabilization measures. While the specific actions to be taken within these areas will require additional evaluation, the cost estimates included are representative of the average cost that may be associated with a range of options, including the soft treatments of willow waddling, anchored trees, root wads, rock structures, and log placement.

6.1.2.4 ALTERNATIVE 4

Alternative 4 for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 1 includes grazing control and limited in-stream habitat enhancement. This alternative can be paired with any of the alternatives for the fluvial mine-waste deposits, including the removal of all of the deposits within Reach

1. In addition to the grazing control measures from Alternative 2, Alternative 4 includes measures for in-stream habitat improvement, such as pool excavation, within subreaches 1A and 1C.

Implementability: The implementablility for grazing controls has been discussed above under Alternative 2. As with alternative 3, the implementation of pool excavation activities to enhance in-stream habitat can be completed using known and reliable techniques and equipment. The development of the specific requirements will require specialized expertise in the design and implementation of such restoration measures, although such expertise is considered to be readily available. BMPs for construction in and along an active channel would be required. The design, permitting and implementation of such restoration activities will require additional evaluation and specialized expertise, although this is not considered to be an impediment to implementation.

Effectiveness: The effectiveness of riparian zone fencing and associated conservation leases in restoring habitat is described under Alternatives 2 and 3. Observation indicates a current lack of pool habitat in subreaches 1A and 1C. Creation of pool habitat has proven effective in improving the quality of a fishery in other watersheds.

Cost: The total estimated cost for Alternative 4 is approximately $180,000 (Table A-6). Costs for pool excavations within subreaches 1A and 1C are included, assuming that one pool will be excavated within each subreach.

6.1.3 AGRICULTURAL LANDS WITHIN THE ARKANSAS RIVER FLOODPLAIN (IRRIGATED MEADOWS)

A predicted phytotoxicity pattern was digitized using Figure 6.1 from USEPA's Ecological Risk Assessment for the Terrestrial Ecosystem (USEPA 2003b) (See Section 3.3.2 and Figure 3-6). The alternatives evaluated in this section for agricultural lands would be implemented in those areas determined to have the greatest potential for phytotoxicity and/or having a HQ > 1, as identified on Figure 3-6 and summarized in Table 3-6. The areas meeting these criteria in each subreach are as follows: subreach 1A contains approximately 2.7 acres within the floodplain and 1.4 acres outside the floodplain; subreach 1B contains 2.4 acres within the floodplain and 1.9 acres outside the floodplain; and subreach

1C contains 0 acres within the floodplain and 26 acres outside the floodplain; for a total of approximately 35 acres.

6.1.3.1 ALTERNATIVE 1

Alternative 1 for Agricultural Lands (Irrigated Meadows) in Reach 1 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: It is likely that, over time, the available metals concentrations in surficial soils will decline and plant cover will improve as new surface soils are formed. Risks to wildlife and livestock associated with metals uptake will also decline. However, the rate of improvement over decades would be slow to imperceptible.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.1.3.2 ALTERNATIVE 2

Alternative 2 identified for Agricultural Lands (Irrigated Meadows) in Reach 1 is deep tilling and reseeding.

Implementability: Deep tilling, to an average depth of 12 inches, is easily implementable in conjunction with standard agricultural practices for preparing land for planting. Deep tilling in riparian corridors containing dense woody vegetation is not readily implementable. As with each of the other alternatives, landowner consent will be required.

Effectiveness: Deep tilling would rapidly decrease surficial soil metals concentrations and the addition of seeding would result in rapid re-establishment of vegetation consistent with adjacent areas.

Alternative 2 would be effective in meeting the objective of reducing potentially harmful metals exposure to wildlife and livestock within Reach 1. Alternative 2 should restore the identified portions of the irrigated meadows to full use within 3 years.

Cost: The estimated cost for this restoration alternative is approximately $148,000 (Table A-7). Because the actions under this alternative are anticipated to be fully effective within 3 years after implementation, and maintenance activities are anticipated to be limited to maintenance fertilizer and spot reseeding (10% of the total area), the O&M costs included for this estimate are presented as totals rather than annual costs and a net-present value analysis has not been included.

6.1.3.3 ALTERNATIVE 3

Alternative 3 for Agricultural Lands (Irrigated Meadows) in Reach 1 is the application of agricultural lime in conjunction with deep tilling and reseeding.

Implementability: Deep tilling, to an average depth of 12 inches, is easily implementable in conjunction with standard agricultural practices for preparing land for planting, and the addition of lime does not significantly affect the implementability. As with Alternative 2, deep tilling in riparian corridors containing dense woody vegetation is not readily implementable. As with each of the other alternatives, landowner consent will be required.

Effectiveness: Alternative 3 has the same level of physical effectiveness as Alternative 2. The addition of lime as a soil amendment will help to buffer any residual acidity, reduce the potential for metals uptake by plants and should be effective in establishing cover consistent with the adjacent areas within two years.

Cost: The total estimated cost for Alternative 3 is approximately $173,000 (Table A-8). In addition to the costs associated with deep tilling, estimated costs are included for lime amendment (at a rate of 10 tons/acre) and revegetation, similar to the fluvial mine waste alternatives. Because the actions under this alternative are anticipated to be fully effective within 3 years after implementation, and maintenance activities are anticipated to be limited to maintenance fertilizer and spot reseeding (10% of

the total area), the O&M costs included for this estimate are presented as totals rather than annual costs and a net-present value analysis has not been included.

6.2 REACH 2

Reach 2 extends 3.79 river miles from the confluence of Lake Fork to the Highway 24 bridge. Flow in Lake Fork can be heavily augmented from "trans mountain" diversions. Access to the river is limited to driveways and ranch roads.

6.2.1 FLUVIAL MINE-WASTE DEPOSITS

Reach 2 contains 35 fluvial mine-waste deposits totaling approximately 9,000 cu. yds. Of the 35 deposits, 3 are high priority, 27 are moderate priority and 5 are low priority. USEPA has not conducted any significant remediation within Reach 2.

6.2.1.1 ALTERNATIVE 1

Alternative 1 for mine-waste deposits of all priorities (low, moderate and high) in Reach 2 is the No Action/Natural Recovery alternative. The No Action/Natural Recovery alternative is included to provide a baseline against which other alternatives can be compared. No additional work would be performed.

Implementability: No action would be taken.

Effectiveness: The majority of Reach 2 fluvial deposits are near the confluence of Lake Fork and the UAR. Most of the deposits are moderate priority and roughly one third have good plant cover. However, approximately one half of the approximately 9 acres of fluvial deposits is comprised of 3 larger high priority deposits. Although the overall risk to wildlife within Reach 2 is low, these deposits, in particular, contribute to the local potential for unacceptable risks to wildlife and livestock. Without action, the potential for wildlife exposure at levels of concern will remain for these small areas. No significant recovery of the areas impacted by fluvial tailings deposits is expected without further action. With time, vegetation will slowly increase around the margins of the deposits, however, habitat/pasture will not be restored to these areas without further action. Under the Natural Recovery alternative, it is unlikely that any portion of the fluvial deposits in Reach 2 would be substantially eroded due to channel migration.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.2.1.2 ALTERNATIVE 2

Alternative 2 consists of a combination of Process Options depending on the priority classification of the deposit. The combination of lime addition, deep tilling and reseeding of the amended deposits with mulch addition is prescribed for the low and moderate priority fluvial mine-waste deposits within Reach 2. For the high priority deposits, Alternative 2 is the combination of lime and biosolids addition, deep tilling and reseeding of the amended deposits.

Implementability: The mine-waste deposits are accessible for lime and biosolids addition, deep tilling and reseeding activities, although the incorporation of amendments to a depth of 18 inches may require special construction equipment and/or techniques to achieve adequate mixing. Incorporation to this depth may require the use of a "Roto-mill", a self-contained soil stabilization/mixing machine, or a specialty pull-behind attachment known as a modified Baker plow. This alternative is considered to be implementable with the use of appropriate equipment. The implementability of this treatment option for high priority near bank deposits could be limited because USEPA regulations prohibit use of non-composted biosolids within 10 feet of the river channel. It is assumed that suitably composted biosolids can be obtained. With respect to administrative implementability, access and consent of the landowners will be required for implementation. Ownership of the land within Reach 2 is limited to two private owners and the State. Based on USEPA's prior work within the 11-Mile Reach, obtaining access is not anticipated to be difficult.

Effectiveness: Alternative 2 will effectively reduce the availability of surficial metals with the addition of lime and deep tilling to a depth of 18-inches, prior to revegetation. The inclusion of biosolids for the high priority deposits will improve moisture-holding capacity and increase plant nutrients, thereby improving growth and restoring habitat. Alternative 2 should meet the objectives of establishing cover/habitat with low potential for metals exposure within 3 to 5 years after implementation for the low and moderate priority deposits and within 2-3 years after implementation for the high priority deposits. Institutional controls addressing future land-use practices may be required to provide long-term assurance that the restored areas will not be disturbed.

Cost: The total estimated cost for this alternative is approximately $178,000 (Table A-9). The largest costs associated with this alternative are related to the procurement and incorporation of lime and biosolids. It is assumed that biosolids may be obtained from a municipality within 50 miles of the site at no cost, other than loading and transportation.

6.2.1.3 ALTERNATIVE 3

Alternative 3 for Fluvial Mine-Waste Deposits within Reach 2 also consists of a combination of process options depending on the priority classification of the deposit. Alternative 3 for low and moderate priority deposits is a combination of lime and biosolids addition, deep tilling and reseeding of the amended deposits. For the high priority mine-waste deposits, Alternative 3 is a combination of lime addition and deep tilling, with the addition of a 12-inch soil cover prior to reseeding. Potential sources of cover soil include stockpiled soil/sediment previously removed during the dredging operations at Mt. Massive Lakes and/or new materials to be removed from the lakes in 2004 (stockpiled within the 11-Mile Reach and within 5-miles of the Reach 2 deposits), and the Malta Gulch borrow pit, located just north of the Malta Gulch tailing impoundments (approximately 3 miles from the confluence of California Gulch and the Arkansas River).

Implementability: The mine-waste deposits are accessible for the Alternative 3 activities, although incorporation of amendments to a depth of 18 inches may require special construction equipment and/or techniques to achieve adequate mixing. The implementability of this treatment option for near bank deposits could be limited because USEPA regulations prohibit use of non-composted biosolids within 10 feet of the river channel. It is assumed that suitably composted biosolids can be obtained.

The application of a 12-inch soil cover over the amended high priority deposits adds some difficulty to the implementation of this alternative, related to the identification and acquisition of a borrow source and increased truck traffic. The placement of a soil cover should not present any construction challenges. While access to the deposits is considered to be good, the implementation of this alternative may require some improvements to accommodate increased truck traffic, related to transporting cover soil, from either US Highway 24, Colorado Highway 300, or from existing gravel access roads within the reach.

Effectiveness: Alternative 3 will effectively reduce the availability of metals in the low and moderate priority deposits with the addition of lime and biosolids, and deep tilling to a depth of 18-inches prior to reseeding will potentially reduce the surficial metals concentrations. The inclusion of biosolids will improve moisture-holding capacity and increase plant nutrients, thereby improving growth and restoring habitat. Alternative 3 for the low and moderate priority deposits should meet the objectives of establishing cover/habitat with low potential for metals exposure within 2-3 years after implementation.

For high priority deposits, Alternative 3 should be very effective in terms of establishing habitat/pasture at all locations. The 12-inch soil cover will also reduce the potential for metals uptake and thereby reduce future exposure concerns. The soil should also improve moisture-holding capacity, if a relatively higher silt/clay content is provided. The 12-inch soil cover should be durable once vegetation is established (2 growing seasons) and will continue to be effective over time. However, given that Reach 2 is comprised of private land, there is a possibility that without institutional controls/deed restrictions, changes in land use or agricultural practices could result in disruption of the soil cover. Institutional controls addressing future land-use practices may be required to provide long-term assurance that the restored areas will not be disturbed.

Cost: The total estimated cost for Alternative 3 is approximately $263,000 (Table A-10). For the purposes of estimating costs for the low and moderate priority deposits it is assumed that biosolids may be obtained from a municipality within 50 miles of the site at no cost, other than loading and transportation. For the high priority deposits it has been assumed that: a borrow source within 10 miles from the work areas can be identified; borrow material may be procured for a nominal price of $2.00 per cubic yard; and that no screening or other processing of the material would be required. Costs are included for relatively minor improvements to haul routes and related restoration. The largest costs associated with implementing this alternative are related to the procurement and incorporation of lime and the placement of the soil cover.

6.2.1.4 ALTERNATIVE 4

Alternative 4 for Fluvial Mine-Waste deposits of all priorities (low, moderate and high) within Reach 2 is complete removal, backfilling the excavation with replacement soil to match the surrounding grade and reseeding. As a matter of course and to ensure the complete removal of mine waste, an additional six inches of underlying soil will also be excavated beyond the waste-soil interface. The

remaining subgrade soils beneath the high priority deposits will be amended with lime prior to backfilling. Banks will be stabilized where removals pose the potential for instability.

Excavated material will be transported to the California Gulch NPL Site repository to be established at the Black Cloud Mine tailings impoundment. For the purposes of this evaluation the capacity of the Black Cloud repository is assumed to be adequate to accommodate the volume of waste and soil removed.

Implementability: Excavation of the mine-waste deposits and underlying soil, to an average depth of 12 inches, is not anticipated to be difficult and can be accomplished with common earthmoving construction equipment. Appropriate control measures will be required when excavating along the riverbank to avoid release of waste material into the river, including the installation of silt fence and other BMPs. The Black Cloud Mine repository is located approximately 10 to 12 miles from the central point of subreach 2A (where the majority of the deposits within Reach 2 are located). This is a reasonable haul distance and although some steep grades exist, the roads are generally in good condition. The implementation of this alternative may also require improvements to access routes to facilitate increased truck traffic from either US Highway 24, Colorado Highway 300, or from existing gravel access roads within the reach. Dust control will be required to mitigate dust on temporary haul roads and gravel access roads. The implementation of this remedy will present some short-term risks associated with potential transport of contaminants, either as dust emissions or as releases to the river during excavation along the riverbank. Both potential release mechanisms may be mitigated through the implementation of appropriate engineering controls. In addition, increased truck traffic along the haul routes may create minor disruptions to residents and businesses along the haul route, through Stringtown and the southern end of Leadville, as well as an increased potential for traffic accidents.

With respect to administrative implementability, access and consent of the landowners will be required for temporary construction and removal activities. Because Asarco and Resurrection are developing the Black Cloud repository, with cooperation from the EPA and the State of Colorado (all MOUP), authorization to use this repository is not considered to be an impediment to implementation. It is expected that USEPA would view transport of the mine wastes to the Black Cloud Repository as consolidation within the same general area of contamination. Excavation along the banks of the river and bank stabilization activities may hold permitting considerations, however, they would not prohibit the work.

Effectiveness: Complete removal of all mapped deposits to the Black Cloud repository within Reach 2 allows for all RAOs to be fulfilled. Liming of underlying soil and soil replacement eliminates concerns for plant uptake of residual metals and allows for establishment of any desired cover type within 2 years. Habitat will be restored consistent with vegetation in surrounding areas. The only potential limitation on effectiveness is related to grazing impacts prior to full establishment of vegetation.

Complete removal also provides additional long-term effectiveness in that no reliance on institutional controls (access control) would be required.

Cost: The total estimated cost for Alternative 4 is approximately $597,000 (Table A-11). The largest costs associated with this alternative are related to the removal of the deposits, transport to the Black Cloud repository, the import of replacement soil, and lime amendment of the underlying soils. Costs are included for the improvement of access routes, the restoration of approximately 2 miles of temporary access/haul roads necessary to access the deposits, and the implementation of engineering controls/BMPs. Costs for streambank stabilization are included, assuming that approximately 500 feet, or 15%, of bank associated with removals would require some specific stabilization measures. While the specific actions to be taken within these areas will require additional evaluation, the cost estimates included are representative of the average cost that may be associated with a range of options. Costs specifically related to developing or preparing, or related to the closure of, the repository at the Black Cloud Mine have not been included, however a $2.00 per cubic yard tipping fee is included.

6.2.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

The in-stream habitat condition within Reach 2 was evaluated to be good. For the upper portion of Reach 2, riparian vegetation cover and streambank stability is also good. In the most down valley portions of Reach 2, the combination of grazing and flow augmentation have had a greater impact on riparian vegetation and bank stability. Impact from grazing is expected to be the ongoing primary factor influencing the quality of riparian habitat, stream bank stability and overall channel stability.

6.2.2.1 ALTERNATIVE 1

Alternative 1 for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 2 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: Although water quality in Reach 2 is better than Reach 1, the relative role of flow augmentation on in-stream habitat versus water quality in determining the quality of the fishery in Reach 2 is unknown. However, the in-stream habitat condition within Reach 2 was evaluated to be good. For the upper portion of Reach 2, riparian vegetation cover and streambank stability is also good. In the most down valley portions of Reach 2, the combination of grazing and flow augmentation have had a greater impact on riparian vegetation and bank stability. It is likely these conditions will persist without action. However, overall, channel stability, in-stream habitat and riparian vegetation conditions within Reach 2 would remain good under the current flow management requirements and agricultural practices.

With regard to stream morphology and riparian zone habitat, rapid changes in channel morphology are not expected. With no action, some areas of bank erosion will continue to be active. However, it is thought that without action, limited erosion of mine waste, loss of riparian habitat and agricultural impacts would not change from their current levels. Impact from grazing is expected to be the ongoing primary factor that influences riparian zone habitat conditions, as well as bank stability.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.2.2.2 ALTERNATIVE 2

Alternative 2 identified for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 2 includes a combination of riparian fencing paired with a 20-year conservation lease (a 25 foot offset, or setback, from the banks encompassing the fenced areas). This alternative may be coupled with any of the restoration alternatives for the fluvial mine-waste deposits, identified above.

