Planning and Community Development Department
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DEVIATION REQUEST AND DECISION FORM

Updated: 6/26/2019

PROJECT INFORMATION

Project Name :	Eagle Rising PCD File No. SP205 & SF2225
Schedule No.(s) :	52290-00-034 & 52290-00-035
Legal Description :	See Attached

APPLICANT INFORMATION

Company :	MyPad, Inc., General Partner, Casas Limited Partnership #4
Name :	Stephen J. Jacobs, Jr., President
	☒ Owner ☐ Consultant ☐ Contractor
Mailing Address :	P.O. Box 2076 Colorado Springs, CO 80901
Phone Number :	(719) 359-1473
FAX Number :	
Email Address :	striplejacobs@gmail.com

ENGINEER INFORMATION

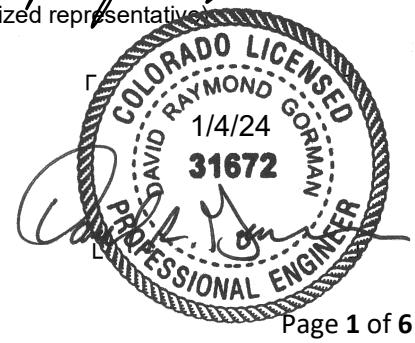
Company :	M.V.E., Inc.		
Name :	David Gorman	Colorado P.E. Number :	31672
Mailing Address :	1903 Lelaray St, Ste 200		
Phone Number :	(719) 635-5736		
FAX Number :			
Email Address :	daveg@mvecivil.com		

OWNER, APPLICANT, AND ENGINEER DECLARATION

To the best of my knowledge, the information on this application and all additional or supplemental documentation is true, factual and complete. I am fully aware that any misrepresentation of any information on this application may be grounds for denial. I have familiarized myself with the rules, regulations and procedures with respect to preparing and filing this application. I also understand that an incorrect submittal will be cause to have the project removed from the agenda of the Planning Commission, Board of County Commissioners and/or Board of Adjustment or delay review until corrections are made, and that any approval of this application is based on the representations made in the application and may be revoked on any breach of representation or condition(s) of approval.

Signature of owner (or authorized representative) _____ Date 1/5/24

Engineer's Seal, Signature And Date of Signature



DEVIATION REQUEST (Attach diagrams, figures, and other documentation to clarify request)

A deviation from the standards of or in Section(s) **ECM 3.3.3 B and C** of the Engineering Criteria Manual (ECM) is requested.

Identify the specific ECM standard which a deviation is requested:

ECM 3.3.3.B: Conformance with DCM Volume 1 Sections 6.5.2, Table 10-4 Channel Velocity,
Concrete, riprap, or soil cement linings as approved by the City/County shall be used where channel bottom velocities exceed 6.0 ft/sec. Grass lined channels shall not be used where velocity exceeds permissible velocities in Table 10-4, or the Froude number is greater than 0.9 for the 100-year storm.

DCM Volume 1 Sections 10.2.1 Soft Lined Channels
Grass lined channels are the preferred means of conveying storm water runoff because of their desirability from the standpoint of erosion protection, maintainability, accessibility, and aesthetics.
Grasses typically used for channel lining are Bermudagrass, Kentucky bluegrass, orchardgrass, redtop, Stalian ryegrass, and buffalograss.

ECM 3.3.3.C Channel Types
1. Soft-Lined Channels
2. Hard-Lined Channels

State the reason for the requested deviation:

Table 10-4 and DCM Volume 1 Section 10.2.1 do not include provisions or standards for the type of willow, sedge, rush and reed vegetation present in Cottonwood Creek within the project reach. Excellent stream stabilization exists within the subject reach of Cottonwood Creek consisting of mature dense vegetation (grasses, sedges, rushes, reeds, 6 species of willows, numerous shrubs and trees), pond embankments which support wetland vegetation and provide stormwater storage, and large boulder grade check and pond bank lining. For more than a decade, the owners, Entech Engineering, Inc. and ERO Resources Corporation consultants have observed and reported on the natural conditions of stream and riparian corridor within the site. All referenced parties want to preserve the creek in its existing stabilizing and well-vegetated state. See reports uploaded in Applicants submittal.

"Natural Channel" is not listed as a channel type in ECM 3.3.3.C
Other sections of the DCM refer to "natural channels" however it is not included as a channel type in the ECM standard.
In the DCM Open Channels and Structures 10.1 General Statement "Generally speaking, a stabilized natural channel, or the man-made channel which most nearly conforms to the character of a stabilized natural channel, is the most efficient and the most desirable."
DCM 2.2.1 Channelization "A stable natural channel reaches "equilibrium" over many years."

Explain the proposed alternative and compare to the ECM standards (May provide applicable regional or national standards used as basis):

Utilize the stabilizing value of the existing established pond embankments, existing willow vegetation and existing boulder placements as fully adequate stabilization and not require additional stabilization where hydraulic analysis indicates channel velocities are less than 6 fps, Froude Number values are lower than 1.0 in accordance with the criteria of DCM Section 6.5.2.

The Cottonwood Creek channel within the Eagle Rising Preliminary Plan contains two existing constructed ponds with stabilized embankments, existing boulder creek bed and pond embankment stabilization, and established dense willow growth that supports established wetlands which provide natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal. The two ponds constitute stabilizing features that provide the added benefits of controlling flow rates in the creek. Also, an important engineering consideration is that the slope of the creek for the project reach is insignificant at only 1% to 2% with an average of 1.2%. The existing pond spillway at DP 104 will require additional riprap installation at time of final plat as noted on the Drainage Plan to protect the spillway during severe storm water overflows from the pond to the downstream creek drainageway. The Spillway at DP 126 has adequate existing riprap in place. The ponds and creek bed have withstood repeated significantly sized rainfall events throughout decades of existence including the events of the 2015 500-year to 1000-year storms and the 2023 100-year storms.

The creek bed, wetland areas and riparian overstory of Cottonwood Creek throughout the site are well vegetated native grasses, shrubs and trees as illustrated by the photos contained in the appendix of this report. The Natural Resources Assessment by ERO Resources Corporation lists with botanic specificity the various plants found. The ERO report also contains photographic documentation of the plants and site conditions. Wetland areas feature native grasses such as Nebraska Sedge, Baltic Rush, Redtop and Broadleaf Cattail. The wetlands also contain mature, dense and well-established willows which serve to anchor the soil of the creek bed throughout the site. Specific willow species include Sandbar Willow, Greenleaf Willow, Peachleaf Willow, Strapleaf Willow, Park Willow and Shining Willow. The riparian overstory is described as containing Peachleaf Willow and Plains Cottonwood trees. Shrubs present in the riparian corridor through the site include Snowberry, Wood's Rose, Golden Current, and Chokecherry. All these species act together to preserve the existing creek alignment and grades that are observed at the site and documented by photographic evidence.

Explain the proposed alternative and compare to the ECM standards (May provide applicable regional or national standards used as basis):

Supplemental information concerning permissible velocities and permissible shear stresses for channel lining materials is included in the appendix. The information includes suggested permissible values for the native grasses, willows and trees that grow in the project reach. Live willow stakes are included and listed to have permissible velocities of 3 to 10 f/sec with permissible shear stress of 2.10 to 3.10 lbs/sf. However, the supplemental information assumes that the vegetation is newly planted, as in Reed Plantings, Hardwood Tree Plantings and Live Willow Stakes. In this case, the vegetative cover throughout the site is not plantings or stakes, but well established, robust, and dense cover that has served to stabilize the creek bed and banks for decades. The upper end (and beyond) of the permissible value range applies in this project reach.

The results of the hydraulic analysis contained in this report indicate four locations that exhibit channel flow velocities that approach or exceed 6 fps and/or have Froude Number values that equal or exceed 1.0. The affected locations include the pond emergency spillways which are protected with riprap as indicated on the Drainage Map. The presence of dense vegetation throughout the project reach serves to provide additional stabilization. The existing boulder structure, located upstream of the pond at DP 104 provides stabilization. Portions of the banks inside the DP 104 pond are lined with large boulders. The boulders have been in place for many years and are well embedded and incorporated into the creek terrain. No further improvements are needed in the creek assuming the existing vegetation is preserved. The vegetation is naturally occurring and has been in place for many years. During this time, it has survived various meteorologic cycles. Additionally, with the present level of development in the upstream watershed, the amount of runoff in this section of Cottonwood Creek is not likely to be altered in the future. Considering all these factors, the exiting vegetation is persistent and not in danger of failing. The owners will preserve the vegetation.

The allowances in Section 6.5.2 and Table 10-4 do not account for the types and condition of the vegetation present in the creek channel and are not applicable to this case. Furthermore, hydraulic analysis results for the channel reach comply with the provision of Section 6.5.2 except where expected at the armored pond spillways.

Alternative Information is provided in the form of attached Table 2 containing Permissible Velocity and Shear Stress values for Long Native Grasses, Hardwood Tree Plantings and Live Willow Stakes complete with a list of sources including documentation from U.S. Army Engineer Research and Development Center, U.S. Dept. of Transportation, Federal Highway Administration, and others.

The DCM provides that concrete, riprap, or soil cement linings as approved by the City/County shall be used where channel bottom velocities exceed 6.0 ft/sec. Grass lined channels shall not be used where velocity exceeds permissible velocities in Table 10-4 or the Froude number is greater than 0.9 for the 100-year storm. Table 10-4 does not account for the type of vegetation present in the creek throughout the project reach. Alternatively, M.V.E., Inc. recommends the allowable velocities for willow staking and native grasses as included in the Appendix of this report. Long Native Grasses have permissible velocities of 4 fps to 6 fps, while Live Willow Stakes have permissible velocities of up to 10 fps. Allowable Shear stresses are also noted in the cited sources of up to 3.10 lbs. per sf. Certain locations exceed 3.10 lbs. per sf. However, these locations also have velocities and Froude Number that complies with the DCM. Furthermore, the actual vegetation on the site is well established and exhibits dense growth. The existing plants possess stabilizing characteristics far beyond those of recent plant stakings. Although the hydraulic analysis of the creek reach indicates acceptable velocities in accordance with the DCM, except at pond spillways, a Deviation Request is submitted in support of the higher allowable velocities for the specific type of creek vegetation found at the site.

Natural well-established creeks typically don't require maintenance. The creek bed and banks within this subdivision are very well established with dense vegetation as detailed above. The owners **elect ECM 3.3.3.K.2.** This access alternative allows lot line easements to serve as access pathways and omits construction of 15’ wide access roads which would unnecessarily deface and destabilize the creekside and interfere with the use and enjoyment of the private residential lots. The 15’ access road may be omitted in recognition that the available corridors through the lot line easements are adequate with regard to available travel width and the traversable terrain. See the attached Creek Access Exhibit These access conditions meet the criteria and intent of ECM 3.3.3.K.2.

LIMITS OF CONSIDERATION

(At least one of the conditions listed below must be met for this deviation request to be considered.)

☒ The ECM standard is inapplicable to the particular situation.

☐ Topography, right-of-way, or other geographical conditions or impediments impose an undue hardship and an equivalent alternative that can accomplish the same design objective is available and does not compromise public safety or accessibility.

☒ A change to a standard is required to address a specific design or construction problem, and if not modified, the standard will impose an undue hardship on the applicant with little or no material benefit to the public.

Provide justification:

The allowances in Section 6.5.2 and Table 10-4 do not account for the types and condition of the vegetation present in the creek channel and are not applicable to this case. The supplemental information provided with this deviation request with allowable flow velocities and shear stresses are more closely applicable to the type of vegetation found within the subject creek reach and site. The results of hydraulic analysis using this appropriate supplemental engineering data show that all sections of the creek channel comply with the provision of Section 6.5.2. The two pond overflow spillways, as expected do not and are armored.

Furthermore the U.S. Army Core of Engineers has, after staff viewing if the site, recommended that the existing wetlands and natural channel and features not be disturbed, seeing no beneficial outcomes to further structural stabilization. The application of the requested data to this project will preserve the existing stabilizing vegetation and natural terrain for the benefit of the site, natural aesthetics, wildlife and future lot owners.

CRITERIA FOR APPROVAL

Per ECM section 5.8.7 the request for a deviation may be considered if the request is **not based exclusively on financial considerations**. The deviation must not be detrimental to public safety or surrounding property. The applicant must include supporting information demonstrating compliance with **all of the following criteria**:

The deviation will achieve the intended result with a comparable or superior design and quality of improvement.

The requested deviation preserves the existing terrain and vegetation, which provides the current natural stabilization of the creek bed and banks. Current structures on the creek include the two ponds and boulder placements. These were installed prior to the time of current ownership. The owners want to preserve the natural features of the existing riparian creek, wetlands and its wildlife. Furthermore, the owners do not wish to see the creek destabilized or the existing terrain, plantings, and natural beauty of the creek harmed or destroyed by the mechanized interventions required to install unnecessary, functionally inferior and maintenance intensive hard drainage structures.

The deviation will not adversely affect safety or operations.

The existing vegetation already fulfills all stabilization requirements for creek. The allowance of the deviation will not adversely affect safety or operations. Allowance of the deviation is superior to the level of stabilization available from other stabilization options.

The deviation will not adversely affect maintenance and its associated cost.

All observation and preservation of the creek and riparian corridor within the Drainage Easement will be undertaken by the owners and the Owners Association. The deviation will not adversely affect maintenance or maintenance costs.

It is understood that "Grass lined channels" are dependent upon continuous growth of "grass." As noted above, the native willow and other dense vegetation in place is significantly superior to grass and is already very well established. It is naturally occurring and has been in place for many decades. During this time, it has survived various meteorologic cycles from drought to overly wet seasons. Additionally, with the present level of development in the upstream watershed, the amount of runoff in this section of Cottonwood Creek is not likely to be altered in the future. Considering all these factors, the existing vegetation is vigorously persistent and not in danger of failing. The owners agree to continue to observe the waterway and to take appropriate steps to preserve the vegetation if its survival is threatened. No maintenance is anticipated, and no maintenance costs will be transferred to El Paso County.

The deviation will not adversely affect aesthetic appearance.

The natural aesthetic appearance of the site will remain intact and in place. Conversely, the engineering comment request for additional constructed stabilization would irreparably harm the site's biodynamic stability and aesthetic appearance.

The deviation meets the design intent and purpose of the ECM standards.

The supporting documentation provided in this deviation request and the MDDP/Preliminary Drainage Report shows that the existing vegetation has served and will serve as the required stabilization within the creek. The purpose of the ECM standard is met.

The deviation meets the control measure requirements of Part I.E.3 and Part I.E.4 of the County's MS4 permit, as applicable.

-The proposed deviation request meets the control measure requirements specified by the County's MS4 Permit.
- The allowance of this deviation will avoid and prevent disturbance of the creek bed and banks and therefore prevent erosion and sedimentation within the creek.
- Stormwater quality treatment for the development site will be provided as required.
- Appropriate stormwater control measures will be implemented for any land disturbance as required in accordance with an approved Grading and Erosion Control Plan.

REVIEW AND RECOMMENDATION:

Approved by the ECM Administrator
This request has been determined to have met the criteria for approval. A deviation from Section _____ of the ECM is hereby granted based on the justification provided.

Denied by the ECM Administrator
This request has been determined not to have met criteria for approval. A deviation from Section _____ of the ECM is hereby denied.

ECM ADMINISTRATOR COMMENTS/CONDITIONS:

1.1. PURPOSE

The purpose of this resource is to provide a form for documenting the findings and decision by the ECM Administrator concerning a deviation request. The form is used to document the review and decision concerning a requested deviation. The request and decision concerning each deviation from a specific section of the ECM shall be recorded on a separate form.

1.2. BACKGROUND

A deviation is a critical aspect of the review process and needs to be documented to ensure that the deviations granted are applied to a specific development application in conformance with the criteria for approval and that the action is documented as such requests can point to potential needed revisions to the ECM.

1.3. APPLICABLE STATUTES AND REGULATIONS

Section 5.8 of the ECM establishes a mechanism whereby an engineering design standard can be modified when if strictly adhered to, would cause unnecessary hardship or unsafe design because of topographical or other conditions particular to the site, and that a departure may be made without destroying the intent of such provision.

1.4. APPLICABILITY

All provisions of the ECM are subject to deviation by the ECM Administrator provided that one of the following conditions is met:

- The ECM standard is inapplicable to a particular situation.
- Topography, right-of-way, or other geographical conditions or impediments impose an undue hardship on the applicant, and an equivalent alternative that can accomplish the same design objective is available and does not compromise public safety or accessibility.
- A change to a standard is required to address a specific design or construction problem, and if not modified, the standard will impose an undue hardship on the applicant with little or no material benefit to the public.

1.5. TECHNICAL GUIDANCE

The review shall ensure all criteria for approval are adequately considered and that justification for the deviation is properly documented.

1.6. LIMITS OF APPROVAL

Whether a request for deviation is approved as proposed or with conditions, the approval is for project-specific use and shall not constitute a precedent or general deviation from these Standards.

1.7. REVIEW FEES

A Deviation Review Fee shall be paid in full at the time of submission of a request for deviation. The fee for Deviation Review shall be as determined by resolution of the BoCC.

NORTH PORTION – (10195 KURIE ROAD)

LEGAL DESCRIPTION:

THAT PORTION OF SECTION 29, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M., EL PASO COUNTY, COLORADO DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF THE NORTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER OF SAID SECTION 29, SAID POINT BEING ON THE SOUTHERLY BOUNDARY OF PARK FOREST ESTATES FILING NO 2 (PLAT BOOK B-2 AT PAGE 52); THENCE S 00° 13'40"E ON THE WEST LINE OF THE EAST HALF OF SAID SECTION 29, A DISTANCE OF 1413.98 FEET TO THE TRUE POINT OF BEGINNING; THENCE N 00° 13'40"W, 1413.98 FEET; THENCE N89˚14'16"E, ON THE SOUTHERLY BOUNDARY OF SAID PARK FOREST ESTATES, A DISTANCE OF 375.32 FEET TO THE SOUTHEAST CORNER OF LOT 14, BLOCK 18 OF SAID PARK FOREST ESTATES; THENCE N89˚13'46"E ALONG SAID SOUTHERLY BOUNDARY, A DISTANCE OF 60.00 FEET TO THE EAST LINE OF KURIE ROAD; THENCE N89˚33'17"E ALONG SAID SOUTHERLY BOUNDARY, A DISTANCE OF 237.50 FEET; THENCE N89˚20'43"E ALONG SAID SOUTHERLY BOUNDARY, A DISTANCE OF 149.96 FEET; THENCE S00˚39'26"E, DEPARTING SAID SOUTHERLY BOUNDARY OF PARK FOREST ESTATES, A DISTANCE OF 231.57 FEET; THENCE S43˚12'03"E, A DISTANCE OF 433.08 FEET; THENCE S43˚12'03"E, A DISTANCE OF 56.61 FEET; THENCE N88˚33'24"E, A DISTANCE OF 0.10 FEET TO THE NORTHWEST CORNER OF LOT 1 POCO SUBDIVISION ACCORDING TO THE TO THE OFFICIAL MAP THEREOF FILED IN THE OFFICE OF THE COUNTY RECORDER OF EL PASO COUNTY, COLORADO, AS RECEPTION NO. 2406425; THENCE SOUTHERLY ALONG THE WESTERLY LINE OF SAID LOT 1 THE FOLLOWING SIX (6) COURSES:

S16˚04'20"E, 158.01 FEET;
S02˚43'41"W, 265.73 FEET:
N84˚46'48"W, 71.67 FEET;
S00˚11'34"W, 147.46 FEET;
N88˚32'26"E, 150.00 FEET;
S01˚27'34"E, 275.63 FEET;

THENCE S89˚45'28"W DEPARTING SAID WESTERLY LINE OF SAID LOT 1, A DISTANCE OF 766.08 FEET; THENCE N00˚14'32"W, 100.00 FEET; THENCE S89˚45'28"W, 152.00 FEET; THENCE S00˚14'32"E, 200.00 FEET; THENCE S89˚45'28"W, 152.00 FEET; THENCE N00˚14'32"W, 100.00 FEET; THENCE S89˚45'28"W, 201.18 FEET TO A POINT ON SAID WEST LINE OF THE EAST HALF OF SAID SECTION 29, SAID POINT BEING THE TRUE POINT OF BEGINNING.

DESCRIPTION PREPARED BY:
M & S CIVIL CONSULTANTS, INC.
102 EAST PIKES PEAK AVE. STE.306
COLORADO SPRINGS, COLORADO

SOUTH PORTION –(10115 KURIE ROAD)

LEGAL DESCRIPTION:

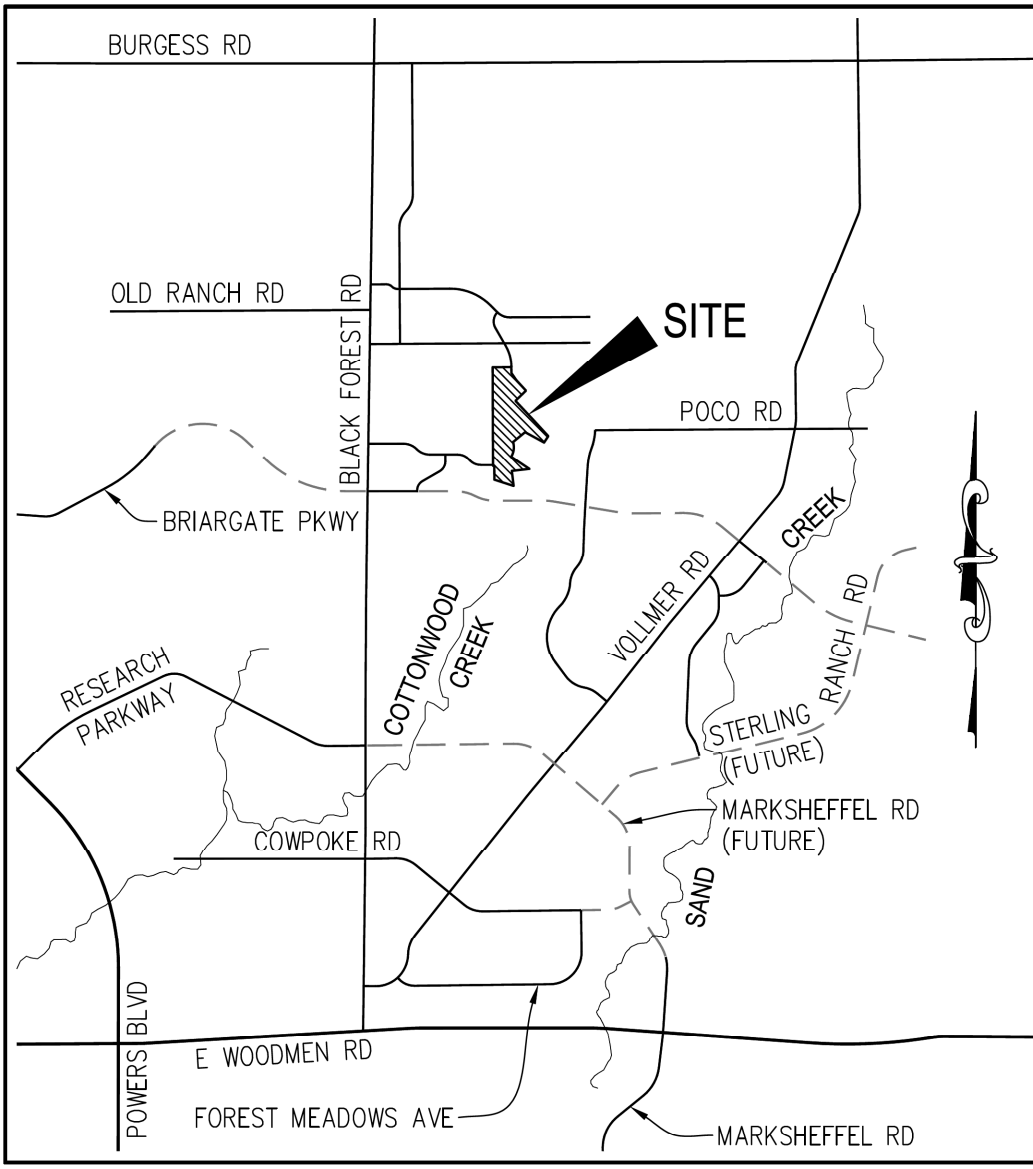
THAT PORTION OF SECTION 29, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M., EL PASO COUNTY, COLORADO, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF THE NORTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER OF SAID SECTION 29, SAID POINT BEING ON THE SOUTHERLY BOUNDARY OF PARK FOREST ESTATES FILING NO. 2 (PLAT BOOK B-2 AT PAGE 52), THENCE N89˚14'16"E, ON THE SOUTHERLY BOUNDARY OF SAID PARK FOREST ESTATES, A DISTANCE OF 375.32 FEET TO THE SOUTHEAST CORNER OF LOT 14, BLOCK 18 OF SAID PARK FOREST ESTATES; THENCE N89˚13'46"E ALONG SAID SOUTHERLY BOUNDARY, A DISTANCE OF 60.00 FEET TO THE EAST LINE OF KURIE ROAD; THENCE N89˚33'17"E ALONG SAID SOUTHERLY BOUNDARY, A DISTANCE OF 237.50 FEET; THENCE N89˚20'43"E ALONG SAID SOUTHERLY BOUNDARY, A DISTANCE OF 149.96 FEET; THENCE S00˚39'26"E, DEPARTING SAIDSOUTHERLY BOUNDARY OF PARK FOREST ESTATES, A DISTANCE OF 231.57 FEET; THENCE S43˚12'03"E, A DISTANCE OF 433.08 FEET; THENCE S43˚12'03"E, A DISTANCE OF 56.61 FEET; THENCE N88˚33'24"E, A DISTANCE OF 0.10 FEET TO THE NORTHWEST CORNER OF LOT 1 POCO SUBDIVISION ACCORDING TO THE TO THE OFFICIAL MAP THEREOF FILED IN THE OFFICE OF THE COUNTY RECORDER OF EL PASO COUNTY, COLORADO, AS RECEPTION NO. 2406425; THENCE SOUTHERLY ALONG THE WESTERLY LINE OF SAID LOT 1 THE FOLLOWING SIX (6) COURSES:

S16˚04'20"E, 158.01 FEET;
S02˚43'41"W, 265.73 FEET:
N84˚46'48"W, 71.67 FEET;
S00˚11'34"W, 147.46 FEET;
N88˚32'26"E, 150.00 FEET;

S01˚27'34"E, A DISTANCE OF 275.63 FEET TO THE TRUE POINT OF BEGINNING; THENCE S01˚27'34"E, A DISTANCE OF 178.87 FEET; THENCE S34˚54'56"W, A DISTANCE OF 563.22 FEET; THENCE S00˚00'00"E, A DISTANCE OF 344.55 FEET; THENCE N90˚00'00"E, A DISTANCE OF 87.56 FEET; THENCE S00˚00'00"E, A DISTANCE OF 459.65 FEET; THENCE S89˚59'26"W, A DISTANCE OF 1035.05 FEET TO A POINT ON THE WEST LINE OF THE EAST HALF OF SAID SECTION 29; THENCE N00˚13'40"W, ALONG SAID WEST LINE, A DISTANCE OF 1439.98 FEET TO A POINT WHICH IS DRAWN S 89° 45'28" W FROM THE POINT OF BEGINNING; THENCE N 89˚45'28"E, A DISTANCE OF 201.18 FEET; THENCE S00˚14'32"E, 100.00FEET; THENCE N89˚45'28"E, 152.00 FEET; THENCE N00˚14'32"W, 200.00 FEET; THENCE N89˚45'28"E, 152.00 FEET; THENCE S00˚14'32"E, 100.00 FEET; THENCE N89˚45'28"E, 766.08 FEET, MORE OR LESS TO THE TRUE POINT OF BEGINNING.

DESCRIPTION PREPARED BY:
M & S CIVIL CONSULTANTS, INC.
102 EAST PIKES PEAK AVE. STE 306
COLORADO SPRINGS, COLORADO
80903



VICINITY MAP

N.T.S.

Table 2. Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
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USACE TR EL 97-8

Eagle Rising Hydraulic Analsyis Results

Velocity, Froude Number & Shear Stress at Selected Channel Sections

Hydraulic Data from HEC-RAS Analysis, M.V.E., Inc.

Shear Stress $\tau = \gamma RS$

Froude No. $Fr = \frac{V}{\sqrt{gD}}$

τ = Shear Stress (Lbs/sf)

γ = Weight Density of Water (lb/cf) = 62.4

R = Hydraulic Radius = Area/Wetted Perimeter (ft)

S = Energy Grade Slope (ft/ft)

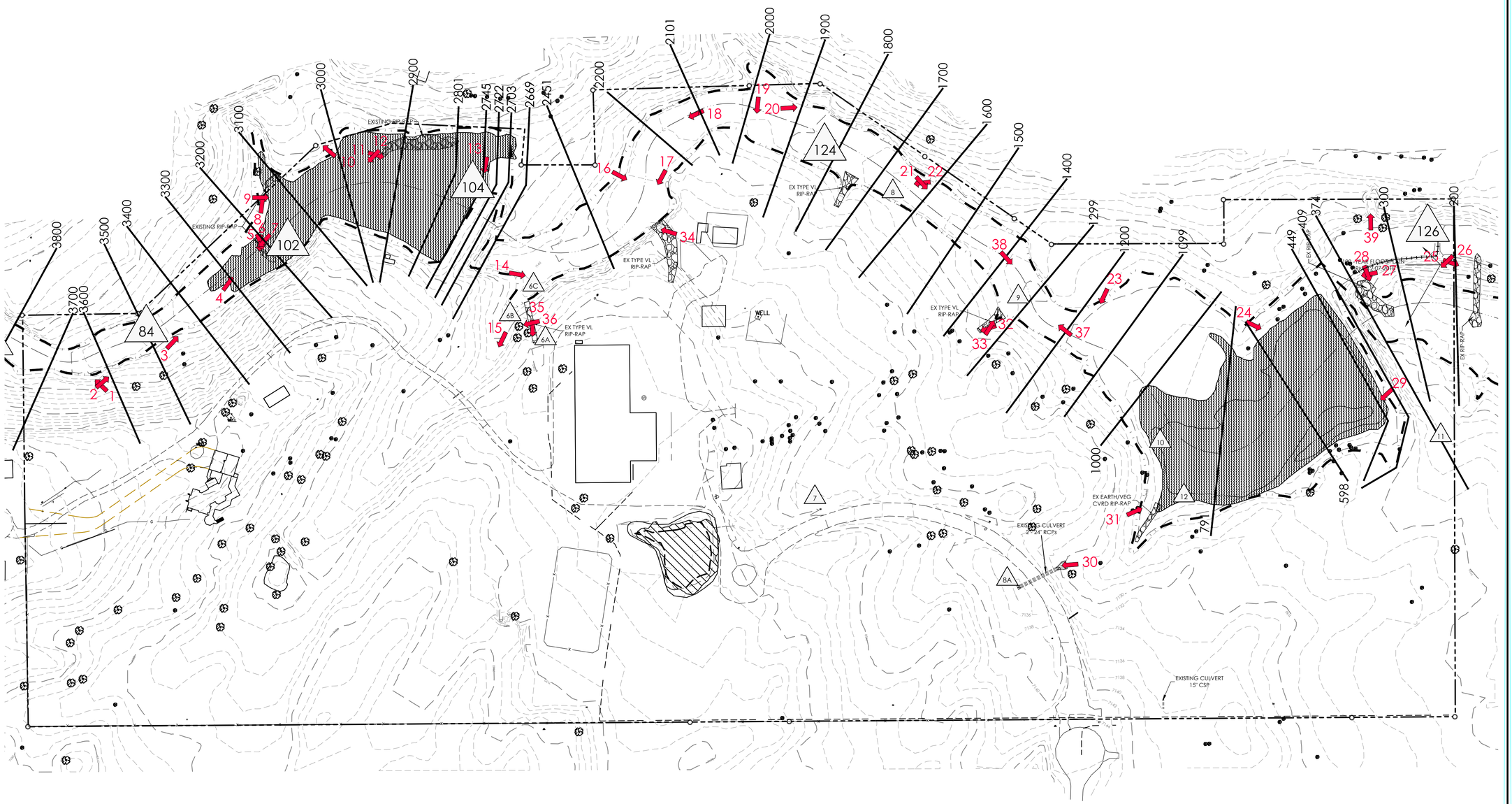
V = Channel Velocity (ft/sec)

D = Hydr Depth = Flow Area / Top Width

g = Accereration of gravity = 32.2 ft/sec^2

Channel Section	Q100 (cfs)	S Energy Slope (ft/ft)	Max Channel Depth (ft)	D Hydraulic (Ave) Depth (ft)	P Wetted Perimeter (ft)	R Hydraulic Radius R (ft)	A Flow Area (sf)	W Top Width (ft)	V Channel Velocity (ft/sec)	Fr Froude No.	τ Shear Stress (lbs/sf)	Notes:
3800	410	0.013	3.3	2.5	72	2.5	180	71	2.3	0.25	1.98	dense vegetation existing
3700	410	0.026	3.5	2.5	49	2.4	119	48	3.3	0.37	3.98	dense vegetation existing
3600	410	0.007	4.1	3.1	73	3.1	222	72	1.9	0.19	1.26	dense vegetation existing
3500	470	0.079	3.0	2.2	71	2.1	152	70	3.1	0.38	10.52	dense vegetation existing
3400	470	0.010	3.3	2.5	88	2.5	223	88	2.1	0.23	1.58	dense vegetation existing
3300	470	0.011	2.5	1.9	95	1.9	184	94	2.6	0.32	1.34	dense vegetation existing
3200	470	0.008	2.1	1.5	115	1.5	175	115	2.7	0.39	0.79	boulder check existing
3100	470	0.001	3.5	2.2	210	2.2	464	210	1.0	0.12	0.10	native grasses and pond existing
3000	560	0.001	3.7	2.9	188	2.9	536	187	1.1	0.11	0.10	native grasses and pond existing
2900	560	0.000	5.4	3.7	223	3.6	814	223	0.7	0.06	0.04	native grasses and pond existing
2801	560	0.000	6.9	5.0	278	4.9	1372	277	0.4	0.03	0.01	native grasses and pond existing
2745	700	0.005	2.1	1.2	303	1.2	354	303	2.2	0.36	0.37	native grasses and pond existing
2722	700	0.018	1.7	1.4	139	1.4	190	139	3.7	0.56	1.56	native grasses and pond existing
2703	700	0.057	1.8	1.0	122	1.0	123	122	6.1	1.06	3.62	spillway riprap proposed
2669	700	0.036	3.0	1.6	65	1.6	106	64	7.9	1.09	3.66	spillway riprap proposed
2451	700	0.015	3.7	2.4	125	2.4	295	124	2.4	0.27	2.25	dense vegetation existing
2200	700	0.013	3.2	2.7	115	2.7	311	114	2.3	0.24	2.23	dense vegetation existing
2101	750	0.024	3.4	2.9	84	2.8	238	83	3.2	0.33	4.22	dense vegetation existing
2000	750	0.011	3.9	2.2	144	2.2	318	144	2.2	0.27	1.48	dense vegetation existing
1900	820	0.020	3.4	2.5	117	2.5	291	116	2.8	0.31	3.19	dense vegetation existing
1800	820	0.012	3.9	3.2	107	3.2	340	106	2.4	0.24	2.33	dense vegetation existing
1700	820	0.018	3.4	3.0	100	3.0	298	99	2.8	0.28	3.26	dense vegetation existing
1600	820	0.010	5.1	3.7	85	3.6	309	84	2.7	0.25	2.33	dense vegetation existing
1500	820	0.026	4.6	3.1	80	3.1	244	79	3.4	0.34	5.01	dense vegetation existing
1400	820	0.035	4.6	2.5	129	2.4	315	128	2.6	0.30	5.34	dense vegetation existing
1299	820	0.005	4.4	3.5	105	3.5	369	104	2.2	0.21	1.19	dense vegetation existing
1200	820	0.036	3.1	1.6	113	1.6	183	113	4.5	0.62	3.64	dense vegetation existing
1099	820	0.005	1.9	1.5	243	1.5	375	243	2.3	0.32	0.51	native grass existing
1000	820	0.000	4.9	3.3	293	3.3	963	293	1.0	0.10	0.06	native grasses and pond existing
791	820	0.000	6.9	5.3	393	5.3	2092	392	0.4	0.03	0.01	native grasses and pond existing
598	820	0.000	9.0	6.4	321	6.4	2045	320	0.5	0.03	0.01	native grasses and pond existing
449	820	0.000	4.9	4.0	409	4.0	1626	409	0.5	0.05	0.02	native grasses and pond existing
409	820	0.059	2.9	1.8	62	1.7	108	62	7.6	1.01	6.42	spillway riprap
374	820	0.062	1.8	1.5	77	1.5	116	77	7.0	1.01	5.82	spillway riprap
300	820	0.003	3.7	2.7	121	2.7	326	121	2.6	0.28	0.55	dense vegetation existing
200	820	0.008	3.3	2.5	157	2.5	391	156	1.8	0.20	1.19	dense vegetation existing
100	820	0.050	1.6	1.5	184	1.5	282	183	2.9	0.42	4.77	dense vegetation existing