Implementability: From a technical perspective, fencing of sensitive riparian zones to restrict and limit cattle access is readily implementable, but requires the cooperation and consent of the landowner. Administratively, the implementation of this alternative will require coordination with the landowners, to negotiate acceptable conservation leases that meet the requirements for restoration and address landowner concerns. This restriction would not significantly reduce the area currently available for grazing within the 500-year floodplain. Given the narrow width of the easement, it would not

preclude the landowner from land uses other than grazing (e.g., development within 25 feet of the bank is unlikely), and should therefore be acceptable. Conservation easements/leases are quite often established in environmentally sensitive areas on private lands.

Effectiveness: Based on observations between reaches and experience in other watersheds, fencing of the riparian zone to limit grazing, in areas where this is not already occurring, will provide the largest single benefit to the quality of riparian habitat, stream bank stability and overall channel stability within Reach 2.

Reestablishment of diminished woody vegetation, potentially including larger trees, will provide improved riparian habitat for wildlife. The increased woody vegetation and the absence of livestock traffic will reduce active erosion and strengthen the streambanks. Over time, as larger woody vegetation reestablishes, there should be benefits to the in-stream habitat. Larger near bank woody vegetation should contribute woody debris, further improving in-stream habitat. Under Alternative 2, riparian vegetation is expected to improve substantially in the first five years. The benefits to bank stability and in-stream habitat would mature over the 20-year lease period. A potential landowner consideration is that the restored riparian vegetation may be more attractive to beavers, which often attempt to dam irrigation ditches.

Alternative 2 would be effective with or without companion actions for fluvial mine-waste deposits. The benefits to the brown trout fishery from Alternative 2 within Reach 2 cannot be quantified. However, the restoration of riparian vegetation is expected to provide benefits to the fishery with or without improvements in water quality.

Cost: The total estimated cost for Alternative 2 is approximately $136,000 (Table A-12). This cost estimate includes costs related to the installation of approximately 40,400 linear feet of three-strand solar-electric fence and maintenance of the fence. In addition, $350/acre has also been included, as a one-time capital cost, for the acreage included within the 20-year conservation lease boundaries on private property to compensate landowners for the loss of use to these areas.

6.2.2.3 ALTERNATIVE 3

Alternative 3 for Channel Morphology/In-Stream Habitat/Riparian Areas within Reach 2 is a combination of technologies, in addition to the grazing control measures from Alternative 2, within subreach 2A including soft treatments for bank protection, channel stabilization and in-stream habitat improvements. Alternative 3 for subreach 2B includes the riparian area grazing control techniques described in Alternative 2. This alternative is intended to be paired with fluvial mine-waste deposit alternatives 2 and 3, involving in-place stabilization of deposits.

Implementability: As with Alternative 2, fencing of sensitive riparian zones is readily implementable, from a technical perspective, but requires the cooperation and consent of the landowner. Administratively, the implementation of this alternative will require coordination with the landowners, to obtain access to perform the bank protection and channel stabilization activities and address landowner concerns. The implementation of soft treatments for bank stabilization and in-stream habitat restoration is technically feasible applying commonly used procedures for stream restoration projects. Materials such as logs, large roots and willow cuttings are readily available. BMPs for construction in and along an active channel would be required. The design, permitting and implementation of such restoration activities will require additional evaluation and specialized expertise, although this is not considered to be an impediment to implementation. Actions addressing streambank stability adjacent to fluvial mine-waste deposits would best be conducted prior to any in-place stabilization restoration actions at a deposit to avoid disturbance of the restored deposit.

Effectiveness: Alternative 3 will provide the improvements in riparian zone habitat described for Alternative 2. It is expected that riparian vegetation would rapidly recover from the impacts of grazing within the first 5 years, and bank stability would improve correspondingly. The bank stabilization measures have proven to be effective in reducing areas of active erosion in other watersheds. Additional measures combining bank stabilization and near bank stream habitat will be effective in improving the overall quality of in-stream habitat providing additional benefits to the objectives of improving the brown trout fishery.

Cost: The total estimated cost for Alternative 3 is approximately $428,000 (Table A-13). Costs for streambank stabilization and in-stream habitat restoration are included, assuming that approximately 5,000 feet, or 150% of the total feet of bank intercepting mine-waste deposits, would require some

specific stabilization measures. While the specific actions to be taken within these areas will require additional evaluation, the cost estimates included are representative of the average cost that may be associated with a range of options, including the soft treatments of willow waddling, anchored trees, root wads, rock structures, and log placement.

6.2.3 AGRICULTURAL LANDS WITHIN THE ARKANSAS RIVER FLOODPLAIN (IRRIGATED MEADOWS)

A predicted phytotoxicity pattern was digitized using Figure 6.1 from USEPA's Ecological Risk Assessment for the Terrestrial Ecosystem (USEPA 2003b) (See Section 3.3.2 and Figure 3-6). The alternatives evaluated in this section for agricultural lands would be implemented in those areas determined to have the greatest potential for phytotoxicity and/or having a HQ > 1, as identified on Figure 3-6 and summarized in Table 3-7. The areas meeting these criteria in each subreach are as follows: subreach 2A contains approximately 4.7 acres within the floodplain and 27 acres outside the floodplain and subreach 2B contains 28.8 acres within the floodplain and 5.6 acres outside the floodplain.

6.2.3.1 ALTERNATIVE 1

Alternative 1 for Agricultural Lands (Irrigated Meadows) in Reach 2 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: It is likely that, over time, the available metals concentrations in surficial soils will decline and plant cover will improve as new soils are formed. Risks to wildlife and livestock associated with metals uptake in those areas will also decline. However, the rate of improvement would be slow to imperceptible.

Cost: There is no cost associated with Alternative 1, since no action would be taken.

6.2.3.2 ALTERNATIVE 2

Alternative 2 identified for Agricultural Lands (Irrigated Meadows) in Reach 2 is deep tilling and reseeding.

Implementability: Deep tilling, to an average depth of 12 inches, is easily implementable in conjunction with standard agricultural practices for preparing land for planting. Deep tilling in areas of overlay with riparian corridors containing dense woody vegetation is not readily implementable. However, it is not anticipated that any areas of overlay within Reach 2 would be substantial. As with each of the other alternatives, landowner consent will be required.

Effectiveness: Deep tilling would rapidly decrease surficial soil metals concentrations and the addition of seeding would result in rapid re-establishment of vegetation consistent with adjacent areas. Alternative 2 would be effective in meeting the objective of reducing potentially harmful metals exposure to wildlife and livestock within Reach 2. Alternative 2 should restore the identified portions of the irrigated meadows to full use within 3 years.

Cost: The total estimated cost for Alternative 2 is approximately $275,000 (Table A-14). Because the actions under this alternative are anticipated to be fully effective within 3 years after implementation, and maintenance activities are anticipated to be limited to maintenance fertilizer and spot reseeding (10% of the total area), the O&M costs included for this estimate are presented as totals rather than annual costs and a net-present value analysis has not been included.

6.2.3.3 ALTERNATIVE 3

Alternative 3 for Agricultural Lands (Irrigated Meadows) in Reach 2 is the application of agricultural lime in conjunction with deep tilling and re-seeding with a metals tolerant/low uptake species.

Implementability: Deep tilling, to an average depth of 12 inches, is easily implementable in conjunction with standard agricultural practices for preparing land for planting, and the addition of lime does not significantly affect the implementability. As with Alternative 2, deep tilling in riparian corridors

containing dense woody vegetation is not readily implementable. As with each of the other alternatives, landowner consent will be required.

Effectiveness: Alternative 3 has the same level of physical effectiveness as Alternative 2. The addition of lime as a soil amendment will help to buffer any residual acidity, reduce the potential for metals uptake by plants and should be effective in establishing cover consistent with the adjacent areas in two years.

Cost: The total estimated cost for Alternative 3 is approximately $308,000 (Table A-15). The unit prices for lime amendment and revegetation activities are the same as those used for the fluvial mine-waste alternatives. O&M costs are presented the same as under Alternative 2.

6.3 REACH 3

Reach 3 extends 3.88 river miles from the Highway 24 bridge to the valley constriction just below Kobe. Cattle grazing still occurs on the Hayden Ranch, however the Arkansas River Ranch is open to the public for recreation. Lake County owns the remaining portion of Reach 3, with the exception of a very small portion of private land (Moyer Ranch) near the highway 24 bridge. There are a number of former ranch roads that serve as access to Reach 3.

6.3.1 FLUVIAL MINE-WASTE DEPOSITS

Reach 3 contains the highest volume (58,500 cu. yds.) and largest number of fluvial deposits (94) of all four reaches. 69 of the deposits are ranked moderate priority. USEPA has conducted treatment on 31 of the Reach 3 deposits (Section 3.3.1). It is assumed that USEPA's activities will provide adequate stabilization and allow for establishment of good vegetation cover. Correspondingly, the treated deposits are not included in Reach 3 alternatives calling for in-place stabilization. Removal alternatives, however, consider all of the deposits regardless of prior amendments.

6.3.1.1 ALTERNATIVE 1

Alternative 1 for mine-waste deposits of all priorities (low, moderate and high) in Reach 3 is the No Action/Natural Recovery alternative. The No Action/Natural Recovery alternative is included to provide a baseline against which other alternatives can be compared. No additional work would be performed, in addition to that work already completed by the USEPA.

Implementability: No action would be taken.

Effectiveness: A substantial amount of work has been conducted by USEPA in Reach 3. Their scope of work included treatment of 31 of the 94 deposits. Treatments generally involving the integration of a variety of combinations of organic matter and lime with the fluvial mine-waste deposits, followed by reseeding, have been utilized for approximately 17 of the 38 acres within Reach 3. Injuries linked to the presence of fluvial deposits are expected to persist absent further action.

USEPA has not formally evaluated the success of their Reach 3 remediation, but has observed that moisture-holding capacity is an important consideration. Their addition of over 100 tons/acre organic amendments should improve the moisture-holding capacity and allow for the near-term development of adequate vegetation cover and, over time, provide suitable habitat/pasture for grazers, effectively restoring conditions within the 17 acres of deposits to the same as those in adjacent areas. Given the initial establishment of cover on these treated deposits, vegetation consistent with surrounding communities should be achieved and maintained, thereby restoring habitat.

Although with time vegetation will slowly increase around the margins of the 21 acres of untreated deposits, habitat/pasture will not be restored to the untreated areas without further action. Although the overall risk to wildlife within Reach 3 is low, these deposits contribute to the local potential for unacceptable risks to wildlife and livestock. Without further action the potential for wildlife/livestock exposure at levels of concern will remain for these 21 acres. No significant recovery of the 21 acres of untreated deposits is expected. It is also unlikely that any substantial portion of the treated or untreated deposits within Reach 3 would be substantially eroded.

Cost: There is no cost associated with Alternative 1, since no action would be taken.

6.3.1.2 ALTERNATIVE 2

Alternative 2 consists of a combination of process options depending on the priority classification of the deposit. The combination of lime addition, deep tilling and reseeding of the amended deposits with mulch addition is prescribed for the previously untreated low and moderate priority fluvial mine-waste deposits within Reach 3. For the previously untreated high priority deposits, Alternative 2 is the combination of lime and biosolids addition, deep tilling and reseeding of the amended deposits.

Implementability: The 21 acres of unremediated mine-waste deposits are accessible for lime and biosolids addition, deep tilling and reseeding activities, although the incorporation of amendments to a depth of 18 inches may require special construction equipment and/or techniques to achieve adequate mixing. Incorporation to this depth may require the use of a "Roto-mill", a self-contained soil stabilization/mixing machine, or a specialty pull-behind attachment known as a modified Baker plow. This alternative is considered to be implementable with the use of appropriate equipment. The implementability of this treatment option for high priority near bank deposits could be limited because

USEPA regulations prohibit use of non-composted biosolids within 10 feet of the river channel. It is assumed that suitably composted biosolids can be obtained. With respect to administrative implementability, access and consent of the landowners will be required for implementation. Based on USEPA's prior work within the 11-Mile Reach, and because the majority of Reach 3 is under public ownership, obtaining access is not anticipated to be difficult. Improvements to existing gravel roads (former ranch access roads) within the reach and construction of temporary access roads would likely be required to facilitate the delivery of amendments to the moderate and high priority deposits. Overall the implementability of this restoration alternative is considered to be good.

Effectiveness: Alternative 2 will effectively reduce the availability of metals and, with the addition of lime and deep tilling to a depth of 18-inches, will potentially reduce surficial metals concentrations prior to reseeding. Revegetation activities under Alternative 2 should meet the objectives of establishing cover/habitat with low potential for metals exposure within 3 to 5 years of implementation. Institutional controls addressing future land-use practices may be required for long-term effectiveness. There is further assurance that the restored areas will not be disturbed by future land-use practices because the majority of Reach 3 is under public ownership.

Cost: The total estimated cost for Alternative 2 is approximately $314,000 (Table A-16). The largest costs associated with this alternative are related to the procurement and incorporation of lime and biosolids. It is assumed that biosolids may be obtained from a municipality within 50 miles of the site at no cost, other than loading and transportation.

6.3.1.3 ALTERNATIVE 3

Alternative 3 for Fluvial Mine-Waste Deposits within Reach 3 also consists of a combination of process options depending on the priority classification of the deposit. Alternative 3 for the previously untreated low and moderate priority deposits is the combination of lime and biosolids addition, deep tilling and reseeding of the amended deposits. For the high priority mine-waste deposits, Alternative 3 is a combination of lime addition and deep tilling, with the addition of a 12-inch soil cover prior to reseeding. Potential sources of cover soil include stockpiled soil/sediment previously removed during the dredging operations at Mt. Massive Lakes and/or new materials to be removed from the lakes in 2004 (stockpiled within the 11-Mile Reach and within 2 miles of the Reach 3 deposits), and the Malta Gulch

borrow pit, located just north of the Malta Gulch tailing impoundments (approximately 3 miles from the confluence of California Gulch and the Arkansas River).

Implementability: As with Alternative 2, the 21 acres of unremediated mine-waste deposits are accessible for revegetation, although incorporation of amendments to a depth of 18 inches may require special construction equipment and/or techniques to achieve adequate mixing. The application of a 12-inch soil cover over the amended high priority deposits adds some difficulty to the implementation of this alternative, related to the identification and acquisition of a borrow source and increased truck traffic. The placement of a soil cover should not present any construction challenges. Improvements to existing gravel roads (former ranch access roads) within the reach and construction of temporary access roads would likely be required to facilitate the delivery of amendments and cover soil to the moderate and high priority deposits. Because the majority of Reach 3 is under public ownership, legal access necessary to develop access routes and perform the revegetation activities is not anticipated to be an impediment to implementation.

Effectiveness: Alternative 3 will effectively reduce the availability of metals in the low and moderate priority deposits with the addition of lime and biosolids, deep tilling to a depth of 18-inches prior to reseeding, will potentially reduce the surficial metals concentrations. The inclusion of biosolids will improve moisture-holding capacity and increase plant nutrients, thereby improving growth and restoring habitat. Alternative 3 for the low and moderate priority deposits should meet the objectives of establishing cover/habitat with low potential for metals exposure within 3 to 5 years after implementation.

For high priority deposits, Alternative 3 should be very effective in terms of establishing habitat/pasture at all locations. The 12-inch soil cover will also reduce the potential for metals uptake and thereby reduce future exposure concerns. The soil should also improve moisture-holding capacity, if a relatively higher silt/clay content is provided. The 12-inch soil cover should be durable once vegetation is established (2 growing seasons) and will continue to be effective over time.

An important consideration regarding effectiveness for all of the above Alternative 3 actions is the public ownership of the majority of Reach 3. In the near term, the ability to readily implement restrictions on grazing will allow for effective initial establishment of vegetation. Over the long-term, the ability to monitor and control future land use will assure long-term effectiveness of Alternative 3 actions.

Cost: The total estimated cost for Alternative 3 is approximately $447,000 (Table A-17). For the purposes of estimating costs, it has been assumed that: a borrow source within 5 miles from the work areas can be identified; borrow material may be procured for a nominal price of $2.00 per cubic yard; and that no screening or other processing of the material would be required. Costs are included for relatively minor improvements to haul routes and related restoration. The largest costs associated with implementing this alternative are related to the procurement and incorporation of lime and the placement of the soil cover.

6.3.1.4 ALTERNATIVE 4

Alternative 4 for Fluvial Mine-Waste deposits of all priorities (low, moderate and high) within Reach 3 is complete removal, backfilling the excavation with replacement soil to match the surrounding grade and revegetation. As a matter of course and to ensure the complete removal of mine waste, an additional six inches of underlying soil will also be excavated beyond the waste-soil interface. The remaining subgrade soils beneath the high priority deposits will be amended with lime prior to backfilling. Banks will be stabilized where removals pose the potential for instability.

Excavated material will be transported to, and placed in an on-site repository located within Reach 3. For the purposes of this evaluation, the repository is assumed to be located approximately one-half mile south of the US Highway 24 bridge over the Arkansas River, at the upgradient end of Reach 3, between Highway 24 and the river. The repository is assumed to encompass an area of 5 to 6 acres, allowing the depth of the deposited waste to be limited to approximately 10 feet. The repository will be unlined and will be covered with an 18-inch thick soil cover.