HEC-RAS Cross Section Location and Photo Key Map

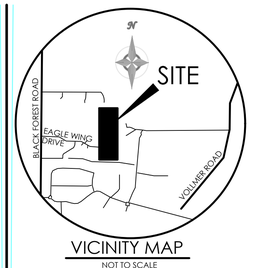


LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING

- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR
- 104 — DBPS DESIGN POINT
- 6C — LOCAL DESIGN POINT
- 14 — DRAINAGE REPORT PHOTO NUMBER / DIRECTION



VICINITY MAP
NOT TO SCALE

BENCHMARK

N

10 0 50 100 200
1" = 100' 1:1,200

MVE, INC.
ENGINEERS, SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY ____ _____
AS-BUILTS BY
CHECKED BY ____ _____

EAGLE RISING
FILING NO.1

STREAM VEGETATION
PHOTO LOCATIONS

MVE PROJECT 61145
MVE DRAWING DRN-MAP-HECRAS

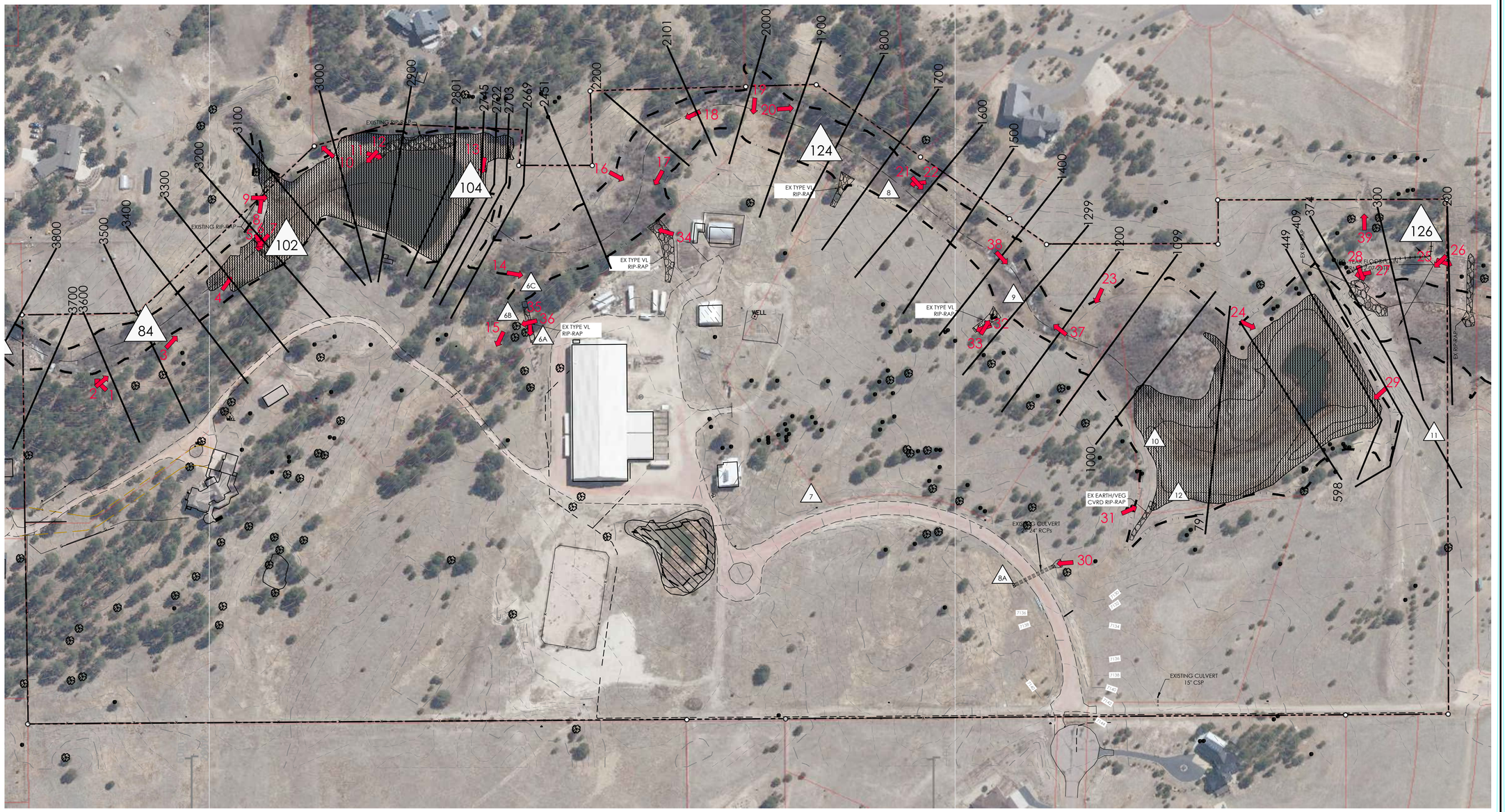
OCTOBER 31, 2023
SHEET 1 OF 1

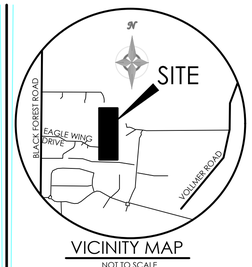
LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR
- 104 DBPS DESIGN POINT
- 6C LOCAL DESIGN POINT
- 14 DRAINAGE REPORT PHOTO NUMBER / DIRECTION





VICINITY MAP
NOT TO SCALE

BENCHMARK

N

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1" = 100' 1:200

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ENGINEERS / SURVEYORS
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DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

EAGLE RISING
FILING NO.1

STREAM VEGETATION PHOTO LOCATIONS

MVE PROJECT 61145
MVE DRAWING DRN-MAP-HECRAS

OCTOBER 31, 2023
SHEET 1 OF 1

1

Looking downstream, from 250 feet downstream of Cottonwood Creek DBPS Design Point 82.

September 27, 2022

2

Looking upstream, from 250 feet downstream of Cottonwood Creek DBPS Design Point 82.

September 27, 2022

3

Looking upstream, from Cottonwood Creek DBPS Design Point 84.

September 27, 2022

4

Looking downstream, from 200 feet downstream of Cottonwood Creek DBPS Design Point 84.

September 27, 2022

5

Looking upstream, from Cottonwood Creek DBPS Design Point 102.

September 27, 2022

6

Looking upstream, from Cottonwood Creek DBPS Design Point 102.

September 27, 2022

7

Looking upstream, from Cottonwood Creek DBPS Design Point 102.

September 27, 2022

8

Looking upstream tributary stream, from Cottonwood Creek DBPS Design Point 102.

September 27, 2022

9

Looking downstream, from Cottonwood Creek DBPS Design Point 102.

September 27, 2022

10

Looking northeast, from 100 feet downstream of Cottonwood Creek DBPS Design Point 102.

September 27, 2022

11

Looking downstream, from 200 feet downstream of Cottonwood Creek DBPS Design Point 102. Emergency spillway on left corner of pond.

September 27, 2022

12

Looking upstream, from 200 feet downstream of Cottonwood Creek DBPS Design Point 102.

September 27, 2022

13

Buried and partially buried riprap at emergency overflow, from Cottonwood Creek DBPS Design Point 104.

September 27, 2022

14

Looking at heavy vegetation downstream, from Design Point 6C.

September 27, 2022

15

Looking at riprap upstream tributary flow, from Design Point 6B.

September 27, 2022

16

Looking southwest across stream, from 450 feet downstream of Cottonwood Creek DBPS Design Point 104.

September 27, 2022

17

Looking up stream, from 450 feet downstream of Cottonwood Creek DBPS Design Point 104.

September 27, 2022

18

Looking upstream, from 300 feet upstream of Cottonwood Creek DBPS Design Point 124.

September 27, 2022

19

Looking west across channel, from 100 feet upstream of Cottonwood Creek DBPS Design Point 124.

September 27, 2022

20

Looking downstream at the upper banks, from 100 feet upstream of Cottonwood Creek DBPS Design Point 124.

September 27, 2022

21

Looking upstream, from Design Point 8.

September 27, 2022

22

Looking downstream, from Design Point 8.

September 27, 2022

23

On the east side of the creek looking west, from 200 feet downstream of Design Point 9.

September 27, 2022

24

Looking southwest towards pond embankment, from 400 feet downstream of Design Point 10.

September 27, 2022

25

Looking downstream towards offsite pond and riprap, from Cottonwood Creek DBPS Design Point 126.

September 27, 2022

26

Looking upstream, from Cottonwood Creek DBPS Design Point 126.

September 27, 2022

27

Looking upstream towards riprap for emergency overflow, from east bank 550 feet downstream of Design Point 10.

September 27, 2022

28

Looking across channel, from east bank 550 feet downstream of Design Point 10.

September 27, 2022

29

Looking upstream, from the west bank 500 feet downstream of Design Point 10.

September 27, 2022

30

Looking north at culverts, on the east side of the road from 100 feet south of Design Point 8A.

September 27, 2022

31

Riprap lining downstream from DP8A, from 100 feet north of Design Point 12.

September 27, 2022

32

Looking northwest up tributary stream, from 100 feet northwest of Design Point 9.

September 27, 2022

33

Looking east, on west bank of creek, from 100 feet northwest of Design Point 9.

September 27, 2022

34

Riprap lined swale from barn area to creek, in need of additional riprap, from 450 feet downstream of Cottonwood Creek DBPS Design Point 104.

September 27, 2022

35

Looking west, existing riprap lined swale in need of additional riprap from Design Point 6A.

September 27, 2022

36

Looking at riprap on tributary flow upstream of DP6B, from Design Point 6A.

September 27, 2022

37

Looking northeast from the centerline of the creek at HECRAS Station 1200.

December 11, 2023

38

Looking southwest from the centerline of the creek at HECRAS Station 1400.

December 11, 2023

39

Looking east at east property line at approximately HECRAS station 300.

December 11, 2023

LEGEND

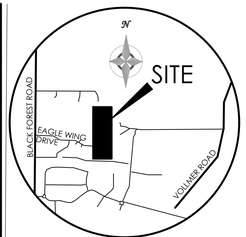
- PROPERTY LINE
- EASEMENT LINE
- NBL — NO BUILD LIMIT LINE
- LOT LINE

EXISTING

- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR

PROPOSED

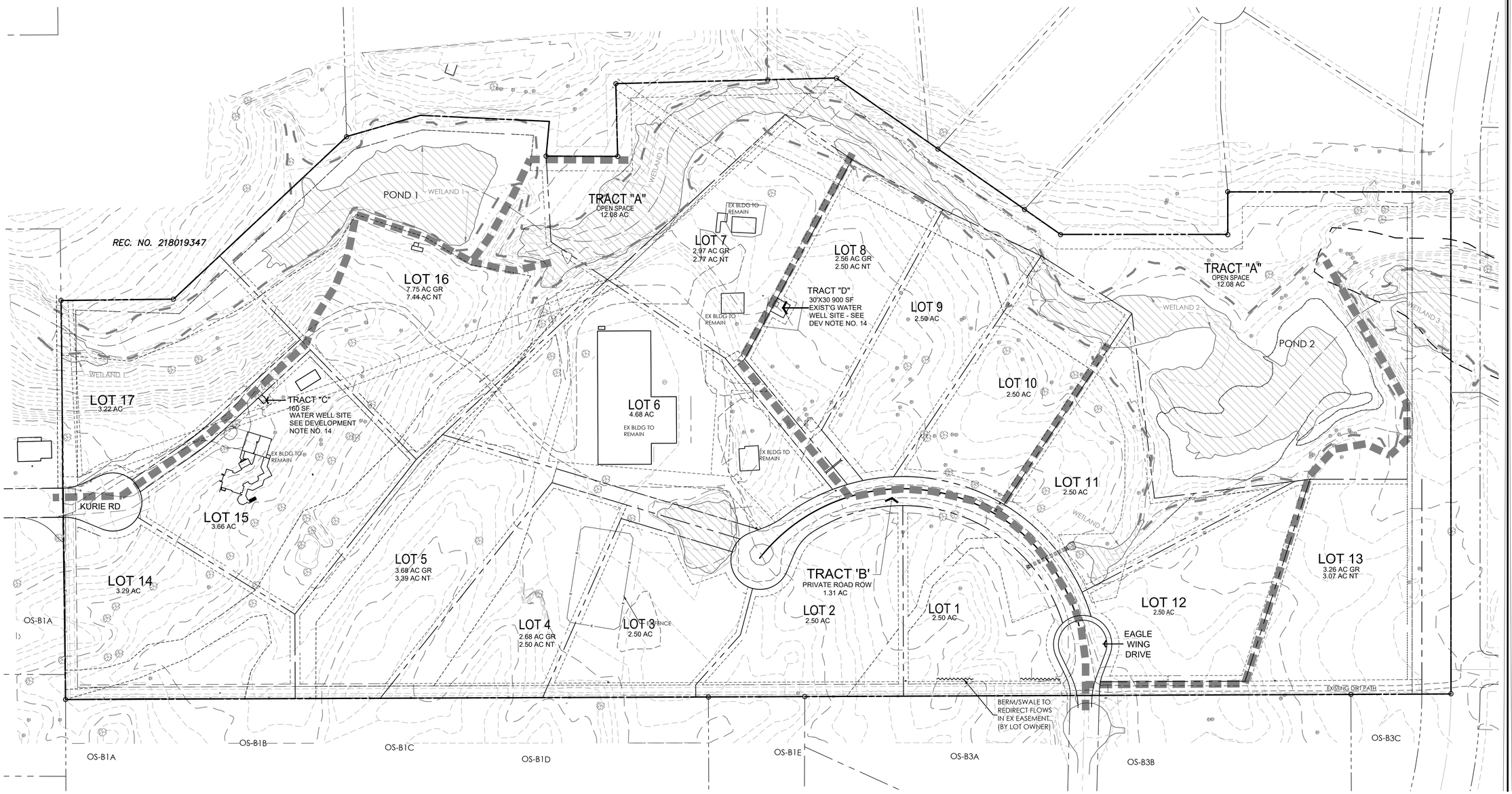
- 5985 — INDEX CONTOUR
- 84 — INTERMEDIATE CONTOUR
- 100 YEAR STORM WATER FLOOD LEVEL
- POSSIBLE ACCESS PATH



VICINITY MAP

NOT TO SCALE

BENCHMARK



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1" = 100' 1:1,200

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REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

EAGLE RISING
PRELIMINARY PLAN

CREEK ACCESS

EXHIBIT

MVE PROJECT 61145

MVE DRAWING DRN-MAP-DEV

DECEMBER 12, 2023

SHEET 1 OF 1

Path: P:\22_100\22_113 Eagle Rising 2022 NRA\Maps\2023\NRA\22_113 Figure 3.mxd

Eagle Rising 2022 Natural Resources Assessment

- Culvert
- Open Water
- Wetland
- Construction/Disturbance Limit
- Project Area Boundary

Image Source: Maxar Technologies©, October 14, 2022

0 120 240 Feet

N

Figure 3
Proposed Subdivision

Prepared for: Steve Jacobs
File: 22_113 Figure 3.mxd (GS)
August 25, 2023

ERO Resources Corp.

be impacted by development of the project area and to identify any significant changes in natural resources since the assessment conducted in 2012.

The project area has been continually influenced by human activities for more than 100 years. Timber was a major industry in the Black Forest in the late 1800's with numerous lumber mills scattered through the area. Grazing and agriculture dominated the land use in the early 1900's, eventually giving way to summer homes, and full-time residences (El Paso County Land Use Department 1987).

Methods

During the 2022 site visits, ERO conducted an updated natural resources assessment of the project area. In addition to the information gathered during the 2022 site visits, natural resource information was obtained from existing databases and sources such as aerial photography, the Colorado Natural Diversity Information Source (NDIS), U.S. Fish and Wildlife Service (Service) National Wetlands Inventory database, U.S. Geological Survey (USGS) National Hydrography Dataset (NHD), and other sources ("Google, Inc." 2022; Natural Diversity Information Source 2021; U.S. Fish and Wildlife Service, n.d.; U.S. Geological Survey 2022). Based on the information gathered from existing sources and the initial site visit, ERO verified existing vegetation communities and identified important wildlife attributes of the project area.

Project Area Description

The National Land Cover Database maps five land cover types in the project area (U.S. Geological Survey 2016). Grassland/Herbaceous is the most dominant and occurs throughout the majority of the western portion of the project area. The other land cover types in the project area include evergreen forest, scrub/shrub, open water, and barren land.

The project area is on the southern edge of the Black Forest, northeast of Colorado Springs (Figure 1). Vegetation in the project area consists of upland grasslands, patches of ponderosa pine (*Pinus ponderosa*) and upland shrubs, and wetland/riparian vegetation along drainages. Three tributaries to Cottonwood Creek converge at the eastern project area boundary. In the project area, Cottonwood Creek generally flows from north to south and primarily consists of wetlands throughout the channel (Figure 2; Photos 5a through 7a, 5b, 6b). Two ponds (Ponds 1 and 2) occur along Cottonwood Creek in the project area that are contained behind earthen dams (Photos 1a through 4a). As a result of water rights negotiations and drought, the wetlands along Cottonwood Creek and the two ponds were drier in 2022 than what was observed in 2012 (Photos 1b through 4b). A third pond (Pond 3), that was excavated in uplands occurs in the west, central portion of the project area (Figure 2; Photos 6a and 6b)). Wetlands occur in the channel and on benches and terraces along Cottonwood Creek and as small fringes along the ponds. A depressional area and swale consisting of wetland vegetation (Wetland 4) occurs downstream of a culvert in the project area northwest of Pond 2 (Figure 2). Wetlands in the project area are dominated by Nebraska sedge (*Carex nebrascensis*), Baltic rush (*Juncus balticus*), redtop (*Agrostis gigantea*), broadleaf cattail (*Typha angustifolia*), sandbar willow (*Salix exigua*), strapleaf willow

(*Salix ligulifolia*), park willow (*Salix monticola*), and shining willow (*Salix lucida* subsp. *caudata*). The riparian overstory along Cottonwood Creek is dominated by peachleaf willow (*Salix amygdaloides*) and plains cottonwood (*Populus deltoides* subsp. *monilifera*) trees. Upland shrubs in the riparian corridor include snowberry (*Symphoricarpos occidentalis*), Woods' rose (*Rosa woodsii*), golden currant (*Ribes aureum*), and chokecherry (*Padus virginiana*) (Photo 10). The soils in the project area primarily consist of Pring coarse sandy loam, 3 to 8 percent slopes (Natural Resources Conservation Service 2022).

The project area is one of the last remaining nonresidential tracts of land along Cottonwood Creek. Rural residential development (2- to 5-acre lots) surrounds the entire project area. Two existing homes are located in the northwest corner of the project area and a large barn, corral, and disturbed area occurs in the north-central portion of the project area (Photo 8a). The uplands in the project area are a mixture of native grassland and disturbed areas (Photos 9a and 9b). The project area has historically been used for cattle grazing, and some limited grazing continues in the southeast corner of the project area. The native upland areas are dominated by blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), threeawn (*Aristida* sp.), soapweed yucca (*Yucca glauca*), Canada wildrye (*Elymus canadensis*), intermediate wheatgrass (*Thinopyrum intermedium*), sideoats grama (*Bouteloua curtipendula*), muhly (*Muhlenbergia* sp.), and ponderosa pine (Photos 9a and 9b). The disturbed uplands are dominated by smooth brome (*Bromus inermis*), diffuse knapweed (*Centaurea diffusa*), Canada thistle (*Cirsium arvensis*), musk thistle (*Carduus nutans*), common mullein (*Verbascum thapsus*), common teasel (*Dipsacus fullonum*), and kochia (*Bassia scopara*).

Conclusions

On behalf of the project proponent, ERO is requesting an approved JD for the old stock pond and upland vegetated swale in the northeastern portion of the project area, Pond 3 and associated Wetland 5, and Wetland 4. Based on the information in this report, if the Corps determines that the wetlands and waters are not jurisdictional, ERO would appreciate a written determination of this request confirming that no further consultation under Section 404 is required.

If you have any questions or need additional information, please do not hesitate to contact me at 303-830-1188 or by email at cmarne@eroresources.com. I look forward to hearing from you.

Sincerely,

Courtney Marne
Biologist/Associate

cc: David Jones - Land Resource Associates
Stephen Jacobs - MyPad, Inc.

Attachments: Figures 1 and 2; Photo Log; Routine Wetland Determination Forms; JD Form

References

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Photo 1a - Cottonwood Creek at the southern boundary of the project area. View is to the south.

Photo 1b - Cottonwood Creek at the southern boundary of the project area. View is to the south.

Photo 2a - Wetlands along Cottonwood Creek in the project area. View is to the south.

Photo 2b - Wetlands along Cottonwood Creek in the project area. View is to the south.

Photo 3a - Pond 1 in the project area. View is to the east.

Photo 3b - Immediately upstream of Pond 1 in the project area. View is to the east.

Photo 4a - Pond 2 in the project area.
View is to the northwest.

Photo 4b - Pond 2 in the project area.
View is to the northwest.

Photo 5a - Vegetated swale upstream of Cottonwood Creek in the project area. View is to the northwest.

Photo 5b - Vegetated swale upstream of Cottonwood Creek in the project area. View is to the northwest.

Photo 6a - Pond 3 in the project area.
View is to the northwest.

Photo 6b - Pond 3 and associate Wetland 5 in the project area.
View is to the northwest.

Photo 7a - Wetland 9 in the project area.
View is to the southeast.

No photo taken in 2022

Photo 7b - Wetland 9 in the project area.
View is to the southeast.

Photo 8a- Disturbed uplands and barn in the project area.
View is to the northeast.

No photo taken in 2022

Photo 8b - Disturbed uplands and barn in the project area.
View is to the northeast.

Photo 9a - Native uplands in the project area.
View is to the northeast.

Photo 9b - Native uplands in the project area.
View is to the northeast.

Photo 10a - Riparian corridor in the project area.
View is to the southeast.

Photo 10b - Riparian corridor in the project area.
View is to the southeast.

Publication indicating the utilization of willow for stream stabilization

Colorado State Parks

COLORADO STATE PARKS STEWARDSHIP PRESCRIPTION

Date Created: April 10, 2002
Revised: April 1, 2005
Author: Mindy Wheeler
Parks Affected: Most

Cottonwood and Willow Management Stewardship Rx

Narrowleaf cottonwoods in autumn along the Yampa River

Significance of cottonwoods and willows in the riparian community

In the arid West, rivers and streams and associated riparian vegetation communities create extraordinarily diverse and lush ecosystems in an otherwise waterless landscape. Cottonwoods (*Populus* spp) and willows (*Salix* spp) are signature species of most healthy riparian ecosystems. Natural hydrology of streams and rivers has created ecosystems well adapted to periodic flooding and slow recession of floodwaters. Floodwaters carve out a plethora of habitats to be used by a variety of plant, bird, mammal and fish species. The combination of readily available water, rich soils and variety of habitats make riparian areas the lifeblood of the American West. These unique ecosystems support exceptionally high biodiversity, primary productivity and critical wildlife habitat. As an example, it has been reported that although riparian areas comprise only about 1% of the land area, they partially support up to 80% of the animals present in the area (Chaney et al 1990).

These numerous positive characteristics of riparian areas have also been the origin of the decline of cottonwoods and willows. Riparian areas and floodplains are very desirable areas for farming, grazing, and recreation and help provide precious water to a growing human population in the West. It has been estimated that greater than 80% of bottomland cottonwood forests have been lost as a result of changing land use practices and the altered hydrology that results from dams and water diversions (Smith et al., 1991). In riparian ecosystems, the loss of cottonwoods has catastrophic consequences. Wildlife habitat is lost, the forest canopy is lost, and the forest understory dies.

The primary goal of this prescription is to inform state park managers and staff how to best manage viable cottonwood and willow stands, how to encourage their natural recruitment (as conditions allow), and give information on the latest methods on planting and maintaining these species. Specifically, this prescription will address:

- Cottonwood and willow life history traits and ecology
- Reasons for the decline of bottomland forests
- Conservation, management and creation of cottonwood and willow stands
- Alternatives to cottonwoods for revegetation projects
- Common afflictions of cottonwoods and willows and how to address them

Once a full understanding of these processes is reached, creative methods may be used to mimic nature in order to experience better success with cottonwood and willow recruitment, establishment, development and maintenance.

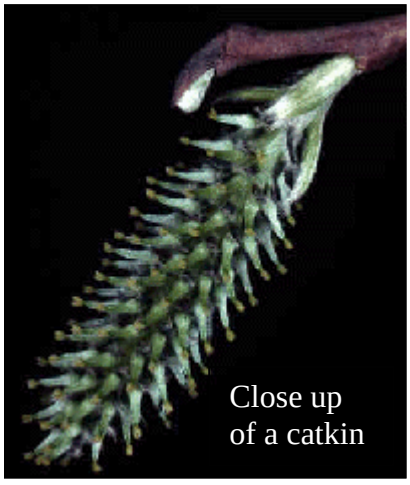
Distribution and life history traits of cottonwood and willow

DISTRIBUTION

The prairie cottonwood (*Populus deltoides*) generally occurs on the eastern plains of Colorado and on the river bottoms of the western slope, while narrowleaf cottonwood (*P. angustifolia*) occurs chiefly in the higher elevation riparian areas of the mountains. Each species also overlaps the other in their distribution.

Willow species are generally distributed along elevation and soil moisture gradients. Although over 35 species of willows occur in the state of Colorado, a handful of willows are recognized for their wide distribution. Peachleaf willow (*Salix amygdaloides*) chiefly inhabits water courses and ditches on the Front Range, but is also occasionally found on the West slope. ***Coyote willow (S. exigua***) is widespread in the lower elevations of the state, and decreases in abundance over 9,200 feet elevation. Coyote willow has the highest tolerance of alkaline and saline conditions, and also withstands periods of drought. Other species with wide distribution and commonly used in revegetation projects include mountain willow (*S. monticola*), and planeleaf willow (*S. planifolia*). Both cottonwoods and willows are known to cross-breed within their genera.

Since different species of cottonwoods and willows grow in various soil types, elevations and moisture gradients, it is almost certain that ecophysiological differences exist between the species inhabiting foothills, mountain valleys and prairie rivers. Mitigation or restoration projects must be adjusted to correspond with the specific type of river system involved.


Close up of a catkin

LIFE HISTORY TRAITS

Sexual reproduction

Sexual reproduction of cottonwoods and willows begins with the production of ‘flowers’ in the spring, usually before the leaves appear. The ‘flowers’ are called catkins (see photo), characterized by having no petals and only male or female parts. Each tree or shrub is also unisexual, possessing only male or female catkins. The pollen produced from the male catkins fertilizes the female flowers within 24 hours after pollination. The seed then matures over a period of 3 to 6 weeks. Both cottonwoods and willows are prolific seed producers. Some cottonwood seeds will remain viable for up to 5 weeks if it stays dry, however, as soon as the seed becomes moistened, the seed viability is shortened to 2-3 days. Willow seeds generally remain viable for up to 1 week

after dispersal. Although seeds are produced every year, successful establishment of cottonwoods may naturally occur once every 2 – 10 years. Cottonwoods reach sexual maturity between 5 and 10 years of age, whereas willows reach sexual maturity between 2 and 10 years.

Photo of the multitude of seeds produced by cottonwoods in the spring

Asexual reproduction

Cottonwoods and willows can also reproduce asexually as they will produce suckers from stumps,root crowns and from cuttings of stems. Sprouting is encouraged when an aboveground stem is broken or destroyed by cutting or flooding. This is done when branch and stem fragments regenerate by forming adventitious roots (if they remain moist), or when portions of stems root naturally if they are buried in moist soil. This clonal reproduction can sometimes be the dominant form of reproduction in a cottonwood or willow stand. Suckering occurs most commonly in middle-aged trees and declines in older trees (Read 1958). This clonal reproduction provides a gradation of tree sizes and increases forest structure, but also decreases the genetic diversity of the stand.

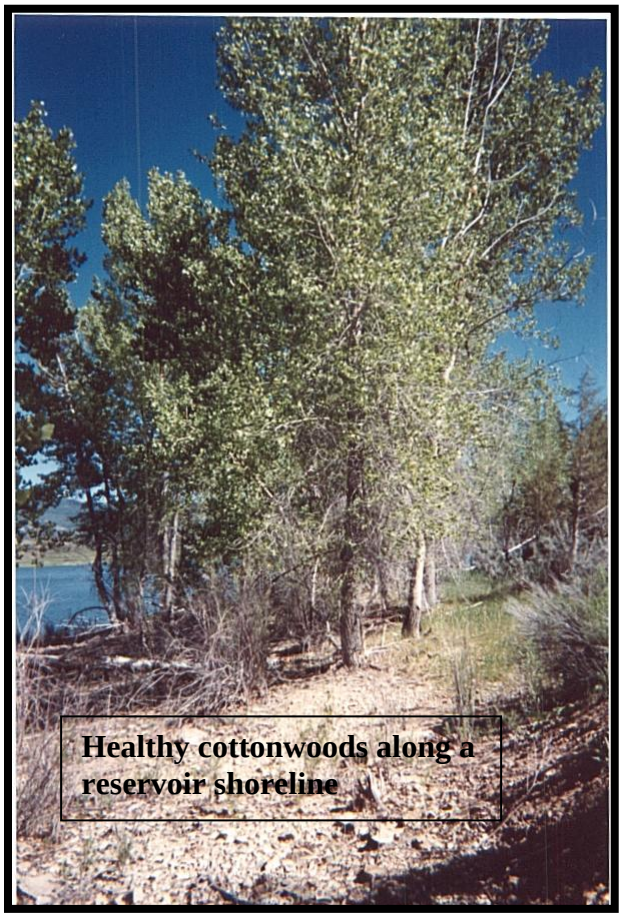
Suckering- A new shoot that is produced from the root or lower part of a stem

ECOLOGY

Cottonwoods and willows are highly dependent upon the hydrology with which they evolved. Streams and rivers flood freely across the floodplain each spring from heavy snowmelt. The large volume of fast moving water scours the streambeds and streambanks and deposits the sediment downstream to form banks of barren mineral soil. These deposits of moist, bare soil are ideal seedbeds for the millions of seeds being produced by cottonwoods and willows. Seed production is strategically timed to coincide with receding flood waters. As

flood waters slowly recede through the summer months, surface soil moisture becomes scarce. At this time, it is critical for the roots of the seedling to be able to follow the dropping water table down into the soil profile since seedlings are especially susceptible to drought. Essential conditions for cottonwood seedling establishment and survival occur at specific streambank elevations. The elevation must be high enough for protection from winter ice scouring and spring flooding, but not so high as to prevent root growth to the declining water table. This chain of events produces distinct bands of even-aged cottonwoods that mirror the historic stream channel along the river valley.

If the roots of the seedling reach a reliable source of water, escape ice scouring events or subsequent floods, a cottonwood can grow at a rate of up to 6-12 feet annually when it is young (FEIS).



Healthy cottonwoods along a reservoir shoreline

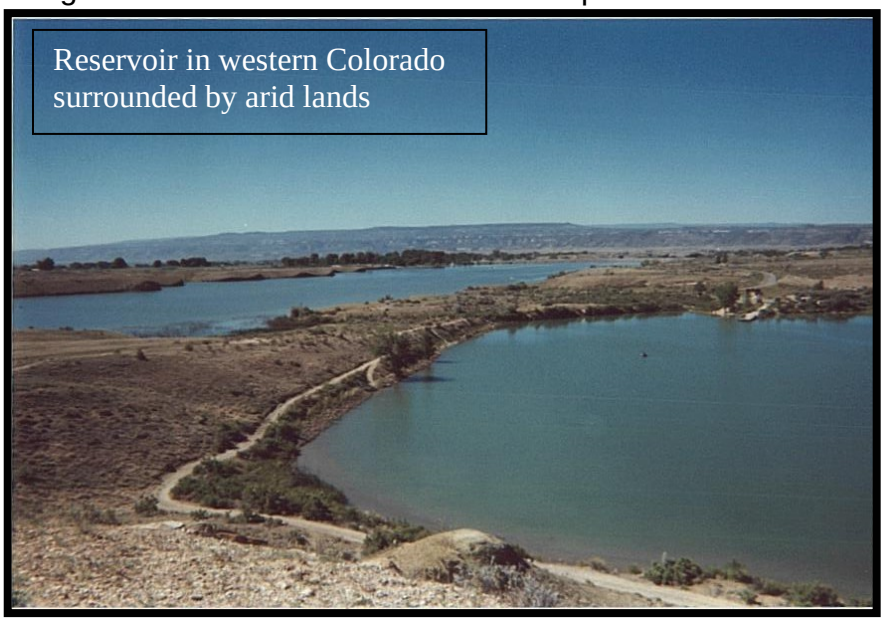
As colonizers of barren alluvial soil where abundant sunlight and moisture is readily available, cottonwoods and some willows are considered a fast growing pioneer species. However, certain species of willows are also considered a climax community. Planeleaf willow and Drummonds willow (*S. drummondiana*) are examples of willow stands considered as high seral (climax) communities.

Cottonwood and willow decline

WATER REGULATION

Increased human population in the arid West has put many strains on riparian ecosystems. Water has become a revered resource in the arid West as dams and water diversions are the rule within watersheds rather than the exception. Water management has seriously altered traditional hydrological processes by reducing peak flows, altering discharges, and decreasing suspended sediment loads. As a result, flood waters rarely possess the energy to transport and deposit sediment along the streambanks, and future seed beds (sediment) remain trapped under reservoir waters. More importantly, high downstream water demands in the summer coincides with a critical need for water for cottonwood and willow seedlings. Water is diverted to parched agricultural fields or thirsty human population centers instead of nurturing seedlings through the hot dry summer. Abrupt drops in the water table during the summer have been found to be extremely detrimental to cottonwood and willow saplings. (Kranjcec et al 1998, Rood et al 1995).

Water regulation has also caused channelization of water ways. Streams are no longer able to meander across the floodplain because the stream is so deeply incised. Water tables subsequently drop and riparian vegetation communities can no longer survive in the drier conditions.



Reservoir in western Colorado surrounded by arid lands

INCREASED SALINITY LEVELS AND PRESENCE OF NON-NATIVES

In addition to altered hydrology conditions, increased salinity levels in some riparian soils and increased presence of non-native species have also created a difficult challenge for cottonwood and willow establishment and survival.

Elevated salinity levels result in part from repeated irrigation and evaporation of agricultural fields. Salt-laden irrigation water evaporates and leaves the solutes behind on the soil surface. Unfortunately, increased salts favor invasive exotic species often found in riparian areas. Tamarisk (*Tamarix ramosissima*), or salt cedar, and Russian olive (*Eleagnus angustifolia*) are more tolerant of these increased saline conditions than cottonwoods and willows. Salt cedar exudes salt from their leaves as a mechanism to tolerate high salinity levels. This exacerbates the salt level in the soil and renders the soil inhospitable for native species.

Tamarisk along a river bank

Moreover, both Russian olives and tamarisk use more water than their native counterparts, which tends to dry up small streams and riparian areas by lowering water tables further. Oddly enough, these invasive species can withstand the dry conditions as well. Drier riparian areas are also more susceptible to fire. Unfortunately, tamarisk can withstand fire whereas cottonwoods are very intolerant of burning. Given the conditions under which cottonwoods, willows, tamarisk and Russian olives thrive and the conditions present in many riparian areas, the decline of cottonwoods and willows has been severe, yet inevitable.

LAND USE PRACTICES

Grazing and farming have also had a negative impact on riparian areas. Many areas have been cleared of woody vegetation to increase crop production. Streambanks become unstable when the strong woody roots of cottonwoods and willows are removed as they become more susceptible to premature sloughing and undercutting. In addition, livestock will browse cottonwood and willow seedlings heavily, and livestock trampling can cause undue soil compaction that can injure or prematurely kill seedlings.

Conservation, management and creation of cottonwood and willow stands

Ideally, the preservation and long-term management of cottonwoods and willows would revolve around the restoration of the natural regeneration processes of these species. Since bottomland forest decline can be primarily attributed to water management, it would be ideal to restore the natural hydrologic and geomorphic processes. However, the multiple uses of water in the west likely precludes the prospect that dams and water diversions shall be managed primarily for riparian ecology rather than agriculture and drinking water. Nevertheless, steps can be taken to restore some critical aspects of riparian ecology.

SITE AND PROJECT ASSESSMENT

Each potential riparian restoration project varies in site physical and ecological characteristics, scale, scope, and objectives. Careful analysis of the landscape (geomorphic valley from, stream type and vegetation community type) should take place before any restoration plans are drawn to verify the feasibility of the project as a whole. Details on these classifications can be found in Rosgen, D.L. 1985 and Carlson et al 1992. If these characteristics are found to be favorable, further investigation into the site should include:

- Depth to the water table throughout the year
- Hydrology data
    - Flood frequency data
    - Stream flow velocity estimates
    - Channel width, depth and shape at both high and low flow conditions
    - Sediment load
    - Water quality
- Soil texture
- Native vegetation community

These data will aid in setting realistic goals and objectives as well as assist with all aspects of the project, from drawing plans for channel recontouring to figuring irrigation requirements. If all options are realized and carefully studied, greater success of riparian restoration shall follow.

Measurement of channel incision
courtesy of Aquatic and Wetland Company

It is also important to assure that a cottonwood and willow management plan becomes a permanent feature of the overall park plan. The combination of the relatively short life expectancy of cottonwoods (under 100 years) and altered hydrology regimes points toward a perpetual maintenance program involving periodic plantings.

PROSPECTS FOR MANAGEMENT, RESTORATION AND MAINTENANCE

A brief description of each management option is given, followed by benefits and possible obstacles of each option. ***It is possible and most likely preferable to employ aspects of each option to create a site-specific riparian restoration plan.***

Before ground is broken for any restoration project, it is essential to remove invasive exotics.
If noxious weed control is not part of the restoration plan, the project is almost certain to fail as weeds tend to increase almost exponentially in disturbed areas. For further information on methods to remove Russian olive and salt cedar, please see the appendices of this prescription. Canada thistle (Breea arvense) and Russian knapweed (Acroptilon repens) are other noxious weeds common in disturbed riparian areas and also should be controlled before, during and after all riparian restoration projects.

OPTION: Restore the natural hydrology and regeneration processes within the riparian ecosystems.

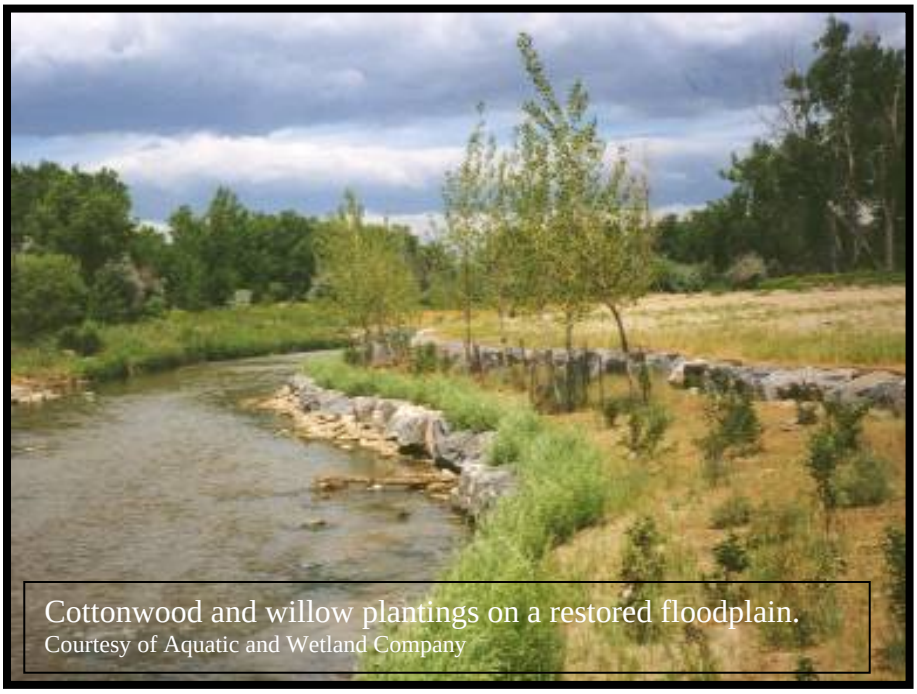
Description: Large scale riparian restoration projects have been known to purchase water rights or work with a local water authority to guarantee the hydrology needed to maintain a self sustaining cottonwood and willow ecosystem. Spring floods are allowed to carry and deposit sediment to its adjacent floodplain, and old oxbows are reconnected to the river to create backwater habitats. The restoration of these processes and habitats serves to release floodwaters slowly over the summer so cottonwoods and willows do not experience deadly dehydration.

Benefit: Restoring a hydrological regime that recreates historical flows has potential to create a self-sustaining native bottomland forest. This in turn will create a plethora of habitats for wildlife, birds and fish.

Possible obstacle(s): This option is likely very expensive- if even possible- to gain water rights or sufficient water. Most riparian restoration, mitigation or management projects do not have the budget to carry out such large-scale operations.

OPTION: Reconnect the stream with its floodplain.

Description: Many stream channels have become excessively incised as a result of water management. Channelized streams are often accompanied by deeper riparian water tables that compound drought mortality. To hydrologically reconnect streams and adjacent floodplains, create gentle slopes alongside streams or reservoirs and plant willows and/or cottonwoods. (see 'Wattles' and 'Live staking' in the appendix)



Cottonwood and willow plantings on a restored floodplain.
Courtesy of Aquatic and Wetland Company

Benefit: The new growth will ultimately be able absorb and then slowly release the flood waters to mimic the hydrology of an intact riparian ecosystem. This will also serve to hold the soil in place

to slow any accelerated erosion.

Possible obstacle(s): Careful analysis of stream flows, channel shape and other characteristics is essential to ensure this option is feasible. High velocity streams may need extra erosion control measures to be installed or deeply incised streams may require an impractically lengthy slope to be created to reconnect the stream and the floodplain.

OPTION: Establish new stands of cottonwoods and willows.

Background: Stands can be established from either nursery grown seedlings 'live staking' (see appendix). It is preferable to plant nursery grown seedlings from seeds collected from the site, but may not always be possible. Nursery grown seedlings also have the potential to increase genetic diversity within the site and have generally shown to have a lower mortality rate than live staking, but are more expensive. Seedlings will also require longer periods of watering and care.

Benefits: Assuming a good supply of cottonwood and/or willow stakes can be found, this can be the most successful and the least expensive method available to grow cottonwoods and willows. It is imperative to plan for appropriate irrigation, and if needed, fencing around the trees for protection from beaver to ensure survival of the stakes.

Possible obstacle(s): Willow stakes need to be in direct contact with the water table or a high rate of mortality will ensue. Cottonwoods will need supplemental irrigation (up to 3 years) until the roots reach the ground water. Perpetuation of planted restored riparian forests may require a maintenance program involving periodic plantings.

OPTION: Encourage suckering from established cottonwoods and willows

Background: Both cottonwoods and willows can be encouraged to grow additional shoots by scarification (abrasion to the roots). Cottonwood and willow stands can be induced to enhance density and age-class distribution, thus improving forest structure. Middle-aged cottonwoods are most likely to sprout from roots. Because new shoots are very palatable to livestock, it is extremely important to keep livestock out of the project area for 2-3 years after the area is scarified.

Benefits: This method will promote a cottonwood or willow stand that has a greater age-class distribution and thus improved forest structure and function.

Possible obstacle(s): Genetic diversity will not be improved with this management method. The disturbance may encourage weed invasions

SIGNS OF STRESSED COTTONWOODS AND WILLOWS AND COMMON AFFLICTIONS

Although mature cottonwood trees have large taproots, water can still be elusive in drought years. Primary indications of drought stress include reduced leaf size, premature leaf loss, and crown dieback (Tyree et al 1994). Prolonged periods of environmental stress such as drought can weaken trees and increase their susceptibility to disease and insect pathogens. The key to disease and pest-fee trees is to maintain its vigor. Any signs of stress should be noted and addressed.

Although plant vigor will help prevent disease and insect pathogens, it is not a guarantee. The appendix contains a list of common afflictions of cottonwoods and willows, noticeable symptoms, and actions to take to maintain a healthy tree or shrub.

Alternative trees for floodplain areas if hydrology will not support cottonwoods

- **Box elder** (*Acer negundo*)- a medium sized, short lived (20-40 years) deciduous tree that grows to 45 feet tall in optimal conditions.

- **Peachleaf willow** (*Salix amygdaloides*) Large deciduous tree growing up to 45 feet in height. Most common along water courses and ditches on the Front Range and Plains, occasionally on the Western slope.

- **Single leaf ash** (*Fraxinus anomala*) A tall deciduous shrub to small tree up to 20 feet in height. Occur naturally in xeric canyons and slopes along water courses and ephemeral drainages. This plant will need to be pruned consistently if it is to take the shape of a tree.

- **Western water birch** (*Betula occidentalis*) This is a fast growing multi-stemmed tree that grows up to 30 feet in height. It occurs naturally near mountain streams and meadows.

- **Hackberry** (*Celtis reticulata*) This deciduous tree grows up to 30 feet high and has bright green saw tooth elm-like leaves. It grows naturally on dry, rocky hillsides and canyon bottoms and is excellent for wildlife and reclamation.

- **Buffaloberry** (*Sheperdia argentea*) Medium sized deciduous shrub to small tree up to 25 feet in height. Naturally occurs at 4500-7500 feet elevation. Good for somewhat saline sites. Only the female plant produces fruit, so a pollinating plant is necessary. This plant will need continuous pruning to encourage a tree shape.

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Methods for planting and maintaining cottonwood and willow

LIVE STAKING

Definition: Live stake planting involves the insertion of live, cottonwood or willow cuttings into the ground in a manner that allows the cutting (stake) to take root and grow.

Purpose: Live stakes are the easiest and cheapest way to get new cottonwoods and willows into the riparian ecosystem. Live stakes will also create a root mat that stabilizes the soil by reinforcing and binding soil particles together.

Construction Specifications:

- Use on-site reconnaisance to identify plant species, growth form, soil and site conditions on the restoration/ construction site as well as on adjacent sites and compare their conditions. Greater success has been experienced with restoration projects that mimic characteristics of nearby sites. For project feasibility, examine the characteristics of the watershed in which the project is to be completed. This includes analyzing the geomorphic valley form, stream type and vegetation community type. Should these characteristics be favorable to a restoration project, further assessments should take place including the depth of the water table, soil texture, the typical hydrology of the site (peak flows, low flows, flood frequency, flow velocity estimates, water quality, channel shape), and identify and remove problematic non-native species such as tamarisk and Russian olive before beginning the restoration project. Details on removal of tamarisk and Russian olive are included in the appendix of this prescription.

Harvesting:

- Stakes shall be harvested and planted when the willows or cottonwoods are dormant. This period is generally from late fall to early spring, or before the buds start to break.
- When harvesting cuttings, select healthy, live wood that is reasonably straight.
- Use live wood at least 1 year old or older. Avoid suckers of current years growth as they lack sufficient stored energy reserves to sprout consistently. The best wood is 2-5 years old with smooth bark that is not deeply furrowed.
- Make clean cuts with unsplit ends. Trim branches from cutting as close as possible. It is best to cut the butt end so it is pointed or angled and the top end is cut square.
- Identification of the top and bottom of cutting is done by angle cutting the butt end. The top, square cut, can be painted and sealed by dipping the top 1-2 inches into a 50-50 mix of light colored latex paint and water. Sealing the top of stake will reduce the possibility of desiccation and disease caused mortality, assures the stakes are planted with the top up, and makes the stakes more visible for subsequent plantings.

Diameter:

- Cuttings should generally be 1/2 inch or larger depending on the species. Highest survival rates are obtained from using cuttings 2-3 inches in diameter.

Length:

- Cuttings of small diameter (up to 1 1/2 inches) should be 18 inches long minimum. Thicker cuttings should be longer.
- Cuttings should be long enough to reach into the mid-summer water table, if possible.
- No less than 1/2 total length must be into the ground.
- Stakes should be cut so that a terminal bud scar is within 1-4 inches (25-101 mm) of the top. At least 2 buds and/or bud scars shall be above the ground after planting.

Installation:

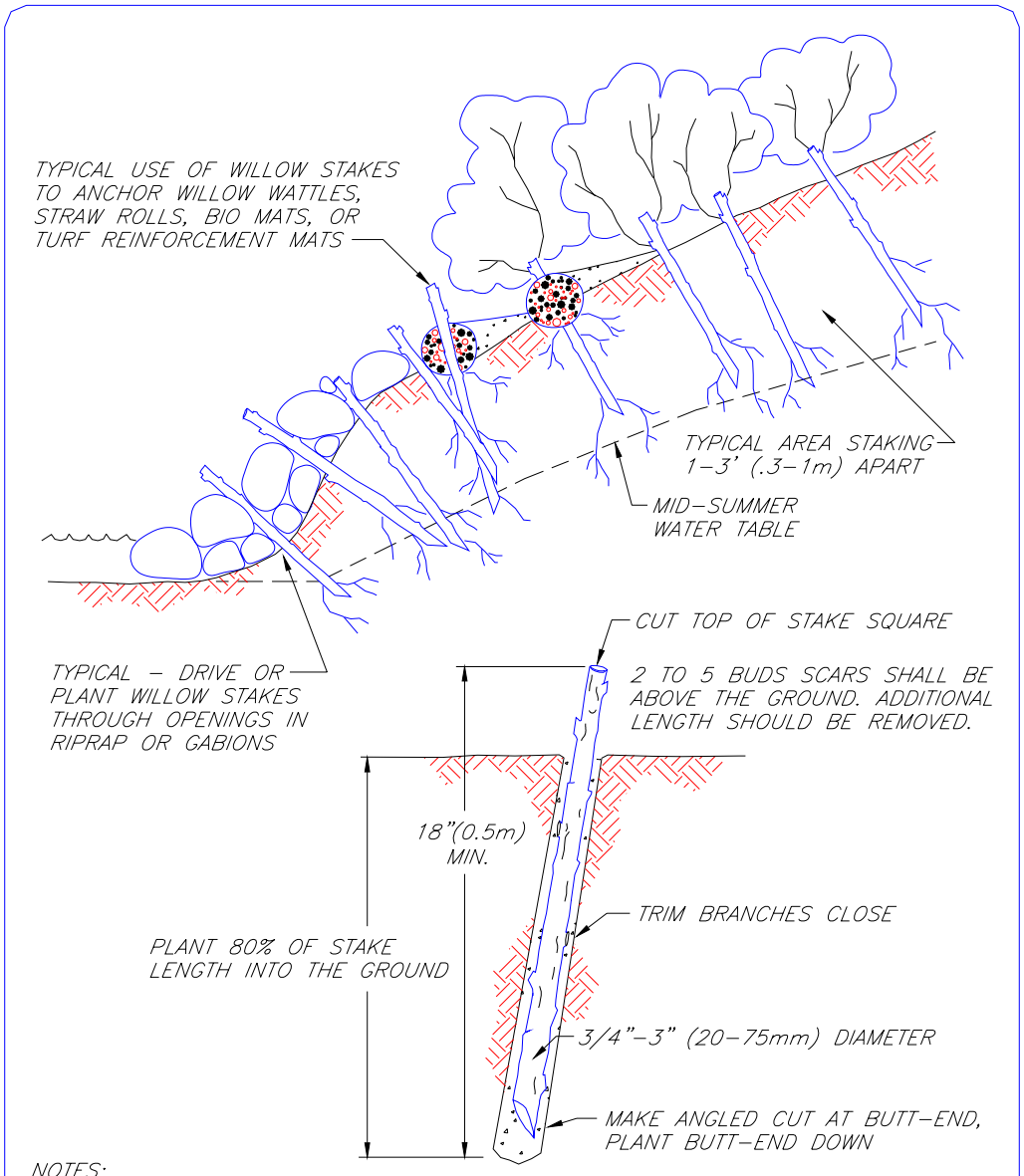
- Stakes must be planted with butt-ends into the ground. Leaf bud scars or emerging buds will point up.
- Soil must be moist to wet when planting stakes.
- Stakes must not be allowed to dry out. All cuttings should be soaked in water for a minimum of 24 hours. Soaking significantly increases the survival rate of the cuttings, however they may be planted the same day they are harvested.
- Plant stakes 1-3 feet apart and 3-4 stakes per hole to improve the survival rate.
- Set the stake as deep as possible into the soil, preferably with 80 percent of its length into the soil and in contact with mid-summer water table.
- It is essential to have good contact between the stake and soil for roots to sprout. Tamp the soil around the cutting.
- Use an iron stake or bar to make a pilot hole in firm soil. A 'stinger' (a bulldozer with a large rod attached to the front) is recommended to create deep, small diameter holes for difficult plantings.
- Do not damage the buds, strip the bark or split the stake during installation.
- Split or damaged stakes should not be used.
- Construct a 4 foot high chicken wire fence around the stakes or trunks of new plantings to prevent beaver herbivory or unwanted human intervention.

Aftercare:

- The amount and frequency of irrigation required will depend on the species planted, depth to the water table and soil texture. It is recommended that stakes be deeply watered at least once a week until the roots reach the groundwater. Cottonwood roots need sufficient water, but they also need sufficient oxygen to their roots. Total inundation for extended periods of time can be injurious to young cottonwoods. When cottonwoods reach the groundwater, a noticeable increase in leaf size occurs, and the rate of growth also increases noticeably. Coyote willow (*Salix exigua*) is surprisingly tolerant of changing water conditions.

- Consistent monitoring of the plantings for the first year is recommended to control invasive species to reduce competition, to ensure a higher rate of survival as fences may need fixing or stakes may need more water.

- As trees/ shrubs get older, watch for signs of drought stress such as crown dieback, reduced leaf size, and premature leaf loss. Prune injured or diseased limbs using sanitized equipment so as to not spread infection.



NOTES:
1. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
2. USE HEALTHY, STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION, USE A PILOT BAR IN FIRM SOILS.
4. SOAK CUTTINGS FOR 24 HOURS (MIN.) PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.

NOT TO SCALE

LIVE STAKING

FILE: LIVESTK

WATTLES (LIVE FASCINES)

Defintion: A wattle is a long bundle of branch cuttings bound together in cylindrical structures. Wattles work best using willow cuttings.

Purpose: To reinforce streambanks or reservoir edges susceptible to erosion with native vegetation to increase bank stability and reduce erosion.

Construction Specifications:

- Use on-site reconnaisance to identify plant species, growth form, soil and site conditions on the restoration/ construction site as well as on adjacent sites and compare their conditions. Greater success has been experienced with restoration projects that mimic characteristics of nearby sites. For project feasibility, examine the characteristics of the watershed in which the project is to be completed. This includes analyzing the geomorphic valley form, stream type and vegetation community type. Should these characteristics be favorable to a restoration project, further assessments should take place including the depth of the water table, soil texture, the typical hydrology of the site (peak flows, low flows, flood frequency, flow velocity estimates, water quality, channel shape), and identify and remove problematic non-native species such as tamarisk and Russian olive before beginning the restoration project. Details on removal of tamarisk and Russian olive are included in the appendix of this prescription.

Wattle Preparation:

- Cuttings shall be harvested and planted when the willows are dormant. This period is generally from late fall to early spring.

- Choose plant materials that are adapted to the site conditions from species that root easily. A portion (up to 50%) of the bundle may be of material that does not root easily or dead material.

- The cuttings should be long (3 feet minimum), straight branches up to 1 1/2 inches in diameter. Trimmings of young suckers and some leafy branches may be included in the bundles to aid filtration. The number of stems varies with the size and kind of plant material.

- Cuttings should be tied together to form bundles, tapered at each end, 6-30 feet in length, depending on site conditions or limitations in handling.

- The completed bundles should be 6-12 inches in diameter, with the growing tips and butt ends oriented in alternating directions.

- Stagger the cuttings in the bundles so that the tips are evenly distributed throughout the length of the wattle bundle.

- Wattle bundles should be compressed and tightly tied with rope or twine of sufficient strength and durability. Polypropolyne 'tree rope' approximately a 3/16 inch diameter provides the necessary strength and durability.
- Wattle bundles should be tied 12-15 inches apart.
- For optimum success wattles should be pre-soaked for 24 hours or installed on the same day they are harvested and prepared. The wattles should be installed within 2 days after harvest unless pre-soaked. Wattles should be stored in the shade and under cover or under water.

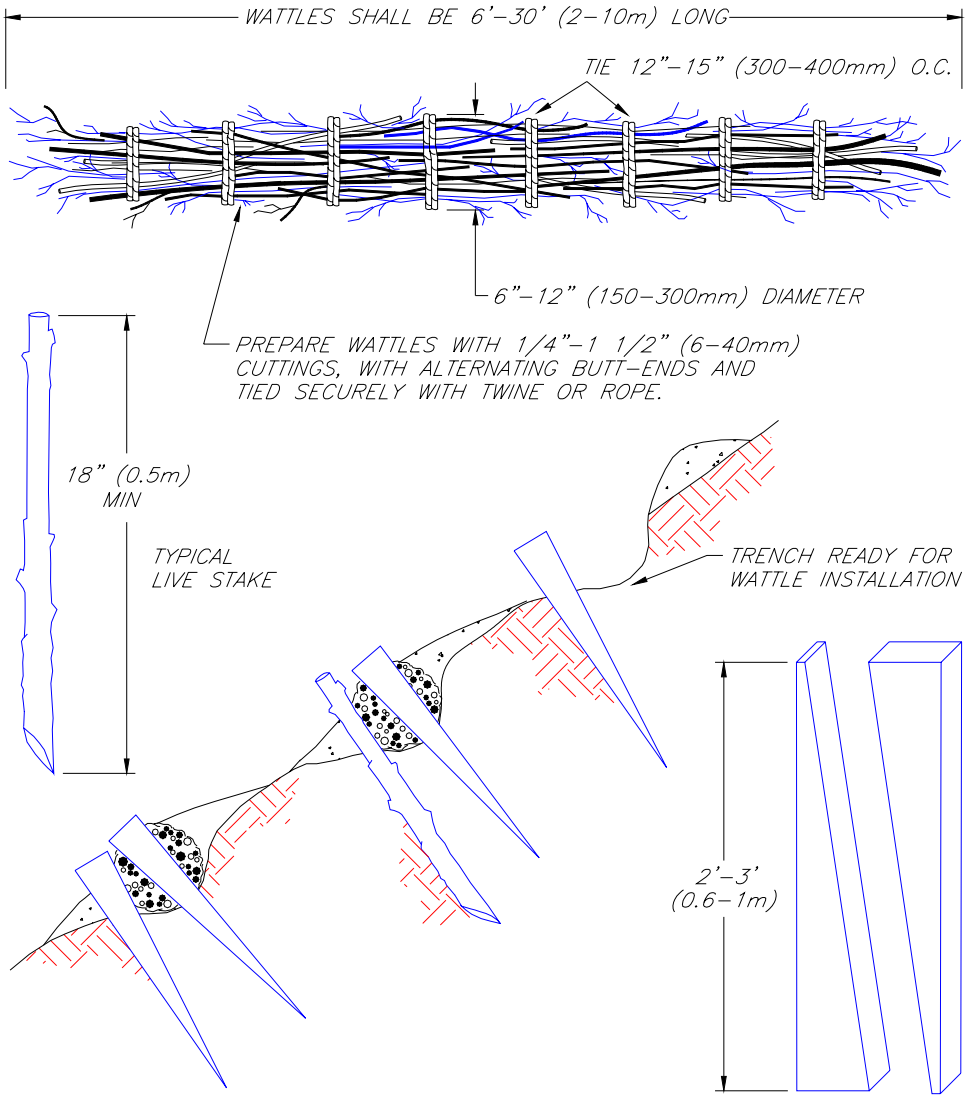
Installation:

- Work should progress from the bottom to the top of the slope.
- Install wattles into trenches dug into the slope on contour
- Spacing of contour trenches (wattles) should be about 5 feet apart or closer if the slope is steeper or soils are more erosive.
- Perform any slope repairs, such as gully repair, slope scaling, diversion dike, gabion, or toe wall construction, prior to wattle installation.
- Beginning at the base of the slope, dig a trench on contour. The trench shall be shallow, about 1/2 the diameter of the wattle. The trench width will vary from 12-18 inches depending on the slope angle.
- Place the wattles immediately after trenching to reduce desiccation of the soil.
- Wattles shall be staked firmly in place with one row of construction stakes on the downhill side of the wattling, not more than 3 feet apart. A second row of stakes shall be placed through the wattles, near the ties, not more than 5 feet apart.
- Overlap the tapered ends of adjacent wattles so the overall wattle thickness of the wattle is uniform. Two stakes shall be used at each bundle overlap such that a stake may be driven between the last two ties of each wattle.
- Live stakes, if specified, are generally installed on the downslope side of the bundle. Drive the live stakes below and against the bundle between the previously installed construction stakes.
- Proper backfilling is essential to the successful rooting of the wattles. Backfill wattles with soil from the slope or trench above. The backfill shall be worked into the wattle interstices and compacted behind and below the bundle by walking on and working from its wattling terrace.
- Repeat the proceeding steps to the top of the slope.
- Place moist soil along the sides of the live bundle. The top of the bundle should be slightly visible when the installation is completed.

- Seed and mulch slope. Shallow slopes, generally 3:1 or flatter may be seeded and mulched by hand. Steeper slopes should have seed applied hydraulically and the mulch should be anchored with tackifier or other approved methods.

Aftercare:

- Regular inspection and maintenance of wattle installations should be conducted, particularly during the first year.
- Repairs should be made promptly. Stakes that loosen because of saturation of the slope or frost action should be re-installed.
- Rills and gullies around or under wattles shall be repaired. Perform slope scaling and brushpacking as necessary.



NOTES:
1. HARVEST AND INSTALL WATTLES DURING DORMANT SEASON.
2. INSTALL WATTLES ON SLOPE CONTOURS.
3. ALL WORK PROCEEDS FROM THE BOTTOM OF THE SLOPE TO THE TOP.
4. FILL OR PARTIALLY COVER WATTLE WITH SOIL FROM SLOPE OR TRENCH ABOVE.
5. COMPACT AND WORK SOIL INTO COMPLETED WATTLES.

NOT TO SCALE

WATTLE
(LIVE FASCINE)

FILE: WATTLE

Common cottonwood and willow afflictions

Common cottonwood and willow afflictions

Cytospora canker – Caused by a fungus that attacks trees that are injured or in a weakened or stressed condition, such as drought or a wound caused by wind breakage. This fungus can be lethal. Cytospora also affects trees with root damage, often found in construction areas or newly planted trees.

Symptoms:
Yellow or orange-brown to black discolored areas on the bark of the truck and branches. Cankers, or sunken dead areas of bark with small black dots may be visible. Dead bark may remain attached to the tree for several year, then fall off in large pieces.

Control: Try to increase the vigor of the tree or shrub. Remove all infected limbs by making a smooth cut at the base of the limb without damaging the branch collar. Jagged and rough cut surfaces promote infection. Clean the wounds with ethyl alcohol or another disinfectant. Remove any dead bark, and clean tools after each cut.

Photo of cytospora canker

Tent catapillars- (*Malacosoma disstria and M. californicum*)-These insects appear in mid summer, flying at night, and deposit eggs in clusters of 150 to 250 in bands encircling twigs. The young catapillars are fully formed in 2-3 weeks, but will overwinter inside the eggs. They chew their way out of the eggs at about the same time as leaves appear in the spring. Outbreaks of these insects can cause reduced tree growth and kill a few branches, but generally will not kill the host.

Symptoms:
The catapillars create conspicuous white silken tents on tree or shrub limbs with clusters of hairy larvae found nearby or in the tents.

Control: Outbreaks of tent catapillars last generally 2-3 years, but can persist for up to 6 years. Tent catapillars are eventually controlled by a variety of factors. Eggs, larvae and pupae are killed by various insect parasites; beetles or bugs consume larvae, and birds eat all forms of this catapillar. Declines in outbreaks are often associated with cold weather at the time larvae are hatching. A crude, yet simple method can also be used to rid the tree or shrub of these catapillars. The tents can be knocked down with a pole, then the larvae can be exterminated with a step of the foot.

Marssonina leaf spot – Caused by the Marssonina fungus that can survive on fallen leaves over the winter that were infected the previous year. When the wet warm weather of the spring arrives, fungal spores are carried by the wind and infect emerging leaves. The disease can be particularly severe on young willow leaves and stems soon after bud break in the spring. Although unsightly, there is generally no significant damage to the growth of the tree or shrub. If the weather remains favorable(favors moist conditions), a secondary infection can cause premature leaf loss.

Symptoms: Leaf spots are dark brown to black irregularly shaped flecks often with yellow outline. These spots which can occur on either side of the leaf have a white center. On severely infected leaves, several spots may fuse to form large black dead patches.

Control: Pruning out dead and diseased branches and raking up fallen leaves can help control this disease to some extent.

Publication on utilizatgion of wills for stream stabilization

RESTORING STREAM BANKS WITH WILLOWS

Willows along a stream serve many important functions. They provide shade and cover for stream life and improve water quality by absorbing and storing chemicals. Their ability to withstand flooding, to stabilize soils, and to grow quickly in saturated areas make them ideal for revegetating stream banks.

Establishing willow cuttings, stakes, and/or wattles on a stream bank will benefit you and the stream. The most appropriate material and method to use will depend upon stream size and planting location.

Willows growing in a nearby area, with similar soil and moisture conditions as your problem area, should be used as planting stock to help increase tree survival.

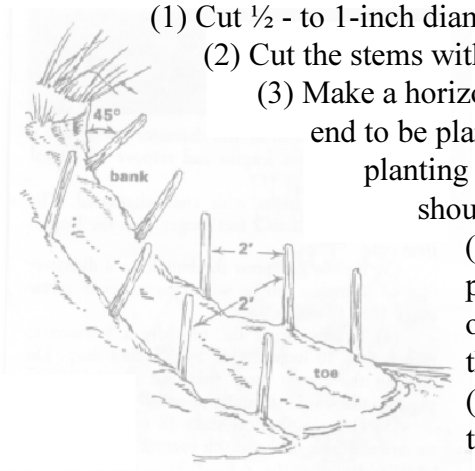
If plants are purchased from a nursery, you should buy cuttings and not rooted seedlings. Also, select a native species to enhance survival and decrease competition with other plants.

Recommended species include black willow (Salix nigra), sand bar willow (S. interior), meadow willow (S. petiolaris), heart-leaved willow (S. rigida) and Ward's willow (S. caroliniana).

Collect and plant the willows during the dormant season. Willows planted in the spring before the buds swell seem to do the best. When storing or transporting plants, keep them cool and slightly moist.

Willow Cuttings

Cuttings are used on small streams where flooding and erosion is minimal. This material is easy to obtain, requires few tools and little labor to plant.



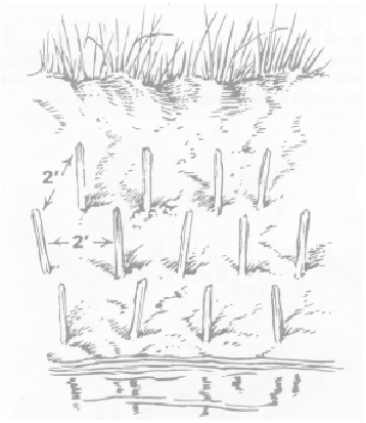
(1) Cut ½ - to 1-inch diameter plants or stems and remove all lateral branches.

(2) Cut the stems with a knife or pruning shears into 12- to 24-inch lengths.

(3) Make a horizontal cut on the end which will remain exposed and a 45° angle cut on the end to be planted. This will prevent you from planting them upside down. Note: Buds on plant should face up.

(4) Push cutting directly into soil or produce a pilot hole by pounding a piece of metal rebar into the soil and then push the cutting into the hole. A planting (dibble) bar may also be used. Plant so that only a few inches remain exposed.

Willow Stakes



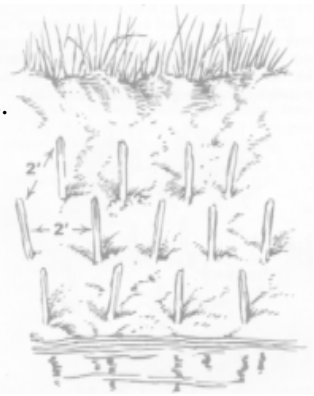
Use stakes where materials need to be driven deeper to improve moisture supply to the stakes.

(1) Cut 1- to 3-inch diameter stems into 18- to 36-inch lengths with a hand saw or chainsaw and remove all lateral stems. (Note: Using an axe or knife to cut the stems may damage the plant.)

(2) Use dibble bar or drive stake with mallet until approximately 3 to 6 inches remain exposed or to refusal. **Do not force and split stake.**

Willow Posts

Posts can also be used to revegetate stream banks. They are most appropriate in situations where a stable moisture supply is deep in the soil and willow materials need to be driven deeper to reach it. This is a very labor intensive method, but posts can withstand relatively high flows.



(1) Cut 3- to 6-inch diameter trees into 6- to 8-foot lengths with a chainsaw and remove all lateral branches. Sharpen bottom end to ease planting and score 12 to 14 inches.

(2) Set posts in post holes or drive with post driver so that at least half of the post is buried. Posts must be set deep enough to maintain contact with the water table, but not so deep that they are completely submerged in water year-round.

(3) The damaged top few inches of each post should be cut after planting if posts were driven.

Wattles

Use wattles in slow-moving water areas to trap sediments and revegetate banks. This method is more labor intensive than planting cuttings or stakes.

(1) Cut 1 1/2-inch or less diameter stems into a minimum of 3-foot lenghts and remove all lateral branches.
(2) Bundle stems with ends alternated. The bundle should be 1 to 2 feet longer than the longest stem cut.
(3) Tightly compress bundle to a diameter of 8 to 10 inches and tie with two wraps of twine every 10 - 15 inches.
(4) Beginning at the toe, dig a horizontal trench 8 to 10 inches wide by 5 inches deep. Do not dig the trench more than one hour prior to planting the wattle to minimize soil drying.
(5) Drive a vertical stake (2 to 3 feet long) on done-hill side of trench every 2 feet.
(6) Place wattles in trench and drive 2- to 3-foot long stakes through the bundle every 3 feet.
(7) Cover with soil and tamp wattle so that no more than 20 percent of the wattle is exposed.

A combination of these methods may be needed based on the characteristics of the stream and its banks.

Proper maintenance will be needed to attain long-term success. Protect young, growing willows from livestock. Also, avoid herbicide treatment on planted areas.

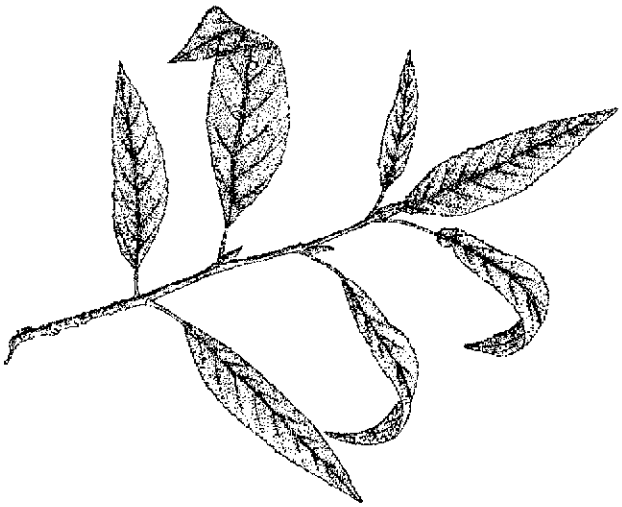
Planting willows along and on stream banks provides a number of benefits to the fragile stream environment and the surrounding land. However, this technique does not replace the need for responsible stream corridor management such as maintaining a permanent corridor of trees along streams. It is merely a tool to help mend problem areas. If you have further questions, please contact your local Conservation Agency District office - http://www.wvca.us/districts.cfm.