Implementability: Excavation of the mine-waste deposits and underlying soil, to an average depth of 18 inches, is not anticipated to be difficult and can be accomplished with common earthmoving construction equipment. Appropriate control measures will be required when excavating along the riverbank to avoid release of waste material into the river. The development of an on-site repository within Reach 3 will result in relatively short haul distances from the deposits. Development of the repository is not anticipated to be difficult, as it will require standard excavating/construction equipment. The implementation of this alternative may also require the improvement of access routes to facilitate truck traffic from the deposits to the repository location. The development of suitable haul roads is not anticipated to be problematic, although the deposits are widely distributed throughout the reach. Dust control will be required to mitigate dust on temporary haul roads and gravel access roads. The

implementation of this remedy will present some short-term risks associated with potential transport of contaminants, either as dust emissions or as releases to the river during excavation along the riverbank. Both potential release mechanisms may be mitigated through the implementation of appropriate engineering controls.

With respect to administrative implementability, access and consent of the landowners will be required for the development of the repository, temporary construction and removal activities. Excavation along the banks of the river and bank stabilization activities may also hold permitting considerations. It is expected that USEPA would view the consolidation of Reach 3 mine waste within a local repository as consolidation within the same general area of contamination. The conceptual repository design is similar to the USEPA selected closure plan for the Apache Tailings, and should, therefore, meet with regulatory approval.

Effectiveness: Complete removal of all mapped deposits to an on-site repository within Reach 3 allows for all of the restoration objectives to be fulfilled. Liming of underlying soil and soil replacement eliminates concerns for plant uptake of residual metals and allows for establishment of any desired cover type. Habitat should be restored consistent with vegetation in surrounding areas within 2 growing seasons. Although not as large a concern within Reach 3, complete removal also provides additional long-term effectiveness regarding the potential for changes in land use.

Cost: The total estimated cost for Alternative 4 is approximately $2,385,000 (Table A-18). The largest costs associated with this alternative are related to removal of the deposits, the import of replacement soil and the development of the on-site repository. For the purposes of estimating, the repository excavation is assumed to be approximately 8 feet deep, with material from the excavation utilized for berm construction, as replacement soil, and for the cover of the repository. Costs are included for the improvement of access routes, the restoration of approximately 2 miles of temporary access/haul roads necessary to access the deposits, an the implementation of engineering controls/BMPs. Costs for streambank stabilization are included, assuming that approximately 750 feet, or 15%, of bank associated with removals would require some specific stabilization measures. While the specific actions to be taken within these areas will require additional evaluation, the cost estimates included are representative of the average cost that may be associated with a range of options.

6.3.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

6.3.2.1 ALTERNATIVE 1

Alternative 1 for Channel Morphology/In-Stream Habitat/Riparian Area in Reach 3 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: As discussed above for fluvial mine-waste deposits, if the current lack of grazing for a large portion of Reach 3 is maintained, improvements in riparian vegetation and streambank stability will result. Over time, a narrowing of the channel width should also occur, if grazing no longer occurs and if augmented flows continue to be managed to control rapid water level fluctuations and extreme peak flows. It is also expected that near bank in-stream habitat would improve with the addition of larger woody debris. However, without establishment of formal restrictions on grazing, the effectiveness cannot be assured. In addition, the lack of larger in-stream habitat structures (e.g., deep pools) would not change without action.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.3.2.2 ALTERNATIVE 2

Alternative 2 identified for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 3 includes a combination of fencing paired with a 20-year conservation lease (a 25 foot offset, or setback, from the banks encompassing the fenced areas). This alternative may be coupled with any of the restoration alternatives for the fluvial mine-waste deposits, identified above.

Implementability: From a technical perspective, fencing of sensitive riparian zones to restrict and limit cattle access is easily implementable from a construction perspective. The cooperation and consent of the landowner should be readily achieved over a majority of Reach 3, as they are public lands. The CDOW holds a lease or easement for public recreation areas. Additional long-term provisions for

grazing restriction should be highly implementable for public lands within Reach 3. Given the relatively small portion of Reach 3 in private ownership, it is expected that agreements could also be reached for a conservation lease in these areas. In addition, given the narrow width of the easement, it would not preclude the landowner from land uses other than grazing (e.g., development), and should therefore be acceptable. Conservation easements/leases are quite often established in environmentally sensitive areas on private lands.

Effectiveness: Alternative 2 would provide assurance that limitations on grazing within the riparian zone would continue until vegetation was fully established and the benefits of a mature riparian zone could be achieved within 5 years. The primary limitation for the effectiveness of Alternative 2 would be the time to achieve improvements in in-stream habitat and the near term lack of in-stream habitat structures. A potential landowner consideration is that the restored riparian vegetation may be more attractive to beavers, which often attempt to dam irrigation ditches.

Cost: The total estimated cost for Alternative 2 is approximately $138,000 (Table A-19). This cost estimate includes costs related to the installation of approximately 41,000 linear feet of three-strand solar-electric fence and maintenance of the fence. In addition, $350/acre has also been included, as a one-time capital cost, for the acreage included within the 20-year conservation lease boundaries on private property to compensate landowners for the loss of use to these areas.

6.3.2.3 ALTERNATIVE 3

Alternative 3 for Channel Morphology/In-Stream Habitat/Riparian Areas within Reach 3 is a combination of technologies, in addition to the grazing control measures from Alternative 2, including soft treatments for bank protection, channel stabilization and in-stream habitat improvements. This alternative is intended to be paired with fluvial mine-waste deposit alternatives 2 and 3, involving in-place stabilization of deposits.

Implementability: As with Alternative 2, fencing of sensitive riparian zones is readily implementable. Administratively, the implementation of this alternative will require coordination with the landowners, to obtain access to perform the bank protection and channel stabilization activities and to negotiate acceptable conservation leases that meet the requirements for restoration and address landowner

concerns. The cooperation and consent of the landowner should be readily achieved over a majority of Reach 3, as they are public lands. The CDOW holds a lease or easement for public recreation areas. Additional long-term provisions for grazing restriction should be highly implementable for public lands within Reach 3. Given the relatively small portion of Reach 3 in private ownership, it is expected that agreements could also be reached for a conservation lease in these areas. The implementation of soft treatments for bank stabilization and in-stream habitat restoration is technically feasible applying commonly used procedures for stream restoration projects and BMPs for construction. The design, permitting and implementation of such restoration activities will require additional evaluation and specialized expertise, although this is not considered to be an impediment to implementation. Actions addressing streambank stability adjacent to fluvial mine-waste deposits would best be conducted prior to any in-place stabilization restoration actions at a deposit to avoid disturbance of the restored deposit.

Effectiveness: Alternative 3 would be effective in rapidly improving bank stability and in-stream structural habitat. Within 5 years, the grazing restrictions in conjunction with the bank stabilization/in-stream habitat treatments should result in full achievement of the restoration objectives. Any limitations on effectiveness would be linked to the management of augmented flows from Lake Fork.

Cost: The total estimated cost for Alternative 3 is approximately $559,000 (Table A-20). Costs for streambank stabilization and in-stream habitat restoration are included, assuming that approximately 7,200 feet, or 150% of the total feet of bank intercepting mine-waste deposits, would require some specific stabilization measures. While the specific actions to be taken within these areas will require additional evaluation, the cost estimates included are representative of the average cost that may be associated with a range of options, including the soft treatments of willow waddling, anchored trees, root wads, rock structures, and log placement.

6.3.2.4 ALTERNATIVE 4

Alternative 4 for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 3 includes the same riparian area grazing control measures as Alternative 2, coupled with in-stream habitat improvements in the form of excavating 10 deep pools (5 pools within each subreach). Both subreaches 3A and 3B currently lack pool habitat.

Implementability: The excavation of pool habitat as an in-stream habitat restoration Process Option is technically feasible applying commonly used procedures for stream restoration projects. The design, permitting and implementation of such restoration activities will require additional evaluation and specialized expertise, although this is not considered to be an impediment to implementation. Fencing of sensitive riparian zones to restrict and limit cattle access is readily implementable. Administratively, the implementation of this alternative will require coordination with the landowners, to negotiate acceptable conservation leases that meet the requirements for restoration and address landowner concerns. Actions addressing streambank stability adjacent to fluvial mine-waste deposits would best be conducted prior to any in-place stabilization restoration actions at a deposit to avoid disturbance of the restored deposit.

Effectiveness: Alternative 4 would be effective in improving bank stability and in-stream structural habitat. Alternative 4 measures, including grazing restrictions, should result in achievement of the restoration objectives within 5 years. As for Alternative 3, the primary limitations would be linked to management of extreme flow conditions that can be associated with trans-mountain diversions through Lake Fork.

Cost: The total estimated cost for Alternative 4 is approximately $692,000 (Table A-21). This cost estimate includes costs related to excavating 10 deep pools and the installation of approximately 41,000 linear feet of three-strand solar-electric fence and maintenance of the fence. In addition, $350/acre has also been included, as a one-time capital cost, for the acreage included within the 20-year conservation lease boundaries on private property to compensate landowners for the loss of use to these areas.

6.3.3 AGRICULTURAL LANDS WITHIN THE ARKANSAS RIVER FLOODPLAIN (IRRIGATED MEADOWS)

A predicted phytotoxicity pattern was digitized using Figure 6.1 from USEPA's Ecological Risk Assessment for the Terrestrial Ecosystem (USEPA 2003b) (See Section 3.3.2 and Figure 3-6). The alternatives evaluated in this section for agricultural lands would be implemented in those areas determined to have the greatest potential for phytotoxicity and/or having a HQ > 1, as identified on Figure 3-6 and summarized in Table 3-7. The areas meeting these criteria in each subreach are as follows: subreach 3A contains approximately 19.9 acres within the floodplain and 3.5 acres outside the floodplain and subreach 3B contains 8.9 acres within the floodplain and 37.9 acres outside the floodplain.

Currently, there is only a small parcel within the upper portion of Reach 3 that is actively ranched. Overall exposure concerns for deer and elk within Reach 3 are limited.

6.3.3.1 ALTERNATIVE 1

Alternative 1 for Agricultural Lands (Irrigated Meadows) in Reach 3 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: It is likely that, over decades, the available metals concentrations in surficial soils in Reach 3 will decline and plant cover will improve. Risks to wildlife and livestock associated with metals uptake will also decline. However, the rate of improvement would be slow to imperceptible.

Cost: There is no cost associated with Alternative 1, since no action would be taken.

6.3.3.2 ALTERNATIVE 2

Alternative 2 identified for Agricultural Lands (Irrigated Meadows) in Reach 3 is deep tilling and reseeding.

Implementability: Deep tilling to an average depth of 12 inches is easily implementable in conjunction with standard agricultural practices for preparing land for planting. Deep tilling in riparian corridors containing dense woody vegetation is not readily implementable. As with each of the other alternatives, landowner consent will be required.

Effectiveness: Deep tilling would rapidly decrease surficial soil metals concentrations, and the addition of seeding would result in rapid re-establishment of cover consistent with adjacent areas.

Alternative 2 would be effective in meeting the objective of reducing potentially harmful metals exposure to wildlife and livestock within Reach 3. Alternative 2 should restore the identified portions of the irrigated meadows to full use within 3 years.

Cost: The estimated cost for Alternative 2 is approximately $291,000 (Table A-22). Because the actions under this alternative are anticipated to be fully effective within 3 years after implementation, and maintenance activities are anticipated to be limited to maintenance fertilizer and spot reseeding (10% of the total area), the O&M costs included for this estimate are presented as totals rather than annual costs and a net-present value analysis has not been included.

6.3.3.3 ALTERNATIVE 3

Alternative 3 for Agricultural Lands (Irrigated Meadows) in Reach 3 is the application of agricultural lime in conjunction with deep tilling and re-seeding with an appropriate species.

Implementability: Deep tilling to an average depth of 12 inches is easily implementable in conjunction with standard agricultural practices for preparing land for planting, and the addition of lime does not significantly affect the implementability. As with Alternative 2, deep tilling in riparian corridors containing dense woody vegetation is not readily implementable. As with each of the other alternatives, landowner consent will be required.

Effectiveness: Alternative 3 has the same level of physical effectiveness as Alternative 2. The addition of lime as a soil amendment will help to buffer any residual acidity, reduce the potential for metals uptake by plants and should be effective in establishing cover consistent with the adjacent areas within two growing seasons.

Cost: The estimated cost for Alternative 3 is approximately $326,000. Unit prices for lime amendment and revegetation are the same as those used for the fluvial mine waste alternatives. Because the actions under this alternative are anticipated to be fully effective within 3 years after implementation, and maintenance activities are anticipated to be limited to maintenance fertilizer and spot reseeding (10%

of the total area), the O&M costs included for this estimate are presented as totals rather than annual costs and a net-present value analysis has not been included.

6.4 REACH 4

6.4.1 FLUVIAL MINE-WASTE DEPOSITS

6.4.1.1 ALTERNATIVE 1

Alternative 1 for mine-waste deposits (all low priority) in Reach 4 is the No Action/Natural Recovery alternative. The No Action/Natural Recovery alternative is included to provide a baseline against which other alternatives can be compared.

Implementability: No action would be taken.

Effectiveness: Given the limited area of low priority fluvial mine-waste deposits within Reach 4, the natural recovery alternative would result in improved vegetation cover with time. However, it is expected that it would require decades for complete restoration of vegetation, even in these small areas, without action.

Cost: There is no cost associated with Alternative 1, since no action would be taken.

6.4.1.2 ALTERNATIVE 2

Alternative 2 for Fluvial Mine-Waste Deposits within Reach 4 consists of the direct revegetation, without amendment, for the low and moderate priority deposits. Direct revegetation will consist of the application of an appropriate planting mixture and mulch.

Implementability: Because of the relatively small area of the suspected mine-waste deposits within Reach 4 and the potential difficulty of accessing the deposits, it is assumed that the direct revegetation activities will be performed using ATVs. Administrative considerations include the requirement to obtain landowner access, which is not anticipated to be problematic. This alternative is considered to be highly implementable.

Effectiveness: Alternative 2 would be effective in accelerating the restoration of vegetation on the few small identifiable deposits of mine waste within Reach 4.

Cost: The total estimated cost for Alternative 2 is approximately $25,000 (Table A-24).

6.4.1.3 ALTERNATIVE 3

Alternative 3 for Fluvial Mine-Waste Deposits within Reach 4 consists of the incorporation of agricultural lime and revegetation.

Implementability: As with Alternative 2, access to the suspected mine-waste deposits will be by ATV. Lime may be applied using a broadcast spreader attachment, however incorporation will be difficult. The lime may be incorporated using a ripper or disc attachment or by hand and therefore the depth of incorporation will be limited to six inches or less.

Effectiveness: Alternative 3 would be effective in accelerating the restoration of vegetation on the few small identifiable deposits of mine waste within Reach 4.

Cost: The total estimated cost for Alternative 3 is approximately $55,000 (Table A-25).

6.4.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

6.4.2.1 ALTERNATIVE 1

Alternative 1 for Channel Morphology/In-Stream Habitat/Riparian Area in Reach 4 is the No Action/Natural Recovery alternative.

Implementability: This alternative is easily implementable since no action would be taken.

Effectiveness: Overall, the level of in-stream habitat and channel stability in Reach 4 is viewed to be good. Grazing in riparian zone and/or the small area of mine-waste deposits does not appear to be occurring. Continued improvements in resource conditions are expected under the No Action/Natural Recovery Alternative.

Cost: There is no cost associated with Alternative 1 since no action would be taken.

6.4.2.2 ALTERNATIVE 2

Alternative 2 identified for Channel Morphology/In-Stream Habitat/Riparian Areas in Reach 4 includes a combination of fencing paired with a 20-year conservation lease (a 25 foot offset, or setback, from the banks encompassing the fenced areas). This alternative may be coupled with any of the restoration alternatives for the fluvial mine-waste deposits, identified above.

Implementability: From a technical perspective, fencing of sensitive riparian zones to restrict and limit cattle access is readily implementable, but requires the cooperation and consent of the landowner. Administratively, the implementation of this alternative will require coordination with the landowners, to negotiate acceptable conservation leases that meet the requirements for restoration and address landowner concerns. This restriction would not significantly reduce the area currently available for grazing within the 500-year floodplain. Given the narrow width of the easement, it would not preclude the landowner from land uses other than grazing (e.g., development within 25 feet of the bank is unlikely), and should therefore be acceptable. Conservation easements/leases are quite often established in environmentally sensitive areas on private lands.

Effectiveness: Alternative 2 would provide additional assurance that the good conditions of the riparian zone and streambanks within Reach 4 remain.

Cost: The total estimated cost for Alternative 2 is approximately $65,000 (Table A-26). This cost estimate includes costs related to the installation of approximately 18,600 linear feet of three-strand solar-electric fence and maintenance of the fence. In addition, $350/acre has also been included, as a one-

time capital cost, for the acreage included within the 20-year conservation lease boundaries on private property to compensate landowners for the loss of use to these areas.

7.0 COMPARATIVE ANALYSIS

The findings of the detailed analysis presented in Section 6 are further considered in terms of relative performance of the alternatives. In particular, the relative implementability and effectiveness of the alternatives in terms of achieving and maintaining the general restoration objectives are discussed. Differences in the time to achieve those objectives and the relative cost are also considered. As detailed in Section 3, the general restoration objectives are to:

- Restore, replace or acquire the equivalent of injured resources with lost services within the 11-Mile Reach to levels consistent with applicable baseline conditions; and
- Provide for restoration actions that are protective of human health and the environment.

The Comparative Analysis is organized by reach (Sections 7-1 through 7-4). A summary organized by restoration need category is also included (Section 7-5). The summary considers the compatibility of alternatives between reaches to provide additional assurance that the relative implementability, effectiveness and cost are fully understood. Tables 7-1 through 7-3 briefly summarize the key finding regarding implementability, effectiveness, cost and time to achieve restoration objectives for each alternative within each restoration need category.