Wetland / Riparian Plant Finder 6: Riparian – Foothills and Canyons

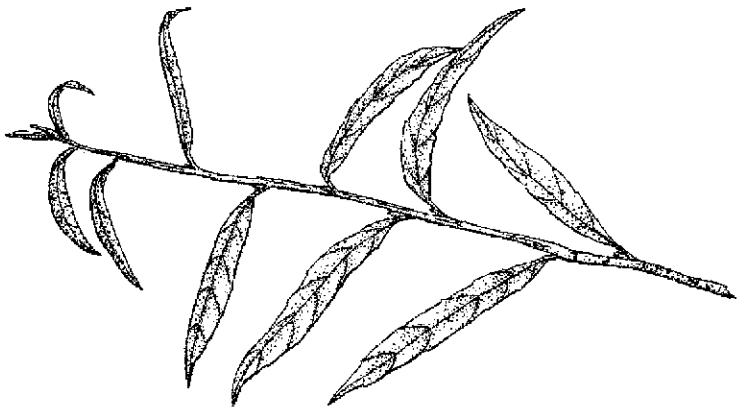
(dominant species in bold type)

TREES AND SHRUBS (continued)

Rubacer parviflorum	thimbleberry
Salix amygdaloides	peachleaf willow
Salix bebbiana	Bebb willow
Salix drummondiana	Drummond's willow
Salix geyeriana	Geyer's willow
Salix irrorata	bluestem willow
Salix lucida	shining willow
Salix monticola	mountain willow
Swida sericea	red-osier dogwood

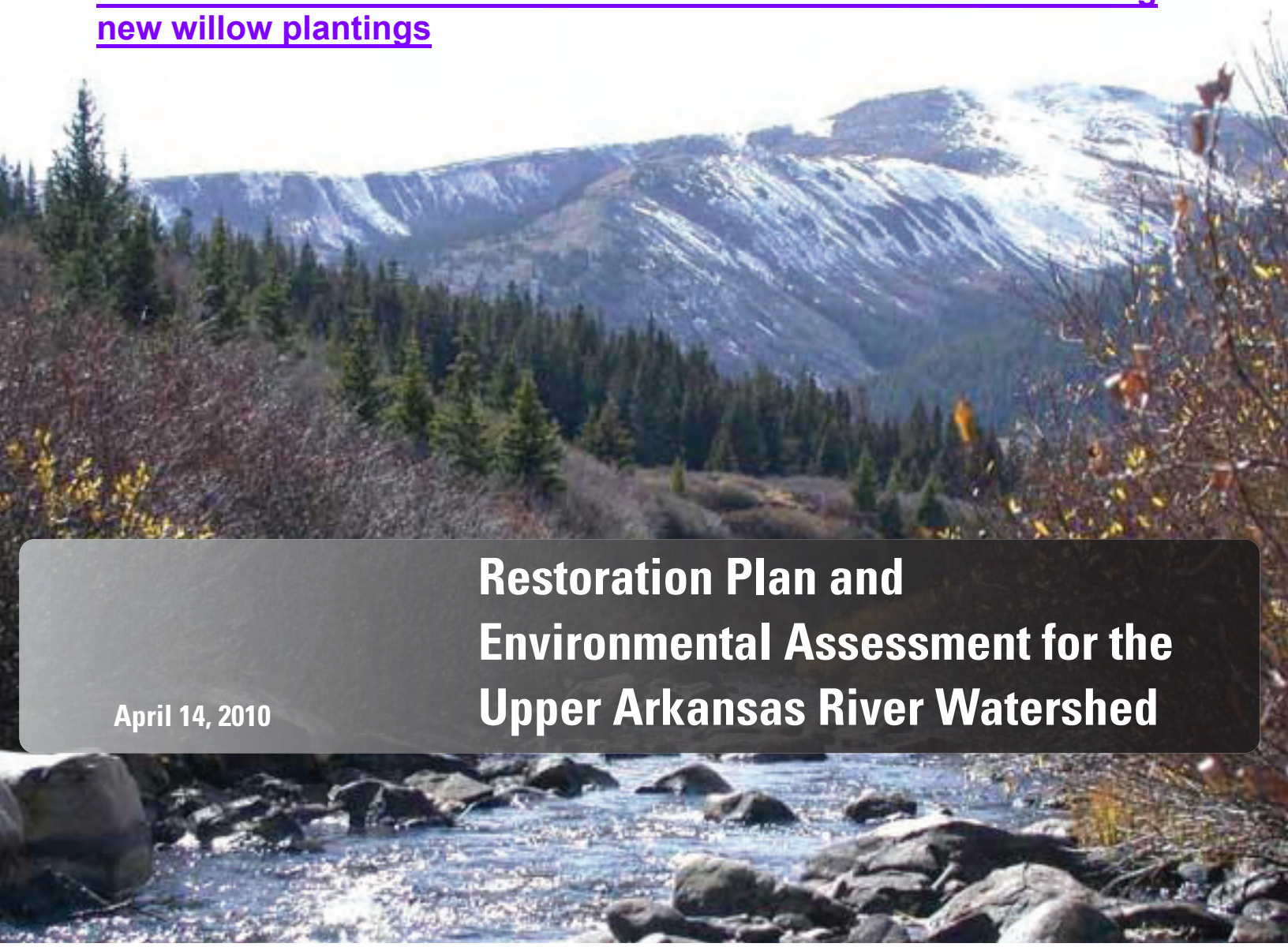


Populus angustifolia



Salix exigua

Publication on restoration of Colorado streams and rivers utilizing new willow plantings



Restoration Plan and Environmental Assessment for the Upper Arkansas River Watershed

April 14, 2010

PREPARED FOR

U.S. Department of the Interior
U.S. Fish and Wildlife Service
U.S. Bureau of Land Management
U.S. Bureau of Reclamation

State of Colorado
Department of Natural Resources
Department of Public Health and Environment
Department of Law

PREPARED BY

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- U.S. Department of the Interior
  - U.S. Fish and Wildlife Service
  - U.S. Bureau of Land Management
  - U.S. Bureau of Reclamation
- State of Colorado
  - Department of Natural Resources
  - Department of Public Health and Environment
  - Department of Law

Legal Authority:

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (as amended), 42 U.S.C. § 9601, et. seq.
- Federal Water Pollution Control Act (Clean Water Act) (as amended), 33 U.S.C. § 1251, et. seq.
- Natural Resource Damage Assessment Regulation, 43 C.F.R. Part 11

Lead Federal Agency for Restoration Plan:

- U.S. Department of the Interior (Region 6, U.S. Fish and Wildlife Service)

Lead Federal Agency for Environmental Assessment:

- U.S. Department of the Interior (Region 6, U.S. Fish and Wildlife Service)

Participating State Agencies:

- Colorado Department of Natural Resources
  - Division of Wildlife, Division of Reclamation Mining and Safety
- Colorado Department of Public Health and Environment
- Colorado Department of Law

Point of Contact:

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719-655-6121

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Acronyms and Abbreviations

AHRA	Arkansas Headwaters Recreation Area	FONSI	Finding of No Significant Impact
ALAD	delta-aminolevulinic acid dehydratase	GPS	global positioning system
AO	authorized official	LCCD	Lake County Conservation District
BLM	U.S. Bureau of Land Management	LCOSI	Lake County Open Space Initiative
BMP	best management practice	MOU	Memorandum of Understanding
BOR	U.S. Bureau of Reclamation	NEPA	National Environmental Policy Act
CDPHE	Colorado Department of Public Health and Environment	NHPA	National Historic Preservation Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	NRCS	Natural Resource Conservation Service
CMC	Colorado Mountain College	NRDA	Natural Resource Damage Assessment
CWA	Clean Water Act	O&M	operation and maintenance
DNR	Department of Natural Resources	OSHA	Occupational Safety and Health Act
DOI	U.S. Department of the Interior	RP	Restoration Plan
DOL	Department of Law	SHPO	State Historic Preservation Office
DOW	Division of Wildlife	T&E	threatened and endangered
DRMS	Division of Reclamation, Mining, and Safety	Trustees	Collectively, the U.S. Department of the Interior represented by the U.S. Fish and Wildlife Service; the U.S. Bureau of Land Management and the Bureau of Reclamation; and the State of Colorado represented by the Colorado Department of Natural Resources, Colorado Department of Public Health and Environment, and Colorado Department of Law
EA	Environmental Assessment	USDA	U.S. Department of Agriculture
EDRR	early detection/rapid response	USFS	USDA Forest Service
EE/CA	Engineering Evaluation and Cost Analysis	USFWS	U.S. Fish and Wildlife Service
EIS	Environmental Impact Statement	USGS	U.S. Geological Survey
EPA	U.S. Environmental Protection Agency		

Executive Summary

Overview of the California Gulch Superfund Site

The California Gulch Superfund Site (the "Site") encompasses more than 15 square miles, including the town of Leadville, Colorado, and surrounding areas where historic mining activities took place. The Site contains more than 2,000 mine waste piles, as well as the Yak Tunnel which discharges drainage from numerous underground mines into California Gulch. Heavy metals and acid released at or from the Site as a result of historic mining activities are hazardous substances that have caused injuries to natural resources. Because of this extensive contamination, the Site was placed on the National Priorities List in September 1983. Emergency response actions and remediation by the U.S. Environmental Protection Agency began in 1986 and continue to this day. The Natural Resource Trustees (the "Trustees"), including agencies of the U.S. Department of the Interior and the State of Colorado, prepared a preliminary estimate of natural resource damages for the Site (Industrial Economics, 2006). In that document, the Trustees determined that releases of hazardous substances from the Site have resulted in injuries to surface water, terrestrial, and groundwater resources, including injuries to brown trout and other aquatic and riparian resources in the upper Arkansas River.

What is the plan to restore injured natural resources?

The purpose of the restoration activities described in this Restoration Plan/Environmental Assessment (RP/EA) is to compensate the public by implementing restoration actions that restore, replace, or acquire the equivalent of the injured natural resources. Federal and state natural resource trustees prepared this RP/EA to plan their restoration actions and obtain public input. The Trustees seek input from the public on the proposed restoration plan contained in this RP/EA and will respond to written comments.

The Trustees previously published an RP/EA for restoration actions at the Tiger and Dinero tunnels. That document proposed two restoration projects as partial compensation for groundwater injuries in California Gulch. Those projects began implementation in 2009.

Where has funding for these restoration activities come from?

Resurrection Mining Company[1] and Newmont USA Limited have agreed to pay $10.5 million to settle allegations that the companies injured natural resources (under the natural resource damage assessment provisions of the Comprehensive Environmental Response, Compensation, and Liability Act) as a result of discharges of hazardous substances from historical mining operations at the Site. In addition, the Trustees have received a $10 million settlement plus interest from ASARCO LLC in bankruptcy proceedings. The proposed restoration projects will be funded from the settlement funds received from these responsible parties.

How were restoration alternatives developed and evaluated?

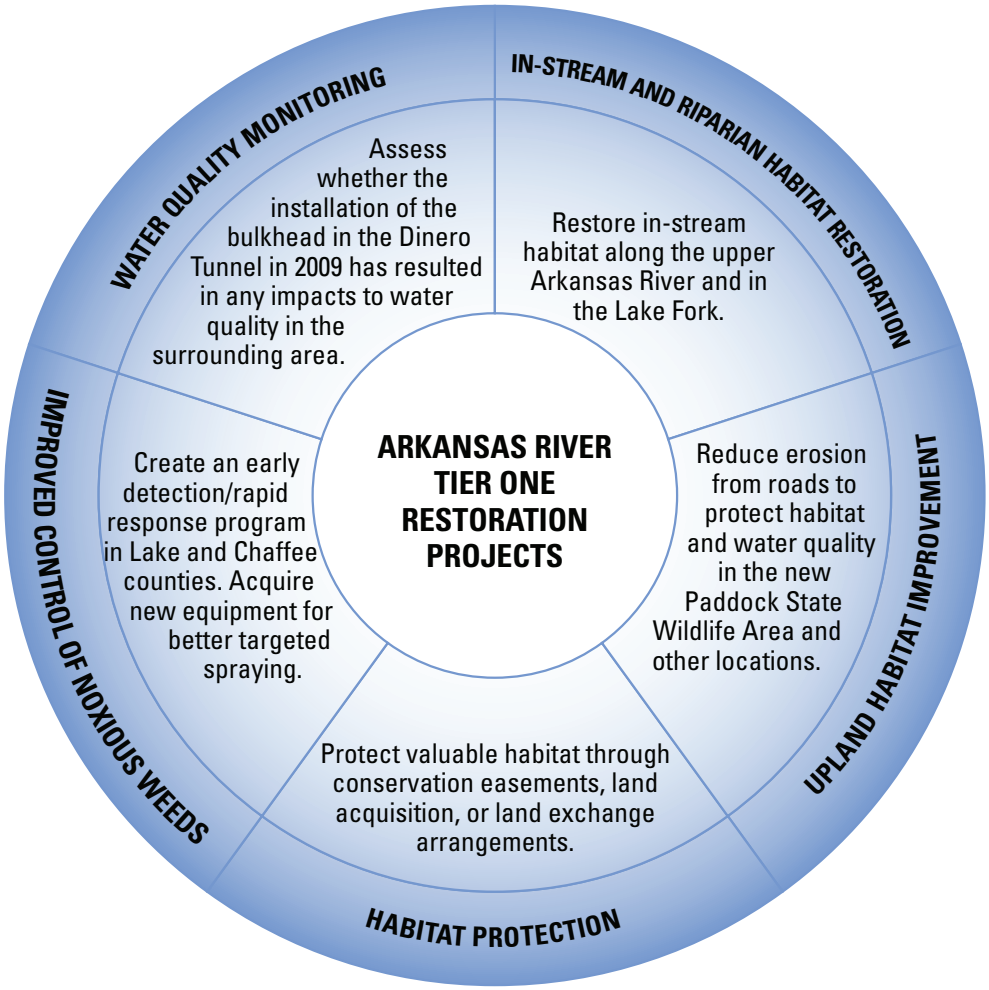
The Trustees solicited a broad range of potential restoration projects from agencies and the public. The Trustees evaluated the projects against their stated selection criteria to screen out projects that did not meet minimum acceptability standards and to determine which projects best provided cost-

[1] Resurrection Mining Company is wholly owned by Newmont USA Limited.

effective, appropriate compensation for injured natural resources. The Trustees grouped the projects into three funding tiers based on their evaluation.

The Trustees expect to fund projects in the first tier in 2010 using available settlement funding. Projects in the second tier will be funded by the Trustees with funding that remains after the projects in the first tier have been funded. The Trustees may choose to wait to fund second tier projects until they have greater certainty regarding costs for the first tier projects.

Projects in the third tier meet minimum Trustee acceptability criteria but information about these projects currently is insufficient either to complete the required National Environmental Policy Act (NEPA) analysis or to allow the Trustees to make a final determination regarding whether the projects meet selection criteria. These projects may be reconsidered by the Trustees at a later date, with appropriate NEPA analysis occurring at that time where necessary. The Trustees also may issue a supplemental RP/EA in the future to fund additional restoration projects, depending on the amount of restoration funding remaining after funding first tier and second tier projects.



Executive Summary

What is the proposed restoration alternative?

The proposed restoration alternative involves a suite of restoration projects that cumulatively will benefit surface water, terrestrial, and groundwater resources. Tier one projects that are proposed for immediate funding with settlement funds include:

- Restoration of in-stream and riparian habitat along the upper Arkansas River on public and private lands, from the confluence with California Gulch to the confluence with Twobit Gulch, and on public and private lands along approximately four miles of the Lake Fork, all in Lake County, Colorado.
- Reduce erosion to protect habitat by closing and rehabilitating informal jeep trails and old mining roads on the Paddock State Wildlife Area and in the Sugarloaf mining district and other areas
- Habitat protection through obtaining conservation easements, land acquisition, or land exchange arrangements with willing parties for parcels with high natural resource values and that are at risk from development
- Improved control of noxious weeds in Lake and Chaffee counties through acquisition of improved equipment for targeted spraying and implementation of an early detection/rapid response program for newly emerging threats
- Implementation of water quality monitoring for the Dinero Tunnel area, to assess whether the installation of the bulkhead in the Dinero Tunnel in 2009 (funded in part with Trustee settlement funds and described in Stratus Consulting, 2009) has resulted in any impacts to water quality in the surrounding area through the emergence of seeps or springs.

Tier two and tier three projects are described in Chapter 3 in the report.

Each project will include appropriate monitoring designed to determine if the project is meeting Trustee objectives and whether any additional work may be necessary to meet objectives.

References

Industrial Economics. 2006. Upper Arkansas River Basin Natural Resource Damage Assessment: Preliminary Estimate of Damages. Prepared for U.S. Fish and Wildlife Service, Bureau of Land Management, Bureau of Reclamation, Colorado Attorney General's Office, Colorado Department of Natural Resources, and Colorado Department of Public Health and Environment. December. Available: http://www.fws.gov/mountain-prairie/nrda/LeadvilleColo/CaliforniaGulch.htm. Accessed November 11, 2009.

Stratus Consulting. 2009. Restoration Plan and Environmental Assessment for the Tiger and Dinero Tunnels Restoration. Prepared for U.S. Dept. of the Interior, U.S. Fish & Wildlife Service, U.S. Bureau of Land Management, U.S. Bureau of Reclamation, Colorado Dept. of Natural Resources, Colorado Dept. of Public Health and Environment, and Colorado Dept. of Law. Stratus Consulting Inc., Boulder, CO. August 25.

This Restoration Plan and Environmental Assessment (RP/EA) presents proposed restoration actions to address public losses caused by the release of hazardous substances from the California Gulch Superfund Site ("the Site"). A draft version of the RP/EA was released for public review and comment. The RP/EA provides information to the public regarding the affected environment, the natural resource injuries at the Site, and the restoration actions proposed to compensate for these injuries. The Site encompasses more than 15 square miles and contains more than 2,000 mine waste piles, as well as the Yak Tunnel which discharges drainage from numerous underground mines into California Gulch (CDPHE, Undated). Because of this extensive contamination, the Site was placed on the National Priorities List in September 1983. Emergency response actions and remediation by the U.S. Environmental Protection Agency (EPA) began in 1986 and continue to this day. A preliminary estimate of damages developed for the Site (Industrial Economics, 2006) determined that releases of hazardous substances from the Site, including heavy metals and acid, have resulted in injuries to groundwater resources, aquatic resources, and terrestrial resources. Injured terrestrial resources include both upland areas associated with mine waste deposits and floodplain areas associated with contaminated riparian areas, irrigated meadows, and fluvial deposits.[1] The proposed restoration actions described in this document will provide compensation to the public for these natural resource injuries.

The natural resource trustee agencies involved in developing this RP/EA are the U.S. Department of the Interior (DOI) represented by the U.S. Fish and Wildlife Service (USFWS); the U.S. Bureau of Land Management (BLM) and the Bureau of Reclamation (BOR); and the State of Colorado represented by the Colorado Department of Natural Resources (DNR), Colorado Department of Public Health and Environment (CDPHE), and Colorado Department of Law (DOL; collectively, the "Trustees").[2] Authority to act on behalf of the public is given to trustees in CERCLA [42 USC §§ 9601 et seq.] and the CWA [33 USC §§ 1251 et seq.]. Actions to restore, replace, or acquire the equivalent of lost resources are the primary means of compensating the public for injuries to natural resources under these authorities.

The Trustees previously published an RP/EA for restoration actions at the Tiger and Dinero tunnels (Stratus Consulting, 2009), which proposed two restoration projects as partial compensation

[1] Additional information on injuries can be found in Chapter 2 of this document and in the Preliminary Evaluation of Damages prepared for the Upper Arkansas River Basin Natural Resource Damage Assessment (NRDA; Industrial Economics, 2006).

[2] Natural resources trustees are designated pursuant to Section 107(f) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC § 9607(f), Section 311 of the Clean Water Act (CWA), 33 USC § 1321, and other applicable law, including Subpart G of the National Contingency Plan, 40 CFR §§ 300.600–300.615. The DOI authorized official ("AO") at this Site is the Region 6 Regional Director for the USFWS, and represents the interests of the Department, including all affected Bureaus. The State trustees, designated pursuant to Section 107 (f), are the Executive Director of CDPHE, the Attorney General of Colorado, and the Executive Director of Colorado DNR.

for groundwater injuries in California Gulch. The Trustees allocated $500,000 for these projects and construction began in 2009. This current RP/EA proposes additional restoration actions to compensate for groundwater, aquatic, and terrestrial resource injuries.

1.1 Trustee Responsibilities under CERCLA and the National Environmental Policy Act

The purpose of this RP/EA is to inform and solicit comments from members of the public on the restoration actions proposed to compensate for natural resource injuries and associated lost services resulting from the releases of hazardous substances at the Site. The RP/EA also serves as an EA pursuant to the National Environmental Policy Act (NEPA) [42 USC §§ 4321 et seq.] and the regulations guiding its implementation at 40 CFR §§ 1500 et seq. This plan describes the purpose and need for the proposed restoration actions, the restoration alternatives considered, including a no-action alternative, and the potential individual and cumulative impacts of restoration actions on the quality of the physical, biological, and cultural environment.

This document also serves as the RP for implementing the selected alternative, pursuant to the NRDA regulations issued by the DOI (43 CFR Part 11). Under the regulations, the alternative selected in the RP should ensure that damages recovered from the responsible parties are used to undertake feasible, safe, and cost-effective projects that address injured natural resources; consider actual and anticipated conditions; and are consistent with applicable laws and policies. Moreover, the RP/EA identifies the proposed alternative and describes how settlement monies received will be spent to achieve restoration goals.

The Trustees considered comments received during the public comment period prior to developing the Final RP/EA. This Final RP/EA includes a summary of comments received and Trustee responses to those comments (Appendix C).

1.2 Summary of Settlement

Resurrection Mining Company[3] and Newmont USA Limited have agreed to pay $10.5 million to settle allegations that the companies injured natural resources (under the NRDA provisions of CERCLA) as a result of discharges of hazardous substances from historical mining operations at the Site. In addition, the Trustees have received a $10 million settlement plus interest from ASARCO LLC in bankruptcy proceedings.

A Memorandum of Understanding (MOU) among the trustee agencies stipulates that natural resource damage funds received will be used to restore natural resources in the upper Arkansas River watershed, in accordance with federal law. The money received will allow the Trustees to work together to restore the kinds of natural resources that were injured by releases of hazardous substances. The proposed restoration projects will be funded from the settlement funds received from these responsible parties. The Trustees also may issue a supplemental RP/EA in the future to fund

[3] Resurrection Mining Company is wholly owned by Newmont USA Limited.

additional restoration projects, depending on the amount of restoration funding remaining after funding first tier and second tier projects.

1.3 Coordination and Scoping

A variety of state and federal agencies are working together to plan and implement restoration activities to compensate for injuries at the Site. Agencies that are actively involved in these restoration activities include the USFWS, BLM, BOR, DNR, CDPHE, DOL, the Colorado Division of Wildlife (DOW), the U.S. Geological Survey (USGS), the Natural Resource Conservation Service (NRCS), and the Lake County Conservation District (LCCD). Faculty and students from Colorado Mountain College also are involved in project implementation.

In addition, the Trustees have worked with a number of different stakeholder groups to coordinate and scope projects. Projects in the Lake Fork, a tributary to the Arkansas River, have been closely coordinated with the work of the Lake Fork Watershed Working Group, which was formed in 2000 to address water quality issues in Lake Fork Creek. This stakeholder group includes representatives from Colorado Mountain College, a variety of federal and state agencies (listed below), Lake County, public interest groups, and private landowners in the area. The federal and state agencies involved include USFWS; BOR; EPA; U.S. Department of Agriculture (USDA) Forest Service; BLM – National Operations Center; USGS – Water Quality Division; CDPHE; Colorado Division of Reclamation, Mining, and Safety (DRMS); and DOW. This partnership has been working in cooperation for several years and several of the projects included in this RP/EA are an outgrowth of that partnership.

A group known as the Implementation Team of the Upper Arkansas River Restoration Project has sought to restore the 11-mile reach of the upper Arkansas River to a healthy condition. This group is led by the Lake County Conservation District in cooperation with local landowners, private industry, and federal and state agencies. The project is a cooperative "watershed approach" involving affected stakeholders to plan and implement restoration in the 11-mile reach. The stakeholder process began in 1996 when the Conservation District hosted a meeting of riverside landowners to determine the level of interest in pursuing river restoration, subsequently, the Conservation District began to coordinate meetings with private, federal, and state stakeholders to cooperatively share information and when appropriate, work on a scientifically-based plan to restore the upper Arkansas River and associated floodplain to a healthy, functioning, and sustaining condition. Proposed Trustee funding for in-stream and riparian restoration along the upper Arkansas River is being coordinated with this group.

The Trustees also have worked with the Lake County Open Space Initiative (LCOSI). LCOSI is a group that began in 1997 and includes more than 20 public agencies and private organizations to help protect and preserve open space, such as the Hayden Ranch. The Trustees are planning to work with LCOSI, Colorado State Parks, and other interested citizens and stakeholders to help identify and prioritize potential parcels for conservation easements, land acquisition, or land exchange arrangements with willing parties.

1.4 Trustee Council Organization and Activities

A Trustee Council has been working on NRDA activities for the Site since 1993 and now operates according to an MOU, which outlines how the Trustee Council will coordinate and cooperate in carrying out the respective responsibilities of the trustee agencies to restore, replace, or acquire the equivalent of the natural resources injured or potentially injured as a result of the release of hazardous substances from the Site. The signatory agencies to the MOU are the CDPHE, DNR, DOL for the state of Colorado, and DOI for the United States. In addition, the USDA Forest Service (USFS) is a signatory to the MOU but has asked USFWS to represent their Trustee interests at the Site. Each of the participating parties has one primary representative to the Trustee Council.

The Trustee Council, through its members acting on behalf of each Trustee, is responsible for all aspects of the restoration process, including developing and selecting final projects, implementing and overseeing the implementation of those projects, and monitoring and evaluating the effectiveness of the projects. All actions approved by the Trustee Council are by unanimous approval.

1.5 Public Participation

This RP/EA provides the public with information about the natural resources and associated injuries assessed at the Site, the restoration objectives, restoration alternatives considered by the Trustees, and the preferred restoration alternative selected by the Trustees. In accordance with Federal and State regulations, a public meeting was held in Leadville on January 13, 2010. At this meeting, the Trustees presented information about the restoration process and the projects described in the Draft RP/EA. The Draft RP/EA was available for public comment for 45 days (January 13, 2010 through February 26, 2010). A notice of the availability of the Draft RP/EA was published in the following local newspaper:

Leadville Herald Democrat
PO Box 980
Leadville, CO 80461
719-486-0641

Copies of the Draft RP/EA were made available at the following locations:

Colorado Mountain College
Timberline Library
901 US Hwy 24 S
Leadville, CO 80461

Lake County Library
1115 Harrison Avenue
Leadville, CO 80461

An electronic version of the Draft RP/EA was posted on the California Gulch NRDA website: http://www.fws.gov/mountain-prairie/nrda/LeadvilleColo/CaliforniaGulch.htm.

1.6 Responsible Party Involvement

The settling parties chose not to participate in restoration planning and implementation.

1.7 Administrative Record

The administrative record contains the official documents pertaining to the Site NRDA. The administrative record for the NRDA case is housed at the USFWS, Saguache Field Office, 46525 Highway 114, Saguache, CO 81149.

1.8 Document Organization

The remainder of the document is organized as follows. Chapter 2 describes the purpose and need for restoration. Chapter 3 describes the projects that make up the proposed restoration alternative and describes the no-action alternative. Chapter 4 describes the affected environment. Chapter 5 presents the environmental and socioeconomic impacts of restoration alternatives. Chapter 6 provides the list of preparers. Chapter 7 provides the list of agencies, organizations, and parties consulted. Appendix A provides further information on the proposed in-stream restoration project. Appendix B provides the land transaction policy for the Trustee Council. Appendix C provides a summary of public comments received and the Trustee responses to those comments, as well as copies of the public comments.

This chapter describes the purpose and need for restoration to address losses to natural resources caused by the releases of hazardous substances at and from the Site. The Trustees determined in their preliminary estimate of damages that groundwater, aquatic, and terrestrial resources have been injured; that the locations of injury include California Gulch, and aquatic resources of the upper Arkansas River and terrestrial resources associated with the 500-year floodplain of the upper Arkansas River; and that restoration is required to compensate the public for these injuries (Industrial Economics, 2006). This RP focuses on projects that will address injuries to natural resources through the restoration of similar resources in locations within the upper Arkansas River Basin (Figure 2.1).

2.1 Summary of Release History and Resulting Public Losses

The Site extends over a large area including more than 15 square miles in and around the town of Leadville, Colorado. Extensive historic mining activities in and around Leadville generated more than 2,000 on-site waste rock piles and resulted in past and ongoing releases of heavy metals and acid mine drainage into California Gulch and, subsequently, to the upper Arkansas River Basin. In particular, the Yak Tunnel, which was constructed to dewater mines in the area, was a significant source of contamination to California Gulch from the time of its construction in 1895 until the Yak Tunnel Water Treatment Plant began operation in 1992. Before construction of the treatment plant, more than 200 tons of metals were discharged into California Gulch each year by the Yak Tunnel (Industrial Economics, 2006). Releases from California Gulch moved downstream into the upper Arkansas River Basin, resulting in downstream injuries to surface water, aquatic biota, and terrestrial resources, including terrestrial biota, riparian habitat, irrigated meadows, and fluvial mine-waste deposits (Redente et al., 2002; Industrial Economics, 2006; Lipton, 2007).

2.1.1 California Gulch

Surface water in California Gulch exceeds adverse effects thresholds for aquatic biota for zinc and cadmium and other metals (Industrial Economics, 2006). This contamination has resulted in the nearly complete loss of a biological community in California Gulch. Benthic macroinvertebrates are severely reduced in number and diversity compared to reference locations. Sampling in 1989 and 1990 also found no fish in the lower perennial portion of California Gulch. Metal concentrations in groundwater wells along California Gulch have consistently exceeded CDPHE basic standards for groundwater for human health, secondary drinking water, and agricultural standards (Tetra Tech/RMC, 2004). Injuries to surface water and groundwater in California Gulch are expected to continue into the foreseeable future.

2.1.2 Upper Arkansas River

Injured aquatic resources in the upper Arkansas River include surface water, benthic macroinvertebrates (including aquatic insects and other similar organisms), fish, and birds. Extensive injuries exist in the Arkansas River from the confluence with California Gulch downstream to Two Bit Gulch, also referred to as the 11-mile reach (Figure 2.1), and some adverse effects extend as far downstream as the Pueblo Reservoir. Surface water in the Arkansas River exceeds Colorado acute and chronic water quality criteria for cadmium, copper, lead, and zinc. The frequency and magnitude of

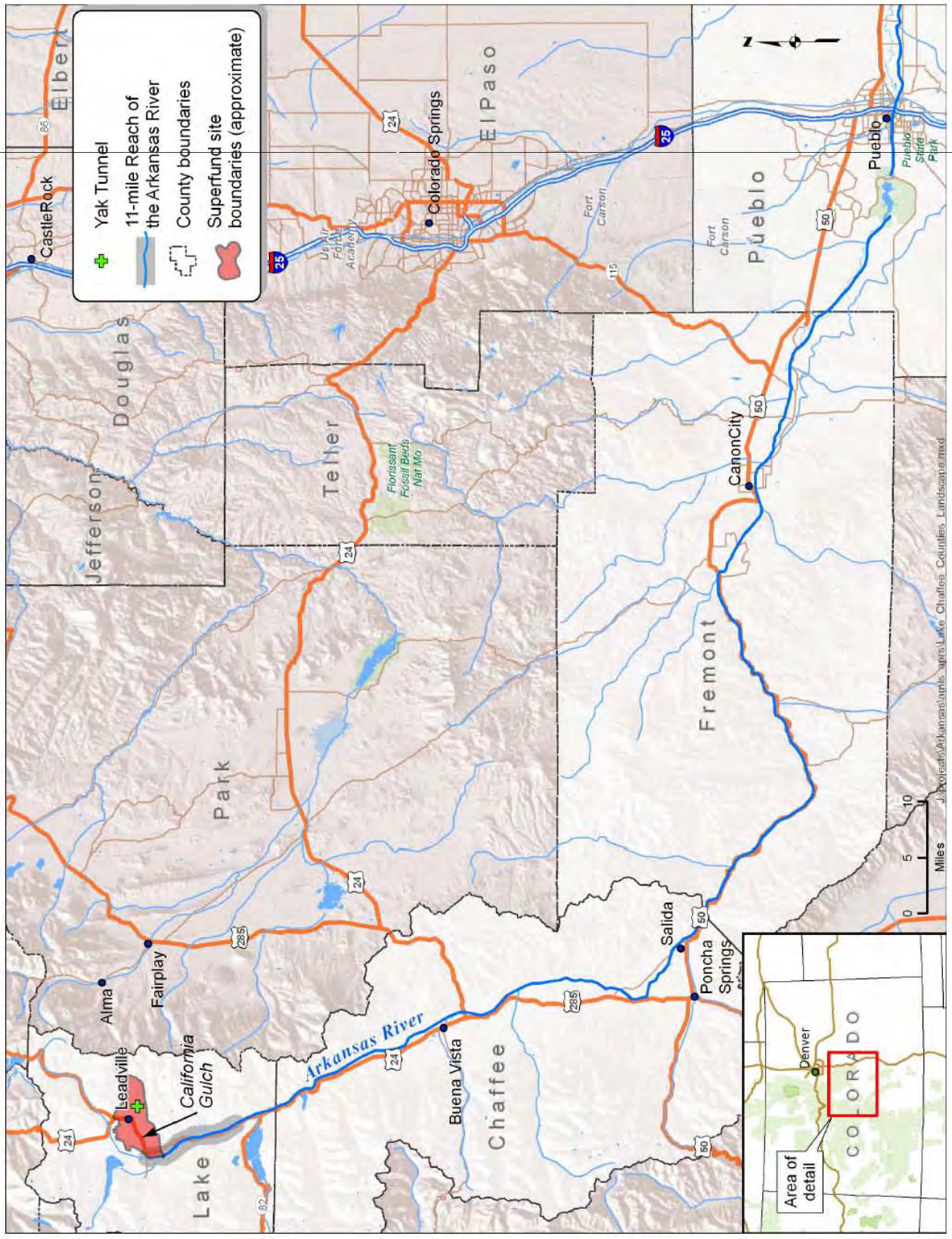


Figure 2.1. Overview map of the Site in the context of the upper Arkansas River Basin.

water quality exceedences generally declines in the downstream reaches compared with exceedences observed in the 11-mile reach (Industrial Economics, 2006).

Surface water and sediment contamination have caused reductions in abundance, biomass, and diversity of the benthic macroinvertebrate community (Industrial Economics, 2006). These impacts are most severe in and immediately downstream of the 11-mile reach. The benthic community farther downstream was historically impacted but, since 1994, has recovered to approximately the same condition as that observed in reference areas (Industrial Economics, 2006).

Fish in the 11-mile reach are exposed to metals directly through contact with contaminated water and indirectly by feeding on contaminated benthic macroinvertebrates. Toxicity studies have found that historic metals concentrations were lethal to brown trout. Field population studies in the 1990s found that brown trout populations and biomass were greatly depressed compared with reference sites. Brown trout populations have begun to recover since the 1990s, however, indications exist to the persistence of toxic conditions (Industrial Economics, 2006). Fish populations downstream of the 11-mile reach also were historically impacted by metals contamination. Recent data show that fish in the area immediately downstream of the 11-mile reach are still impacted by metals concentrations. Since remedial activities were conducted in California Gulch, fish in the farther downstream reaches are recovering (Industrial Economics, 2006).

Birds dependent on aquatic resources also have been injured as a result of contamination in the aquatic environment, primarily by feeding on contaminated benthic macroinvertebrates. Tissue and blood samples found concentrations of cadmium, copper, lead, and zinc that are similar to those measured in benthic macroinvertebrates, indicating that aquatic-dependent birds have been exposed by the release of hazardous substances into the environment. Studies evaluating American dippers (*Cinclus mexicanus*) and tree swallows (*Tachycineta bicolor*) also evaluated nest success and evidence of toxicity. Birds nesting in the 11-mile reach had significantly lower nest success compared with reference sites (Industrial Economics, 2006). Similarly, blood and liver samples taken from American dippers indicate that lead contamination has injured migratory birds downstream of the 11-mile reach (Industrial Economics, 2006).

2.1.3 Terrestrial Resources

Terrestrial resources have been injured by releases of hazardous substances from the Site. More than 2,000 onsite waste rock piles have caused injuries to upland resources. Natural resources in the Arkansas River floodplain were exposed to hazardous substances when water from California Gulch or the upper Arkansas River was used to irrigate floodplain meadows, during flooding events, and from the presence of mine waste in the floodplain. EPA evaluated terrestrial resources in the 11-mile reach and found evidence that contamination was present in sufficient concentrations to cause a toxic response in plants. The Trustees concluded that, in addition to impacts to soils and vegetation, contamination is sufficient to cause injury to wildlife and livestock in the riparian and floodplain habitats (Industrial Economics, 2006).

2.2 Restoration Goals

The purpose of the proposed restoration actions is to compensate the public through environmental restoration for injuries to natural resources that have been caused by releases of hazardous substances into the environment. As outlined under Section 107(f)(1) of CERCLA and specified in the Trustee's MOU, funds from natural resource damage settlements will be used only to restore, replace, or acquire the equivalent of natural resources injured, destroyed, or lost as a result of the release of hazardous substances, about which the settlement was reached.

Accordingly, this RP/EA has been developed to select restoration projects designed to compensate the public for injuries to natural resources in the upper Arkansas River Basin, caused by releases from the Site. The NRDA activities undertaken by the Trustees are distinct from the removal and remediation actions (termed "response actions") that have been and continue to be conducted by EPA and CDPHE. Response actions have the objective of protecting human health and the environment by controlling exposure to released hazardous substances. Restoration actions are designed to compensate the public for injuries by restoring, rehabilitating, replacing, or acquiring the equivalent of the injured resources.

The Trustees favor "in-kind" restoration, which means that the restoration projects focus on restoring the same types of resources as the ones that were injured. The Trustees intend to identify restoration projects that will compensate the public with the same type and quality of resources and services that were lost. These actions make the public whole by providing compensation for lost natural resources and associated ecological services. The restoration projects proposed in the upper Arkansas River Basin are expected to reduce, remove, or compensate for the injuries caused by mining activities. In addition, because response actions at the Site are ongoing, the Trustees have chosen to focus on restoration alternatives that will not be put at risk by any planned or proposed response actions.

2.3 Need for Restoration

The proposed restoration actions are needed to restore natural resources equivalent to those injured by releases of hazardous substances to the upper Arkansas River Basin. Based on recommendations set forth in this RP/EA and input from the public, the Trustees will select the preferred restoration alternative.

2.4 Compliance with Other Authorities

The following environmental laws, regulations, and executive orders may affect completion of the restoration projects. Compliance with these authorities was considered as part of the restoration planning process, and the proposed restoration projects are consistent with these acts.

2.4.1 Environmental Protection	
National Environmental Policy Act	NEPA requires that federal agencies consider the environmental impacts of proposed actions and reasonable alternatives to those actions. The AO will determine, based on the facts and recommendations in this document and input from the public, whether this EA supports a "Finding of No Significant Impact" (FONSI), or whether an "Environmental Impact Statement" (EIS) will need to be prepared.
Clean Water Act	The CWA is intended to protect surface water quality, and regulates discharges of pollutants into waters of the United States. All proposed restoration projects will comply with CWA requirements, including obtaining any necessary permits for proposed restoration actions. For example, it is likely that the proposed in-stream restoration projects will require a CWA Section 404 permit from the U.S. Army Corps of Engineers because the project will result in alterations to the current stream channel.
Federal Land Policy and Management Act	The Federal Land Policy and Management Act of 1976, as amended, 43 USC §§ 1701–1782, established the BLM mandate of multiple-use for BLM lands and sets forth the principles of sustainable land management for BLM. The proposed projects will comply with BLM land management policy and guidance where relevant.
Endangered Species Act	The Federal Endangered Species Act of 1973, as amended, 16 USC §§ 1531 et seq., was designed to protect species that are threatened with extinction. It provides for the conservation of ecosystems upon which these species depend and provides a program for identification and conservation of these species. Federal agencies are required to ensure that any actions are not likely to jeopardize the continued existence of a threatened and endangered (T&E) species. The following candidate, threatened, and endangered species are known to occur in Lake County, Colorado: Canada lynx (*Lynx canadensis*; threatened), Greenback cutthroat trout (*Oncorhynchus clarki stomias;* threatened), Gunnison's prairie dog (*Cynomys gunnisoni*; candidate), Penland alpine fen mustard (*Eutrema penlandii*; threatened), and Uncompahgre fritillary butterfly (*Boloria acrocnema*; endangered). The areas potentially affected by the proposed restoration actions are not known to provide core habitat for any of these species, with the potential exception of the Paddock State Wildlife Area. Elimination of motorized travel on informal trails at the Paddock State Wildlife Area would benefit Canada lynx and the Uncompahgre fritillary butterfly, as well as bighorn sheep, northern leopard frog, and boreal toad.
Migratory Bird Treaty Act	The Migratory Bird Treaty Act of 1918 as amended, 16 USC §§ 703–712, protects all migratory birds and their eggs, nests, and feathers and prohibits the taking, killing, or possession of migratory birds. The proposed restoration actions would not result in the taking, killing, or possession of any migratory birds.

2.4.2 Cultural Preservation

National Historic Preservation Act	The National Historic Preservation Act (NHPA) of 1966, as amended, 16 USC §§ 470 et seq., is intended to preserve historical and archaeological sites. Compliance with the NHPA would be undertaken through consultation with the Colorado State Historic Preservation Office (SHPO), which is discussed further in Chapter 5.
Archaeological Resources Protection Act	The Archaeological Resources Protection Act of 1979, as amended, 16 USC §§ 470aa–mm, was enacted to secure the protection of archaeological resources and sites on public lands. A permit is required to excavate or remove any such archaeological resource. If such resources are identified in the areas affected by the proposed restoration projects, a permit will be obtained prior to disturbance.

2.4.3 Other Laws

The Occupational Safety and Health Act (OSHA) of 1970, as amended, 29 USC §§ 651 et seq., governs the health and safety of employees from exposure to recognized hazards, such as exposure to toxic chemicals, excessive noise, mechanical dangers, and unsanitary conditions. All work conducted on the proposed restoration actions will comply with OSHA requirements.

The Trustees considered a broad set of potential restoration alternatives for this RP/EA, including a "no action" or "natural recovery" alternative. The proposed alternative identified by the Trustees is a suite of restoration projects that cumulatively aim to compensate for injuries to surface water, groundwater, aquatic resources, and terrestrial resources at the Site. The projects were identified by the Trustee agencies, based on their knowledge of restoration opportunities in the area, and also through outreach to a broad range of local, state, and federal agencies; organizations; and stakeholder groups (see Chapter 7 for contacts). This chapter describes the criteria for identifying and selecting alternatives (Section 3.1), describes the no-action alternative (Section 3.2), presents detailed descriptions of each of the projects included in the proposed alternative (Section 3.3), and describes restoration alternatives that were considered but eliminated from detailed analysis (Section 3.4). Descriptions of the restoration projects included in the proposed alternative include an overview of the environmental and socioeconomic consequences associated with individual projects. A broader discussion of impacts, including cumulative impacts from implementing the full suite of restoration projects, can be found in Chapter 5.

The Trustees have grouped preferred projects into three tiers. Projects in the first tier will have top priority for funding and the Trustees expect to fund these projects in 2010 with the settlement funding available to the Trustees. Projects in the second tier will be funded by the Trustees with funding that remains after the first tier projects have been funded. The Trustees may choose to wait to fund second tier projects until they have greater certainty regarding costs for the first tier projects.

The Trustees have determined that projects in the third tier meet Trustee criteria. At the present moment, sufficient information is unavailable about projects in the third tier to complete the required NEPA analysis or to make a final determination of Trustee preference. Therefore, these projects may be reconsidered by the Trustees at a later date, with appropriate NEPA analysis occurring at that time. The Trustees may choose to conduct a second round of project solicitation in the future to identify any new restoration project ideas. The Trustees would then issue a supplemental RP/EA at the time when they decide to fund third tier projects or newly identified projects.

3.1 Criteria for Identifying and Selecting the Proposed Restoration Projects

The Trustees prefer a mix of natural resource restoration projects to provide a broad array of natural resource services throughout the upper Arkansas River Basin. Thus, a variety of goals are supported, rather than a single objective. The categories of restoration projects that the Trustees prefer include improvement of aquatic habitat, terrestrial habitat protection and enhancement (including uplands, wetlands, and riparian), water quality protection or improvement, and increased access to natural resources (where appropriate). The Trustees also support monitoring projects that provide key data needed to attain restoration goals.

The Trustees prefer projects that are located in the environments of the mainstem Arkansas River or its tributaries. The Trustees also prefer projects with a closer proximity to injured locations (e.g., all things being equal, a project in Lake County would generally be preferred to an equivalent

project in Chaffee County). The Trustees expect to balance geographic preferences with the project evaluation criteria listed in Table 3.1. These criteria also were used in the Tiger and Dinero tunnels RP/EA previously published by the Trustees (Stratus Consulting, 2009). The Trustees evaluated each proposed project against the threshold acceptance criteria to determine if the project met minimum standards for acceptability. Projects that did not meet these standards were designated as "non-preferred." Projects that met the threshold acceptance criteria then were evaluated against the project evaluation criteria, using a qualitative assessment of project strengths and weaknesses. This qualitative assessment of project strength and weakness versus the criteria is described in the project descriptions provided below and was the basis for grouping projects into three tiers. Projects that best met the criteria were placed into the first tier for funding.

Table 3.1. Summary of Trustee criteria for evaluating restoration projects

Threshold acceptance criteria	1. Project must restore, replace, or acquire natural resources, not merely human services. 2. Restoration projects must be subject to a reasonable degree of Trustee management, control, and monitoring. 3. Project must have a reasonable likelihood of success. The project should be technically feasible and viable. 4. Project must comply with laws and be protective of health and safety. 5. Project must be generally acceptable to the public.
Project evaluation criteria	1. Projects that are consistent with existing state, regional, and local resource management and development plans will be strongly preferred. 2. Projects that provide higher flows of services throughout the project lifetime will be preferred. It is preferable and more cost-effective for projects to provide higher levels of near-term benefits as compared to projects that require protracted periods to realize benefits. Projects that provide long-term sustainable service flows are also preferred. 3. Projects with less long-term operation and maintenance (O&M) will be preferred. Projects with significant long-term O&M will only be considered if the costs are assumed by other parties and the Trustees are assured that O&M will be adequately carried out for as long as necessary. 4. Projects that are likely to benefit more than one resource and more services will be preferred. 5. Projects that can be reasonably monitored and have benefits that can be measured and verified will be preferred. 6. Projects that provide actual resource improvements will be preferred over projects that entail only conservation of open space, unless development threats are imminent or the conservation opportunity is of an advantageous scale or timing. 7. Projects that provide a high ratio of expected benefits compared to expected long-term costs for planning, implementation, and O&M will be preferred. Cost-effectiveness may be assessed relative to other projects that benefit the same resources; more cost-effective projects will be preferred. 8. Projects will be preferred if they are not likely to be funded through other mechanisms, or if implementation of the project would free restoration funding sources to finance other restoration projects. 9. Projects will be preferred if they leverage damage recoveries to match other funding sources and thereby enable projects to be larger or more comprehensive in scope.

3.2 No-Action/Natural Recovery Alternative

A no-action alternative is required to be considered under NEPA [40 CFR § 1502.14(d)]. The selection of this alternative by the Trustees would mean that no actions would be taken by the Trustees to restore injured natural resources, that existing natural resource losses would continue to occur, and that the public would not receive compensation for losses that occurred in the past or are ongoing. Natural recovery of contaminated surface water and groundwater in California Gulch and of terrestrial resources injured from mine wastes at the Site is not expected to occur within the foreseeable future (i.e., the next 100 years). Recovery of injured surface water and aquatic resources in the Arkansas River has already started as remedial actions help to reduce the concentration of heavy metals. These resources are expected to recover fully within the next two decades in areas where remedial actions have taken place; however, the no-action alternative would not result in any compensation for past and current injuries. Additionally, habitat in areas still impacted by mine waste will not recover without treatment. This alternative may be used as a benchmark to evaluate the comparative benefit of other actions. Because no action is taken, this alternative also has no cost. This alternative also provides no economic benefits to the population in Leadville and surrounding areas (Archuleta et al., 2003).

3.3 Proposed Alternative

The proposed alternative[5] is the alternative that the Trustees believe would best compensate the public for injuries to natural resources resulting from releases of hazardous substances at the Site. This alternative consists of a suite of projects that benefit each of the major categories of injured natural resources (Table 3.2). Tier one projects are described first, followed by tier two and tier three projects. As described above, tier one projects are the projects that best meet the restoration criteria and will be funded immediately in 2010. Tier two projects meet the restoration criteria and will be funded by the Trustees with funding that remains after the first tier projects have been funded. Tier three projects appear to meet Trustee criteria but more information is necessary before the Trustees can make a final determination of preference.

Table 3.2 provides information on the type of project, its location, the proposed sponsoring entity, the total project cost, and the proposed allocation from the NRDA settlement. As part of the proposed alternative, the Trustees will engage in appropriate public outreach activities, including public information meetings, publishing public informational documents online and in hard copy, and developing press releases and articles that will be provided to local media outlets. The Trustees may also develop educational signage at the sites of restoration activities to educate the public about the restoration actions and the role of the NRDA settlement in providing funding. Figure 3.1 provides a map that identifies geographic features mentioned in the restoration project descriptions (e.g., Hayden Ranch, Canterbury Tunnel) to help the reader understand where projects might occur. The Trustees are not restricting restoration project implementation to the area on the map.

[5] Under NEPA, the proposed alternative is equivalent to the proposed action.

For each project, a "logic model" is provided that briefly describes the key restoration action of a project, the expected short-term result from the proposed restoration action, and the pathway or process that will lead to the desired long-term results. In addition, each project description provides a brief overview of expected maintenance and monitoring requirements for the project so that the Trustees can determine if the desired benefits are being achieved and take remedial actions if necessary. The Trustees intend to develop a separate maintenance and monitoring document that will provide further detail on monitoring plans for all of the projects in the proposed alternative.

Table 3.2. Proposed restoration projects for the proposed alternative divided by funding tier

Project title	Type of project	Location(s)	Sponsoring entity	Total cost estimate	Proposed natural resource damage allocation
TIER 1					
Arkansas River in-stream habitat restoration	Improve aquatic resources	11-mile reach and Lake Fork	Colorado DOW, NRCS, LCCD	$9,666,000	$8,784,000
Weed control in Lake and Chaffee counties	Habitat enhancement (riparian and uplands)	Lake and Chaffee counties	Lake/Chaffee Weed Board	$230,000	$230,000
Dinero Tunnel water quality monitoring	Water quality improvement	Dinero Tunnel and surrounding areas	USGS/CMC	$634,000	$165,000
Erosion control on roads	Habitat enhancement (uplands)	Paddock State Wildlife Area, Lake Fork watershed	USFS–Leadville Ranger District, BLM	$200,000	$200,000
Habitat protection (easements, acquisition, or land exchange)	Habitat protection	Upper Arkansas River watershed	AHRA/Colorado DOW/BLM/LCOSI	To be determined by market study	$650,000
			Total cost for Tier 1 projects:	**$10,730,000**	**$10,029,000**
TIER 2					
Habitat protection (easements, acquisition, or land exchange)	Habitat protection	Upper Arkansas River	AHRA/Colorado DOW/BLM/LCOSI	To be determined by market study	$1,150,000
Native plant propagation at Hayden Ranch	Habitat enhancement	Hayden Ranch on the Arkansas River	CMC/LCOSI	$100,000	$200,000
Development and Implementation of an Engineering Evaluation and Cost Analysis (EE/CA) for the Venture Mine and Sugarloaf Mine dumps	Water quality improvement	Sugarloaf district	CMC/BLM	$400,000	$200,000
Hayden Ranch revegetation	Habitat enhancement (riparian)	Hayden Ranch	BLM	$25,000	$20,000
Canterbury Tunnel rehabilitation	Groundwater beneficial use	Canterbury Tunnel	Parkville Water District	$2,000,000	$200,000 (10% of total project cost)
Habitat management for land protected by Trustees	Habitat enhancement (riparian and uplands)	Lake and/or Chaffee County	Colorado State Forest Service	$100,000	$100,000
			Total cost for Tier 2 projects:	**$2,625,000**	**$1,870,000**
TIER 3					
Colorado Gulch wetland and upland restoration	Improve aquatic habitat/fishery	Colorado Gulch wetlands site	Lake Fork Watershed Group	$600,000	$300,000
Remediation of acid mine drainage in tributaries to the Arkansas River	Water quality improvement	Chalk Creek and St. Kevin's Gulch	USFS	$1,450,000	$400,000
Erosion Control on the Arkansas Headwaters Recreation Area	Habitat enhancement	Arkansas River Headwaters Recreation Area	Colorado State Parks	To be determined by watershed plan	$100,000
			Total cost for Tier 3 projects:	**$2,050,000**	**$800,000**
			Total cost of preferred action alternatives:	**$15,405,000**	**$12,699,000**
Considered but eliminated from further analysis					
Iowa Gulch wetland enhancement	Habitat enhancement	Sherman Mine (downstream)	BLM	$200,000	---
Lake Fork watershed-wide monitoring	Monitoring	Lake Fork	CMC/USGS/ BLM	$252,000	---
California Gulch remedial projects	Water quality improvement	California Gulch	Lake County Commissioners	$4,100,000	---

CMC = Colorado Mountain College, AHRA = Arkansas Headwaters Recreation Area

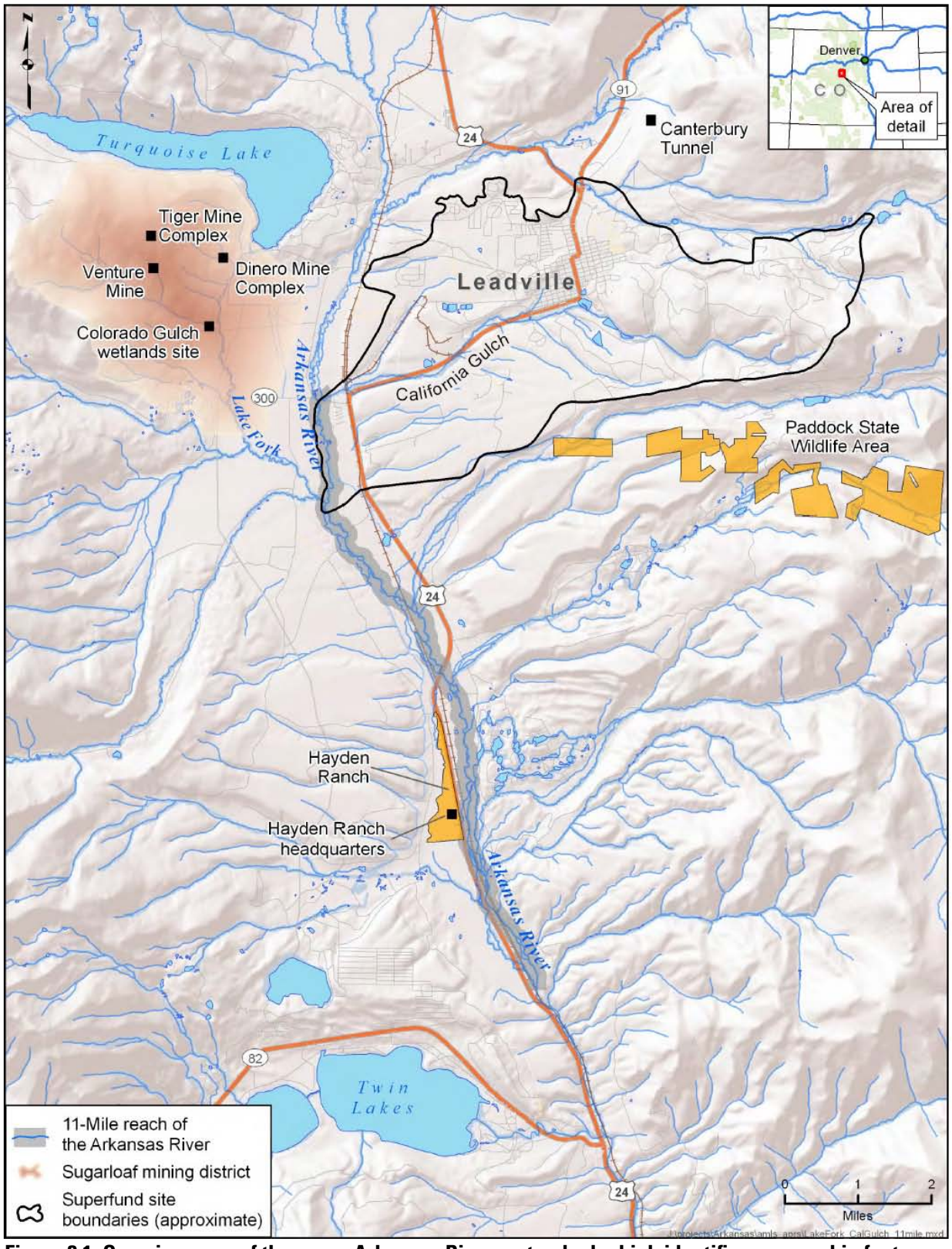


Figure 3.1. Overview map of the upper Arkansas River watershed which identifies geographic features mentioned in the restoration project descriptions.

3.3.1 ARKANSAS RIVER IN-STREAM HABITAT RESTORATION — TIER 1

Restoration objective

Improve in-stream aquatic habitat and increase brown trout populations by providing feeding areas, overhead cover, spawning areas, and overwintering refuge habitat along the 11-mile reach of the Arkansas River below the confluence with California Gulch and along the Lake Fork, which is an ecologically important tributary to the 11-mile reach. In targeted areas, improve riparian habitat and reduce bank erosion. See Figure 3.2 for the project logic model.

Project description

Trout habitat in the 11-mile reach of the Arkansas River is degraded, in part because of historic land-use practices that have altered the morphology of the river channel – resulting in a channel that is too wide and shallow and lacks important habitat features for trout such as deep-water pools. In-stream habitat restoration projects will address three major issues including (1) bank erosion, (2) altered river channel morphology, and (3) degraded in-stream trout habitat. This work will take place on both public and private land in the 11-mile reach and in the Lake Fork.

A detailed description of the proposed habitat treatments for the Arkansas River and the Lake Fork is provided in Appendix A. These treatments are based on an initial restoration plan developed by the Colorado DOW after a field inventory and survey of river conditions that included qualitative assessments of bank stability and riparian vegetation, counts of the ratio of riffle habitat to pool habitat, calculation of the width to depth ratio of the river, aerial imagery, investigation of stream flow data from gauges, and determination of access logistics. These treatments will be further evaluated and adjusted during the development of final engineering plans for each reach of the river. General descriptions of the proposed habitat treatments are discussed below; further detail is provided in Appendix A.

Specific treatments proposed to restore natural river processes through modification of river channel morphology include (1) reducing channel width, (2) excavating pools, (3) elevating the river-bottom substrate that creates riffles, (4) excavating streambeds under overhanging woody vegetation, (5) construction of riparian benches to extend the width of the riparian

FIGURE 3.2. ARKANSAS RIVER IN-STREAM HABITAT RESTORATION– LOGIC MODEL

Restoration action	Stabilize stream banks and create diverse stream morphology.
Expected short-term result	Reduction in erosion and downstream sedimentation; decrease in water temperatures during low-flow summer months; creation of diverse in-stream habitat including deep-water pools, riffles, and bars.
Pathway/process	Increase spawning and winter refuge habitat for brown trout and other fish.
Desired long-term results	Increase fish populations, especially brown trout in the 11-mile reach of the Arkansas River below the confluence of California Gulch.

3.3.1 ARKANSAS RIVER IN-STREAM HABITAT RESTORATION *(continued)* TIER 1

zone, and (6) planting and reseeding riparian vegetation along stream banks. Treatments proposed to stabilize stream banks and prevent erosion include (1) adding woody debris such as logs or root wads to stream banks to divert and slow water flow at the water-bank interface, and (2) installing single boulders or groups of boulders along stream banks and into the stream channel to deflect water away from the stream bank and to aid in forming downstream pools. Treatments proposed to improve in-stream trout habitat include the placement of boulders and root wads in the channel to provide cover, slow-water refuge areas, and spawning habitat. All restoration treatments will be engineered to be successful within the maximum and minimum legal water releases from Turquoise lake.

Riparian habitat improvements will be made as needed throughout the 11-mile reach and the Lake Fork and may include installation of livestock exclusion fencing, planting or seeding riparian vegetation, and development of grazing management plans. In some cases, upland treatments may be included to improve upland grazing conditions and protect the restored riparian habitat.

Implementation of this project will be closely coordinated by a group of agencies and stakeholders. The Colorado DOW will design and implement restoration actions on public land and on land where a conservation easement is held by a public agency. For work on private land, the Lake County Conservation District and the NRCS will work in partnership with willing private landowners to plan and facilitate the implementation of restoration work that is consistent with the work being carried out by the Colorado DOW. The NRCS will develop grazing management plans and upland grazing plans where they are needed. Overall, the Trustees are committed to ensuring close coordination by all parties to ensure that restoration work in one segment of the river will complement work done in adjacent segments. The agencies involved with implementation also will coordinate with adjacent landowners and holders of water rights to ensure that the proposed restoration actions do not have a negative impact on those property and water rights.

Project location

Public and private land along the reach of the Arkansas River known as the "11-mile reach" (Industrial Economics, 2006), which extends from the confluence of California Gulch with the Arkansas River downstream to the confluence of the Arkansas River and Twobit Gulch in Lake County, Colorado (Appendix A). The project also will include up to 4 miles of public and private land along the Lake Fork, which is a tributary that provides important habitat for trout and their prey base.

Expected benefits and timeframe of benefits

In-stream habitat restoration treatments in the Arkansas River and Lake Fork are expected to perform the following functions: (1) improve natural river processes and enhance the connection between the river and the floodplain and riparian zone, (2) stabilize banks in a manner that also creates winter habitat and cover for trout, and (3) enhance mid-stream habitats for trout and their prey base (forage fish or invertebrates). These in-stream habitat improvements are expected to provide an immediate

3.3.1 ARKANSAS RIVER IN-STREAM HABITAT RESTORATION *(continued)* TIER 1

benefit to resident and transient trout populations by improving feeding habitat, overhead cover, flow refugia, spawning habitat, and overwinter refuge areas. The habitat improvements also are expected to provide benefits to birds and mammals that feed on fish and aquatic invertebrates. Long-term benefits such as increased trout biomass, increased trout density, and improved trout body condition may not be realized until four to six years after project completion, given that brown trout in the Rocky Mountain region reach sexual maturity at two to three years of age (Adams et al., 2008). Similar habitat restoration projects in other locations observed a peak in trout populations more than six years (two to three generations) after project completion (Hunt, 1976; Binns, 1994). The Trustees expect to quantify improvements to the fishery based on changes over time in trout density and biomass, the availability and quality of spawning grounds, improvements to the forage base, and the number of large adult fish. The Trustees expect to quantify overall benefits to birds dependent on aquatic resources (integrating habitat improvements from the in-stream restoration work and reductions in metals exposure from the remediation work) by comparing the current health of tree swallows to those studied in 1997 and 1998, prior to the remediation and restoration activities.

Brief overview of maintenance and monitoring

Monitoring of the restoration project will take place in the following phases: baseline monitoring before project initiation, implementation monitoring, short-term monitoring, and long-term monitoring. Full details about the monitoring actions and budget will be described in the Monitoring Plan that will be released by the Trustees. This section provides a description of maintenance actions and a brief overview of each monitoring phase.

Maintenance of the project will be coordinated by pre-designated, participating agencies who will be responsible for identifying and documenting any treatment failures during the first 10 years of the project. A project maintenance fund and contingency fund will allow reconstruction and revegetation, if necessary, to ensure that the project continues to provide habitat benefits. For example, plantings that fail within the first two years will be replaced with new vegetation. Because the rivers are constantly moving and changing, the Trustees do not expect habitat conditions to remain frozen in time. Therefore, natural changes in river morphology that affect some of the treatments will not necessarily trigger corrective action. The need for corrective action will be determined by a review committee, including Colorado DOW personnel and Trustee representatives who will examine changes and determine if corrective actions are necessary to maintain habitat benefits.

Baseline monitoring is important because an understanding of the current ecological condition of the project areas is essential for evaluating the success of any proposed in-stream treatments. The Colorado DOW has already been undertaking the baseline quantification of the benthic invertebrate and fish communities along the 11-mile reach in anticipation of project approval.

3.3.1 ARKANSAS RIVER IN-STREAM HABITAT RESTORATION *(continued)* TIER 1

Implementation monitoring will take place as the construction and revegetation work take place and will be focused on ensuring that project implementation is consistent with engineering and revegetation plans. Short-term monitoring (e.g., years 1–2) will focus on evaluating the initial engineering success associated with bank stabilization and in-stream structures as well as evaluating the initial biological response to the treatments. Long-term monitoring will focus on quantifying biological responses to the treatments (such as changes in fish populations). During short-term and long-term monitoring, water quality will be monitored to determine if water quality problems could be limiting the ecological response to the physical habitat improvements.

Additional long-term monitoring will examine tree swallow populations along the upper Arkansas River. Tree swallows have been chosen for monitoring for several reasons. First, they feed on aquatic invertebrates and should show a positive population response to improved in-stream habitat that benefits invertebrates. Second, tree swallows along the upper Arkansas River were assessed for lead exposure and injury as part of the initial NRDA activities in 1997 and 1998 (Custer et al., 2003). A repeated assessment 10–15 years later, after the extensive remediation and restoration have occurred, would provide regulatory and management agencies an assessment of the overall efficacy of those efforts for the upper Arkansas River.

Probability of success

Aquatic habitat restoration utilizing the physical improvements described in Appendix A has been practiced since the 1950s with documented improvements in trout population densities as high as 116% (Binns, 1999). These methods are widely known and accepted in the fisheries community (e.g., Hunt, 1976; Wesche, 1985; Binns, 1994, 1999; Orth and White, 1999; Roni et al., 2002; and Avery, 2004). Thus, the Trustees believe that there is a high likelihood that this project will successfully improve brown trout habitat and increase brown trout populations in the upper Arkansas River. Given the current condition of the habitat along the 11-mile reach and the expected future improvements, the Trustees have previously contended that they expect to observe up to a 40% improvement in fish population metrics compared to current conditions (Lipton, 2007).

Risks to project success result from several issues. There is an ongoing possibility that the concentration of heavy metals, such as zinc and cadmium, in the upper Arkansas River could exceed toxicity thresholds for brown trout fry or trigger avoidance behavior by adult trout under certain weather conditions and during certain times of the year. Ongoing monitoring of water quality will help the Trustees determine if this is posing a problem to the project. Another risk results from the need for treatments to be integrated across both public and private lands. A successful outcome for this project depends on successful integration and coordination across the project area.

Estimated costs

The estimated costs for all in-stream restoration in the 11-mile reach and the Lake Fork (including public and private land work) is approximately $9.7 million. These costs include funding for all in-

3.3.1 ARKANSAS RIVER IN-STREAM HABITAT RESTORATION *(continued)* TIER 1

stream treatments, contingency costs, maintenance, and monitoring. The Colorado DOW expects to contribute $0.8 million to this project. NRCS also will contribute approximately $48,000 plus additional in-kind contributions to the project for engineering review and oversight of restoration work on private land. The LCCD will work with NRCS, CDOW, the Trustees, and private landowners to coordinate funding for the work done on private land.

Environmental and socioeconomic consequences

Improving in-stream habitat in the 11-mile reach and the Lake Fork will improve the ecological functioning of the upper Arkansas River that is essential for brown trout populations and for other fish and wildlife species. The project also will have a positive socioeconomic impact on the community.

Specific biological impacts resulting from this project would include improved water quality (through decreased erosion), improved habitat for fish and wildlife species, and increased aquatic productivity. Improving water quality and habitat in the project areas provides a direct benefit to resources that were injured by releases of hazardous substances at the Site. Remedial actions taken by EPA to reduce metals loading to the upper Arkansas River and to remediate contaminated meadows and fluvial deposits along the 11-mile reach have created the necessary preconditions for success for this in-stream restoration project. There will be some short-term impacts to aquatic habitat due to construction activities, which will likely result in increased sediment suspension and turbidity. Previous projects completed by the Colorado DOW have shown that these impacts, as measured by trout populations, are short-lived (Nicole Vieira, Colorado Division of Wildlife, personal communication, October 13, 2009). The long-term benefits to the aquatic community outweigh any short-term adverse impacts associated with construction. In addition, impacts will be mitigated by halting construction before spawning season for brown trout (beginning in mid-October each year).

Public use and enjoyment of these resources will be improved by this project through improved fishing conditions, based on an expected increase in the size, condition, and population density of brown trout, as well as public enjoyment of enhanced wildlife populations that depend on aquatic resources. The construction activities also may have a positive short-term impact on the local economy through the need to fill construction jobs or obtain materials from local suppliers. During the construction period, there will be short-term negative impacts to fishing access and public enjoyment of the river. This impact will be minimized through the phased implementation schedule, so the entire project area will not be disrupted simultaneously. There also may be short-term air pollution impacts associated with the use of heavy equipment with diesel motors. The construction zone is not located adjacent to populated areas, so this impact is considered to be minimal. The long-term benefits for public use and enjoyment of an enhanced resource and improved fishery outweigh any short-term adverse impacts associated with the construction.

3.3.1 ARKANSAS RIVER IN-STREAM HABITAT RESTORATION *(continued)* TIER 1

Trustee evaluation and proposed allocation

This project is proposed as a Tier 1 project. The project has a strong nexus to the NRDA injury because it will benefit aquatic resources in the 11-mile reach of the Arkansas River, where documented injury to surface water, brown trout, and tree swallows occurred. The in-stream restoration project served as one of the example restoration projects used by the Trustees to quantify natural resource damages in the Arkansas River, as described in the Preliminary Evaluation of Damages (Industrial Economics, 2006). The need for in-stream habitat improvement has been identified in a variety of regional and local resource management and development plans, including the "Restoration Alternatives Report" developed for the upper Arkansas River NRDA case (Archuleta et al., 2003). This project is expected to provide a high flow of ecological services through the project lifetime, because the restoration work will improve aquatic habitat and the natural functioning of the river. The project benefits more than one resource and has benefits that can be measured and verified. The project also provides actual resource improvements with a high ratio of expected benefits to expected long-term costs. The project has a high likelihood of success because the Colorado DOW has demonstrated expertise and a track record of success for implementing in-stream restoration projects. The project has leveraged in-kind and cash funding from the Colorado DOW, NRCS, and the LCCD, but requires natural resource damage funding for successful implementation. The Trustees propose to allocate $8.8 million in settlement funding for this project.

3.3.2 WEED CONTROL IN LAKE AND CHAFFEE COUNTIES TIER 1

Restoration objective

Provide support to the Lake/Chaffee Weed Board to create an early detection/rapid response (EDRR) program for control of emerging weed threats and to purchase new equipment to better target their weed control efforts. See Figure 3.3 for the project logic model.

Project description

Invasive plants threaten the habitat value of riparian areas along the upper Arkansas River and its tributaries and in upland areas in Lake and Chaffee counties. New weed threats can emerge quickly as species are transported by vehicles, livestock, and through transport of contaminated hay or manure. Some recent threats that have been observed in Lake and Chaffee counties include elongated mustard (*Brassica elongate*), orange hawkweed (*Hieracium aurantiacum*), diffuse and spotted knapweed (*Centaurea diffusa* and *Centaurea stoebe*), and plumeless thistle (*Carduus acanthoides*). When new weed threats emerge, there can be a delay until the weed is classified officially as a noxious weed and subject to weed enforcement rules.