For the purpose of the Comparative Analysis, it is expected that the implementation of all the considered alternatives for a reach could occur within one or two construction seasons. Correspondingly, there are no significant distinctions between alternatives for time of implementation. Time frames for achievement of restoration objectives discussed in the Comparative Analysis generally relate to differences in the expected time for recovery of vegetation/cover, after the initial construction activity is complete.

7.1 REACH 1

Reach 1 extends from the confluence of California Gulch to tributary flow from Lake Fork. A full range of alternatives was considered for each Restoration Need category in Reach 1 (Table 5-1).

7.1.1 FLUVIAL MINE-WASTE DEPOSITS

A significant distinction for Reach 1 relative to other reaches is the large amount of fluvial mine-waste remediation work conducted by USEPA since 1998. Over the last 5 construction seasons, USEPA has remediated all of the high priority fluvial mine-waste deposits using varying amendments of lime and organic matter. The amended deposits were also seeded. The exact planting mixture varied by deposit. Approximately 3 out of the 18 acres of Reach 1 mine-waste deposits remain untreated (2 low priority and 6 moderate priority deposits).

The primary considerations for the No Action/Natural Recovery alternative are the expected effectiveness of USEPA's recent remediation and the importance of the 3 acres of untreated deposits in terms of achieving the restoration objectives. Given the initial establishment of cover and small area of the deposits, vegetation consistent with surrounding communities should be achieved and maintained, thereby restoring habitat. USEPA's remedy should also reduce the relative bioavailability and plant uptake of metals of the treated fluvial mine-waste deposits, assuring that the potential for wildlife exposure to metals remains below levels of concern. However, without further action, it is unlikely that the remaining 3 acres of untreated deposits will achieve the restoration objectives.

Alternatives 2 and 3 address the issue of the remaining 3 acres through the addition of amendments (lime or lime and biosolids) and deep tilling with reseeding. Both alternatives are expected to achieve the restoration objectives through the establishment of cover/habitat consistent with the surrounding Reach 1 areas and the deep tilling component of both alternatives has the added benefit of potentially reducing surficial metals concentrations at some locations. The incorporation of lime by deep tilling, in conjunction with seeding and mulch addition under Alternative 2 is considered to be effective and the restoration objectives will be achieved within approximately 3 to 5 years after implementation of the alternative. However, the inclusion of biosolids for Alternative 3 will improve moisture-holding capacity and increase plant nutrients, thereby improving growth and possibly accelerating the time to achieve the restoration objectives to 2 to 3 years after implementation of the alternative.

Alternative 4, which calls for removal of all mapped mine-waste deposits, regardless of prior remediation, provides the highest level of certainty that the restoration objectives will be achieved for fluvial mine-waste deposits within Reach 1. For the 3 acres of untreated deposits, the time frame for removal, soil replacement and restoration of cover/habitat would be consistent with Alternative 3. Considering USEPAs progress to date on the high priority deposits, Alternatives 3 and 4 are generally expected to provide a similar time frame for restoration of cover/habitat within Reach 1. In terms of effectiveness, the complete removal of all mine-waste deposits in Reach 1 provides additional benefit over Alternatives 2 and 3, where long-term restrictions of land use may be needed to protect the integrity of the restoration measures.

All of the alternatives are considered implementable. Alternative 4 involves somewhat greater logistical considerations than Alternatives 2 and 3, including stabilization of 300 feet of streambanks where removed mine-waste deposits intersect the channel. It is expected that for Alternative 4, disposal at the Black Cloud Repository can be arranged and adequate material for fill can be obtained locally.

With regard to cost, Alternatives 2 and 3 have similar estimated total costs of approximately $85,000 and $89,000, respectively. O&M component costs are also similar for these two alternatives. The costs for removal of the fluvial mine-waste deposits under Alternative 4 are more than an order of magnitude greater ($1,521,000) than the costs for in-place stabilization under Alternatives 2 or 3.

Overall, Alternative 3 provides the highest level of cost effectiveness in terms of restoring acceptable cover/habitat for the fluvial mine-waste deposits in Reach 1. Given the large Reach 1 remediation effort already conducted by USEPA, and the reasonable likelihood that it will be successful in achieving the objectives of restoring cover/habitat on the deposits consistent with baseline conditions, the removal considered under Alternative 4 offers no significant advantage for a much greater cost. Although Alternative 2 is also considered to be effective, the small difference in cost between Alternative 2 and Alternative 3 is outweighed by the anticipated benefits offered by the addition of biosolids, including improved moisture-holding capacity and plant nutrient availability, and the slightly accelerated time to achieve the restoration objectives.

7.1.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/ IN-STREAM HABITAT

Improvements in riparian cover/habitat, bank stability and the quality of in-stream habitat are the primary restoration needs to be addressed by the developed alternatives in Reach 1. The No Action/Natural Recovery alternative would not result in improvements in the resource conditions. In

contrast, Alternative 2 comprised of 20-year conservation leases and fencing to restrict cattle grazing within 25 feet of the channel banks would be effective in improving riparian habitat, thereby increasing bank stability and providing some improvement in in-stream habitat through overhanging vegetation. In addition, with time, the development of more bank side fish habitat would develop. Riparian vegetation is expected to improve substantially in the first 5 years and the benefits to bank stability and in-stream habitat would mature over the 20-year lease period.

Alternative 3 provides the additional benefit of combined bank stabilization/in-stream habitat improvements at the locations where fluvial deposits comprise a portion of the bank (approximately 3,000 feet). Although Alternative 3 potentially offers additional short-term effectiveness relative to Alternative 2 in terms of bank stability, there will be not likely be a significant difference in overall bank stability between the two alternatives. This is because the largest benefit should come from the grazing restrictions offered under both Alternatives 2 and 3. However, the bank stabilization actions included in Alternative 3 will result in more rapid improvements in in-stream habitat. Alternative 4 also provides the same benefits as Alternatives 2 and 3 through restriction of grazing, but provides for the excavation of pool habitat within sub-reaches 1A and 1C. Lack of pool habitat was identified as a specific restoration need within Reach 1.

Alternatives 2, 3 and 4 are all readily implementable. Alternatives 3 and 4 involve significantly more design and construction management effort than Alternative 2. However, the streambank stabilization and pool excavation actions contemplated under these alternatives are routinely utilized and could be conducted during periods of low flow to minimize associated sediment transport.

In terms of estimated costs, Alternative 4 (approximately $180,000) is roughly $100,000 more than Alternative 2 (approximately $66,000). The costs associated with approximately 3,000 feet of streambank stabilization for Alternative 3 (approximately $241,000) are roughly $60,000 more than the estimated costs of Alternative 4.

The primary benefits within Reach 1 for restoration of riparian habitat and improvements in streambank stability are provided by the institutional and physical restrictions to grazing included in Alternatives 2, 3 and 4. The main difference between Alternatives 3 and 4 is the combined addition of approximately 3,000 feet of bank stabilization/in-stream habitat improvements, at the locations of certain fluvial deposits, called for under Alternative 3. Although there may be some additional short-term benefit to bank stability, it is not anticipated that there would be a significant long-term effectiveness in bank stability over the grazing restrictions alone. Furthermore, analyses conducted in support of the SCR (MOUP CT 2002) indicated that erosion of mine-waste deposits would not have a measurable effect on

water quality within the UARB. Therefore, the difference in approach and cost for the in-stream habitat improvements offered by Alternatives 3 and 4 are the main comparison considerations.

Even with detailed modeling it would be difficult to determine the long-term difference in brown-trout productivity offered by the combined bank stabilization/habitat improvement measures of Alternative 3 vs. the construction of pool habitat prescribed under Alternative 4. Some of the immediate habitat improvements offered by Alternative 3 would likely also occur over time under Alternative 4, as grazing restrictions allow larger woody vegetation to develop and contribute woody debris to the stream. However, it is unlikely that the lack of pool habitat within Reach 1 will change without the pool excavation component of Alternative 4. Assuming relatively equal benefits to the brown trout fishery for Alternatives 3 and 4, the additional Alternative 3 cost of approximately $60,000 would provide a limited benefit in terms of short-term improvements in bank stability.

7.1.3 AGRICULTURAL LANDS

The areas of agricultural lands comprised of irrigated meadows within Reach 1 that were identified by USEPA as potentially posing unacceptable risk to deer and elk and livestock are small. When examined in the context of the whole reach, which is a reasonable exposure range for grazing animals, unacceptable risks were not identified. Nonetheless, Alternatives 2 and 3 were developed to address the smaller areas of elevated surficial soil metals concentrations that appear to have resulted due to historic irrigation.

As noted above, the potential for injury to wildlife associated with Reach 1 irrigated meadows is small. Under the Natural Recovery alternative, that potential would over decades continue to slowly diminish. This is due both to the ongoing improvements in the quality of the UAR water used for irrigation, and the gradual dilution of surficial soils with the natural soil building cycle. In contrast, Alternative 2 would immediately reduce surficial soils metals concentrations in the identified areas through deep tilling. Re-seeding should be effective in establishing cover consistent with the adjacent areas in two growing seasons. Alternative 3 calls for the same deep tilling and seeding, with the addition of agricultural lime. The addition of lime for Alternative 3 would increase effectiveness where low soil pH may be a limiting factor.

Both Alternatives 2 and 3 are readily implementable. The cost difference of approximately $25,000 between the two alternatives is associated with the amending of the tilled soil (lime addition) under Alternative 3.

Overall, Alternatives 2 and 3 would be equally effective in addressing any exposure/phytotoxicity concerns associated with surficial soil metals concentrations in these irrigated areas. Alternative 3 provides the highest level of effectiveness in terms of rapidly restoring the desired cover/habitat in the tilled areas where low soil pH is the limiting factor.

7.2 REACH 2

Reach 2 extends from the confluence of Lake Fork to the Highway 24 bridge. Significant baseline considerations for Reach 2 are flow augmentation through Lake Fork and grazing. A full range of alternatives was considered for each restoration need category in Reach 2 (Table 5-7).

7.2.1 FLUVIAL MINE-WASTE DEPOSITS

Reach 2 contains approximately 9 acres of fluvial mine-waste deposits. Nearly half of the acreage is comprised of 3 overlapping high priority deposits at the boundary with Reach 1. The majority of Reach 2 fluvial deposits are within the Smith Ranch property. No significant remediation has occurred or is planned by USEPA for Reach 2.

Conditions of the fluvial deposits within Reach 2 are not expected to change under Alternative 1, the Natural Recovery Alternative. The fluvial deposits would continue to have the same basic chemical and physical characteristics they currently have for decades. It is not expected that there would be significant erosion of the deposits.

Alternatives 2 and 3 combine several different actions depending upon the priority of the deposits. Alternatives 2 and 3 address the low and moderate priority deposits through the addition of amendments (lime or lime and biosolids) and deep tilling with reseeding. Both alternatives are expected to achieve the restoration objectives through the establishment of cover/habitat consistent with the surrounding Reach 2 areas. The deep tilling component of both alternatives has the added benefit of potentially reducing surficial metals concentrations at some locations. The incorporation of lime by deep tilling, in conjunction with seeding and mulch addition under Alternative 2 should effectively meet the restoration objectives for low and moderate priority deposits within approximately 3 to 5 years after implementation of the alternative. However, the inclusion of biosolids for Alternative 3 will improve moisture-holding capacity and plant nutrients, thereby improving growth and possibly accelerating the time to achieve the restoration objectives to 2 to 3 years after implementation of the alternative.

For high priority deposits, Alternative 2 includes biosolids application, deep tilling and liming, prior to reseeding. Alternative 3 adds a 12-inch soil cover to the high priority deposits. Again, the expected level of effectiveness in terms of the restoration objectives is similar, however, the soil cover would provide more rapid restoration and greater assurance of continued protection. It may take 2-5 years to restore low to high priority mine-waste deposits under Alternative 2, where Alternative 3 for the

high priority deposits provides greater assurance that the restoration objectives would achieved after 2 growing seasons. A long-term effectiveness consideration for both Alternatives 2 and 3 is private ownership of Reach 2. Without institutional controls, changes in land use could result in disturbances of the treated deposits, potentially reducing the effectiveness of the remedy.

In contrast to the in-situ stabilization measures of Alternatives 2 and 3, Alternative 4 calls for the complete removal of mapped fluvial mine-waste deposits. In terms of overall effectiveness in achieving the restoration objectives, it is not expected that Alternative 4 will substantially differ from Alternative 3. For high priority deposits, it is expected that the soil cover of Alternative 3 will provide the same level of effectiveness as removal and replacement, within the same time period. However, given the private ownership of Reach 2, Alternative 4 has an advantage in terms of expected long-term effectiveness. Removal of the mine-waste also eliminates the need for associated institutional controls, such as deed restrictions.

All of the alternatives are equally implementable. Alternative 4 is a slightly more complex construction scenario than Alternatives 2 or 3. Access needs are similar between alternatives and it is expected that the landowner will provide the same level of cooperation under each alternative.

The relative cost of the alternatives varies substantially. Alternatives 2 and 3 have estimated costs of approximately $178,000 and $263,000, respectively. Alternative 4 has the highest estimated cost (approximately $597,000) assuming a nominal tipping fee for disposal at the Black Cloudy repository. It should be noted that neither Alternative 2 nor 3 include possible costs associated with long-term land-use restrictions for the 9 acres (e.g., deed restrictions).

Overall, the primary distinction between Alternatives 2, 3 and 4 relate to the likelihood of effectively achieving and maintaining the restoration objectives over the long-term. Although it is expected that all of these alternatives would meet the goal of restoring acceptable cover/habitat to the areas occupied by fluvial deposits, Alternatives 2, 3 and 4 incrementally provide additional benefits in terms of the time to achieve the objectives and/or the assurance that the restoration measures will remain effective. For example, the soil cover for high priority deposits under Alternative 3 will allow for more rapid establishment of safe cover/habitat than the biosolids amendment of Alternative 2. In terms of time to establish habitat/cover and the quality of that habitat, there is no significant distinction expected between the actions of Alternatives 3 and 4. However, Alternative 4 offers improvement in terms of long-term effectiveness over Alternatives 2 and 3, in that reliance on private land institutional controls are not necessary. The relative difference in cost over Alternative 3, for the additional long-term effectiveness and lower long-term O & M requirements of Alternative 4, is roughly $330,000.

7.2.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

Improvements in riparian cover/habitat and the related localized conditions of streambank stability were identified as the restoration needs to be addressed by the developed alternatives. The need for restoration of these conditions is greater near the downstream end of subreach 2B, where the riparian vegetation appears to be diminished.

The No Action/Natural Recovery alternative would not result in improvements in the riparian vegetation or streambank stability. However, both Alternatives 2 and 3 would achieve improvements in cover and habitat to be consistent with the upstream reference reach (Reach 0). As described for Reach 1, the riparian area conservation lease and electric fencing provided under Alternative 2 would be effective in meeting the restoration objectives. It is expected that riparian vegetation would rapidly recover from the impacts of grazing within the first 5 years, and bank stability would improve correspondingly. Some additional short-term improvement in bank stability could be achieved through the soft stabilization treatments of the banks at stream locations intersecting fluvial mine-waste deposits under Alternative 3. These Alternative 3 measures would also provide additional in-stream habitat.

Alternatives 2 and 3 are both readily implementable but require coordination with the landowner. Alternative 3 is more involved in terms of design and construction requirements. Correspondingly, the estimated cost of Alternative 3 is approximately $428,000 vs. approximately $136,000 for Alternative 2.

Over the long-term (5-10 years), it is not expected that Alternatives 2 and 3 will differ greatly in terms of improving bank stability. Considering that the in-stream habitat within Reach 2 is generally good and that the improvements in riparian zone vegetation offered by both Alternatives 2 and 3 will also benefit the fishery, the difference in effectiveness offered by the more rapid in-stream habitat improvements of Alternative 3 is small in comparison to the approximately $300,000 difference in cost.

7.2.3 AGRICULTURAL LANDS

Approximately 66 acres of irrigated meadows were identified for restoration measures within Reach 2. Sixty-six acres comprises a small portion of Reach 2 agricultural lands. When the potential risks to wildlife and livestock associated with these areas were evaluated by USEPA, unacceptable risks were not identified in the context of the entire reach. Even so, Alternatives 2 and 3 were developed to address areas exhibiting a high potential for phytotoxicity and/or HQ > 1 for grazing animals associated with the 66 acres.

Under the No Action/Natural Recovery alternative, the small potential for injury to plants and grazing animals associated with the 66 acres would remain into the foreseeable future. Alternative 2 would immediately reduce the potential for injury through deep tilling. Deep tilling would lower metals concentrations in surficial soil and seeding would result in rapid re-establishment of cover consistent with adjacent areas. The addition of lime for Alternative 3 would increase effectiveness where low soil pH may be a limiting factor.

Both Alternatives 2 and 3 are common agricultural practices that are readily implementable in Reach 2. Both would involve coordination with the landowner(s). The addition of lime under Alternative 3 results in an estimated cost of approximately $308,000 vs. approximately $275,000 for Alternative 2.

Both Alternatives 2 and 3 would be equally effective in rapidly addressing any exposure/phytotxoicity concerns associated with surficial soil metals concentrations in these irrigated areas. Alternative 3 provides the highest level of effectiveness in terms of rapidly restoring the desired cover/habitat in the tilled areas where low soil pH is the limiting factor.

7.3 REACH 3

Reach 3 extends from the Highway 24 bridge downstream to the valley constriction just below Kobe. The vast majority of land within Reach 3 is controlled by the State of Colorado, the City of Aurora and Lake County. A full range of alternatives was considered for each restoration need category in Reach 3 (Table 5-9).

7.3.1 FLUVIAL MINE-WASTE DEPOSITS

Reach 3 contains 37.62 acres of fluvial deposits and the largest volume of mine waste of the 4 reaches. USEPA has conducted a substantial amount of work within Reach 3, treating 16.8 acres. Their work addresses slightly less than half of the deposits. USEPA's work is expected to be effective in restoring cover/habitat to the treated areas. Injuries associated with the untreated fluvial deposits are expected to persist under the No Action/Natural Recovery Alternative.

Alternatives 2 and 3 combine several different actions depending upon the priority of the deposits. Alternative 2 for the low, moderate and high priority deposits and Alternative 3 for the low and moderate priority deposits include the addition of amendments and deep tilling with reseeding. Both Alternatives 2 and 3 are expected to achieve the restoration objectives through the establishment of cover/habitat consistent with the surrounding Reach 3 areas. The deep tilling component of both alternatives has the added benefit of potentially reducing surficial metals concentrations at some locations. The incorporation of lime by deep tilling, in conjunction with seeding and mulch addition under Alternative 2 should effectively meet the restoration objectives for low and moderate priority deposits within approximately 3 to 5 years after implementation of the alternative. However, the inclusion of biosolids for Alternative 3 will improve moisture-holding capacity and increase plant nutrients, thereby improving growth and possibly accelerating the time to achieve the restoration objectives to 2 to 3 years after implementation of the alternative.

Alternative 3 for the high priority deposits provides a greater level of certainty that restoration objectives would be rapidly and effectively achieved. Under Alternative 3, the high priority deposits would be deep tilled with lime addition prior to placement of a 12-inch soil cover and seeding. The soil cover would provide slightly more rapid restoration of habitat and greater assurance of continued protection than the incorporation of amendments alone. It may take 2 to 5 years to restore low to high priority mine-waste deposits under Alternative 2, where Alternative 3 for the high priority deposits provides greater assurance that the restoration objectives would be achieved after 2 growing seasons.

Alternative 4 calls for the complete removal of all mapped fluvial deposits, regardless of prior remediation, with consolidation in a constructed repository within the reach.

As for Reaches 1 and 2, it is expected that over time, Alternatives 2, 3 and 4 would be effective in meeting the restoration objectives of safely restoring baseline conditions at the locations of the untreated fluvial mine-waste deposits. Alternatives 2, 3 and 4 would allow for re-establishment of cover consistent with the surrounding areas and would reduce or eliminate the potential for wildlife exposure to metals in plants and soil at these locations. The primary difference in effectiveness between alternatives is related to the time to achieve the restoration objectives and over the long-term, the reliability of maintaining the restoration objectives. The differences between Alternatives 2 and 3 are more distinct for the high priority deposits. For low and moderate priority deposits, the difference in effectiveness between Alternatives 2 and 3 is expected to be small. For low and moderate priority deposits, the addition of biosolids under Alternative 3 should somewhat shorten the time required to achieve cover relative to limiting amendments to lime under Alternative 2. For high priority deposits, the use of a 12-inch soil cover under Alterative 3 will provide for more rapid restoration of habitat (after 2 growing seasons) and greater assurance that habitat will remain established over time than for Alternative 2.

Alternatives 3 and 4 have a similar level of near-term effectiveness, in that they will both rapidly provide acceptable restoration of habitat. Over the long-term, Alternative 4 may be slightly more effective because the mine-waste deposits are removed from the floodplain and consolidated in a central repository within the reach. However, the greater ability to control future land use and establish institutional controls on lands in public ownership lessens any long-term effectiveness distinction between Alternatives 3 and 4.

All of the alternatives are considered to be implementable. Construction of an on-site repository in Reach 3 would require landowner acceptance. However, it is assumed that in-place stabilization and soil covers would also require acceptance from the landowner. The footprint of the repository could be approximately 6 acres, which is smaller than the roughly 38 acres currently occupied by the fluvial mine-waste deposits. Locating a repository in Reach 3 may pose some administrative and legal issues, but they are not assumed to be more significant than for other actions. If the repository is located on public lands, there may be fewer administrative implementability concerns, given that some institutional controls are already in place (e.g., restrictions on vehicle access). There are no significant distinguishing factors related to the construction aspects of the alternatives.

Cost for the alternatives varies substantially. Alternative 2 estimated costs are approximately $314,000. Total costs for Alternative 3 are estimated to be approximately $447,000. The cost for

implementation of Alternative 3 could be reduced if a substantial volume of organics-rich sediment, excavated from Mt. Massive Lakes, was available for use as a soil cover. The estimated cost for Alternative 4 is approximately $2,385,000. A large difference in cost between Alternatives 3 and 4 is due to the greater amount of replacement soil and repository cover soil required to address both the treated and untreated deposits under Alternative 4. Although not evaluated as an alternative, the costs for disposal of excavated fluvial deposits at the Black Cloud Repository vs. construction of a repository were also estimated. The difference in cost between these two disposal options is an increase of approximately $650,000 for transportation to the Black Cloud Repository (i.e., total cost of roughly $3,000,000).

With time, it is expected that all of the alternatives would meet the objectives of restoring habitat consistent with adjacent areas. Alternatives 3 and 4 would meet the restoration objectives more rapidly (2-3 years after implementation) than Alternative 2 (3-5 years after implementation). Alternatives 3 and 4 are also expected to be slightly more effective than Alternative 2 over the long-term. All of the alternatives are expected to achieve an acceptable reduction in the potential for metals exposure at the fluvial mine-waste deposits. In general, Alternatives 3 and 4 are expected to provide a similar level of effectiveness and implementability. The O & M burden associated with the Alternative 4 repository would be slightly less than for the deposits in place. The estimated total cost for Alternative 4 is roughly $1,900,000 more than for Alternative 3.

7.3.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

The primary restoration needs to be addressed by the developed alternatives are improvements in riparian habitat, streambank stability and in-stream habitat. Observation indicates that Reach 3 has monotonous riffle habitat and a broad shallow channel.

It is not known whether the informal exclusion of grazing associated with the recent transition from private to public lands along portions of Reach 3 riparian areas will continue. As there are no formal restrictions on grazing currently in place, grazing could resume within the Reach 3 areas. Based on the lack of formal restrictions, it is not assured that the No Action/Natural Recovery alternative would result in continued improvements in riparian vegetation, bank stability or in-stream habitat.

Alternatives 2, 3 and 4 all would provide substantial improvements in riparian habitat through the purchase of conservation easements and fencing at a 25 foot offset from the channel. These measures would allow the riparian habitat to recover to expected baseline levels within the first 5 years. With time, bank stability would also improve with increasing vegetation and lack of cattle traffic. Restored riparian

vegetation would benefit the fishery in Reach 3 through a narrowing of the active channel and the development of near bank habitat, and would increase terrestrial food sources. Alternatives 3 and 4 include additional measures to address bank stability and/or in-stream habitat. Alternative 3 includes combined soft bank stabilization/in-stream habitat improvement actions (e.g., root wads, log placement, boulder placement). Alternative 4 includes pool excavation for habitat improvements. Ten pool habitats (5 in subreach 3A and 5 in subreach 3B) would be excavated under Alternative 4.

Alternative 3 provides more rapid improvements in bank stability and somewhat greater assurance of effectiveness over the long-term, relative to Alternatives 2 and 4. However, as riparian vegetation matures during the 20-year riparian zone conservation lease, the relative benefits of bank stability for Alternative 3 decrease. For Reach 3, in terms of in-stream habitat improvements, there is no clear distinction between the restoration benefits of pool excavation under Alternative 4 and the placement of logs, root wads, and boulders to be utilized under Alternative 3. Alternatives 3 and 4 are viewed to be equally effective in terms of improving in-stream habitat.

All of the alternatives are believed to be readily implementable. The level of construction complexity is greater for Alternatives 3 and 4. Some levels of institutional controls are already in place in the public areas (e.g., vehicle access restrictions). If broader restrictions on grazing are instituted in conjunction with the current public access policy for the Hayden Meadows, Hayden Ranch and Arkansas River Ranch properties, the need for fencing and a lease would be limited to a small segment of private property (Moyer Ranch) at the north end of Reach 3.

The difference in cost between alternatives is commensurate with the level of construction included. Total costs for Alternative 2 are estimated to be approximately $138,000 compared to approximately $559,000 for Alternative 3, and approximately $692,000 for Alternative 4. The costs for all of these alternatives include fencing, which may or may not be necessary.

The vast majority of restoration of the Reach 3 riparian area habitat would be equally achieved under Alternatives 2, 3 and 4 through conservation leases and fencing. Alternatives 3 and 4 will also provide improvements in in-stream habitat. The net benefits to in-stream habitat quality are assumed to be equivalent between Alternatives 3 and 4.

7.3.3 AGRICULTURAL LANDS

Overall, agricultural lands within Reach 3 were not identified as posing unacceptable risks to deer and elk or livestock. However, some specific locations of potential concern associated with historic irrigation exist. Approximately 70 acres within Reach 3 were identified as having surficial soil metals concentrations that could pose a risk to grazing livestock and/or limit plant growth.

Under the No Action/Natural Recovery alternative, the potential for injury to plants and grazing animals at these locations would remain for decades. Surficial soil conditions in these areas will not significantly change without restoration. Alternative 2 would immediately reduce the potential for injury through deep tilling by lowering metals concentrations in surficial soil. Re-seeding would result in rapid re-establishment of cover consistent with adjacent areas. In contrast, the addition of lime under Alternative 3 would increase the effectiveness where low soil pH may be a limiting factor.

Both Alternatives 2 and 3 are common agricultural practices that are readily implementable in Reach 3. Both would involve coordination with the landowner(s). The addition of lime under Alternative 3 results in an estimated cost of approximately $326,000 vs. approximately $291,000 for Alternative 2.

Both Alternatives 2 and 3 would be equally effective in rapidly addressing any exposure/phytotxoicity concerns associated with surficial soil metals concentrations in these irrigated areas. Alternative 3 provides the highest level of effectiveness in terms of rapidly restoring the desired cover/habitat in the tilled areas where low soil pH is the limiting factor.

7.4 REACH 4

The conditions of the riparian area vegetation and in-stream habitat within Reach 4 are considered to be consistent with Reach 0. There are no mapped fluvial deposits and only a few small areas of fluvial mine-waste deposition observed in Reach 4. Table 5-10 summarizes the alternatives considered for each restoration need category in Reach 4.

7.4.1 FLUVIAL MINE-WASTE DEPOSITS

Conditions within Reach 4 would not change substantially under the No Action/Natural Recovery alternative. However, it appears that there is considerably less than 2 acres where mine wastes can be observed. In these areas, vegetation is only slightly diminished and it is likely to improve with time. Alternative 2 would enhance the rate of natural recovery in these areas through reseeding and mulch. Alternative 3 has the same group of actions, but also includes lime as an amendment. It is anticipated that Alternative 3 may be slightly more effective in restoring plant cover, however, it is not known if soil pH is low in these areas. Overall, the distinction in effectiveness between Alternatives 1, 2 and 3 will be small given the limited area of Reach 4 mine-waste deposition.

Both Alternatives 2 and 3 could be readily implemented with landowner approvals. The relative estimated costs for the two alternatives are approximately $25,000 for Alternative 2 and approximately $55,000 for Alternative 3.

7.4.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

As noted above, the overall condition of riparian habitat in Reach 4 appears to be good. Grazing of riparian areas appears to be limited. Given the good condition of the riparian resource, it appears that if there were historic impacts to the riparian areas, natural recovery has occurred. Alternative 1 assumes no addition work. Alternative 2 is included for consideration as a potential mechanism for assuring that riparian habitat and bank stability remain good. Implementation of Alternative 2 would require coordination with several landowners to establish leases. The primary capital costs for Alternative 2 are for fencing of the riparian corridor (approximately $65,000).

7.5 SUMMARY OF COMPARATIVE ANALYSIS

The following provides a brief summary of the primary distinctions between alternatives identified through the detailed and comparative analyses. Considerations regarding the implementability, effectiveness and cost across reaches are also identified.

7.5.1 FLUVIAL MINE-WASTE DEPOSITS

Across all reaches the primary considerations related to implementability, effectiveness and cost of remedial alternatives for the fluvial mine-waste deposits are:

- Level of remediation already conducted;
- Volume of mine waste within a reach;
- Distance to the Black Cloud repository; and
- Private versus public ownership of lands.

These considerations are balanced by detailed analyses that indicate restoration objectives related to establishment of habitat and acceptable levels of metals exposure can be met by alternatives for both in-place stabilization and removal. A further consideration is the low potential for mass erosion of deposits stabilized in place and the negligible impacts to surface water, if such an event were to occur.

Within Reach 1, the Comparative Analysis indicates that in-place stabilization of the few remaining low and moderate priority fluvial mine-waste deposits (Alternative 3), consistent with the USEPA remedy already applied to a majority of the deposits, would be the most cost effective approach. This evaluation is based upon the expectation that USEPA's work to date will be effective in restoring cover/habitat. Completion of the USEPA initiated remedy should also decrease the potential for metals uptake by wildlife at the treated deposits.

Given the expected level of effectiveness for Alternative 3 in achieving the restoration objectives, the removal contemplated under Alternative 4 offers little advantage, for a large additional cost (approximately $1,500,000). The expected cost/benefit ratio difference between Alternatives 3 and 4 is even greater when the substantial investment for remediation already made by USEPA in Reach 1 is considered. Alternatives 2 and 3 are of similar cost, however, the addition of biosolids under Alternative 3 provides somewhat greater assurance that the restoration objectives will be achieved in the remaining deposits.

Within Reach 2, the absence of prior remediation by USEPA and the relatively small volume of mine-waste deposit influences the analysis. The relatively small volume of mine waste in comparison to Reaches 1 and 2 results in a lower cost difference between in-place stabilization (Alternatives 2 and 3) and removal (Alternative 4). Alternative 3 offers more rapid achievement of the restoration objectives and greater assurance of long-term effectiveness for the high priority deposits than Alternative 2. Although no real difference in expected performance was identified for Alternatives 3 and 4 in terms of achieving the restoration objectives, the removal of mine-waste under Alternative 4 would eliminate the need for long-term O & M and possible institutional controls on private lands. In contrast to Reach 1, the additional cost for the improvement in long-term effectiveness associated with Alternative 4 is not as disproportionate. It should also be noted that if a repository were established in Reach 3, the cost differential between Alternatives 3 and 4 would be reduced because of the shorter haul distance.

Within Reach 3, the combination of a significant amount of remediation already conducted by USEPA, the large total volume of mine-waste, and public ownership of the majority of the 500-year floodplain, influence the alternatives analysis somewhat differently. As for Reach 1, the cost differential between the in-place stabilization alternatives 2 and 3, and the removal prescribed in Alternative 4, is large (over $2,000,000), even with a local repository. Again, like Reach 1, the differential is even larger if USEPA's expenditures to date are considered. In contrast to Reach 2, the expected difference in long-term effectiveness between the in-situ stabilization alternatives (Alternatives 2 and 3), and the removal alternative (Alternative 4) is lessened by the public ownership of most of Reach 3. The public ownership allows for a greater potential to establish effective long-term institutional controls and an O & M program, and thereby lessens the likelihood that changes in land use would reduce the effectiveness of in-place stabilization.

With regard to comparisons between Alternatives 2 and 3 for Reach 3, the primary difference is the slightly shortened time to achieve the restoration objectives and the somewhat greater certainty that the high priority deposits will be effectively restored over the long-term under Alternative 3 utilizing soil covers.

For Reach 4, the level of restoration need is so low that the in-place stabilization offered by Alternatives 2 or 3 would not be discernibly different in terms of achieving the restoration objectives of restoring safe habitat. Correspondingly, there are no comparative analysis considerations that are related to other reaches.

7.5.2 RIPARIAN AREAS/CHANNEL MORPHOLOGY/IN-STREAM HABITAT

For all reaches, the analysis of alternatives indicates that the greatest benefits in terms of restoration objectives achievement will come from the combination of conservation leases and fencing. Fencing of the riparian areas will allow for recovery of vegetation/habitat and improve bank stability. Over time, in some areas, these changes will also lead to improvements in in-stream habitat through narrowing of the channel and accumulation of near bank woody vegetation. This alternative would have similar implementability and effectiveness across all reaches. The only potential landowner consideration identified is that the restored riparian vegetation may be more attractive to beavers, which often attempt to dam irrigation ditches. Because of the high benefit to cost ratio, fencing and conservation easements are included for all reaches in all but the No Action/Natural Recovery alternative.

There are no significant cross-reach implementability and cost considerations for the other Riparian Area/Channel Morphology/In-Stream Habitat alternatives. However, it should be noted that the more contiguous the restoration of the riparian areas within the 11-Mile Reach, the greater benefit to wildlife and the fishery.

Between reaches, the primary implementability, effectiveness and cost considerations are:

- The quality of existing in-stream habitat and bank stability; and
- The rate at which in-stream habitat improvements occur.

The quality of existing in-stream habitat and degree of bank instability within a reach influences the comparison, primarily in terms of cost effectiveness and the rate at which in-stream habitat improvements occur. Within Reach 1, the habitat is generally good and signs of rapidly eroding streambanks were not observed. However, lack of pool habitat was identified as a specific subreach (1A and 1C) restoration need. Alternatives 3 and 4 both offer improvements in in-stream habitat. Alternative 4 is focused specifically on the restoration need of pool habitat. Alternative 3 offers a combination of bank stability measures coupled with in-stream habitat improvements. As noted above, the fencing and conservation leases included for all action alternatives will provide the primary benefits in terms of bank stability. The additional measures of Alternative 3 are expected to provide only a small level of incremental benefit to near-term bank stability relative to Alternative 4. However, Alternative 4 offers more direct improvements in in-stream habitat.