This project involves support for developing an EDRR program that can respond quickly and effectively to emerging weed threats to prevent the spread of weeds to additional locations. The program would be managed by the Lake/Chaffee Weed Board. The National Invasive Species Council has identified EDRR programs as high priorities for invasive species control efforts. This program would follow established national guidelines for developing an effective EDRR program that includes coordinated and sustained actions for early detection, rapid assessment, and rapid response (National Invasive Species Council, 2003).

Dedicated funding for an EDRR program in Lake and Chaffee counties would allow weed threats to be treated as soon as they are identified. The program would fund mapping and control efforts and would target invasive species that are newly identified in Lake and/or Chaffee counties or are not yet classified as noxious weeds. Control methods could include targeted herbicide spraying, using a boomless sprayer as appropriate, mechanical control, or other methods as appropriate. All regulations regarding pesticide applications would be followed.

FIGURE 3.3. WEED CONTROL IN LAKE AND CHAFFEE COUNTIES

Restoration actions	Implement an EDRR program in Lake and Chaffee counties to prevent the spread of novel weeds and purchase improved equipment for weed control.
Expected short-term result	Identification, mapping, and control of novel invasions.
Pathway/process	Improved control of novel invasive species benefits native vegetation; decreased herbicide use over the long-term reduces risk to water quality.
Desired long-term results	Native vegetation maintained with minimal impacts from novel invasive species. Water quality preserved with minimal herbicide residues.

3.3.2 WEED CONTROL IN LAKE AND CHAFFEE COUNTIES *(continued)* TIER 1

Part of the funding for this project will be used to purchase a new boomless sprayer for the Lake/Chaffee Weed Board. This equipment provides better control of herbicide application with more targeted spraying capabilities that allows more herbicide to remain on leaves and less to reach the ground surface and, ultimately, surface water and groundwater. The sprayer reduces the total volume of herbicide used and includes a GPS (global positioning system) unit allowing automatic mapping of new or established infestations. In addition to likely use in the newly established EDRR program, this equipment will be used to support other restoration and remedial projects in the Arkansas River watershed, enhancing the effectiveness of all Trustee actions.

Project location

The project location includes any location in Lake and Chaffee counties where newly emergent weed threats have been identified and the property owner provides consent for the weed treatment. Where a species has become well-established in a single location and is difficult to eradicate, the EDRR program might use a strategy of containment to prevent further spread.

In addition to newly emerging threats, the boomless sprayer may be used in any location identified by the Lake/Chaffee Weed Board that requires spraying. Likely locations include the irrigated meadows and fluvial deposits remediated by EPA in 2008–2009 and other lands disturbed by remedial work, including borrow areas, staging areas, and roads that were constructed to support remedial work.

Expected benefits and timeframe of benefits

This project would decrease the risk of new invasive species spreading into additional locations as soon as the program becomes operational. The Trustees plan to fund the EDRR program for an initial period of four years with the hope that new sources of funding would take over and continue the program at that time. There would be long-term benefits to habitat quality from the effective control of new invasive species. Benefits realized by purchase of the boomless sprayer will be realized immediately, as weed control improves, and long-term, as long as the equipment remains in-use. Annual reporting would document the number of acres treated and the species targeted with the EDRR funding.

Brief overview of maintenance and monitoring

During the time of the project, weed control requires a commitment to ongoing maintenance and monitoring. The Trustees expect that the program would be structured so that areas where control efforts take place would be mapped and surveys made in subsequent years to detect if regrowth or spread of the species had occurred. Maintenance actions involve repeating weed control efforts where the weed is found to be present again.

3.3.2 WEED CONTROL IN LAKE AND CHAFFEE COUNTIES *(continued)* TIER 1

Probability of success

The likelihood of success is very high if established guidelines for developing an EDRR program is followed (National Invasive Species Council, 2003). The Lake/Chaffee Weed Board has worked successfully to control weeds in their jurisdiction.

Estimated costs

The estimated cost is $230,000 for four years of EDRR funding and purchase of the boomless sprayer.

Environmental and socioeconomic consequences

Implementing effective weed control will improve riparian and upland habitats. Attacking weeds when populations are still small and easily controlled also minimizes herbicide use and decreases risks to water quality.

Specific biological impacts resulting from this project would include increased cover of native vegetation and decreased cover of novel invasive plants. Targeting weeds during the early stage of invasion will decrease herbicide use and prevent risks to habitat value. This project is expected to have a positive socioeconomic impact on the surrounding community because control of invasive species helps to maintain property values through maintaining the forage quality of ranchland.

In areas with more established weeds, the boomless sprayer will minimize herbicide use, map weed-infested areas and thus help streamline future weed control efforts, and reduce the amount of herbicide reaching the soil, surface water, and groundwater.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 1 project. The project has a strong nexus to the NRDA injury because it will benefit riparian habitat along the Arkansas River and upland habitat, through decreasing the risk of spread of novel invasive species. Additionally, improved weed control in remediated areas will benefit all restoration and remedial actions conducted in Operable Unit 11. The elimination of each novel weed threat through an EDRR program provides significant long-term benefits compared to an alternative scenario where the weeds spread and cause widespread environmental or economic damages. The project has a high likelihood of success because the Lake/Chaffee Weed Board has the capacity to develop and implement this type of program. The Trustees propose to allocate $230,000 in settlement funding for this project.

3.3.3 DINERO TUNNEL WATER QUALITY MONITORING — TIER 1

Restoration objective

Conduct necessary hydrologic and biologic monitoring of the Sugarloaf Mountain area in the Lake Fork watershed to assess changes in water quality and flow conditions attributable to the plugging of the Dinero Tunnel. See Figure 3.4 for the project logic model.

Project description

This project involves providing partial support for hydrologic monitoring of the Sugarloaf Mountain area in the Lake Fork watershed through 2020. The goal of the monitoring is to determine if the installation of the bulkhead in August 2009 to plug the Dinero Tunnel has changed water quality and flow conditions in areas that could be hydrologically connected to the tunnel. Water samples will be analyzed for a range of water quality parameters, likely including pH, specific conductance, acid neutralizing capacity, dissolved metals and major ions, chloride, and sulfate. In addition, measurements of deuterium and oxygen isotopes in water from seeps or springs can be used to help detect the source of that water. New monitoring data will be compared to baseline data to assess what major changes, if any, could be attributed to the Dinero Tunnel bulkhead installation. Biological monitoring of fish populations and fish conditions also will be conducted in conjunction with the hydrologic monitoring to determine if water quality improvements are resulting in improvements to fish populations in the Lake Fork watershed.

The need to conduct this monitoring work was already described in the previous restoration planning document developed by the Trustees, entitled "Restoration Plan and Environmental Assessment for the Tiger and Dinero Tunnels Restoration" (Stratus Consulting, 2009). For this project, the Trustees will provide partial support for a sampling program developed by CMC and USGS, in conjunction with the Lake Fork Watershed Working Group. The sampling program (referred to as the "Sugarloaf BMP monitoring") has received partial funding from the 2009 Colorado nonpoint source program and matching support from USGS, BLM, the Colorado Division of Reclamation Mining Safety, the Colorado DOW, the Lake Fork Watershed Working Group, CMC, and Trout Unlimited – Collegiate Peaks Chapter. The contribution from the Trustees will help provide the remaining amount of funding necessary to implement the full hydrologic monitoring plan during low-flow and high-

FIGURE 3.4. DINERO TUNNEL WATER QUALITY MONITORING – LOGIC MODEL

Restoration actions	Conduct hydrologic monitoring of the Sugarloaf Mountain area in the Lake Fork watershed.
Expected short-term result	Assess whether installation of the bulkhead in the Dinero Tunnel has altered water quality or flow conditions.
Pathway/process	Monitoring result will lead to management changes if necessary (e.g., releasing water through the bulkhead valve).
Desired long-term results	Water quality is protected; wildlife and human health is not put at risk from contaminated seeps or springs.

3.3.3 DINERO TUNNEL WATER QUALITY MONITORING *(continued)* TIER 1

flow conditions and additional funding to continue a subset of this monitoring through 2020.

Project location

Forty-five sample sites will be included in the project from 2010 to 2013 (Figure 3.5); these sites were monitored for baseline conditions by USGS before the bulkhead installation. The sample sites include surface water sites such as springs, geologic features (faults/veins), abandoned draining features associated with historic mining, and some existing groundwater wells in the area. From 2014 to 2020, the project will focus on eight long-term monitoring sites in the Lake Fork and an additional eight sites in the vicinity of the Dinero Tunnel that will be selected based on the results of the 2010–2013 monitoring.

Expected benefits and timeframe of benefits

This project would allow scientists to determine whether water quality is deteriorating upgradient of the tunnel, which could happen if rising water in the mine is discharged through springs or seeps. Sampling also will allow a determination of whether water quality is improving down-gradient of the Dinero Tunnel, as expected. This monitoring is an important part of determining the long-term success of the Dinero Tunnel project, previously supported in part by Trustee funding. The monitoring also will allow adaptive

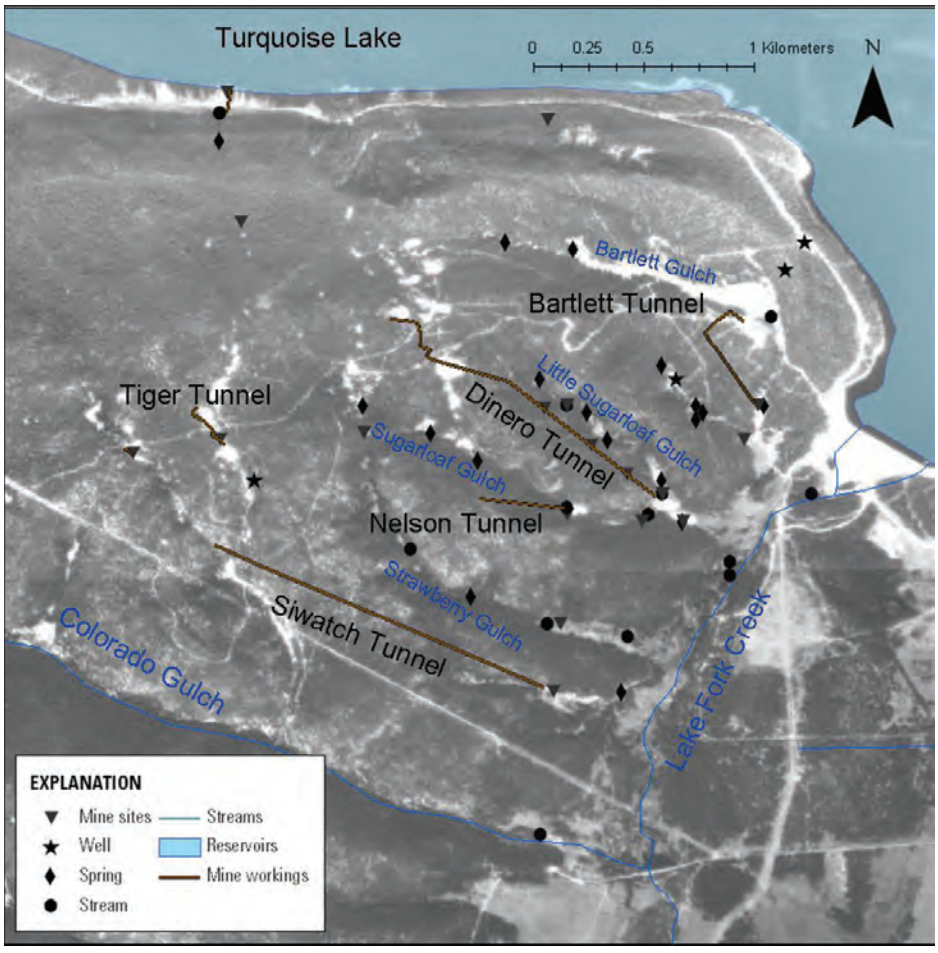


Figure 3.5. Map of Dinero Tunnel area showing 45 sampling sites for the years 2010–2013 study, plus eight additional sites that were monitored during the baseline water quality assessment. *Source: CMC, 2009, Figure 3.*

3.3.3 DINERO TUNNEL WATER QUALITY MONITORING *(continued)* TIER 1

management of the Dinero Tunnel bulkhead to occur (such as releasing water through the valve, if necessary, to decrease water levels and eliminate upgradient seeps or springs). Sampling would take place from 2010 to 2020.

Brief overview of maintenance and monitoring

This project provides part of the necessary monitoring for the Dinero Tunnel project previously funded in part by the Trustees. These sampling activities do not require separate maintenance and monitoring.

Probability of success

The likelihood of success for this project is very high. The project proponents (CMC and USGS) are highly experienced with this type of sampling and analysis and have already conducted the necessary baseline monitoring.

Estimated costs

The total estimated cost for this project is $509,000 from 2010 to 2013, plus $125,000 for monitoring the 16 Lake Fork and Dinero Tunnel sites from 2014 to 2020. The total estimated cost is based on the approximate cost for three years of BMP monitoring in the Lake Fork and 10 years of monitoring for the Lake Fork and Dinero Tunnel.

Environmental and socioeconomic consequences

Conducting a comprehensive monitoring program for the Sugarloaf Mountain area will reduce the risk of unintended discharges (seeps or springs) threatening water quality or harming wildlife. Specific biological impacts resulting from this project includes a decreased risk of wildlife exposure to contaminants, if rising water levels in the Dinero Tunnel result in contaminated seeps or springs. This project is expected to have a positive socioeconomic impact on the surrounding community because it decreases the risk of threats to water quality and increases public confidence in the safety of the Dinero Tunnel bulkhead installation.

Expected benefits and timeframe of benefits

This project would allow scientists to determine whether water quality is deteriorating upgradient of the tunnel, which could happen if rising water in the mine is discharged through springs or seeps. Sampling also will allow a determination of whether water quality is improving down-gradient of the Dinero Tunnel, as expected. This monitoring is an important part of determining the long-term success of the Dinero Tunnel project, previously supported in part by Trustee funding. The monitoring also will allow adaptive management of the Dinero Tunnel bulkhead to occur (such as releasing water through the valve, if necessary, to decrease water levels and eliminate upgradient seeps or springs). Sampling would take place from 2010 to 2020.

3.3.3 DINERO TUNNEL WATER QUALITY MONITORING *(continued)* TIER 1

Trustee evaluation and proposed allocation

This project is proposed as a Tier 1 project because it is a necessary component of the Dinero Tunnel project previously funded by the Trustees. The project has a high likelihood of success because USGS and CMC have the capacity to implement this type of monitoring. The Trustees propose to allocate $165,000 in settlement funding for this project.

3.3.4 EROSION CONTROL ON ROADS

TIER 1

Restoration objective

Reduce erosion from roads to protect habitat and water quality. Where appropriate, create legal and safe transportation options on designated roads and eliminate "non-system" travel. Initial locations identified for this work are the Paddock State Wildlife Area and the Sugarloaf mining district in the Lake Fork watershed. Other locations in Lake County may be identified as well. See Figure 3.6 for the project logic model.

Project description

User-created motorized routes (i.e., "jeep trails") cause erosion and threaten aquatic and wildlife habitat(Figure 3.7). In addition, these informal roads lack drainage structures, so stream channels are sometimes diverted to run down wheel ruts. These problems are prevalent throughout the newly-created Paddock State Wildlife Area in the Leadville Ranger District, where there are numerous user-created motorized routes that are negatively affecting resource management objectives and creating confusion for visitors trying to access the wildlife area.

Similarly, many roads that were constructed in decades past to access mining claims are eroding badly. The Sugarloaf mining district of the Lake Fork watershed has many roads with significant erosion problems, especially those in higher altitude areas east of Lake Fork. Historic mining roads were not designed with consideration of erosion, water flow, or other environmental impacts and, therefore, contribute large amounts of sediment to the Lake Fork. An example of a problem road is the access road to Colorado Gulch above Lake Fork. Other locations in Lake County have similar problems.

This project would involve providing support for road improvement in the Paddock State Wildlife Area, the Sugarloaf mining district, and other areas with similar problems if identified. Specifically, in the Paddock State Wildlife Area, the USFS would work with Colorado DOW and BLM to designate official system routes for travel and to eliminate and rehabilitate non-system routes. The project would provide funding to

FIGURE 3.6. EROSION CONTROL ON ROADS – LOGIC MODEL

Restoration actions	Develop a planning process and implement actions to eliminate non-system travel and rehabilitate informal roads in the vicinity of the Paddock State Wildlife Area. Implement erosion control actions on high-altitude roads in the Lake Fork watershed and in other areas if identified.
Expected short-term result	Travel consolidated on designated routes; non-system travel is minimized or eliminated. Road improvements occur.
Pathway/process	Closure of non-system routes and improvements to roads decrease erosion and sedimentation and minimize wildlife disturbance.
Desired long-term results	Water quality improved in streams and in the Arkansas River; sensitive aquatic species protected; wildlife populations increased.

3.3.4 EROSION CONTROL ON ROADS *(continued)* TIER 1

complete a planning process and EA that would address obvious non-system routes that need to be obliterated, as well as addressing access and travel issues throughout the area. The project also would provide partial funding for implementation of road closure and road improvements in the Paddock State Wildlife Area, with the remainder of the implementation expected to be provided by project partners. This project also would provide funding for road improvements in the Sugarloaf district of the Lake Fork watershed and other areas if identified. Implementation would include construction of appropriate drainage structures so that streams were no longer diverted onto roads. The project also would provide public education on the importance of remaining on system routes to minimize disruptions to wildlife and to reduce erosion and sedimentation into the Arkansas River.

Project location

The project locations would be (1) on the east side of the Leadville Ranger District including the Paddock State Wildlife Area, and (2) in the Sugarloaf mining district of the Lake Fork watershed. Additional locations may be identified with input from relevant agencies and stakeholders.

Expected benefits and timeframe of benefits

This project would provide environmental benefits as soon as the non-system road closure and rehabilitation occurs, which is expected on the Paddock State Wildlife Area to take place in 2013 after the conclusion of the planning and NEPA process. Improvements may occur sooner in the Sugarloaf mining district and would begin when road conditions were fixed. Expected benefits include improved public safety, reduced sedimentation, and improved water quality in the Arkansas River and in the Lake Fork (e.g., Dunnigan et al., 1998). Aquatic resources in small streams would benefit from no longer being diverted onto jeep tracks. Wildlife resources would benefit as well from decreased habitat fragmentation and disturbance. There would be long-term benefits to habitat quality from decreased erosion and wildlife disturbance.

Figure 3.7. Example of user-created "non-system" route on the Leadville Ranger District. Closure and rehabilitation of these non-system routes would enhance habitat for threatened, endangered, and sensitive species; improve water quality in the headwaters of the Arkansas River; provide for the safety of recreational users; and eliminate trespass issues on surrounding private land.

3.3.4 EROSION CONTROL ON ROADS *(continued)* TIER 1

Brief overview of maintenance and monitoring

Maintenance of the newly designated system routes will be the responsibility of USFS and will be incorporated into their normal road maintenance programs. Maintenance of road closures will be done by rangers who will post signs, monitor public use, and conduct additional closure actions if necessary. Monitoring will take place in phases and will include monitoring of travel on system and non-system routes and qualitative monitoring of water quality and wildlife presence.

Probability of success

The likelihood of success is very high. The USFS has had success in the Salida Ranger District obtaining public support for closure of non-system routes because of the improved hunting opportunities that result from a decrease in disturbance from motorized vehicles. The techniques for rehabilitating closed roads are well established and can result in the successful recovery of forested habitat. The techniques for improving highly eroding historic mine roads are well established as well. The USFS Leadville Ranger District has the personnel and capacity necessary to implement this project.

Estimated costs

The estimated total cost for this project is $200,000 for planning and contributions to implementation partnerships.

Environmental and socioeconomic consequences

Closing and rehabilitating non-system roads will improve aquatic and upland habitats and benefit water quality and wildlife.

Multiple radiotelemetry and satellite locations suggest that the federally threatened Canada lynx moves through the proposed project area. Potential habitat for the federally endangered Uncompahgre fritillary butterfly exist at higher elevations in the project area. There are two known breeding boreal toad populations in the project area and there was a leopard frog sighting documented in 2009. Specific biological impacts resulting from this project would include decreased disturbance to the Canada lynx and Uncompahgre fritillary butterfly. Other wildlife that would benefit include bighorn sheep, northern leopard frog, and boreal toad, which are classified as sensitive species in Region 2 of the USFS. Big game species in the area include mule deer, elk, and black bear – these species all would benefit from decreased disturbance by motorized vehicles on non-system roads and from decreased habitat fragmentation. Aquatic species, including boreal toads, northern leopard frogs, and other aquatic species would benefit from reduced sedimentation, reduced direct impact from being run over, and increased aquatic connectivity (proper planning of system roads would include culverts or other adequate structures to facilitate passage). Many aquatic species would benefit from decreased erosion into headwater streams, the Lake Fork, and the Arkansas River.

This project would have positive socioeconomic consequences because it would decrease sediment into the Lake Fork and Arkansas River, thereby benefiting the trout fishery and helping to maintain

3.3.4 EROSION CONTROL ON ROADS *(continued)* TIER 1

good quality surface water that is used as a drinking water supply. The current non-system routes also pose a threat to community safety because the trails are extremely rutted or washed out and exceed safe grades for ascent and descent. Many of these routes also facilitate trespass onto adjacent private property. Closure and rehabilitation of these routes would improve safety and decrease trespass.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 1 project. The project has a strong nexus to the NRDA injury because it will benefit aquatic habitat in the Lake Fork and Arkansas River and upland habitat for a large variety of wildlife species. The project improves habitat at the Paddock State Wildlife Area, which was created as a result of an easement obtained on the Moyer Ranch. The Trustees had identified obtaining an easement on the Moyer Ranch as an important restoration project to benefit terrestrial resources in their Preliminary Estimates of Damages (Industrial Economics, 2006). Although the easement was put into place without Trustee funding, this project will provide a long-term improvement for aquatic and terrestrial habitats associated with the easement. This project also benefits aquatic habitat in the Lake Fork River and complements the previous work conducted by the Trustees in the Sugarloaf mining district at the Tiger and Dinero tunnels to improve water quality in the Lake Fork River by reducing metals loading. This project provides significant long-term benefits for a low cost. The project has a high likelihood of success because the USFS Leadville Ranger District has experience in developing and implementing this type of project. The Trustees propose to allocate $200,000 in settlement funding for this project.

3.3.5 HABITAT PROTECTION (EASEMENTS, ACQUISITION, OR LAND EXCHANGE) TIER 1 & 2

Restoration objective

To protect land in high-priority locations in the upper Arkansas River watershed to preserve natural resource benefits and avoid the risk of development. See Figure 3.8 for the logic model.

Project description

Wildlife habitat in riparian and upland areas in Lake County is threatened by development, mining, and other land uses that can have negative impacts on habitat value. The goal of this project is to preserve lands and habitats that provide important benefits to natural resources or increase opportunities for natural resource-based recreation. Preservation may be accomplished through land acquisition, obtaining a conservation easement in perpetuity, or a land exchange that would deed land to an appropriate agency.

The Trustees are undertaking a systematic feasibility analysis to identify high priority parcels for land tenure adjustment. This process will be undertaken with opportunities for public review and comment on the resource benefits and risks associated with different parcels. Final selection of parcels will be based on an analysis that considers a variety of factors, including:

- Context of surrounding land use and land protection status (e.g., Does the parcel provide important connectivity to other protected land or habitat?)
- Whether the parcel has already been identified as a high priority for protection in existing local or regional land-use planning documents (e.g., the Lake County Open Space Initiative Ecosystem Management Plan, Colorado State Parks planning documents)
- Type and condition of natural resource benefits provided by the parcel
- Nature and likelihood of development threats
- Cost of protection, based on the best mechanism for land protection for that parcel (acquisition, easement, or land transfer).

After completing this analysis, the Trustees expect to identify high priority parcels for

FIGURE 3.8. HABITAT PROTECTION – LOGIC MODEL

Restoration actions	Protect habitat at risk of development in the upper Arkansas River watershed, using conservation easement, fee-title acquisitions, or land exchange.
Expected short-term result	Increase the amount of protected land held in the public trust.
Pathway/process	More land available for wildlife use and potentially public use for natural resource-based activities.
Desired long-term results	Increase the area of protected habitat with subsequent improvements in wildlife populations, riparian habitat quality, and opportunities for natural resource-based public uses.

3.3.5 HABITAT PROTECTION *(continued)* TIER 1 & 2

protection and will provide funding or partial funding (where matching funds exist) to complete land transactions. The Trustees will conduct transactions only with willing participants.

The Trustees will ensure that all land transactions conform with their land transaction policy (Appendix B). Land acquired will be deeded to the appropriate entity (local, state, or federal government; land trust; or conservation nongovernmental organizations) after following the specific procedures and standards required by each entity. Payment in lieu of taxes (also called Impact Assistance Grant payments) will be made on land deeded to government parties.

Because the primary purpose of land preservation is to protect natural resource values, public access may not necessarily be permitted in all portions of acquired properties. The Trustees expect that some parcels may be managed for public access, through an entity such as Colorado State Parks (if the land is acquired) or through a recreational easement with a willing landowner. The nature of public access will be determined on a case-by-case basis.

The Trustees expect to identify opportunities for improved natural resource management on land parcels that have been protected with NRDA funding. The Trustees have designated funding that can be used to enhance resource values, as appropriate. For private land protected with conservation easements, the Trustees will provide funding for habitat management planning to ensure that the habitat values of the protected land are maintained (see the project in Section 3.3.10 – Habitat management for land protected by Trustees).

Project location

Various locations throughout the upper Arkansas River Basin, including properties along the upper Arkansas River and tributaries, will be considered. Riparian habitats and upland habitats that are similar to those impacted by mine waste and mining activities will be given highest priority.

Expected benefits and timeframe of benefits

Land protection arrangements, such as conservation easements or land acquisitions, are important tools for preserving habitat used by wildlife and for improving the quality of natural resource-based recreational activities. For example, protection of parcels that are contiguous with other areas of protected land can protect movement corridors that wildlife use for food, travel, mating, and rearing their young. Increasing the amount of protected land will improve wildlife habitat and benefit wildlife populations throughout the upper Arkansas River Basin.

Parcel acquisition can occur as soon as all the necessary planning documents are in place, a process that is likely to take three to six months after the Trustees have identified preferred targets for acquisition and authorized funding. The benefits of land acquisition accrue over the time period when the land would have been threatened by development.

3.3.5 HABITAT PROTECTION *(continued)* TIER 1 & 2

Brief overview of maintenance and monitoring

Maintenance and monitoring will be the responsibility of the future holding agency responsible for that parcel. Lands protected by conservation easements will be inspected on a yearly basis at a minimum to ensure that the terms of the easement are being upheld. For acquired land, land management activities will take place consistent with the procedures of the acquiring entity, such as Colorado State Parks.

Probability of success

The likelihood of success for this project is very high. Organizations like the LCOSI and Colorado State Parks have already identified parcels that they consider high priorities for acquisition, suggesting that there are appropriate opportunities which are expected to meet Trustee needs. Agencies and nonprofit organizations that are likely to partner with the Trustees for this effort have experience and expertise in developing land protection arrangements, with appropriate legal protections.

Estimated costs

The estimated costs for protection of specific parcels will not be known until the Trustees complete their feasibility analysis.

Environmental and socioeconomic consequences

Land protection will contribute to the protection of important habitat for wildlife, likely including sensitive species. Land protection also is likely to enhance habitat connectivity, thus preserving movement corridors. In some cases, land acquisition may have beneficial impacts on surface water or groundwater, through protecting water quality. No adverse environmental impacts are expected from land protection.

Land protection is likely to have a positive socioeconomic impact on the local community. Tourism and recreation are important industries in Leadville, and the protection of important land parcels contributes to the natural resource values that attract tourism and recreation to the mountain environment. In addition, it is likely that some of the acquisitions will have public access, which will increase recreational opportunities.

Trustee evaluation and proposed allocation

This project is proposed as both a Tier 1 and a Tier 2 project. The project has a strong nexus to the NRDA injury because it provides the opportunity to protect parcels that provide resource benefits for the same type of resources as those that were injured. Existing planning processes have identified land acquisition as a high priority in the Arkansas River Valley and in the watershed. The Trustees expect to allocate approximately $650,000 for land protection as part of the first tier of project funding. The Trustees estimate allocating $1,150,000 for land protection as part of the second tier of project funding. In addition, the Trustees have designated $150,000 of the funding provided in both Tier 1 and Tier 2 ($300,000 total) for habitat enhancements on protected land where required. Additional funding may be allocated as part of the second tier of project funding, depending on funding availability and the opportunities identified during the feasibility analysis.

3.3.6 NATIVE PLANT PROPAGATION AT HAYDEN RANCH

TIER 2

Restoration objective

To develop a facility at the Hayden Ranch Headquarters property for propagation of native plants for use in forestry and wetland remediation and restoration activities. See Figure 3.9 for the project logic model.

Project description

CMC – Timberline Campus and the Lake County Open Space Initiative have completed a preliminary feasibility analysis for the development of a "Center for Sustainable Agronomy Research" at the Hayden Ranch Headquarters property, which is owned by the college (Conlin Associates, 2009). The center would include a greenhouse for initial plant propagation and outdoor nursery plots where plants would be adapted ("hardened") to the local environmental conditions and grown to a size where they can be used in reforestation and remediation projects in the upper Arkansas River Valley. This project would provide partial funding for the study, design, and construction of the greenhouse and nursery facilities. The center would also include a community garden, but that part of the project is not included in the request for natural resource damage funding.

Currently, there is no local source of root stock and nursery seedlings for species that are adapted to the local conditions of the upper Arkansas River Valley. There is a current need for wetland species for remedial projects in areas impacted by historic mining activities. For example, the construction of sulfate reducing bioreactors for final treatment of any residual contaminated water is anticipated at the Tiger and Dinero tunnel remediation sites (previously supported by natural resource damage funding) (Stratus Consulting, 2009). These bioreactors require wetland vegetation to be established and then replaced at regular intervals as part of the maintenance of the bioreactors. Currently, wetland vegetation either needs to be harvested from existing wetlands, which damages current wetlands and poses environmental and regulatory problems, or they have to be purchased from nurseries along the Front Range, which is cost prohibitive. A local source of wetland plants would increase the likelihood of success for the Tiger and Dinero tunnels projects and other similar remediation projects. There also is an anticipated future need for root stock and saplings of coniferous and deciduous forest species to revegetate areas that are likely to be impacted by mountain pine beetle.

FIGURE 3.9. NATIVE PLANT PROPAGATION AT HAYDEN RANCH – LOGIC MODEL

Restoration actions	Develop a greenhouse and nursery facility to propagate locally-adapted forestry and wetland plants.
Expected short-term result	Forest and wetland species are available for remediation and restoration activities.
Pathway/process	Using inexpensive, locally-adapted species increases the success of reforestation and remediation projects.
Desired long-term results	Water quality is protected; wildlife and human health is not put at risk from contaminated seeps or springs.

3.3.6 NATIVE PLANT PROPAGATION AT HAYDEN RANCH *(continued)* TIER 2

A preliminary feasibility analysis for the project has been completed and detected no major impediments to the project (Conlin Associates, 2009). CMC has committed to providing the land to construct the infrastructure for this project and to maintain and operate the facility as an off-campus program. The greenhouse would be constructed in a manner that would be consistent with the historic conservation easement on the site. Surface water from Box Creek is the planned source of irrigation water for the greenhouse, saturated wetland plots, and the tree nursery. The project has received initial letters of support from the Lake County Board of County Commissioners, the Board of Water Works of the City of Pueblo, and the City of Aurora Water Department to work cooperatively to identify and secure water rights and/or storage capacity that would be needed for the project. The wetland plot is planned for a ½ acre pasture adjacent to Box Creek, where surface water flowing from Box Creek would then re-enter the Box Creek drainage through a pond at the lower end of the pasture.

The project proponents require funding for the study design phase of project planning, which would develop the final scope for project elements, submit permit applications, and complete architectural design and engineering. Funding for construction is also necessary.

Project location

The project is located on the Hayden Ranch Headquarters, along the Arkansas River within the 11-mile reach of the Arkansas River.

Expected benefits and timeframe of benefits

This project would increase the likelihood of success of restoration activities in the upper Arkansas River Valley by providing nursery stock that is adapted to local conditions. Currently, vegetation is transported from the Front Range at greater cost and without the benefit of local adaptation. Benefits will be realized when the facility is constructed, which is likely to be 3–5 years into the future.

Maintenance and monitoring

Successful management of the greenhouse and nursery complex would require ongoing O&M activities, which CMC has committed to provide. CMC intends to use these facilities as off-campus classrooms and would operate these facilities to provide their students with experiential learning and research opportunities.

Probability of success

The likelihood of success for this project is moderate. Development of the project plan has a high likelihood of success but the likelihood of obtaining funding for full implementation of the project is not known at this time. CMC has successfully obtained funding for other campus initiatives, so there is a reasonable likelihood that they will be able to arrange implementation funding for this project as well, if additional sources of funding beyond the natural resource damage contribution are required. Initial commitments of support for obtaining the water necessary for this project suggest that there is a good likelihood of success for obtaining the year-round water rights necessary to support the project; however, some risk remains with respect to water rights.

3.3.6 NATIVE PLANT PROPAGATION AT HAYDEN RANCH *(continued)* TIER 2

Estimated costs

An initial cost estimate of $100,000 has been developed for the Phase 1 planning effort, through an analysis by Conlin Associates, in conjunction with CMC. The total cost for implementation will be developed during the Phase 1 planning effort.

Environmental and socioeconomic consequences

This project will have positive environmental benefits by increasing the likelihood of success of revegetation efforts in the upper Arkansas Valley. "Bioreactors" and other constructed wetlands for treating acid mine drainage will have a greater likelihood of success if they are planted with native plants adapted to local conditions. Local nursery stock will also be of great importance for revegetation efforts that are expected to be necessary in the next five years as mountain pine beetle has a greater impact on the Leadville area. In addition, improving revegetation efforts on mine spoils in forested habitat will protect the forest ecosystem and further protect aquatic habitat and water quality by reducing erosion. The project may have a negative impact on water levels in Box Creek due to consumptive uses involved with greenhouse operations (this impact has not yet been fully quantified).

This project also will have positive socioeconomic consequences. The facilities would help train students in important agronomy and forestry skills that would help improve their likelihood of gaining employment. A local source of seedlings would help revegetate forests that are impacted by mountain pine beetle, which would have a positive impact on tourism and quality of life in the region. The sale of plants from the nursery also would have a positive impact on the budget of CMC. The project would be conducted in a manner that is consistent with the historic conservation easement on the property and with the scenic conservation overlay zone in the Lake County Land Development Code. Thus, the project is not expected to have a negative impact on cultural values. Finally, the greenhouse is intended to function on renewable energy, so it would not increase the carbon footprint of the college.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 2 project. The project has a nexus to the NRDA injury because it would provide the wetland vegetation to treat contaminated surface water and groundwater and would provide forest seedlings to benefit upland resources. CMC has the forestry and agronomic expertise to successfully manage the greenhouse and nursery complex. The greatest risks to the project are that full funding may not be obtained to complete the project according to its full project plan or that water rights may not be available. The project has received letters of support from the Colorado State Forest Service and the USFS, who have indicated their willingness to serve as project partners. The Trustees propose to allocate $200,000 in settlement funding for planning ($100,000) and future implementation ($100,000) of this project, if that level of funding is available after Tier 1 projects are funded.

3.3.7 DEVELOPMENT AND IMPLEMENTATION OF AN EE/CA FOR THE VENTURE MINE AND SUGARLOAF MINE DUMPS

TIER 2

Restoration objective

Develop and implement an EE/CA for the Venture Mine and Sugarloaf Mine dumps. See Figure 3.10 for the project logic model.

Project description

The Venture Mine complex is directly downstream of the Tiger Mine complex, between the Tiger Mine and the Arkansas River. It is the only remaining area in the Lake Fork watershed where waste rock has not been cleaned up and is a major contributor of heavy metals contamination into the Little Frying Pan Gulch tributary. A key step in the cleanup process is the development of the EE/CA. In the past, BLM has had a difficult time securing funding to develop the EE/CA, but once it is completed, they have been successful in acquiring the funding needed to implement the preferred restoration actions.

Restoration work completed at the Venture Mine and in the Sugarloaf Mine dumps would be similar to that completed at the Tiger and Dinero tunnels (see BLM, 2006a, 2006b; Stratus Consulting, 2009). The restoration actions would be designed to break hazardous substance pathways to natural resources at the Venture Mine and Sugarloaf Mine dumps.