Within Reach 2, the existing in-stream habitat structure is generally evaluated to be good, as is bank stability. For this reason, only three alternatives were developed. The additional incremental

benefits from the bank stabilization/in-stream habitat measures of Alternative 3 are limited and are primarily related to more rapidly improving conditions than Alternative 2. However, it does not appear that the incremental benefits of Alternative 3 are commensurate with the roughly $290,000 cost increase over Alternative 2.

Within Reach 3, the physical in-stream habitat needs and bank stability concerns are the greatest of the 4 reaches. Correspondingly, the incremental benefits from actions beyond the fencing and conservation leases are expected to be larger than for other reaches. As for Reach 1, Alternatives 3 and 4 contrast broader bank stability/in-stream habitat actions with the development of pool habitat. For Reach 3, however, the pool habitat creation is more intensive than for Reach 1. Overall, the net benefit to the fishery is expected to be similar between Alternatives 3 and 4. Alternative 3 offers more short-term effectiveness in terms of bank stability at a cost of approximately $558,000 versus approximately $692,000 for Alternative 4. However, given the varying conditions along Reach 3, it may be that during the design phase, elements of Alternative 3 and Alternative 4 may be alternately more appropriate depending upon the specific stream segments.

7.5.3 AGRICULTURAL LANDS WITHIN THE ARKANSAS RIVER FLOODPLAIN (IRRIGATED MEADOWS)

Both Alternatives 2 and 3 include deep tilling and reseeding of impacted agricultural lands to dilute surficial metals concentrations and rapidly re-establish cover/habitat. This technology will rapidly achieve restoration goals.

For Reaches 1, 2 and 3, the primary consideration for effectiveness of Alternatives 2 and 3 for the agricultural lands is the acidity of the soils being addressed. Since information on soil acidity is not available, it was inferred that the soil had slightly depressed pH and the addition of lime would increase the effectiveness of the deep tilling, both in terms of reducing the availability of metals and enhancing plant growth. The incremental cost for potential additional effectiveness is small, approximately $25,000 to $35,000, depending upon the reach. There were no reach specific distinctions identified in the comparative analysis.

Table 7-1
Comparative Analysis Summary
Fluvial Mine-Waste Deposits

	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
Reach 1				
Alternative	*Natural Recovery*	*Liming, Deep Tilling, Reseeding, Mulch*	*Liming, Biosolids, Deep Tilling, Reseeding*	*Removal, Lime Addition, Reseeding*
Implementability	No Action	Readily implementable	Similar implementability to Alternative 2. Use of composted biosolids necessary.	More complex construction scenario than Alternatives 2 and 3. Requires stabilization of banks where deposits intersect channel. Disposal considerations.
Effectiveness	Not effective for meeting ROs	Effective in establishing cover/habitat and potentially reducing surficial metals concentrations at some locations. Institutional controls required for long-term effectiveness.	Somewhat more effective than Alternative 2 because of increased moisture-holding capacity and plant nutrients	Higher level of certainty than Alternatives 2 and 3. Waste is removed and therefore no reliance on institutional controls is required. However, given the large amount of remediation already conducted, this alternative offers no significant advantage for a greater cost.
Time to Achieve ROs*	N/A	3 to 5 years	2 to 3 years	2 years
Cost	**$0**	**$85,000**	**$89,000**	**$1,521,000**
Reach 2				
Alternative	*Natural Recovery*	*Liming, Deep Tilling, Reseeding, Mulch (low and moderate)* *Lime, Biosolids, Deep Tilling, Reseeding (high)*	*Liming, Biosolids, Deep Tilling, Reseeding (low and moderate)* *Lime, Deep Tilling, Soil Cover, Reseeding (high)*	*Removal, Lime Addition, Reseeding*
Implementability	No Action	Readily implementable	Similar implementability to Alternative 2. Use of composted biosolids necessary. Availability of soil for cover may be limited.	More complex construction scenario than Alternatives 2 and 3. Requires stabilization of banks where deposits intersect channel. Disposal considerations.
Effectiveness	Not effective for meeting ROs	Effective in establishing cover/habitat and potentially reducing surficial metals concentrations at some locations. For high priority deposits, there is the added benefit of increased moisture-holding capacity and plant nutrients from biosolids addition. Institutional controls required for long-term effectiveness.	Effective in establishing cover/habitat and potentially reducing surficial metals concentrations at some locations with the added benefit of increased moisture-holding capacity and plant nutrients from biosolids addition. For high priority deposits the soil cover would provide more rapid restoration and greater assurance of continued protection than Alternative 2. Institutional controls required for long-term effectiveness.	Higher level of certainty than Alternatives 2 and 3. Waste is removed and therefore no reliance on institutional controls is required.
Time to Achieve ROs*	N/A	3 to 5 years *(low and moderate priority)* 2 to 3 years *(high priority)*	2 to 3 years *(low and moderate priority)* 2 years *(high priority)*	2 years
Cost	**$0**	**$178,000**	**$263,000**	**$597,000**

Table 7-1
Comparative Analysis Summary
Fluvial Mine-Waste Deposits

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reach 3				
Alternative	*Natural Recovery*	*Lime, Deep Tilling, Reseeding, Mulch (low and moderate)* *Lime, Biosolids, Deep Tilling, Reseeding (high)*	*Lime, Deep Tilling, Reseeding, Mulch (low)* *Lime, Biosolids, Deep Tilling, Reseeding (moderate)* *Lime, Deep Tilling, Soil Cover, Reseeding (high)*	*Removal, Lime Addition, Reseeding*
Implementability	No Action	Readily implementable. Public ownership allows for rapid establishment of institutional controls.	Readily implementable. Public ownership allows for rapid establishment of institutional controls.	More complex construction scenario than Alternatives 2 and 3 – construction of repository might pose administrative and legal issues.
Effectiveness	Not effective for meeting ROs	In combination, treatments for the low, moderate and high priority deposits are expected to effectively meet ROs. Institutional controls required for long-term effectiveness.	Higher level of certainty than Alternative 2 that habitat will remain established over time. Institutional controls required for long-term effectiveness.	Similar level of short-term effectiveness as Alternative 3. Slightly higher level of long-term effectiveness because there is no need for reliance on institutional controls.
Time to Achieve ROs*	N/A	3 to 5 years *(low and moderate priority)* 2 to 3 years *(high priority)*	3 to 5 years *(low priority)* 2 to 3 years *(moderate priority)* 2 years *(high priority)*	2 years
Cost	**$0**	**$314,000**	**$447,000**	**$2,385,000**
Reach 4				
Alternative	*Natural Recovery*	*Direct Revegetation*	*Lime, Direct Revegetation*	*N/A*
Implementability	No Action	Readily implementable	Readily implementable	N/A
Effectiveness	Not effective for meeting ROs	Effective at enhancing the rate of natural recovery	Slightly more effective than Alternative 2 if soil pH is an issue.	N/A
Time to Achieve ROs*	N/A	5 years	5 years	N/A
Cost	**$0**	**$25,000**	**$55,000**	**N/A**

RO = Restoration Objectives
* Time frames for achievement of ROs relate to the expected time for recovery of vegetation/cover after the initial construction activity is complete.

Table 7-2
Comparative Analysis Summary
Riparian Areas/Channel Morphology/In-Stream Habitat

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reach 1				
Alternative	*Natural Recovery*	*Riparian Area Grazing Control (conservation leases/fencing)*	*Soft Treatments for Bank Protection/Channel Stabilization/In-stream Habitat Improvements and Riparian Area Grazing Control*	*Riparian Area Grazing Control and Pool Excavations in subreaches 1A and 1C*
Implementability	No Action	Readily implementable with landowner approval	Readily implementable, but involves significantly more design and construction management effort than Alternative 2	Similar level of implementability as Alternative 3
Effectiveness	Not effective for meeting ROs	Effective in improving riparian habitat and bank stability.	Offers limited additional short-term effectiveness over Alternative 2, because of the additional bank stabilization/in-stream habitat improvements. However, not a significant improvement over Alternative 2 for long-term effectiveness.	More effective in improving pool to riffle ratio than Alternatives 2 and 3. .
Time to Achieve ROs*	N/A	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease.	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease. 2 years for banks/in-stream habitat.	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease. 2 years for banks/in-stream habitat.
Cost	**$0**	**$66,000**	**$241,000**	**$180,000**
Reach 2				
Alternative	*Natural Recovery*	*Riparian Area Grazing Control (conservation leases/fencing)*	*Riparian Area Grazing Control (conservation leases/fencing) and Soft Treatments in Upper Portions of subreach 2A.*	*N/A*
Implementability	No Action	Readily implementable with landowner approval	Involves significantly more design and construction management effort than Alternative 2.	N/A
Effectiveness	Not effective for meeting ROs	Effective in improving riparian habitat and bank stability.	Offers limited additional short-term effectiveness over Alternative 2, because of the additional bank stabilization/in-stream habitat improvements. However, not a significant improvement over Alternative 2 for long-term effectiveness.	N/A
Time to Achieve ROs*	N/A	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease.	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease. 2 years for banks/in-stream habitat.	**N/A**
Cost	**$0**	**$136,000**	**$428,000**	**N/A**

Table 7-2
Comparative Analysis Summary
Riparian Areas/Channel Morphology/In-Stream Habitat

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reach 3				
Alternative	*Natural Recovery*	*Riparian Area Grazing Control (conservation leases/fencing)*	*Soft Treatments for Bank Protection/Channel Stabilization/In-stream Habitat Improvements and Riparian Area Grazing Control*	*Riparian Area Grazing Control and Pool Excavations in subreaches 3A and 3B*
Implementability	No Action	Readily implementable	Readily implementable, but involves significantly more design and construction management effort than Alternative 2	Readily implementable, but involves significantly more design and construction management effort than Alternative 2, equally implementable as Alternative 3.
Effectiveness	Not effective for meeting ROs if there are no formal grazing restrictions in place.	Effective in improving riparian habitat and bank stability.	Offers limited additional short-term effectiveness over Alternative 2, because of the additional bank stabilization/in-stream habitat improvements. However, not a significant improvement over Alternative 2 for long-term effectiveness.	More effective in improving pool to riffle ratio than Alternatives 2 and 3.
Time to Achieve ROs*	N/A	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease.	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease. 2 years for banks/in-stream habitat.	Riparian cover and habitat restored in 5 years and would continue to mature over 20-year lease. 2 years for banks/in-stream habitat.
Cost	**$0**	**$138,000**	**$559,000**	**$692,000**
Reach 4				
Alternative	*Natural Recovery*	*Riparian Area Grazing Control (conservation leases/fencing)*	*N/A*	*N/A*
Implementability	No Action	Readily implementable	N/A	N/A
Effectiveness	Effective for meeting ROs	Effective in assuring the riparian habitat and bank stability remain good.	N/A	N/A
Time to Achieve ROs*	N/A	Riparian cover and habitat improved in 5 years and would continue to mature over 20-year lease.	N/A	N/A
Cost	**$0**	**$65,000**	**N/A**	**N/A**

RO = Restoration Objectives
* Time frames for achievement of ROs relate to the expected time for recovery of vegetation/cover after the initial construction activity is complete.

Table 7-3
Comparative Analysis Summary
Agricultural Lands

	Alternative 1	Alternative 2	Alternative 3
Reach 1			
Alternative	*Natural Recovery*	*Deep Tilling and Reseeding*	*Liming, Deep Tilling and Reseeding*
Implementability	No Action	Readily Implementable	Readily Implementable
Effectiveness	Effective for meeting ROs	Effective in reducing surficial soil metals concentrations by deep tilling and in establishing cover by reseeding.	Effective in reducing surficial soil metals concentrations by deep tilling and in establishing cover by reseeding. Addition of lime would increase effectiveness where low soil pH may be a limiting factor.
Time to Achieve ROs*	Decades	Immediate	Immediate
Cost	**$0**	**$148,000**	**$173,000**
Reach 2			
Alternative	*Natural Recovery*	*Deep Tilling and Reseeding*	*Liming, Deep Tilling and Reseeding*
Implementability	No Action	Readily Implementable	Readily Implementable
Effectiveness	Effective for meeting ROs	Effective in reducing surficial soil metals concentrations by deep tilling and in establishing cover by reseeding.	Effective in reducing surficial soil metals concentrations by deep tilling and in establishing cover by reseeding. Addition of lime would increase effectiveness where low soil pH may be a limiting factor.
Time to Achieve ROs*	Decades	Immediate	Immediate
Cost	**$0**	**$275,000**	**$308,000**
Reach 3			
Alternative	*Natural Recovery*	*Deep Tilling and Reseeding*	*Liming, Deep Tilling and Reseeding*
Implementability	No Action	Readily Implementable	Readily Implementable
Effectiveness	Effective for meeting ROs	Effective in reducing surficial soil metals concentrations by deep tilling and in establishing cover by reseeding.	Effective in reducing surficial soil metals concentrations by deep tilling and in establishing cover by reseeding. Addition of lime would increase effectiveness where low soil pH may be a limiting factor.
Time to Achieve ROs*	Decades	Immediate	Immediate
Cost	**$0**	**$291,000**	**$326,000**

RO = Restoration Objectives
* Time frames for achievement of ROs relate to the expected time for recovery of vegetation/cover after the initial construction activity is complete.

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TABLE A-1
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 1 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	16	hr	125.00	$2,000
road restoration (incl. reveg)	4000	lf	0.75	$3,000
Low & Moderate Priority Deposits				
Direct revegetation				
seed/ fertilizer/ mulch	3	ac	1,500.00	$4,500
Lime application				
agricultural limestone (75 T/Acre)	225	ton	25.00	$5,625
deliver/ spread lime (50 mi one way)	225	ton	15.00	$3,375
18" tilling	3	ac	1,900.00	$5,700
Dust control	5	day	540.00	$2,700
Silt fencing	1000	lf	0.97	$970
SUBTOTAL DIRECT CAPITAL COSTS				$27,870
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$2,787
Engineering/Administration Costs			20%	$5,574
Construction Management Costs			20%	$5,574
SUBTOTAL INDIRECT CAPITAL COSTS				$13,935
Contingency			25%	$10,451
TOTAL ESTIMATED CAPITAL COST				**$52,256**
ANNUAL OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas - every other year for 6 years - 3 applications)	1.5	A/yr	400.00	$600
Maintenance Seeding (5% per year for first 3 yrs)	0.15	A/yr	500.00	$75
Maintenance Liming (5% per year for first 3 yrs)	0.15	A/yr	3,000.00	$450
Periodic inspection & reporting (avg annual cost)	1	yr	1,600.00	$1,600
SUBTOTAL ANNUAL O&M COSTS				$2,725
O&M Administration			10%	$160
O&M Contingency			25%	$400
TOTAL ANNUAL O&M COSTS				**$3,285**
O&M COSTS NPV (5% rate of return over 20 years)				$32,960
TOTAL COSTS (NPV)				**$85,216**

TABLE A-2
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 1 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	16	hr	125.00	$2,000
road restoration (incl. reveg)	4000	lf	0.75	$3,000
Low & Moderate Priority Deposits				
Direct revegetation				
seed/ fertilizer/ mulch	3	ac	1,500.00	$4,500
Lime/Biosolids application				
agricultural limestone (75 ton/acre)	225	ton	25.00	$5,625
deliver/ spread lime (50 mi one way)	225	ton	15.00	$3,375
deliver/ spread biosolids (40 ton/acre)	120	ton	15.00	$1,800
18" tilling	3	ac	1,900.00	$5,700
Dust control	5	day	540.00	$2,700
Silt fencing	1000	lf	0.97	$970
SUBTOTAL DIRECT CAPITAL COSTS				$29,670
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$2,967
Engineering/Administration Costs			20%	$5,934
Construction Management Costs			20%	$5,934
SUBTOTAL INDIRECT CAPITAL COSTS				$14,835
Contingency			25%	$11,126
TOTAL ESTIMATED CAPITAL COST				**$55,631**
ANNUAL OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas - every other year for 6 years)	1.5	A/yr	400.00	$600
Maintenance Seeding (5% per year for first 3 yrs)	0.15	A/yr	500.00	$75
Maintenance Liming (5% per year for first 3 yrs)	0.15	A/yr	3,000.00	$450
Periodic inspection & reporting (avg, annual cost)	1	yr	1,600.00	$1,600
SUBTOTAL ANNUAL O&M COSTS				$2,725
O&M Administration			10%	$273
O&M Contingency			25%	$681
TOTAL ANNUAL O&M COSTS				**$3,679**
O&M COSTS NPV (5% rate of return over 20 years)				$32,960
TOTAL COSTS (NPV)				**$88,591**

TABLE A-3
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 1 - ALTERNATIVE 4

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	24	hr	125.00	$3,000
gravel roadbase (incl. haul and spread)	100	ton	12.50	$1,250
road restoration (incl. Reveg)	4000	lf	0.75	$3,000
Low & Moderate Priority Deposits				
Excavation of mine waste piles plus an additional six inches of soil				
excavate/ load	11000	cy	1.80	$19,800
haul/ place (9 mi)	11000	cy	6.00	$66,000
Tipping fee @ Black Cloud Repository	11000	cy	2.00	$22,000
Replacement Soil				
excavate/ haul/ place (within 5 miles)	11000	cy	7.50	$82,500
Revegetation				
seed/ fertilizer/ mulch	4.5	ac	1,500.00	$6,750
High Priority Deposits				
Excavation of mine waste piles plus an additional six inches of soil				
excavate/ load	36500	cy	1.80	$65,700
haul/ place (9 mi)	36500	cy	6.00	$219,000
Tipping fee @ Black Cloud Repository	36500	cy	2.00	$73,000
Lime application				
limerock (incl. loading)	1020	ton	25.00	$25,500
deliver/ spread lime (50 mi one way)	1020	ton	15.00	$15,300
Replacement Soil				
excavate/ haul/ place (within 5 miles)	36500	cy	7.50	$273,750
Revegetation				
seed/ fertilizer/ mulch	13.5	ac	1,500.00	$20,250
Dust control	20	day	540.00	$10,800
Stream bank stabilization	300	lf	35.00	$10,500
Silt fencing	3000	lf	0.97	$2,910
SUBTOTAL DIRECT CAPITAL COSTS				$921,010
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$92,101
Engineering/Administration Costs			10%	$92,101
Construction Management Costs			10%	$92,101
SUBTOTAL INDIRECT CAPITAL COSTS				$276,303
Contingency			25%	$299,328
TOTAL ESTIMATED CAPITAL COST				**$1,496,641**
ANNUAL OPERATION & MAINTENANCE COSTS				
Annual Inspection & Reporting (first 3 years only)	1	yr	5,000.00	$5,000
Vegetation Maintenance (10% fert/seed within first 3 years)	1.5	A/yr	1,000.00	$1,500
SUBTOTAL ANNUAL O&M COSTS				$6,500
O&M Administration and Fees			10%	$650
O&M Contingency			25%	$1,625
TOTAL ANNUAL O&M COSTS				**$8,775**
O&M COSTS NPV (5% rate of return over 20 years)				$23,897
TOTAL COSTS (NPV)				**$1,520,538**

TABLE A-4
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 1 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	18800	lf	1.70	$31,960
20 yr conservation lease (approx 11 acres)	11	ac	350.00	$3,850
SUBTOTAL DIRECT CAPITAL COSTS				$35,810
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$3,581
Engineering/Administration Costs			10%	$3,581
Construction Management Costs			10%	$3,581
SUBTOTAL INDIRECT CAPITAL COSTS				$10,743
Contingency			25%	$11,638
TOTAL ESTIMATED CAPITAL COST				**$58,191**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	940	lf	1.00	$940
SUBTOTAL ANNUAL O&M COSTS				$2,540
O&M Administration and Fees			10%	$254
O&M Contingency			25%	$635
TOTAL ANNUAL O&M COSTS				**$3,429**
O&M COSTS NPV (5% rate of return over 20 years)				$7,734
TOTAL COSTS (NPV)				**$65,925**

TABLE A-5
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 1 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	18800	lf	1.70	$31,960
20 yr conservation lease (approx 11 acres)	11	ac	350.00	$3,850
Bank/Channel Stabilization				
Soft treatment	3000	lf	35.00	$105,000
Silt fencing	3000	lf	0.97	$2,910
SUBTOTAL DIRECT CAPITAL COSTS				$143,720
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$14,372
Engineering/Administration Costs			10%	$14,372
Construction Management Costs			10%	$14,372
SUBTOTAL INDIRECT CAPITAL COSTS				$43,116
Contingency			25%	$46,709
TOTAL ESTIMATED CAPITAL COST				**$233,545**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	940	lf	1.00	$940
SUBTOTAL ANNUAL O&M COSTS				$2,540
O&M Administration and Fees			10%	$254
O&M Contingency			25%	$635
TOTAL ANNUAL O&M COSTS				**$3,429**
O&M COSTS NPV (5% rate of return over 20 years)				$7,734
TOTAL COSTS (NPV)				**$241,279**

TABLE A-6
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 1 - ALTERNATIVE 4

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	18800	lf	1.70	$31,960
20 yr conservation lease (approx 11 acres)	11	ac	350.00	$3,850
In-Stream Habitat Improvement				
Pool Excavation (2 Pools each - 2' deep x 25 - 50' wide x 100' long)				
Sheet Piling/Coffer Dam - 10' deep x 150' (each location)	3000	sf	15.00	$45,000
Excavate w/ clamshell or dragline	1000	cy	12.00	$12,000
Haul & place excavated material - 9 mil haul	1000	cy	6.00	$6,000
Gabions/Boulder control structures	70	sy	100.00	$7,000
Silt fencing	500	lf	0.97	$485
SUBTOTAL DIRECT CAPITAL COSTS				$106,295
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$10,630
Engineering/Administration Costs			10%	$10,630
Construction Management Costs			10%	$10,630
SUBTOTAL INDIRECT CAPITAL COSTS				$31,889
Contingency			25%	$34,546
TOTAL ESTIMATED CAPITAL COST				**$172,729**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	940	lf	1.00	$940
SUBTOTAL ANNUAL O&M COSTS				$2,540
O&M Administration and Fees			10%	$254
O&M Contingency			25%	$635
TOTAL ANNUAL O&M COSTS				**$3,429**
O&M COSTS NPV (5% rate of return over 20 years)				$7,734
TOTAL COSTS (NPV)				**$180,463**

TABLE A-7
DETAILED COST ESTIMATE
AGRICULTURAL LANDS
REACH 1 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
12" tilling	35	ac	1,250.00	$43,750
Revegetation seed & fertilizer	35	ac	900.00	$31,500
SUBTOTAL DIRECT CAPITAL COSTS				$75,250
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$7,525
Engineering/Administration Costs			10%	$7,525
Construction Management Costs			10%	$7,525
SUBTOTAL INDIRECT CAPITAL COSTS				$22,575
Contingency			25%	$24,456
TOTAL ESTIMATED CAPITAL COST				**$122,281**
OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas within first 3 yrs)	35.0	Acre	400.00	$14,000
Maintenance Seeding (10% within first 2 years)	3.5	Acre	500.00	$1,750
Inspection & reporting (one time only)	1	yr	3,200.00	$3,200
SUBTOTAL O&M COSTS				$18,950
O&M Administration			10%	$1,895
O&M Contingency			25%	$4,738
TOTAL O&M COSTS				**$25,583**
O&M COSTS NPV (5% rate of return over 20 years)				N/A
TOTAL COSTS				**$147,864**

TABLE A-8
DETAILED COST ESTIMATE
AGRICULTURAL LANDS
REACH 1 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Revegetation				
seed & fertilizer	35	ac	900.00	$31,500
Lime application				
limerock (incl. loading)	350	ton	25.00	$8,750
deliver/ spread lime (50 mi one way)	350	ton	15.00	$5,250
12" tilling	35	ac	1,250.00	$43,750
SUBTOTAL DIRECT CAPITAL COSTS				$89,250
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$8,925
Engineering/Administration Costs			10%	$8,925
Construction Management Costs			10%	$8,925
SUBTOTAL INDIRECT CAPITAL COSTS				$26,775
Contingency			25%	$29,006
TOTAL ESTIMATED CAPITAL COST				**$145,031**
OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas within first 2 yrs)	35.0	Acre	400.00	$14,000
Maintenance Seeding (10% within first 2 years)	3.5	Acre	500.00	$1,750
Maintenance Liming (10% within first 2 yrs)	3.5	acre	600.00	$2,100
Inspection & reporting (one-time)	1	yr	3,200.00	$3,200
SUBTOTAL O&M COSTS				$21,050
O&M Administration			10%	$2,105
O&M Contingency			25%	$5,263
TOTAL O&M COSTS				**$28,418**
O&M COSTS NPV (5% rate of return over 20 years)				N/A
TOTAL COSTS				**$173,449**

TABLE A-9
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 2 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	16	hr	125.00	$2,000
road restoration (incl. reveg)	5000	lf	0.75	$3,750
Low & Moderate Priority Deposits				
Lime application				
limerock (incl. loading)	383	ton	25.00	$9,575
deliver/ spread lime (50 mi one way)	383	ton	15.00	$5,745
18" tilling	5.1	ac	1,900.00	$9,690
Direct Revegetation				
seed/ fertilizer/ mulch	5.1	ac	1,500.00	$7,650
18" tilling	5.1	ac	1,900.00	$9,690
High Priority Deposits				
Lime/Biosolids application				
agricultural limestone (75 ton/acre)	300	ton	25.00	$7,500
deliver/ spread lime (50 mi one way)	300	ton	15.00	$4,500
deliver/ spread biosolids (40 ton/acre)	160	ton	15.00	$2,400
18" tilling	4.1	ac	1,900.00	$7,790
Direct revegetation				
seed/ fertilizer/ mulch	4.1	ac	1,500.00	$6,150
Silt fencing	1000	lf	0.97	$970
SUBTOTAL DIRECT CAPITAL COSTS				$77,410
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$7,741
Engineering/Administration Costs			10%	$7,741
Construction Management Costs			10%	$7,741
SUBTOTAL INDIRECT CAPITAL COSTS				$23,223
Contingency			25%	$25,158
TOTAL ESTIMATED CAPITAL COST				**$125,791**
ANNUAL OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas - every other year for 6 years)	4.5	A/yr	400.00	$1,800
Maintenance Seeding (5% per year for first 3 yrs)	0.45	A/yr	500.00	$225
Maintenance Liming (5% per year for first 3 yrs)	0.45	A/yr	3,000.00	$1,350
Periodic inspection & reporting (avg. annual cost)	1	yr	2,000.00	$2,000
SUBTOTAL ANNUAL O&M COSTS				$5,375
O&M Administration			10%	$538
O&M Contingency			25%	$1,344
TOTAL ANNUAL O&M COSTS				**$7,256**
O&M COSTS NPV (5% rate of return over 20 years)				$51,772
TOTAL COSTS (NPV)				**$177,563**

TABLE A-10
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 2 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	16	hr	125.00	$2,000
road restoration (incl reveg)	5000	lf	0.75	$3,750
Low & Moderate Priority Deposits				
Lime/Biosolids application				
agricultural limestone (75 ton/acre)	383	ton	25.00	$9,575
deliver/ spread lime (50 mi one way)	383	ton	15.00	$5,745
deliver/ spread biosolids (40 ton/acre)	204	ton	15.00	$3,060
18" tilling	5.1	ac	1,900.00	$9,690
Direct Revegetation				
seed/ fertilizer/ mulch	5.1	ac	1,500.00	$7,650
High Priority Deposits				
Lime application				
limerock (incl. loading)	308	ton	25.00	$7,700
deliver/ spread lime (50 mi one way)	308	ton	15.00	$4,620
18" tilling	4.1	ac	1,900.00	$7,790
Cover				
excavate/ haul/ place	7607	cy	7.50	$57,053
Cover revegetation				
seed/ fertilizer/ mulch	4.1	ac	1,500.00	$6,150
Dust control	15	day	540.00	$8,100
Silt fencing	2000	lf	0.97	$1,940
SUBTOTAL DIRECT CAPITAL COSTS				$134,823
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$13,482
Engineering/Administration Costs			10%	$13,482
Construction Management Costs			10%	$13,482
SUBTOTAL INDIRECT CAPITAL COSTS				$40,447
Contingency			25%	$43,817
TOTAL ESTIMATED CAPITAL COST				**$219,087**
ANNUAL OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (direct reveg areas - every other year for 6 years)	2.5	A/yr	400.00	$1,000
Maintenance Seeding (all areas 5% per year for first 3 yrs)	0.45	A/yr	500.00	$225
Maintenance Liming (direct reveg areas 5% per year for first 3 yrs)	0.25	A/yr	3,000.00	$750
Periodic inspection & reporting (avg. annual cost)	1	yr	2,000.00	$2,000
SUBTOTAL ANNUAL O&M COSTS				$3,975
O&M Administration			10%	$0
O&M Contingency			25%	$0
TOTAL ANNUAL O&M COSTS				**$3,975**
O&M COSTS NPV (5% rate of return over 20 years)				$44,085
TOTAL COSTS (NPV)				**$263,171**

TABLE A-11
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 2 - ALTERNATIVE 4

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	24	hr	125.00	$3,000
road restoration (incl reveg)	5000	lf	0.75	$3,750
Low & Moderate Priority Deposits				
Excavation of mine waste piles plus an additional six inches of soil				
excavate/ load	10500	cy	1.80	$18,900
haul/ place (12 mi)	10500	cy	7.00	$73,500
Tipping fee @ Black Cloud Repository	10500	cy	2.00	$21,000
Replacement Soil				
excavate/ haul/ place (within 5 miles)	10500	cy	7.50	$78,750
Revegetation				
seed/ fertilizer/ mulch	5.2	ac	1,500.00	$7,800
High Priority Deposits				
Excavation of mine waste piles plus an additional six inches of soil				
excavate/ load	5500	cy	1.80	$9,900
haul/ place (12 mi)	5500	cy	7.00	$38,500
Tipping fee @ Black Cloud Repository	5500	cy	2.00	$11,000
Lime application				
limerock (incl. loading)	300	ton	25.00	$7,500
deliver/ spread lime (50 mi one way)	300	ton	15.00	$4,500
Replacement Soil				
excavate/ haul/ place (within 5 miles)	5500	cy	7.50	$41,250
Revegetation				
seed/ fertilizer/ mulch	4.1	ac	1,500.00	$6,150
Stream bank stabilization	500	lf	35.00	$17,500
Dust control	15	day	540.00	$8,100
Silt fencing	3000	lf	0.97	$2,910
SUBTOTAL DIRECT CAPITAL COSTS				$354,010
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$35,401
Engineering/Administration Costs			10%	$35,401
Construction Management Costs			10%	$35,401
SUBTOTAL INDIRECT CAPITAL COSTS				$106,203
Contingency			25%	$115,053
TOTAL ESTIMATED CAPITAL COST				**$575,266**
ANNUAL OPERATION & MAINTENANCE COSTS				
Annual Inspection & Reporting (first 3 years only)	1	yr	5,000.00	$5,000
Vegetation Maintenance (10% fert/seed within first 3 years)	1	A/yr	1,000.00	$1,000
SUBTOTAL ANNUAL O&M COSTS				$6,000
O&M Administration and Fees			10%	$600
O&M Contingency			25%	$1,500
TOTAL ANNUAL O&M COSTS				**$8,100**
O&M COSTS NPV (5% rate of return over 20 years)				$22,058
TOTAL COSTS (NPV)				**$597,325**

TABLE A-12
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 2 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	40400	lf	1.70	$68,680
20 yr conservation lease (approx 23 acres)	23	ac	350.00	$8,050
SUBTOTAL DIRECT CAPITAL COSTS				$76,730
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$7,673
Engineering/Administration Costs			10%	$7,673
Construction Management Costs			10%	$7,673
SUBTOTAL INDIRECT CAPITAL COSTS				$23,019
Contingency			25%	$24,937
TOTAL ESTIMATED CAPITAL COST				**$124,686**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	2020	lf	1.00	$2,020
SUBTOTAL ANNUAL O&M COSTS				$3,620
O&M Administration and Fees			10%	$362
O&M Contingency			25%	$905
TOTAL ANNUAL O&M COSTS				**$4,887**
O&M COSTS NPV (5% rate of return over 20 years)				$11,022
TOTAL COSTS (NPV)				**$135,708**

TABLE A-13
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 2 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	40400	lf	1.70	$68,680
20 yr conservation lease (approx 23 acres)	23	ac	350.00	$8,050
Bank/Channel Stabilization				
Soft treatment	5000	lf	35.00	$175,000
Silt fencing	5000	lf	0.97	$4,850
SUBTOTAL DIRECT CAPITAL COSTS				$256,580
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$25,658
Engineering/Administration Costs			10%	$25,658
Construction Management Costs			10%	$25,658
SUBTOTAL INDIRECT CAPITAL COSTS				$76,974
Contingency			25%	$83,389
TOTAL ESTIMATED CAPITAL COST				**$416,943**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	2020	lf	1.00	$2,020
SUBTOTAL ANNUAL O&M COSTS				$3,620
O&M Administration and Fees			10%	$362
O&M Contingency			25%	$905
TOTAL ANNUAL O&M COSTS				**$4,887**
O&M COSTS NPV (5% rate of return over 20 years)				$11,022
TOTAL COSTS (NPV)				**$427,964**

TABLE A-14
DETAILED COST ESTIMATE
AGRICULTURAL LANDS
REACH 2 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Revegetation				
seed & fertilize	66	ac	900.00	$59,400
12" tilling	66	ac	1,250.00	$82,500
SUBTOTAL DIRECT CAPITAL COSTS				$141,900
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$14,190
Engineering/Administration Costs			10%	$14,190
Construction Management Costs			10%	$14,190
SUBTOTAL INDIRECT CAPITAL COSTS				$42,570
Contingency			25%	$46,118
TOTAL ESTIMATED CAPITAL COST				**$230,588**
OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas within first 3 yrs)	66.0	acre	400.00	$26,400
Maintenance Seeding (10% within first 2 years)	6.6	acre	500.00	$3,300
Inspection & reporting (one time only)	1	yr	3,200.00	$3,200
SUBTOTAL O&M COSTS				$32,900
O&M Administration			10%	$3,290
O&M Contingency			25%	$8,225
TOTAL O&M COSTS				**$44,415**
O&M COSTS NPV (5% rate of return over 20 years)				N/A
TOTAL COSTS				**$275,003**

TABLE A-15
DETAILED COST ESTIMATE
AGRICULTURAL LANDS
REACH 2 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Revegetation				
seed & fertilize	66	ac	900.00	$59,400
Lime application				
limerock (incl. loading)	660	ton	25.00	$16,500
deliver/ spread lime (50 mi one way)	660	ton	15.00	$9,900
12" tilling	66	ac	1,250.00	$82,500
SUBTOTAL DIRECT CAPITAL COSTS				$168,300
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$16,830
Engineering/Administration Costs			10%	$16,830
Construction Management Costs			10%	$16,830
SUBTOTAL INDIRECT CAPITAL COSTS				$50,490
Contingency			25%	$54,698
TOTAL ESTIMATED CAPITAL COST				**$273,488**
OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas within first 3 yrs)	66.0	acre	400.00	$26,400
Maintenance Seeding (10% within first 2 years)	6.6	acre	500.00	$3,300
Inspection & reporting (one time)	1	yr	3,200.00	$3,200
SUBTOTAL O&M COSTS				$32,900
O&M Administration			10%	$330
O&M Contingency			25%	$825
TOTAL O&M COSTS				**$34,055**
O&M COSTS NPV (5% rate of return over 20 years)				N/A
TOTAL COSTS				**$307,543**