Restoration actions (based on the work completed at the Tiger and Dinero mines) likely would include elimination of waste rock dumps and acid-mine drainage pathways by construction of control structures to divert clean surface water and clean shallow groundwater away from waste rock piles, and relocation and capping of waste piles in an on-site repository. The steps involved in designing and implementing the restoration work include identifying and designing a repository site for mine waste piles, preparation of the repository site, relocation of mine waste piles to the repository, reclamation of the mine waste sites including revegetation and stream restoration, and long-term O&M of the site.

Project location

Venture Mine and Sugarloaf Mine dumps, Lake Fork watershed.

FIGURE 3.10. DEVELOPMENT AND IMPLEMENTATION OF AN EE/CA FOR THE VENTURE MINE AND SUGARLOAF MINE DUMPS – LOGIC MODEL

Restoration actions	Development and implementation of an EE/CA to contain mine waste in a repository.
Expected short-term result	Development of an EE/CA allows funding to be obtained for implementation of the preferred actions.
Pathway/process	Restoration actions isolate contaminant sources.
Desired long-term results	Aquatic habitat and associated terrestrial habitat quality are improved; metals loading to the Lake Fork and the Arkansas River are reduced.

Expected benefits and timeframe of benefits

This project will benefit natural resources in the Lake Fork watershed and the Arkansas River. Aquatic habitat will benefit, leading to increases in fish populations. Aquatic resources other than fish and terrestrial resources and wildlife that depend on the aquatic environment will also benefit from these restoration actions.

Benefits will be realized starting immediately after restoration actions are completed. Diverting clean water away from the mine waste will have an immediate effect on the downstream environment by reducing or eliminating the last remaining source of contaminated surface and shallow groundwater in the Lake Fork watershed. Containing mine waste contamination will remove the ongoing source of contamination from the watershed, leading to an immediate reduction in contaminant concentrations found in the environment and a longer-term, gradual reduction as already-contaminated resources move through the environment.

Maintenance and monitoring

Maintenance and monitoring will be conducted to ensure that restoration actions are effective and remain in place. Long-term activities will include monitoring the repository, monitoring the restored site, and monitoring water quality in Little Frying Pan Gulch.

Probability of success

The types of reclamation and restoration proposed at the Venture Mine and Sugarloaf Mine dump sites have been employed successfully at nearby mine waste sites in the Lake Fork watershed. The techniques proposed are well-established and are likely to be highly successful at reducing the contaminant load from these sites that reaches Little Frying Pan Gulch and, ultimately, the Arkansas River. The risk for this project is that development of the EE/CA will not lead to implementation of the restoration actions.

Estimated costs

The estimated total cost to develop and implement the EE/CA for the Venture Mine and Sugarloaf Mine dumps is $400,000. BLM expects to obtain partial funding from the Colorado Section 319 nonpoint source program ($150,000) and from in-kind services ($50,000).

Environmental and socioeconomic consequences

Improving water quality in the Lake Fork watershed will improve habitat for fish and wildlife species, increase aquatic productivity, and provide a direct benefit to injured resources similar to those resources and injuries that occurred in the upper Arkansas River. Additionally, improving habitat in the Lake Fork watershed will lead to improved habitat quality in the upper Arkansas River. Construction activities will lead to some short-term impacts to the environment, resulting from the presence and use of construction equipment. Impacts may include short-term increases in erosion

3.3.7 DEVELOPMENT AND IMPLEMENTATION OF AN EE/CA FOR THE VENTURE MINE AND SUGARLOAF MINE DUMPS *(continued)*

TIER 2

and sedimentation, physical disturbance, and equipment-related impacts. The long-term benefits of improved water quality outweigh any short-term adverse impacts associated with construction.

Public use and enjoyment of these public resources will be improved as a result of these restoration actions by improving surface water and groundwater quality, improving aquatic habitat, improving fishing, and improving habitat in the Lake Fork watershed for all wildlife. Construction activities may have a short-term positive impact on the local economy by providing construction jobs and obtaining materials from local suppliers. However, construction activities also may have a short-term adverse impact on public use and enjoyment as a result of short-term air-pollution associated with heavy equipment use. The long-term benefits for public use and enjoyment outweigh any short-term adverse impacts associated with construction activities.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 2 project. The project has a strong nexus to the NRDA injury because it benefits aquatic resources in Little Frying Pan Gulch and the Lake Fork watershed, which are tributaries to the Arkansas River. The natural resources and associated injuries in the Lake Fork watershed are similar to those documented in the Arkansas River. This project has a high likelihood of success because BLM has experience and a positive track record of success for mine reclamation projects. The Trustees propose to allocate $200,000 in settlement funding for this project, funding will be used to develop the EE/CA and to support implementation work.

3.3.8 HAYDEN RANCH REVEGETATION

TIER 2

Restoration objective

To seed 222 acres of the Hayden Ranch with native vegetation. See Figure 3.11 for the project logic model.

Project description

BLM will seed 222 acres of the Hayden Ranch with native vegetation. The native vegetation in this area typically consists of a mountain sagebrush (*Artemesia tridentata*) community; common species associated with this community include forbs such as silvery lupine (*Lupinus argenteus*), Nuttall's larkspur (*Delphinium nuttallianum*), hairy goldenaster (*Heterotheca villosa*), and arrowleaf balsamroot (*Balsamorhiza sagittata*) and graminoids such as Sandberg bluegrass (*Poa secunda*), muttongrass (*Poa fendleriana*), Indian ricegrass (*Oryzopsis hymenoides*), onion grass (*Melica* spp.), and prairie junegrass (*Koeleria macrantha*) (Colorado Natural Areas Program et al., 1998). The goal for the seeding project is to return this land to a natural vegetative community. Planting will most likely be conducted using a drill-seeding method; a disc seeding method may also be used if needed. Seedlings will not be irrigated. A certified weed-free seed supplier will be identified. Ideally, BLM will use their preferred, high-standard seed supplier.

Project location

The project is located on 222 acres on the north side of the Hayden Ranch property, along the Arkansas River within the 11-mile reach of the Arkansas River (Figure 3.12).

Expected benefits and timeframe of benefits

Planting native seeds benefits upland habitat for wildlife and helps minimize the potential for non-native plant species to become established. Native habitat attracts desirable native wildlife such as elk and provides forage and protection for these species. Additionally, healthy native plant communities can help minimize erosion, improving in-stream water quality.

Benefits will be realized within the first year of planting, as plants become established. Benefits continue into the future as natural reproduction and succession further establish native species and improve habitat conditions.

FIGURE 3.11. HAYDEN RANCH REVEGETATION – LOGIC MODEL

Restoration actions	Seed 222 acres of the Hayden Ranch with native vegetation.
Expected short-term result	The cover of native vegetation increases.
Pathway/process	Increased cover of native vegetation restores native habitat, attracts wildlife species, and improves overall ecological function.
Desired long-term results	Restored habitat helps prevent erosion, minimizes the risk that invasive plant species will become established, and attracts a broad array of wildlife, including elk.

3.3.8 HAYDEN RANCH REVEGETATION *(continued)*

TIER 2

Maintenance and monitoring

The site will be monitored using photo documentation to evaluate growth and the need for weed control. A livestock exclusion fence will be erected for one to two years; after that, the site will be open to managed grazing.

Probability of success

Moderate to high. The seeded area may require weed control and will require livestock exclusion fencing for the first one to two years after planting. Once the native seedlings are established, the site will require little maintenance and provide high-quality native habitat.

Estimated costs

$20,000 including ground preparation and seed application. The cost of livestock exclusion fencing will be comparable to the cost of fencing that will be part of the those costs for the Arkansas River in-stream habitat restoration project, approximately $2.20 per foot of fencing. The BLM will provide in-kind services at a value of approximately $5,000. Maintenance and monitoring costs will be minimal.

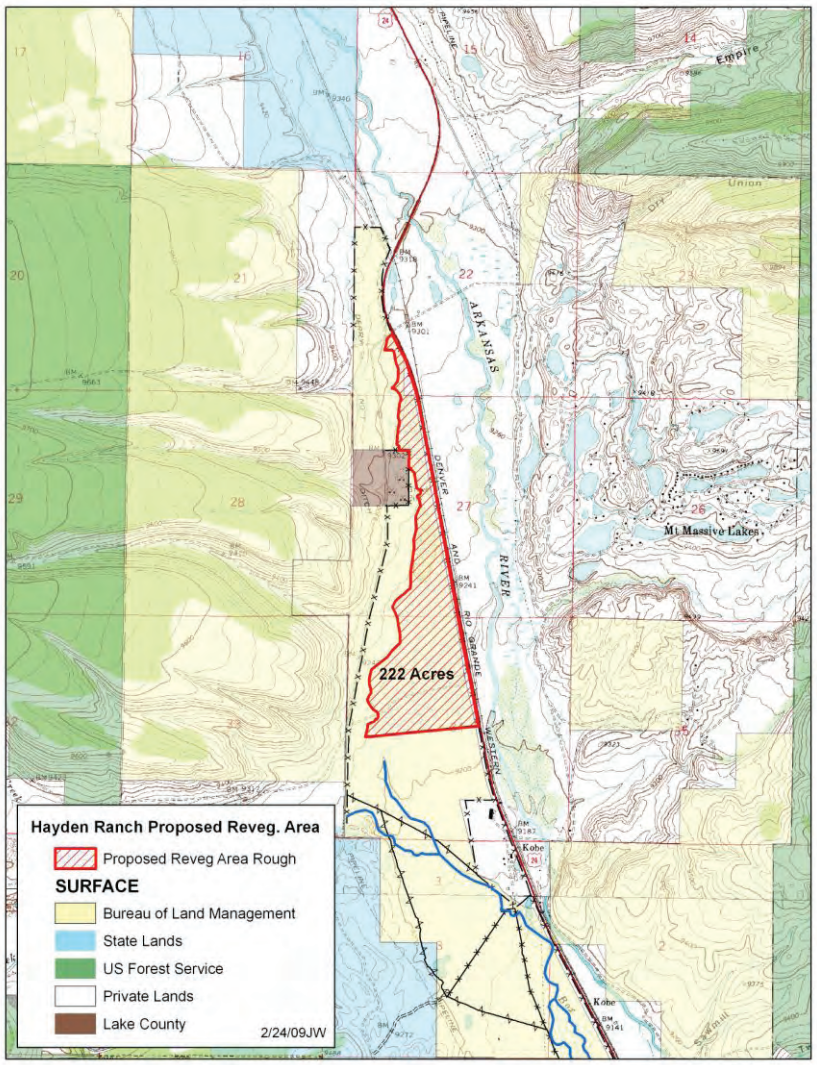


Figure 3.12. Map showing the location of the Hayden Ranch seeding project in relation to federal and private land holdings.
Source: John Smeins, BLM.

Environmental and socioeconomic consequences

This project would have positive environmental and socioeconomic consequences.

Specific biological impacts resulting from this project would include improved habitat for wildlife and improved water quality through decreased erosion. Maintaining good quality habitat for elk and other wildlife provides a positive socioeconomic benefit by providing good hunting conditions and wildlife viewing.

3.3.8 HAYDEN RANCH REVEGETATION *(continued)* TIER 2

Trustee evaluation and proposed allocation

This project is proposed as a Tier 2 project. The project has a nexus to the NRDA injury because it benefits upland resources in the 11-mile reach of the Arkansas River, where documented injury to upland natural resources was reported. This project has a high likelihood of success because BLM has experience and a positive track record of successfully planting and managing native vegetation in areas with degraded habitat. The Trustees propose to allocate $20,000 in settlement funding for this project, if that level of funding is available after Tier 1 projects are funded.

3.3.9 CANTERBURY TUNNEL REHABILITATION

TIER 2

Restoration objective

To restore the Canterbury Tunnel as a major water supply for the Parkville Water District. See Figure 3.13 for the project logic model.

Project description

The Canterbury Tunnel was constructed in 1924 with the intention that it would help drain several of the active mines in the Leadville area and improve mine operations. Although the tunnel was not successful for that purpose, beginning in the early 1960s, the Leadville Water Company (a predecessor to the current Parkville Water District) used groundwater from the tunnel as a clean source of water for the city of Leadville. The Canterbury Tunnel served as an important source of drinking water for Leadville because the district had a water right allowing it to use 600 gallons per minute (3.2 acre-feet per day), out of a total flow of 1,500 gallons per minute from the tunnel (Wibbenmeyer, 2007). The tunnel also has a constant temperature of approximately 54°F (Greg Teter, General Manager, Parkville Water District, personal communication, November 9, 2009). This water helped alleviate two difficult operational problems for the Parkville water system – low surface flow in Evans Creek in the winter (the major surface water supply for the system), and cold surface water temperatures that result in frozen water mains in the winter.

Beginning in 2000, support structures in the tunnel began to fail, causing intermittent cave-in events that reduced the flow from the tunnel portal and increased the turbidity of the water. The Parkville Water District stopped using water from the tunnel in 2002. Since losing this source of water, Parkville is again forced to cope with water shortages in the winter and frozen water lines, which result in a loss of service and high repair costs. For example, a block of frozen water mains in 2007 cost over $50,000 to restore service.

A study completed by USGS (Paschke et al., 2008) determined that the Canterbury Tunnel did not have a hydrologic connection to the Leadville Mine Drainage Tunnel and therefore the collapse in the Canterbury Tunnel was not increasing water levels in the Leadville Mine Drainage Tunnel. This study also provided an overview of four drilling options that could restore water supply from the Canterbury Tunnel. The Parkville Water District has determined that a vertical well drilled into the tunnel with a pipeline to the existing Evans Gulch Treatment Plant

FIGURE 3.13. CANTERBURY TUNNEL REHABILITATION – SIMPLIFIED LOGIC MODEL

Restoration actions	Construct a well and pipeline to pipe water from the Canterbury Tunnel to the Parkville Water District.
Expected short-term and long-term result	Restore a flow of groundwater to the water treatment plant that provides a clean, sustainable supply of drinking water to Leadville (Parkville Water District), which also reduces the risk of water main freezing.

3.3.9 CANTERBURY TUNNEL REHABILITATION *(continued)* TIER 2

would be the most practical solution for regaining access to drinking water from this source. This project would resolve the lack of adequate surface flow in the winter from Evans Creek and the cold surface water temperatures that result in frozen water mains. The district is actively seeking funding for this project because current water supplies are inadequate for the winter and would be unable to accommodate future growth and development in Leadville.

Project location

The project is located at the Canterbury Tunnel, which is approximately two miles to the northeast of the downtown area of Leadville, Colorado (Figure 3.1).

Expected benefits and timeframe of benefits

The benefit of this project is the development of an additional drinking water resource for the city of Leadville that also provides protection against water mains freezing. Benefits would occur as soon as the project came on-line and would be expected to last indefinitely. The project would likely take approximately one year to complete after funding is made available.

Maintenance and monitoring

Maintenance of the pump and groundwater well would be the responsibility of the Parkville Water District. The pump and well would be part of the routine maintenance activities of the district and can be accommodated within existing operations budgets.

Probability of success

The probability of success for this project is high. The technical feasibility of drilling through bedrock to reach the Canterbury Tunnel is high, if the appropriate contractor is selected. This option has the lowest risk, compared to other alternatives that involved drilling through the collapsed sections of the tunnel.

Estimated costs

Parkville Water District estimates that the cost of the project will be $2 million. They expect to receive $500,000 in funding from the Colorado Department of Local Affairs.

Environmental and socioeconomic consequences

This project is expected to have minimal environmental impacts on surface resources. The pipeline would need to be routed through areas that avoid sensitive habitats. The project results in beneficial use of a groundwater resource that is recharged through snowmelt (Paschke et al., 2008).

This project provides significant socioeconomic benefits to the city of Leadville. The Parkville Water District does not have the capital reserves to undertake this project without outside financial assistance. The most likely funding source for the project would be a loan from the State Revolving Fund, which would then require a substantial rate increase to cover the debt service. Natural resource

3.3.9 CANTERBURY TUNNEL REHABILITATION *(continued)* TIER 2

damage funding for this project would allow the project to be completed sooner, without a large financial impact on the citizens of Leadville that are customers of the Parkville Water District. Access to groundwater from the Canterbury Tunnel would allow future development to occur in Leadville without the worry of water shortages in the winter. The decrease in the risk of water mains freezing also would provide a significant benefit to Leadville citizens, who have had to cope with winter water outages in the past.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 2 project. The project has a strong nexus to the NRDA injury because it provides compensation to the public for the loss of groundwater resources caused by contamination in California Gulch. This project restores a groundwater resource that is currently not usable because of the tunnel collapse. This project has a high likelihood of success because the engineering is feasible. The Trustees propose to allocate 10% of the total project cost ($200,000) in settlement funding for this project, if that level of funding is available after Tier 1 projects are funded.

3.3.10 HABITAT MANAGEMENT FOR LAND PROTECTED BY TRUSTEES — TIER 2

Restoration objective

To improve forest and grazing management on private land protected with natural resource damage funding. See Figure 3.14 for the logic model.

Project description

The Trustees may choose to fund land protection on private land to preserve wildlife habitat from development [see project in Section 3.3.5: Habitat protection (easements, acquisition, or land exchange)]. In some cases, the long-term habitat value of the land protected with conservation easements would benefit from improved resource management. The LCCD and the Colorado State Forest Service are able to provide willing landowners with technical expertise to develop grazing and forestry management plans. Grazing management plans are important for maintaining habitat, especially riparian habitat, in good condition. Forestry management plans can help improve wildlife habitat and decrease the risk of mountain pine beetle damage by diversifying the species and age-structure of the forest.

This project would provide funding for management plans to be developed and implemented on private lands where conservation easements have been obtained with natural resource damage funding.

Project location

The project is located in the upper Arkansas River watershed. Specific locations will depend on the parcels protected with easements.

Expected benefits and timeframe of benefits

The expected benefits from this project are improved wildlife habitat for areas where grazing and forestry management would protect or enhance habitat. The timeframe of benefits would begin at the time when the management plan was put into place and would continue for as long as the plan is implemented. It would likely take approximately one to three years for plans to be developed and implemented, because implementation can proceed in phases.

FIGURE 3.14. HABITAT MANAGEMENT FOR LAND PROTECTED BY TRUSTEES– LOGIC MODEL

Restoration actions	Develop and implement grazing and forestry management plans for private land protected with natural resource damage funding.
Expected short-term result	Management plans are developed and implemented.
Pathway/process	Improved management protects habitat, diversifies species, and improves overall ecological function.
Desired long-term results	Support a broad array of native vegetation and wildlife. Reduce fire risk from mountain pine beetle damage.

3.3.10 HABITAT MANAGEMENT FOR LAND PROTECTED BY TRUSTEES *(continued)*

TIER 2

Maintenance and monitoring

Management plans require ongoing maintenance and monitoring to be successful. The agencies developing the management plans potentially can provide periodic reviews of implementation. The organization that holds the conservation easement also can monitor whether management actions have occurred.

Probability of success

Moderate to high. The benefits of a specific management plan depend on the actions required to be taken and the diligence of the landowner in implementing these actions. Because management actions can provide benefits to the landowner (such as reducing the risk of fire through improved forest management), landowners are likely to be motivated to implement the management plans.

Estimated costs

The total costs for developing and implementing management plans depend on the size and condition of the property. The Colorado State Forest Service charges $20 per acre to develop a plan for a property of 20–80 acres. Treatment costs can range anywhere from $500 to $5,000 per acre, depending on the treatments needed, the terrain, and the condition of the land.

Environmental and socioeconomic consequences

Improving land management will provide positive biological impacts for habitat and for wildlife. The project is expected to have a positive socioeconomic impact on the surrounding community because management actions are likely to maintain or improve property values by improving the grazing management of rangeland and/or decreasing fire risk.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 2 project. The project has a nexus to the NRDA injury because it will improve the natural resource condition for land that the Trustees protect through conservation easements. This project has a moderate to high likelihood of success because the LCCD and Colorado State Forest Service have experience working with landowners and providing technical expertise. The Trustees propose to allocate $100,000 in settlement funding for this project, if that level of funding is available after Tier 1 projects are funded. Funds will be used for both planning and implementation actions.

3.3.11 COLORADO GULCH WETLAND AND UPLAND RESTORATION — TIER 3

Restoration objective

Restore degraded stream habitat that has been adversely impacted by upstream erosion and contamination. See Figure 3.15 for the project logic model.

Project description

Wetland habitat near the downstream end of Colorado Gulch is degraded. Weathered bedrock outcrops, mine waste piles, and unimproved roads upstream of this property have eroded and transported both contaminated and uncontaminated sediments into the wetlands. Data indicate that water quality upstream of the impaired wetlands is better than water quality downstream of the wetlands. Therefore, restoring these wetlands is expected to improve water quality in Colorado Gulch downstream of the wetlands.

Approximately 3.5 acres of wetlands will be restored. Restoration actions will include dredging excess and contaminated sediments and placing them in a repository. Replacement soil will be obtained and placed in the dredged area. After dredging, new vegetation will be planted on-site and the slope will be stabilized.

Project location

This project is located on the McNichols property, in Western Lake County.

Expected benefits and timeframe of benefits

Benefits of this restoration project include improved water quality, reduced sediment toxicity, and improved wetland, riparian, and aquatic habitats.

This project will not start until upstream restoration at the former Venture and Tiger mines is completed. Benefits such as improved water quality will be realized immediately following dredging activities. Benefits resulting from revegetation and habitat improvements will be realized within the first year and will continue to improve as the vegetation matures. Long-term benefits are expected to be maintained because the property is encumbered with a conservation easement and the property owners support the project.

FIGURE 3.15. COLORADO GULCH WETLAND AND UPLAND RESTORATION – LOGIC MODEL

Restoration actions	Remove contaminated sediments, restore degraded wetland habitat, and create in-stream habitat.
Expected short-term result	Improve in-stream and wetland habitat quality and reduce erosion.
Pathway/process	Improved habitat will mitigate effects of sedimentation, contamination will be eliminated during restoration, and restoration will provide habitat to aquatic and riparian wildlife.
Desired long-term results	Improved water quality, improved habitat quality, and access for aquatic and riparian wildlife.

3.3.11 COLORADO GULCH WETLAND AND UPLAND RESTORATION *(continued)* TIER 3

Maintenance and monitoring

New vegetation will be monitored and revegetation will take place as needed. Additional dredging may be needed in the future, particularly from catch basins that will be constructed to catch sediment migrating from upstream. The Lake Fork Watershed Working Group will oversee maintenance and monitoring activities.

Probability of success

The chance of success is moderate to high. The types of restoration proposed at the Colorado Gulch site have been employed successfully at nearby mine waste sites in the Lake Fork watershed. Restoration on the McNichols property will not begin until the major sources of upstream contamination – the Venture and Tiger mines – have been removed.

Estimated costs

The estimated total cost is $600,000, of which $300,000 would come from NRDA funding, $25,000 from National Fish and Wildlife Foundation Funds, $200,000 from other wetland restoration funding sources, and $75,000 through in-kind donations from CMC and Lake Fork Watershed Working Group partners.

Environmental and socioeconomic consequences

Specific biological impacts resulting from this project would include improved water quality (through decreased erosion), improved habitat for fish and wildlife species, and increased aquatic productivity. There would be some short-term impacts to aquatic habitat due to construction activities, which would likely result in increased sediment suspension and turbidity. The long-term benefits to the aquatic community outweigh any short-term adverse impacts associated with construction.

Improved fishing conditions are expected in the Lake Fork downstream of Colorado Gulch after this project is completed., which would have a positive socioeconomic benefit.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 3 project. The project is well planned but restoration actions would not take place until upstream removal actions are completed, which have an uncertain timeline. The project has a strong nexus to the NRDA injury because it benefits aquatic and wetland resources in the upper Arkansas River Basin, where documented injury to wetland, surface water, and aquatic resources occurred. This project has a high likelihood of success because the landowner is committed to restoration and the Lake Fork Watershed Working Group has experience and a positive track record of success for wetland restoration projects. The Trustees tentatively propose to allocate $125,000 in settlement funding for this project.

3.3.12 REMEDIATION OF ACID MINE DRAINAGE IN TRIBUTARIES TO THE ARKANSAS RIVER — TIER 3

Restoration objective

Reduce contamination from waste piles and flowing mine tunnels in tributaries to the Arkansas River. See Figure 3.16 for the project logic model.

Project description

Heavy metals and acid drainage associated with historic mining activity result in negative impacts to aquatic resources in tributaries to the Arkansas River. Funding for cleanup of these sites can be difficult to obtain when the sites are "abandoned" and there is no financially-viable responsible party. Two potential reclamation sites have been identified by the abandoned mine land program of the USFS in the Pike and San Isabel National Forests. At the Chalk Creek project area, drainage from the Golf Tunnel accounts for the largest point-source of heavy metals into Chalk Creek, which is a tributary to the Arkansas River near Buena Vista. The USFS has received funding to conduct a feasibility study of installing a bulkhead to control drainage from the tunnel and constructing a repository for waste rock that also contributes metals loadings to the creek. Another identified location is St. Kevin's Gulch, near the headwaters of the upper Arkansas River, where acid-mine drainage from the Griffin Mine waste rock pile results in loadings of metals and acid to the gulch, a downstream wetland, Tennessee Creek, and ultimately the Arkansas River. Construction of a repository at this site, as well as the potential installation of a bulkhead at another mine tunnel (the Rosse Tunnel) would reduce the impacts to aquatic resources caused by releases of contaminants.

For the location in Chalk Creek, this project would involve implementation of the preferred alternative that emerges from the study that is being initiated. For St. Kevin's Gulch, funding would be needed for a study to identify alternatives and then for implementation.

Project location

Chalk Creek and St. Kevin's Gulch.

Expected benefits and timeframe of benefits

Water quality in Chalk Creek, St. Kevin's Gulch, Tennessee Creek, and the Arkansas River would benefit from a decrease in metals loadings. Aquatic resources, including trout, would benefit from improved water quality. Benefits will begin to be realized as soon as the remedial actions are put into place, which is likely to be one to three years from now, to account for the need to study and plan implementation actions.

Maintenance and monitoring

Long-term maintenance and monitoring would be needed to ensure that the

FIGURE 3.16. REMEDIATION OF ACID MINE DRAINAGE IN TRIBUTARIES TO THE ARKANSAS RIVER – LOGIC MODEL

Restoration actions	Install bulkheads and construct mine waste repositories at abandoned mine land sites along tributaries to the Arkansas River.
Expected short-term result	Reduce metals loading to tributaries to the Arkansas River.
Pathway/process	Reduced metals loading will improve aquatic habitat quality.
Desired long-term results	Improved water quality will be maintained and aquatic populations will increase in tributaries to the Arkansas River.

3.3.12 REMEDIATION OF ACID MINE DRAINAGE IN TRIBUTARIES TO THE ARKANSAS RIVER *(continued)* TIER 3

bulkheads are not having a negative impact on upgradient water quality through the emergence of seeps or springs. The repositories also would need maintenance and monitoring to ensure that the waste rock was remaining contained and the repositories were kept in good shape without erosion. Specific details of maintenance and monitoring would be developed at a future date, when more information is known about the specific alternatives that would be implemented.

Probability of success

The probability of success is high. USFS has experience and expertise in reclaiming abandoned mine lands, including bulkhead installation and construction of repositories. The project also can benefit from the successful reclamation efforts at the Tiger and Dinero tunnels, because the proposed projects are similar to those efforts.

Estimated costs

The total cost is unknown. The Chalk Creek project has a general estimate of $750,000 for implementation. The St. Kevin's Gulch project has a general estimate of $300,000 for the repository alone and $600,000–$700,000 to include the bulkhead installation. The Trustees have estimated a total cost for both projects of $750,000 + $700,000 = $1,450,000.

Environmental and socioeconomic consequences

Improving water quality in tributaries to the Arkansas River will improve their ecological functioning for aquatic and other wildlife species. This project will also have a positive socioeconomic impact on the community.

Specific biological impacts resulting from this project will include improved water quality through reduced metals loading, leading to improved habitat for fish and wildlife and increased aquatic productivity. Improved water quality in tributaries benefits resources similar to those that were injured by the release of hazardous substances at the Site. Further improvements made to water quality in tributaries also will benefit fish in the Arkansas River that use these tributaries for spawning. Construction-related impacts may include temporarily increased erosion, dust, and exhaust from heavy equipment use. The long-term benefits to the aquatic community outweigh the short-term adverse impacts associated with restoration-related construction activities.

Public use and enjoyment of natural resources in the tributaries and in the Arkansas River will be improved through improved fishing and better water quality.

Trustee evaluation and proposed allocation

This project is proposed as a Tier 3 project. The project is contingent on remedial studies being completed and implementation actions being identified. The project has a strong nexus to the NRDA injury because it benefits aquatic and wetland resources in the upper Arkansas River Basin. This project has a high likelihood of success because the types of reclamation and restoration work likely required for these sites have been implemented successfully in other locations. The Trustees tentatively propose to allocate $400,000 in settlement funding for this project.

3.3.13 EROSION CONTROL IN THE ARKANSAS HEADWATERS RECREATION AREA

TIER 3

Restoration objective

Reduce erosion and increase habitat value for wildlife and recreational activities in the Arkansas Headwaters Recreation Area. See Figure 3.17 for the project logic model.

Project description

With participation from other local stakeholders such as the USFS and the BLM, Colorado State Parks is preparing to develop a watershed plan that will be used to manage and protect against nonpoint source pollution in the Arkansas River headwaters. The watershed plan will follow EPA guidance and include the nine key elements that are required by EPA for a plan to be eligible for CWA Section 319 funding (U.S. EPA, 2008).

This project involves providing funding to help implement appropriate and effective restoration actions or "management measures" in the Arkansas Headwaters Recreation Area that are identified in the watershed plan and do not have implementation funding from other sources. Examples of possible restoration actions include constructing sediment basins to collect and trap sediment before it reaches the river, seeding areas that have damaged vegetation to prevent erosion, or conducting vegetation management practices to reduce erosion potential on steep slopes (e.g., promoting cover of herbaceous grasses by controlling over-growth of shrubs).

Project location

Arkansas Headwaters Recreation Area.

Expected benefits and time frame of benefits

Restoration projects that target erosion reduction have wide-ranging benefits across ecosystems. Upland projects may include vegetation management and planting; this type of action improves habitat for upland wildlife. Upland projects that reduce erosion also benefit riparian, wetland, and aquatic habitats by reducing sediment transport across these habitats, improving water quality and habitat quality. Riparian and wetland projects that reduce sedimentation improve habitat for riparian and aquatic wildlife, and also improve water quality by reducing sediment loading into the

FIGURE 3.17. EROSION CONTROL IN THE ARKANSAS HEADWATERS RECREATION AREA – LOGIC MODEL

Restoration actions	Implement erosion control actions in degraded areas identified through a watershed plan.
Expected short-term result	Erosion control measures will reduce sediment loading to the Arkansas River.
Pathway/process	Reduced erosion leads to healthier terrestrial vegetation, reduced sediment loading into the river, and improved aquatic habitat.
Desired long-term results	Improved water quality in the Arkansas River with a commensurate improvement in fish populations and associated aquatic and terrestrial wildlife populations. Upland terrestrial habitat, riparian habitat, and aquatic habitat will improve.

3.3.13 EROSION CONTROL IN THE ARKANSAS HEADWATERS RECREATION AREA *(continued)* TIER 3

aquatic environment. All erosion reduction projects will benefit water quality and improve aquatic habitat, thus helping to benefit fish populations and wildlife populations that depend on the aquatic ecosystem.

Benefits will begin to be realized after restoration actions are completed. The benefits will continue to increase as vegetation matures and other erosion control measures become established. Benefits will continue to be realized for as long as the project elements are properly maintained.

Brief overview of maintenance and monitoring

Monitoring actions will be developed to evaluate the success of erosion control projects. A monitoring plan likely will include evaluation of the effectiveness of upland source control measures, inspection of any engineered structures, and appropriate water quality measurements.

Probability of success

The probability of success is very high. Colorado State Parks will spend two years developing a comprehensive watershed plan that will identify the areas most in need of restoration. Following the watershed planning process, a restoration planning process will identify the most appropriate restoration actions in the targeted areas. The restoration actions will use established techniques that have been proven successful at other locations.

Estimated costs

Costs for implementing restoration actions have not yet been estimated; costs will vary depending on the type of project.

Environmental and socioeconomic consequences

Reducing erosion in the Arkansas Headwaters Recreation Area will improve water quality in the Arkansas River, improve aquatic and terrestrial habitats, and likely will enhance recreation opportunities. Restoration actions will occur in targeted areas that are most vulnerable to erosion, maximizing the improvements to the ecosystem.

Some potential restoration actions may have short-term negative impacts on the environment if they involve construction. There may be short-term increases in sediment loading to the river and short-term habitat disturbance in upland and riparian habitats. This project would have positive socioeconomic consequences because it would decrease sediment into the Arkansas River, thereby benefiting the trout fishery and helping to maintain good quality surface water that is used as a drinking water supply. The long-term benefits of improved habitat, improved water quality, and thus improved recreation opportunities outweigh the temporary adverse impacts associated with construction.

3.3.13 EROSION CONTROL IN THE ARKANSAS HEADWATERS RECREATION AREA *(continued)*

TIER 3

Trustee evaluation and proposed allocation

This project is proposed as a Tier 3 project; it will take place after the Colorado State Parks watershed planning phase is completed and targeted restoration actions have been identified. The project has a strong nexus to the NRDA injury because it benefits aquatic and upland resources in the upper Arkansas River, where documented injury to surface water, aquatic resources, and upland resources occurred. This project has a high likelihood of success because Colorado State Parks has experience and a positive track record of success in identifying and implementing erosion control projects. The Trustees propose to allocate $100,000 in settlement funding for this project.

3.4 Alternatives Considered but Eliminated from Detailed Analysis

The Trustees investigated additional potential restoration projects to benefit aquatic, terrestrial, and groundwater resources. These alternatives were eliminated from detailed analysis because (1) they either failed the screening criteria, or (2) a preliminary evaluation determined that projects passed the screening criteria but scored lower against the evaluation criteria compared to the projects included in the proposed alternative.

3.4.1 Iowa Gulch Wetland Enhancement

This project involves enhancing wetland habitat in Iowa Gulch that had been degraded from sediment and contaminated mine waste released from the Sherman Mine, near the Leadville area. The Trustees investigated the feasibility of providing funding for this wetland enhancement work. This project was eliminated from detailed analysis because the Trustees learned that BLM has already completed the project using other sources of funding.

3.4.2 Lake Fork Watershed-wide Monitoring

This project involves providing partial funding to monitor stream water quality in Lake Fork from 2013 to 2020, following completion of the Sugarloaf best management practice (BMP) monitoring program that is being funded by a grant from the Colorado nonpoint source pollution control program ("319 funding"). Beginning in 2013, a watershed-wide monitoring program will be in place to continue monthly monitoring and sampling at 16 established monitoring sites; baseline data were collected from these sites in 2001. This monitoring effort is designed to take over when the Sugarloaf BMP monitoring concludes. Samples will be collected monthly from April to September each year, beginning in 2013 and continuing through 2020. Data collected will include stream discharge, total dissolved solids, pH, conductivity, total dissolved oxygen, total sulfate, and turbidity. Water samples will be analyzed either at the Timberline Analytical Laboratory or at the Colorado School of Mines.

This project was eliminated from detailed analysis because the Trustees are planning to fund water-quality sampling in the vicinity of the Dinero Tunnel through the project in Section 3.3.5. Monitoring across the entire Lake Fork that is not specifically in conjunction with natural resource damage funded restoration actions does not meet the threshold acceptance criteria of "restoring, replacing, or acquiring natural resources."

3.4.3 California Gulch Remedial Projects

This project involves implementing several remedial projects proposed by the Lake County Commissioners for the California Gulch Superfund Site. One project involves constructing a site-wide repository to receive contaminated soil. Another project involves establishing a seasonal spring bypass for California Gulch by routing California Gulch through a constructed treatment wetland to reduce metals loadings from California Gulch into the Arkansas River. A third project involves constructing and operating a pump station to isolate specific springs below the Yak Treatment Plant impoundment and pumping that water to the Yak Treatment Plant for processing.

These project ideas were eliminated from detailed analysis because the Trustees believe that these are remedial projects that should be considered by EPA in developing a Record of Decision for Operable Unit 12 at the Site (site-wide groundwater). Furthermore, the Trustees will not fund projects that could conflict with remedial actions.