TABLE A-16
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 3 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	32	hr	125.00	$4,000
road restoration (incl reveg)	10000	lf	0.75	$7,500
Low & Moderate Priority Deposits				
Lime application				
agricultural limestone (75 tons/acre)	1100	ton	25.00	$27,500
deliver/ spread lime (50 mi one way)	1100	ton	15.00	$16,500
18" tilling	14.5	ac	1,900.00	$27,550
Direct Revegetation				
seed/ fertilizer/ mulch	15	ac	1,500.00	$22,500
High Priority Deposits				
Lime/Biosolids application				
agricultural limestone (75 tons/acre)	410	ton	25.00	$10,250
deliver/ spread lime (50 mi one way)	410	ton	15.00	$6,150
deliver/ spread biosolids (40 tons/acre)	220	ton	15.00	$3,300
18" tilling	5.5	ac	1,900.00	$10,450
Direct revegetation				
seed/ fertilizer/ mulch	5.5	ac	1,500.00	$8,250
Dust control	5	day	540.00	$2,700
Silt fencing	1000	lf	0.97	$970
SUBTOTAL DIRECT CAPITAL COSTS				$147,620
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$14,762
Engineering/Administration Costs			10%	$14,762
Construction Management Costs			10%	$14,762
SUBTOTAL INDIRECT CAPITAL COSTS				$44,286
Contingency			25%	$47,977
TOTAL ESTIMATED CAPITAL COST				**$239,883**
ANNUAL OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas - every other year for 6 years)	10.0	A/yr	400.00	$4,000
Maintenance Seeding (5% per year for first 3 yrs)	1	A/yr	500.00	$500
Maintenance Liming (5% per year for first 3 yrs)	1	A/yr	3,000.00	$3,000
Periodic inspection & reporting (avg. annual cost)	1	yr	2,000.00	$2,000
SUBTOTAL ANNUAL O&M COSTS				$9,500
O&M Administration			10%	$950
O&M Contingency			25%	$2,375
TOTAL ANNUAL O&M COSTS				**$12,825**
O&M COSTS NPV (5% rate of return over 20 years)				$73,924
TOTAL COSTS (NPV)				**$313,807**

TABLE A-17
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 3 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements (motor grader)	32	hr	125.00	$4,000
road restoration (incl reveg)	5000	lf	0.75	$3,750
Low & Moderate Priority Deposits				
Lime/Biosolids application				
agricultural limestone (75 tons/acre)	1125	ton	25.00	$28,125
deliver/ spread lime (50 mi one way)	1125	ton	15.00	$16,875
deliver/ spread biosolids (40 tons/acre)	600	ton	15.00	$9,000
18" tilling	15	ac	1,900.00	$28,500
Direct Revegetation				
seed/ fertilizer/ mulch	15	ac	1,500.00	$22,500
High Priority Deposits				
Lime/Biosolids application				
limerock (incl. loading)	410	ton	25.00	$10,250
deliver/ spread lime (50 mi one way)	410	ton	15.00	$6,150
18" tilling	5.5	ac	1,900.00	$10,450
Cover				
excavate/ haul/ place (within 5 miles)	10350	cy	7.50	$77,625
Cover revegetation				
seed/ fertilizer/ mulch	5.5	ac	1,500.00	$8,250
Dust control	15	day	540.00	$8,100
Silt fencing	2000	lf	0.97	$1,940
SUBTOTAL DIRECT CAPITAL COSTS				$235,515
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$23,552
Engineering/Administration Costs			10%	$23,552
Construction Management Costs			10%	$23,552
SUBTOTAL INDIRECT CAPITAL COSTS				$70,655
Contingency			25%	$76,542
TOTAL ESTIMATED CAPITAL COST				**$382,712**
ANNUAL OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (direct reveg areas - every other year for 6 years)	7.5	A/yr	400.00	$3,000
Maintenance Seeding (all areas 5% per year for first 3 yrs)	1	A/yr	500.00	$500
Maintenance Liming (direct reveg areas 5% per year for first 3 yrs)	0.75	A/yr	3,000.00	$2,250
Periodic inspection & reporting (avg. annual cost)	1	yr	2,000.00	$2,000
SUBTOTAL ANNUAL O&M COSTS				$7,750
O&M Administration			10%	$775
O&M Contingency			25%	$1,938
TOTAL ANNUAL O&M COSTS				**$10,463**
O&M COSTS NPV (5% rate of return over 20 years)				$64,315
TOTAL COSTS (NPV)				**$447,026**

TABLE A-18
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 3 - ALTERNATIVE 4

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Access roads				
access road improvements & maint. (motor grader)	40	hr	125.00	$5,000
road restoration (incl reveg)	5000	lf	0.75	$3,750
Low & Moderate Priority Deposits				
Excavation of mine waste piles plus an additional six inches of soil				
excavate/ load	60000	cy	1.80	$108,000
haul/ place	60000	cy	3.80	$228,000
Replacement Soil				
haul & place - utilize excess from repository excavation	54000	cy	5.00	$270,000
import fill - excav/haul/place (within 5 miles)	6000	cy	7.50	$45,000
Cover revegetation				
seed/ fertilizer/ mulch	26.5	ac	1,500.00	$39,750
High Priority Deposits				
Excavation of mine waste piles plus an additional six inches of soil				
excavate/ load	28750	cy	1.80	$51,750
haul/ place	28750	cy	3.80	$109,250
Lime application				
agricultural limestone (75 tons/acre)	825	ton	25.00	$20,625
deliver/ spread lime (50 mi one way)	825	ton	15.00	$12,375
Replacement Soil				
import fill - excav/haul/place (within 5 miles)	28750	cy	7.50	$215,625
Cover revegetation				
seed/ fertilizer/ mulch	11	ac	1,500.00	$16,500
Stream bank stabilization	750	lf	35.00	$26,250
Repository				
Access roads				
road construction	2000	lf	0.55	$1,100
gravel roadbase (incl. haul and spread)	200	ton	12.50	$2,500
Excavate repository				
excavate borrow	72000	cy	3.00	$216,000
place fill for embankment	2400	cy	3.50	$8,400
Repository cover (18" thick - utilize mat'l from excavation)				
spread stockpiled fill	15600	cy	2.75	$42,900
Revegetate repostiory				
seed/ fertilizer/ mulch	6	ac	1,500.00	$9,000
Dust control	25	day	540.00	$13,500
Silt fencing	3000	lf	0.97	$2,910
SUBTOTAL DIRECT CAPITAL COSTS				$1,448,185

TABLE A-18
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 3 - ALTERNATIVE 4

INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$144,819
Engineering/Administration Costs			10%	$144,819
Construction Management Costs			10%	$144,819
SUBTOTAL INDIRECT CAPITAL COSTS				$434,456
Contingency			25%	$470,660
TOTAL ESTIMATED CAPITAL COST				**$2,353,301**
ANNUAL OPERATION & MAINTENANCE COSTS				
Annual Inspection & Reporting (first 3 years only)	1	yr	5,000.00	$5,000
Vegetation Maintenance (10% fert/seed within first 3 years)	3.5	A/yr	1,000.00	$3,500
SUBTOTAL ANNUAL O&M COSTS				$8,500
O&M Administration and Fees			10%	$850
O&M Contingency			25%	$2,125
TOTAL ANNUAL O&M COSTS				**$11,475**
O&M COSTS NPV (5% rate of return over 20 years)				$31,249
TOTAL COSTS (NPV)				**$2,384,550**

TABLE A-19
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 3 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	41000	lf	1.70	$69,700
20 yr conservation lease (approx 24 acres)	24	ac	350.00	$8,400
SUBTOTAL DIRECT CAPITAL COSTS				$78,100
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$7,810
Engineering/Administration Costs			10%	$7,810
Construction Management Costs			10%	$7,810
SUBTOTAL INDIRECT CAPITAL COSTS				$23,430
Contingency			25%	$25,383
TOTAL ESTIMATED CAPITAL COST				**$126,913**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	2050	lf	1.00	$2,050
SUBTOTAL ANNUAL O&M COSTS				$3,650
O&M Administration and Fees			10%	$365
O&M Contingency			25%	$913
TOTAL ANNUAL O&M COSTS				**$4,928**
O&M COSTS NPV (5% rate of return over 20 years)				$11,113
TOTAL COSTS (NPV)				**$138,026**

TABLE A-20
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 3 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	41000	lf	1.70	$69,700
20 yr conservation lease (approx 24 acres)	24	ac	350.00	$8,400
Bank/Channel Stabilization				
Soft treatment	7200	lf	35.00	$252,000
Silt fencing	7200	lf	0.97	$6,984
SUBTOTAL DIRECT CAPITAL COSTS				$337,084
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$33,708
Engineering/Administration Costs			10%	$33,708
Construction Management Costs			10%	$33,708
SUBTOTAL INDIRECT CAPITAL COSTS				$101,125
Contingency			25%	$109,552
TOTAL ESTIMATED CAPITAL COST				**$547,762**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	2050	lf	1.00	$2,050
SUBTOTAL ANNUAL O&M COSTS				$3,650
O&M Administration and Fees			10%	$365
O&M Contingency			25%	$913
TOTAL ANNUAL O&M COSTS				**$4,928**
O&M COSTS NPV (5% rate of return over 20 years)				$11,113
TOTAL COSTS (NPV)				**$558,875**

TABLE A-21
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 3 - ALTERNATIVE 4

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	41000	lf	1.70	$69,700
20 yr conservation lease (approx 24 acres)	24	ac	350.00	$8,400
Bank/Channel Stabilization				
Access roads				
acces roads built for mine waste deposit access can be used for channel stabilization		lf		$0
Pool Excavation (10 Pools each - 2' deep x 25 - 50' wide x 100' long)				
Sheet Piling/Coffer Dam - 10' deep x 150' (each location)	15000	sf	15.00	$225,000
Excavate w/ clamshell or dragline	5000	cy	12.00	$60,000
Haul & place excavated material - within reach	5000	cy	3.80	$19,000
Gabions/Boulder control structures	350	sy	100.00	$35,000
Silt fencing	2000	lf	0.97	$1,940
SUBTOTAL DIRECT CAPITAL COSTS				$419,040
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$41,904
Engineering/Administration Costs			10%	$41,904
Construction Management Costs			10%	$41,904
SUBTOTAL INDIRECT CAPITAL COSTS				$125,712
Contingency			25%	$136,188
TOTAL ESTIMATED CAPITAL COST				**$680,940**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	2050	lf	1.00	$2,050
SUBTOTAL ANNUAL O&M COSTS				$3,650
O&M Administration and Fees			10%	$365
O&M Contingency			25%	$913
TOTAL ANNUAL O&M COSTS				**$4,928**
O&M COSTS NPV (5% rate of return over 20 years)				$11,113
TOTAL COSTS (NPV)				**$692,053**

TABLE A-22
DETAILED COST ESTIMATE
AGRICULTURAL LANDS
REACH 3 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Revegetation				
seed & fertilize	70	ac	900.00	$63,000
12" tilling	70	ac	1,250.00	$87,500
SUBTOTAL DIRECT CAPITAL COSTS				$150,500
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$15,050
Engineering/Administration Costs			10%	$15,050
Construction Management Costs			10%	$15,050
SUBTOTAL INDIRECT CAPITAL COSTS				$45,150
Contingency			25%	$48,913
TOTAL ESTIMATED CAPITAL COST				**$244,563**
OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas within first 3 yrs)	70.0	acre	400.00	$28,000
Maintenance Seeding (10% within first 2 years)	7	acre	500.00	$3,500
Inspection & reporting (one time only)	1	yr	3,200.00	$3,200
SUBTOTAL O&M COSTS				$34,700
O&M Administration			10%	$3,470
O&M Contingency			25%	$8,675
TOTAL O&M COSTS				**$46,845**
O&M COSTS NPV (5% rate of return over 20 years)				N/A
TOTAL COSTS				**$291,408**

TABLE A-23
DETAILED COST ESTIMATE
AGRICULTURAL LANDS
REACH 3 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Revegetation				
seed & fertilize	70	ac	900.00	$63,000
Lime application				
limerock (incl. loading)	700	ton	25.00	$17,500
deliver/ spread lime (50 mi one way)	700	ton	15.00	$10,500
12" tilling	70	ac	1,250.00	$87,500
SUBTOTAL DIRECT CAPITAL COSTS				$178,500
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$17,850
Engineering/Administration Costs			10%	$17,850
Construction Management Costs			10%	$17,850
SUBTOTAL INDIRECT CAPITAL COSTS				$53,550
Contingency			25%	$58,013
TOTAL ESTIMATED CAPITAL COST				**$290,063**
OPERATION & MAINTENANCE COSTS				
Maintenance Fertilizer (all areas within first 3 yrs)	70.0	acre	400.00	$28,000
Maintenance Seeding (10% within first 2 years)	7	acre	500.00	$3,500
Inspection & reporting (one time)	1	yr	3,200.00	$3,200
SUBTOTAL O&M COSTS				$34,700
O&M Administration			10%	$350
O&M Contingency			25%	$875
TOTAL O&M COSTS				**$35,925**
O&M COSTS NPV (5% rate of return over 20 years)				N/A
TOTAL COSTS				**$325,988**

TABLE A-24
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 4 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Low & Moderate Priority Deposits				
Direct revegetation (ATV access)				
ATV rental	1	wk	500.00	$500
seed/ fertilizer/ mulch	2	ac	3,000.00	$6,000
SUBTOTAL DIRECT CAPITAL COSTS				$6,500
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$650
Engineering/Administration Costs			10%	$650
Construction Management Costs			10%	$650
SUBTOTAL INDIRECT CAPITAL COSTS				$1,950
Contingency			25%	$2,113
TOTAL ESTIMATED CAPITAL COST				**$10,563**
ANNUAL OPERATION & MAINTENANCE COSTS				
Annual inspection & reporting (first 3 years only)	1	yr	1,600.00	$1,600
Maintenance Fertilizer (all areas - 2x over first 3 years)	1.3	A/yr	1,500.00	$1,995
Maintenance Seeding (5% per year for first 3 yrs)	0.1	A/yr	2,000.00	$200
SUBTOTAL ANNUAL O&M COSTS				$3,795
O&M Administration			10%	$380
O&M Contingency			25%	$949
TOTAL ANNUAL O&M COSTS				**$5,123**
O&M COSTS NPV (5% rate of return over 20 years)				$13,952
TOTAL COSTS (NPV)				**$24,514**

TABLE A-25
DETAILED COST ESTIMATE
FLUVIAL MINE-WASTE DEPOSITS
REACH 4 - ALTERNATIVE 3

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Low & Moderate Priority Deposits				
All Terrain Vehicle	1	ea	5,500.00	$5,500
Direct revegetation (ATV access)				
seed/ fertilizer/ mulch	2	ac	3,000.00	$6,000
Lime application (ATV access)				
limerock (incl. loading)	150	ton	25.00	$3,750
deliver (50 mi one way)	150	ton	15.00	$2,250
spread lime	150	ton	50.00	$7,500
SUBTOTAL DIRECT CAPITAL COSTS				$25,000
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$2,500
Engineering/Administration Costs			10%	$2,500
Construction Management Costs			10%	$2,500
SUBTOTAL INDIRECT CAPITAL COSTS				$7,500
Contingency			25%	$8,125
TOTAL ESTIMATED CAPITAL COST				**$40,625**
ANNUAL OPERATION & MAINTENANCE COSTS				
Annual inspection & reporting (first 3 years only)	1	yr	1,600.00	$1,600
Maintenance Fertilizer (all areas - 2x over first 3 years)	1.3	A/yr	1,500.00	$1,995
Maintenance Seeding (5% per year for first 3 yrs)	0.1	A/yr	2,000.00	$200
SUBTOTAL ANNUAL O&M COSTS				$3,795
O&M Administration			10%	$380
O&M Contingency			25%	$949
TOTAL ANNUAL O&M COSTS				**$5,123**
O&M COSTS NPV (5% rate of return over 20 years)				$13,952
TOTAL COSTS (NPV)				**$54,577**

TABLE A-26
DETAILED COST ESTIMATE
IN-STREAM HABITAT/RIPARIAN AREAS
REACH 4 - ALTERNATIVE 2

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Riparian Area Isolation				
Fencing				
3 strand solar electric fence (incl. delivery/installation)	18600	lf	1.70	$31,620
20 yr conservation lease (approx 11 acres)	11	ac	350.00	$3,850
SUBTOTAL DIRECT CAPITAL COSTS				$35,470
INDIRECT CAPITAL COSTS				
Mob/Demob			10%	$3,547
Engineering/Administration Costs			10%	$3,547
Construction Management Costs			10%	$3,547
SUBTOTAL INDIRECT CAPITAL COSTS				$10,641
Contingency			25%	$11,528
TOTAL ESTIMATED CAPITAL COST				**$57,639**
ANNUAL OPERATION & MAINTENANCE COSTS				
Incremental Annual O&M Costs				
Inspection (every 5 years)	1	yr	1,600.00	$1,600
Fencing Maintenance (5% every 5th year)	930	lf	1.00	$930
SUBTOTAL ANNUAL O&M COSTS				$2,530
O&M Administration and Fees			10%	$253
O&M Contingency			25%	$633
TOTAL ANNUAL O&M COSTS				**$3,416**
O&M COSTS NPV (5% rate of return over 20 years)				$7,703
TOTAL COSTS (NPV)				**$65,342**