As required by NEPA, this chapter briefly describes the physical, biological, and cultural environment that will be affected by the proposed restoration activities in the upper Arkansas River Basin.

4.1 Physical Environment

Proposed restoration activities will occur in the upper Arkansas River Basin, which includes the watershed of the upper Arkansas River downstream to the reservoir at Pueblo, Colorado. The Arkansas River headwaters are fed by runoff beginning as winter snowpack from a series of perennial and ephemeral drainages in the alpine and sub-alpine basins of the Mosquito and Sawatch mountains near Leadville, Colorado. The mainstem Arkansas River originates at an elevation of 10,100 feet just west of Leadville. From its origin, the Arkansas River flows through a broad mountain valley characterized by significant areas of wetland and floodplain meadows. In this upper reach, important land uses include irrigated pasture and haying operations, livestock production, recreation, and residential development. Approximately 12 miles downstream of Leadville, the Arkansas River enters a valley formed by the Mosquito Range and the Collegiate Peaks of the Sawatch Range. This stretch of the river is characterized by fast water and whitewater, attracting recreational kayakers, rafters, and anglers (Redente et al., 2002; Industrial Economics, 2006) (Figure 4.1). From this point, the Arkansas River flows approximately 160 miles, drains approximately 28,000 square miles, and loses about 5,000 feet of elevation before reaching the Pueblo Reservoir.

Important natural resources found throughout the upper Arkansas River Basin include surface water, riparian habitat, wetland meadow habitat, alluvial groundwater, and aquatic and terrestrial wildlife. In addition, livestock grazing is important in the irrigated meadows of the 11-mile reach.

The Trustees will prioritize projects occurring within the 11-mile reach but will consider projects throughout the upper Arkansas River Basin. The 11-mile reach extends 11-miles downstream in the Arkansas River from the confluence with California Gulch. Downstream of Pueblo, the Arkansas River flows through eastern Colorado and into Kansas, Oklahoma, and Arkansas before its confluence with the Mississippi River at the Arkansas-Mississippi border (Redente et al., 2002; Industrial Economics, 2006).

Figure 4.1. River rafting on the Arkansas River.
Photo source: Colorado State Parks, 2009.

Currently, aquatic habitats are highly degraded throughout much of the 11-mile reach due to chemical contamination and

physical disturbance caused by fluvial deposits washed downstream from the Superfund Site. As described in Chapter 2, surface water in the Arkansas River exceeds Colorado acute and chronic water quality criteria for cadmium, copper, lead, and zinc. There are hundreds of abandoned mines, miles of underground tunnels and shafts, large waste rock and tailings deposits, and numerous historic processing facilities in the watershed. Wastes such as mill tailings, slag, and dust were historically deposited in piles, into waste ponds, or left in and around drainages in the Leadville mining district. These deposits washed downstream into the mainstem Arkansas River, causing the contamination apparent now. Throughout the upper Arkansas Basin, untreated mine wastes and abandoned mines that discharge acid mine drainage continue to release hazardous substances into the aquatic and terrestrial environments of the upper Arkansas River Basin (USFWS, 2009).

In addition to chemical contamination, historic mining operations caused significant physical damage to the river channel. Hydraulic placer mining removed large amounts of sediment and flushed them downstream, causing erosion and widening the channel. The over-wide channel of the 11-mile reach provides impoverished habitat for fish and remains vulnerable to erosion. Fluvial deposits washed in from the Site cause physical disturbance that impacts riparian and floodplain habitats, as well as being an ongoing source of water quality impairment. Remedial actions at the Site have improved conditions in the upper Arkansas River Basin, but habitat throughout the basin is still impacted by historic mine activities (Redente et al., 2000; Industrial Economics, 2006; USFWS, 2009) (Figure 4.2).

4.2 Biological Environment

Historically, the upper Arkansas River Basin was a highly productive ecosystem that supported a broad diversity of North American alpine flora and fauna. The pre-European Settlement environment consisted of primary producers, primary consumers, and predators in both the aquatic and terrestrial environments. The first European inhabitants were trappers, who negatively impacted populations of targeted species, such as beaver. As mining began, the mining settlers hunted extensively, damaging populations of deer, bison, elk, and wolves. Native fish populations were replaced by exotic fish, stocked for sport. Finally, as mining contamination increased and physical disturbance became more extensive, the vegetative communities also became degraded and no longer supported the remaining aquatic and terrestrial communities (Klima, 2000).

Figure 4.2. Abandoned mine waste in California Gulch.
Photo source: USGS, 2007.

Portions of the biological environment are recovering from mining and other

anthropogenically caused environmental damages. Remediation work to remove hazardous substances from the river and work to stabilize the river banks have helped recovery. An elk herd has moved back into the upper Arkansas River Valley near Leadville, and native trout are making a comeback. However, the environment has been permanently altered and a directed effort to improve the most problematic damages (mine waste in and along waterways, denuded banks, the over-wide river channel, and enhancing riparian and upland vegetation) is required for the upper Arkansas River Basin to support self-sustaining, healthy ecosystems.

4.2.1 Aquatic Habitat

The upper Arkansas River Basin is a high-elevation mountain river supporting a cold-water trout fishery. The aquatic environment was historically characterized by a relatively narrow, meandering channel, fast-moving water, and diverse in-water habitat. The river supported a healthy benthic macroinvertebrate community and a robust cutthroat trout fishery, exemplified by the Colorado native greenback cutthroat trout (*Oncorhynchus clarkii stomias*) (Klima, 2000).

Coincident with the Leadville mining and population boom, stocking efforts introduced non-native trout species such as brown trout, rainbow trout, and salmon. The non-native species were extremely successful in their introduced environment, leading to a severe decline in greenback cutthroat trout populations in the Arkansas Basin and the extinction of yellowfin cutthroat trout (*Oncorhynchus clarkii macdonaldi*) in the Twin Lakes. As the impacts of mining accumulated, the quality of the aquatic environment declined and caused declines in the fisheries (Klima, 2000). Fish surveys in the 1990s found no fish in California Gulch and very small populations (and small individuals, where present) in downstream reaches. Recent remedial work has improved brown trout populations; however, populations and individual fish size are still small compared with reference sites (Industrial Economics, 2006).

4.2.2 Riparian Habitat

The glacial valleys in which the Arkansas River originates and through which the upper reaches of the river flow support high-elevation riparian ecosystems. Riparian areas and wetlands in the upper Arkansas River Basin are fed by surface runoff and groundwater flow. Herbaceous species, such as sedges and mesic grasses, along with willows, dominate the wetlands and riparian areas. In the dryer edges of the wetland, willows and mesic sedges and grasses are dominant (Klima, 2000; BLM, 2006b).

In high-elevation riparian habitat, bird diversity is typically low but the density of nesting birds can be high in dense willow thickets. Typical bird species in riparian habitat include the broad-tailed hummingbird (*Selasphorus platycercus*), dusky flycatcher (*Empidonax oberholeri*), yellow warbler (*Dendroica petachia*), MacGillivray's warbler (*Oporornis tolmiei*), Wilson's warbler (*Wilsonia pusilla*), Lincoln's sparrow (*Melospiza lincolnii*), song sparrow (*Melospiza melodia*), white-crowned sparrow (*Zonotrichia leucophrys*), and fox sparrow (*Passerella iliaca*) (Erik Brekke, Wildlife Biologist, BLM, personal communication, April 21, 2008).

Healthy riparian habitat supports a diverse wildlife community including riparian specialists and both upland and aquatic inhabitants. Because it provides plentiful water, food, and shelter, riparian habitat is critical to the ecological health of a region. Historically, the upper Arkansas River Basin boasted a diverse biological community that included a balanced mix of upland, riparian, and aquatic biota. Some formerly common wildlife that are no longer present in the basin include bison (*Bison bison*) (which had extensive herds prior to European settlement) and wolf (*Canis lupus*). Other examples of historically abundant wildlife include wild turkey (*Meleagris gallopavo*), elk (*Cervus canadensis*), deer (*Odocoileus* spp.), bighorn sheep (*Ovis canadensis*), bear (*Ursus* spp.), mink (*Mustela vison*), raccoon (*Procyon lotor*), skunk (family *Mephitidae*), coyote (*Canis latrans*), fox (*Vulpes* spp.), bobcat (*Felis rufus*), mountain lion (*Felis concolor*), hares (*Lepus* spp.), shrews (family *Soricidae*), squirrels (*Sciurus fremonti* and *S. aberti*), chipmunks (*Tamias* spp.), and others (Klima, 2000).

4.2.3 Upland Habitat

The upper Arkansas River Basin is located in a high-elevation montane environment typical of the Rocky Mountains. These high elevation uplands are dominated by lodgepole pine, spruce/fir, and scattered stands of aspen (*Populus tremuloides*). Typical understory species include sagebrush (*Artemisia* spp.) and kinnikinnick (*Arctostaphylos uva-ursi*). Birds commonly found in this forest type include the gray jay (*Perisoreus canadensis*), mountain chickadee (*Poecile gambeli*), red-breasted nuthatch (*Sitta canadensis*), ruby-crowned kinglet (*Regulus calendula*), hermit thrush (*Catharus guttatus*), pine grosbeak (*Pinicola enucleator*), and pine siskin (*Carduelis pinus*) (Erik Brekke, Wildlife Biologist, BLM, personal communication, April 21, 2008).

4.3 Threatened and Endangered Species

T&E species whose historic range includes Lake County, Colorado, include the Canada lynx, greenback cutthroat trout, and Penland alpine fen mustard (*Eutrema penlandii*, threatened). Potential habitat for Uncompahgre fritillary butterfly (*Boloria acrocnema*, endangered) is likely present in higher elevation alpine areas in Lake County. Gunnison's prairie dog (*Cynomys gunnisoni*) is a candidate for listing and is a known local resident. In 2009, there was a credible leopard frog (*Rana pipiens*) sighting documented in the vicinity of the Paddock State Wildlife Area and there are two breeding populations of boreal toad (*Anaxyrus boreas boreas*), also in the vicinity of the Paddock State Wildlife Area. Leopard frog are currently under review for listing and petitions for the listing of boreal toad have been submitted; neither species is currently listed as a federally threatened or endangered species. There is no designated critical habitat for any of these species in Lake County and areas potentially affected by the proposed restoration actions are not known to support populations of any of these species. Canada lynx could potentially use the project sites as a small part of a travel corridor when moving across the valley. The proposed restoration actions are unlikely to disrupt travel patterns of the Canada lynx because there are alternative routes available (Laura Archuleta, environmental contaminants specialist, USFWS, personal communication, April 25, 2008; Matt Comer, wildlife biologist, USFS, personal communication, December 28, 2009).

In addition, any disturbances resulting from the construction activities at the restoration sites would be of relatively short duration (one to three years). These restoration projects would provide long-term benefits to habitat for any T&E species by either reducing exposure to hazardous substances or improving habitat conditions.

4.4 Cultural and Socioeconomic Environment

Leadville is located in Lake County, Colorado, at an elevation of approximately 10,150 feet. The city of Leadville was incorporated in February 1878 (Colorado State Archives, 2009). Leadville is the County Seat and the only municipality in Lake County. In 2008, the estimated population for the city of Leadville was 2,743 while Lake County had an estimated total population of 7,994 (City of Leadville, 2009; U.S. Census Bureau, 2009). According to the 2000 Census, the population was 54% male and 46% female; 78% of the population was classified as White; while populations classified as Black or African American, American Indian and Alaskan Native, Asian, and Native Hawaiian and Pacific Islander combined were less than 2% of the total population; 18% of the population was classified as "Some Other Race"; and 36% (of any race) was identified as Hispanic or Latino (U.S. Census Bureau, 2009). The median household income in Lake County is $41,492, which is 75% of the median household income in Colorado ($55,517); the median income in Chaffee County is $42,464 (USDA Bureau of Labor Statistics, 2009).

The upper Arkansas River is an important component of the current economy in Lake County. The Arkansas River supports recreational fishing, rafting, and other outdoor activities. Commercial rafting on the Arkansas River is estimated to contribute $352 per acre foot of water compared with $145 per acre foot on the Poudre River and $18 per acre foot of water on the Colorado River through Glenwood Canyon (Loomis, 2007).

4.5 Native American Religious Concerns

There is evidence that the Arkansas River was historically important for Native Americans. The Ute Indians used it as an important and productive hunting ground until the early to mid-1800s, when European settlers entered the region (Klima, 2000). Although aboriginal sites are present in the vicinity of the area of potential effect, there is no known evidence that suggests the project area currently holds special significance for Native Americans. In many of the project locations, the natural environment has been severely impacted and any aboriginal remains that might have been present before the mines were constructed likely were obliterated during the mining era.

The environmental and socioeconomic consequences associated with each individual restoration project in the proposed restoration alternative were identified in Chapter 3. This chapter provides a description of the cumulative impacts of the proposed alternative and compares these impacts to those of the no-action alternative.

Over the long term, the proposed restoration projects that together form the proposed restoration alternative identified in this RP/EA would provide positive environmental and socioeconomic benefits for the upper Arkansas River Valley. The analysis of impacts assumes that all of the Tier 1 and Tier 2 restoration projects would be implemented. If funding is not sufficient for implementation of all Tier 2 projects, then the cumulative impact of restoration (both positive and negative) would be lessened. Analysis of the impacts of Tier 3 projects would occur at a later date when more information becomes available regarding these projects.

5.1 Environmental Impacts of the Proposed Alternative

Overall, the cumulative environmental impact of the proposed alternative would be positive because natural resources would benefit from the proposed restoration actions. Descriptions of impacts for specific categories of environmental resources are detailed below.

5.1.1 Water Resources

Over the long term, the proposed alternative will have a net positive impact on water resources in the upper Arkansas River Valley. During implementation of the in-stream restoration projects in the 11- mile reach of the Arkansas River and the Lake Fork, there would be temporary increases in sediment transport and in the turbidity level of surface water because of the presence of heavy equipment in the stream channel and along the riparian corridor. These impacts would be temporary, because the restoration activities ultimately would stabilize and revegetate stream banks and result in a long-term decrease in erosion and improvement in water quality. Temporary impacts would be minimized by following BMPs for in-stream work and conforming to all requirements of the permits that would be necessary to conduct the project.

Other projects in the proposed alternative also would have long-term positive impacts on water resources. The project to obtain better equipment for noxious weed control would help to protect water quality from pesticide runoff and residues, because the equipment allows more targeted spraying of weeds with a lower volume of herbicide. The Dinero Tunnel water quality monitoring project would detect the emergence of contaminated seeps or springs upgradient of the plugged Dinero Tunnel, and would help ensure that downstream water quality is protected by triggering corrective actions if necessary. The project to develop an EE/CA for the Venture Mine and Sugarloaf Mine dumps would ultimately lead to improved surface water and groundwater quality in the Lake Fork through remediation of mine waste piles. Finally, the Canterbury Tunnel rehabilitation project would restore the beneficial use of a groundwater resource as a drinking water supply.

5.1.2 Vegetation Resources

The restoration projects in the proposed alternative would enhance vegetation resources in riparian, floodplain, and upland habitats. The Arkansas River in-stream restoration project would result in increased cover of native riparian vegetation, through fencing to exclude cattle and replanting of native species. The weed control projects would result in improved control of noxious weeds and emerging weed threats, and would help protect native vegetation from being crowded out by weeds. The erosion control on roads project would result in recovered vegetation where vegetation had been damaged by motorized travel on informal trails. The project to develop native plant propagation at the Hayden Ranch would improve wetland and forestry revegetation efforts by providing locally adapted nursery stock. Revegetation of the Hayden Ranch would result in a direct improvement to native vegetation by increasing the cover of native plants through direct seeding. Finally, development of forest and grazing management plans also would benefit vegetation through improved management and decreased risk of widespread pine beetle attacks in areas where the forest cover is diversified.

5.1.3 Fish and Wildlife Resources

The restoration projects in the proposed alternative would enhance fish and wildlife resources in the upper Arkansas River Valley. The in-stream restoration projects are designed to improve fish habitat and increase fish populations in the 11-mile reach of the Arkansas River and the Lake Fork, with a particular focus on benefiting brown trout. Projects to protect or improve water quality in the Lake Fork (Dinero Tunnel water quality monitoring and development of an EE/CA for the Venture Mine and Sugarloaf Mine dumps) would improve fish resources in Lake Fork. Wildlife would benefit from many projects as well. The erosion control on roads project would decrease disturbance of wildlife and improve habitat conditions and connectivity. Development of forest and grazing management plans also would benefit wildlife, through the promotion of increased diversity and protection of native habitats, which would result, especially on private land, in increased cover of native riparian vegetation through fencing to exclude cattle and replanting of native species. The weed control projects would result in improved control of noxious weeds and emerging weed threats and would help protect native vegetation from being crowded out by weeds. The erosion control on roads project would result in recovered vegetation where vegetation had been damaged by motorized travel on informal trails. The project to develop native plant propagation at the Hayden Ranch would improve wetland and forestry revegetation efforts by providing locally adapted nursery stock. Revegetation of the Hayden Ranch would result in a direct improvement to native vegetation by increasing the cover of native plants through direct seeding. Finally, development of forest and grazing management plans also would benefit vegetation through improved management and decreased risk of widespread pine beetle attacks in areas where the forest cover is diversified.

5.1.4 Special Status Species

As noted previously, the T&E species whose historic range includes Lake County, Colorado, are the Canada lynx, greenback cutthroat trout, Penland alpine fen mustard, and possibly Uncompahgre fritillary butterfly. Gunnison's prairie dog is a candidate for listing. For the USFS, bighorn sheep, northern leopard frog, and boreal toad are classified as sensitive species in Region 2. The proposed

restoration actions would not affect any of these species because none are known to occur in the proposed project activity areas and there is no critical habitat in any area potentially affected by the proposed action. Elimination of motorized travel on informal trails at the Paddock State Wildlife Area would benefit Canada lynx if they pass through the area.

In general, any disturbances resulting from construction activities at the restoration sites would be of relatively short duration (one to three years). These restoration projects would provide long-term benefits to habitat for any T&E species.

5.1.5 Air and Noise

The use of heavy equipment to implement some of the projects may generate local air pollution, especially from diesel engines and noise pollution that could disturb wildlife on a temporary basis. Because the work will be temporary and will only occur during daylight hours and in limited locations, wildlife likely will be able to avoid the noise and air pollution impacts. Construction work on the in-stream habitat restoration project will proceed in phases, to minimize the area being disturbed at any single point in time.

5.1.6 Geology and Minerals

The proposed alternative would not have a negative impact on geology or mineral resources. The proposed restoration projects would not result in any change in mining activity in the area or in any change in the use of mineral resources.

5.1.7 Soils

The proposed alternative would have a positive impact on soils because many of the projects would result in decreased erosion and increased soil stability. Specifically, the in-stream restoration projects along the 11-mile reach of the Arkansas River and the Lake Fork, the erosion control on roads project, revegetation on the Hayden Ranch, and improved forest and grazing management on private land would improve soil stability and soil management.

5.2 Cultural and Socioeconomic Impacts of the Proposed Alternative

Overall, the cumulative cultural and socioeconomic impacts of the proposed alternative would be positive because the human population in the area affected by the proposed alternative would benefit from the proposed restoration actions. Descriptions of impacts for specific categories of cultural and socioeconomic considerations are detailed below.

5.2.1 Lands and Access

The proposed restoration actions that make up the proposed alternative would not conflict with Lake County or state or federal policies for land management. Land acquisition would conform to the policies of the agency accepting the land (e.g., Colorado State Parks, USFS, BLM). Parcels proposed for acquisition are expected to be consistent with existing management plans such as the Lake County Open Space Initiative and the Colorado State Parks strategic planning process for the Arkansas River Headwaters Recreation Area. The proposed alternative would have a minimal impact

on existing land use. Depending on the parcels pursued for acquisition, there could be a change in land use for a parcel from private land to public land accessible for recreation.

Some opportunities for public access and recreation along the upper Arkansas River and the Lake Fork will be limited during the time when the in-stream habitat restoration project is being implemented. These impacts will occur directly from the presence of construction equipment and indirectly if the temporary increase in turbidity decreases opportunities or enjoyment of fishing or other water-based recreation. The erosion control on roads project would consolidate access on official system routes and eliminate access on user-created motorized routes. This project is planned to undergo additional NEPA review through the USFS so that the public can comment on specific plans to alter travel through the area. Ultimately, public access and recreation would benefit from implementation of the proposed alternative, through the likely acquisition of land that will provide increased recreational access to the upper Arkansas River and through enhanced fishing and other nature-based recreational opportunities as a result of improved fish and wildlife habitats.

5.2.2 Air, Noise, and Visual Resources

Because most of the restoration work is planned for locations away from residential areas, the air, noise, and visual impacts to human populations would be minimal. During the implementation of the projects, however, some temporary negative impacts would occur. As described above under environmental impacts, the use of heavy equipment to implement some of the projects would generate local air and noise pollution and could disrupt the scenic "viewshed" of the area. Because the work would be temporary and would only occur during daylight hours and in limited locations, the overall impact to air, noise, and visual resources would be limited and temporary. In addition, construction work on the in-stream habitat restoration project would proceed in phases, to minimize the area being disturbed at any single point in time. Over the long-term, protection of land parcels at risk of development would help maintain the scenic viewshed of the upper Arkansas River Valley.

5.2.3 Cultural and Paleontological Resources and Native American Religious Concerns

For all ground disturbing activities, a cultural inventory would be conducted prior to project implementation and mitigation would be applied as necessary to protect any cultural resources found. Acquisition of appropriate permits for individual projects would include consultation with the SHPO to determine if the proposed undertakings would result in adverse effects to cultural resources. For example, implementation of remedial actions at the Venture Tunnel and Sugarloaf Mine dumps area would likely result in adverse effects to cultural resources and would require mitigation options. Similar mitigation options were undertaken by BLM at the Tiger and Dinero tunnels sites, because those projects were found to have adverse effects on cultural resources.

Development of the greenhouse and nursery facility for native plant propagation at the Hayden Ranch Headquarters would be subject to the terms of a historic conservation easement held by the Colorado Historical Foundation. Construction of a greenhouse would occur in a manner consistent with the terms of the easement, with the intent of preserving and maintaining the historic integrity of the Hayden Homestead site in perpetuity.

Other projects that are included in the proposed alternative are not expected to have impacts on cultural or paleontological resources, or to impact Native American religious concerns, because they do not involve alterations of structures or construction at the land surface that could displace artifacts.

Cultural resource inventories conducted in the vicinity of the Tiger and Dinero tunnels did not find any sites that might hold special significance for Native Americans. If sites with special significance were found at any point during the implementation of the projects included in the proposed alternative, work would cease and not resume until consultation is complete.

5.2.4 Socioeconomic Impacts

The proposed restoration projects included in the proposed alternative would have a cumulative positive socioeconomic impact on the city of Leadville and the surrounding areas. Although there would be short-term negative impacts to public access and recreation during construction of the in-stream habitat restoration project, these impacts would be outweighed by the long-term benefits to public access and recreation. These long-term benefits would result from the likely acquisition of land that would provide increased recreational access to the upper Arkansas River and through enhanced fishing and other nature-based recreational opportunities as a result of improved fish and wildlife habitats.

Each of the projects that would enhance or protect fish and wildlife habitats would help to preserve the natural resource base that is at the heart of the area's tourism and recreation-based industries and quality of life. Construction projects would have a positive economic effect on the area through potential employment opportunities, either directly or indirectly through the supply chain for materials. The general land use patterns of the area would not be affected by the projects because the proposed land protection projects would be protecting habitat that is already in a natural state. The protection projects would have a minimal or neutral impact on the local tax base because a payment in lieu of taxes would be made for acquired parcels that are taken out of the tax base. The Canterbury Tunnel rehabilitation project would provide a secure source of drinking water that would help the city of Leadville accommodate growth or development that may occur over time, as well as protecting current citizens from disruptions to their water supply in the winter months.

5.2.5 Environmental Justice

This alternative would benefit the residents of Leadville, including minority and low-income populations, through improvement of fishing opportunities in the upper Arkansas River, overall economic benefits to the town, and access to the drinking water resources of the Canterbury Tunnel with a lower burden of rate hikes for customers of the Parkville Water District.

5.3 Impacts of the No-Action Alternative

Under the no-action alternative, no habitats would be preserved, restored, or enhanced beyond what agencies and organizations such as Colorado State Parks, the Lake Fork Watershed Working Group, and the Lake County Open Space Initiative are already doing in the area with limited existing

resources. Aquatic and riparian habitats would continue to be degraded along the 11-mile reach of the upper Arkansas River and in Lake Fork Creek. Weed control would be less effective, pose a greater risk to water quality, and not target emergent threats. Wildlife impacts caused by non-system travel at the Paddock State Wildlife Area would continue to occur. Important habitat parcels would not be protected from development risk. There would be no local source of nursery stock to support wetland and forestry revegetation programs. Finally, Leadville would continue to have inadequate drinking water supplies in the winter, with high risks of water mains freezing. Local populations would not benefit from improved fishing opportunities and increased construction activities in the area. Future generations would not have access to an improved environment.

5.4 Cumulative Impacts of the Proposed Alternative and the No-Action Alternative

The cumulative impacts of the proposed alternative and the no-action alternative are summarized in Table 5.1 and discussed below.

The Trustees selected the restoration projects included in the proposed alternative to improve natural resources as compensation for natural resource injuries. Therefore, the cumulative environmental impact from implementing the restoration projects is expected to be beneficial. Any impacts to air quality, water quality, or noise associated with implementation of the projects is expected to be minimal and short-term. The projects would result in long-term benefits to water quality, vegetation, fish, and wildlife in and around the project sites. There also would be long-term socioeconomic benefits to the city of Leadville and surrounding areas through protection and improvement of natural resources and an improved supply of drinking water. Any cultural impacts associated with implementation of remedial actions at the Venture Mine and Sugarloaf Mine dumps would be mitigated according to requirements of the SHPO.

Under the no-action alternative, there would be no positive change to habitats or wildlife beyond the actions taken by other agencies and organizations with limited funding. There would be no short-term impacts associated with project implementation and no long-term benefits from implementation of the proposed alternative. In short, the public would not be compensated for the extensive injuries to natural resources resulting from the release of hazardous substances at the California Gulch Superfund Site.

Table 5.1. Comparison of impacts by alternative

Category of impact	No-action alternative	Proposed action/proposed alternative
Habitat impacts	No additional habitats preserved, restored, or enhanced. Continued impairment of aquatic, riparian, and upland resources.	Aquatic, riparian, and upland habitats would be preserved, restored, and enhanced.
Biological impacts	Continued ongoing adverse impacts to fish and wildlife.	Improvements to fish and wildlife resulting from habitat improvements.
Cultural resource impacts	No impacts to historic properties.	Adverse effects to cultural resources could occur at the Venture site and would be mitigated by appropriate actions.
Native American religious concerns	No impacts expected.	No impacts expected.
Environmental justice	No benefits to Leadville residents, including minority and low-income populations.	Benefits to Leadville residents, including minority and low-income populations, from improved fishing opportunities and a more reliable source of drinking water.
Socioeconomic impacts	No positive indirect economic impacts on the local economy.	Construction activities would generate short-term economic benefits. Improved fishing conditions, habitat protection, and a reliable drinking water supply would generate long-term economic benefits, including benefits to the local eco-tourism economy.
Indirect impacts	No indirect impacts.	Indirect beneficial impacts expected through improved habitat for fish, birds, and wildlife in the project areas.
Cumulative impacts	Cumulative impacts would be negative because of continued degradation of aquatic, riparian, and upland habitats under current conditions.	Cumulative impacts expected to be beneficial through long-term benefits to water quality, fish, and wildlife in and around the project sites.

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(This information was developed by the Colorado Division of Wildlife.)

Habitat restoration actions, in tandem with further remediation efforts, will significantly contribute to restoring the brown trout population in metals-impacted stream reaches of the upper Arkansas River below California Gulch. Historical placer mining within the river and grazing in the riparian areas of the river have reduced the amount of quality habitat for the brown trout fishery (Industrial Economics, 2006). Much of the 11-mile reach is over-width and aggraded, and presents as a continuous run or riffle with little deep pool or undercut bank habitat for over-wintering refugia. In addition, the banks are highly erodible due to lack of strong establishment of riparian shrubs such as native high-elevation willow species. Mine tailings and spoils are largely responsible for the poor vegetative growth, as well as a history of grazing and railroad activity in the area.

Physical habitat improvements within the 11-mile reach (including habitat and geomorphology improvements, bank stabilization, and riparian improvements) are expected to improve the fishery (density, biomass, spawning, and/or the number of large adult fish) up to 40% higher than current conditions. In-stream habitat restoration treatments are generally designed to perform one of the following functions, all of which directly or indirectly improve trout habitat: (1) improve natural river processes and connection between the river and the floodplain and riparian zone; (2) stabilize banks in a way which also creates winter habitat and cover for trout; and (3) enhance mid-stream habitats for trout and their prey base (forage fish or invertebrates). Photographs of in-stream restoration activities are included in Section A.3, bank erosion treatments in Section A.4, and aquatic habitat treatments in Section A.5.

Potential treatments for the entire 11-mile reach (Figure A.1) were identified and evaluated for the Preliminary Estimate of Damages (Industrial Economics, 2006). Table A.1 describes the general nature of the habitat restoration treatments that serve these functions and that will be considered for the reaches in the 11-mile segment. Stream reaches will be prioritized to develop an in-stream restoration timeline based on the (1) status of the brown trout population, (2) level of current and future contamination, (3) ease of access for heavy equipment, (4) public access after restoration, and (5) presence/absence of confounding factors such as water rights, ditches, agricultural practices, etc. With this prioritization scheme, Reach 3 between Highway 24 and Kobe was ranked as Phase I. EPA has conducted recent work in this reach and thus there are access roads that will facilitate in-stream restoration activities. In addition, the brown trout populations in this reach have not recovered to reference levels, and since metals contamination is lower in this reach compared to directly below California Gulch, we hypothesize that habitat is the limiting factor. Phase II of the project will be on the Moyer easement and Reach 2, which also shows severely degraded habitat and will have public access. Phase III includes private property from California Gulch to the confluence of the Lake Fork in Reach 1. There are issues in Reach 1 that must be addressed, including the maintenance of ditch access and agricultural practices, and protection of grazing land and physical structures. These issues may be best addressed with assistance from the National Resource Conservation Service. Work with private landowners was described in Section 3.3.1. Phase IV will include any point in Reach 4 where access and permission is granted.

Proposed treatment regimes for in-stream habitat restoration

Treatment regimes were proposed for the 11-mile reach of the upper Arkansas River based on initial inventory and survey techniques (Table A.1). These techniques include qualitative assessments of bank stability and riparian vegetation, counts of riffle to pool ratios, width to depth ratio measurements, aerial imagery at high and/or low flows, investigation of stream flow data from gauges, and determination of access logistics and private versus public property issues. Treatments for each reach are described in further detail below. These treatments will be further evaluated and adjusted or deleted when engineering models are applied to develop the final treatment plans for each reach. Nothing is currently proposed for the reference stream reach above California Gulch (Reach 0).

A.1 Engineering and Design

To assist with evaluating the size of material (boulders, cobbles, etc.) to use in various habitat treatments, a two-dimensional computer model will be developed. The United States Army Corps of Engineers' HEC-RAS computer program will be used to model each reach. This program is one of the industry standards for evaluating rivers in their current state as well as how planned improvements will affect the system. HEC-RAS utilizes river cross-section geometry, length of channel between cross-sections, channel roughness (amount of vegetation in the channel and overflow banks, size and shape of rock in the channel, etc.), and flow to determine water surface elevations, width of the water, and water velocity (impacts bank and channel bottom stability). The program will also help predict the ability of the river to transport sediment though the reach. This is important to design the river so there is neither agradation (deposit) nor degradation (erosion) at the structures.

The HEC-RAS computer model will evaluate river reaches as a system but is limited in its capability to predict how individual treatments/structures will affect the river at a particular location. To help evaluate the potential impacts that a particular treatment may have on the river in critical locations, it may be prudent to develop a three-dimensional model. There are several good three-dimensional hydraulic computer programs currently in use, such as the USGS MD-SWMM program.

A.2 Project Management and Construction

The preferred alternative of in-stream habitat restoration will require detailed engineering for each designated stream reach and associated construction and heavy equipment operations along the banks and within the streambed. While engineering plans will be adhered to as much as possible, there may be a need or opportunity for design-build activities beyond the engineering plans. Access roads previously developed by EPA for reclamation and restoration activities will be used, although additional access points may be required. Project management will require both knowledge of heavy equipment operations, placement of in-stream restoration treatment types, and fish behavior and ecology.

TABLE A.1. PROPOSED RESTORATION TREATMENTS FOR THE 11-MILE REACH OF THE UPPER ARKANSAS RIVER

A. Descriptions of treatments used to improve natural river process

River channel treatments	*Restoration treatment descriptions*
Reduce Channel Width	Excavated channel substrate material, imported gravel, and cobble or riparian vegetation sod blocks can be used to reduce river channel width.
Pool Excavation	Pool habitats should be excavated at a spacing of about 5–7 channel widths along either outside river curves or in straight channel reaches. Excavated substrate materials can be used to create point bars and reduce channel width.
Elevate Riffle Substrate	Riffle substrates can be elevated using gravel or cobble so it will not be transported during high-stream flow events. This treatment can be used to increase channel substrate elevation in a high-flow braided channel reach. During low-river discharge this treatment confines the river flow into a single low-flow channel. During high flows the elevated riffle channel becomes an over-flow channel and reduces the erosion potential along riverbanks in the low-flow channel. An elevated riffle placed in a low-gradient river channel creates additional channel roughness, increases trout habitat diversity, and provides excellent juvenile trout habitat.
Riparian Bench	A bench is constructed using river channel substrate, riverbank materials, or imported soil materials. The top elevation of the constructed bench should be slightly below bankfull elevation. Blocks of riparian vegetation sod scooped up in a bucket of an excavator or front-end loader are placed on top of the constructed bench. Buckets are rinsed before digging up the sod. After loading the sod block, it is soaked in water before being placed on the prepared bench. The soaking helps the vegetation block slide from the bucket. The top elevation of the placed riparian sod should be slightly above bankfull elevation. Depending upon the material size used to construct the bench and the river gradient, it may be necessary to line the front of the riparian bench with appropriately sized cobble to lessen riverbank erosion.
Increase Overhead Trout Cover Under Woody Vegetation	Sites best adapted for this treatment have woody vegetation creating overhead cover in river reaches located along outside river curves where trout habitat is limited by shallow water. Additional trout habitat is created using an excavator by extending the boom and carefully removing river channel substrate material under the woody vegetation. The increased water depth creates more useable overhead cover for trout.
Riparian Vegetation	Moving willow clumps during the dormant season maximizes success of survival. Survival of bare root willow stock and dormant stub plantings, planted deep enough to remain in permanent soil moisture, should exceed 80%. Seeding appropriate riparian grass species along stream banks disturbed during restoration increases the recovery of riparian vegetation.

B. Descriptions of woody materials treatments used to reduce riverbank erosion

Bank erosion treatments	*Restoration treatment descriptions*
Log Spur	Logs for this treatment should exceed 1 ft in diameter. In locations where stream banks are composed of alluvial material, a trench should be dug into the top of the riverbank. The angle of the trench facing upstream should be 15–25 degrees from the tangent line where the log intercepts the riverbank and have a downward slope of 2–7 degrees. The top elevation of the log where it meets the stream bank should be at or slightly above bankfull elevation. About one-half the length of the log should be placed into the riverbank. The upstream end of the log should be below the water surface at low flow and buried into the channel substrate. For additional anchoring and trout habitat, a boulder can be placed on the upstream end of the log that is buried in the river substrate. A boulder placed next to the riverbank on the downstream side of the log provides an additional anchor. Rather than excavating a trench, if stream banks contain moist clay or silt, the log may be pushed or pulled into the riverbank.
Log Vane	This treatment is installed the same as a log spur. Log length should exceed 20 ft and the log angle should be 15–20 degrees from the tangent line where the vane intercepts the riverbank and have a downward slope of 2–7 degrees. Fabric material should be placed between the riverbank and the log. The fabric should be attached at the top of the log and covered with excavated substrate material. Unlike a log spur that passes water under the log, the fabric material covered with substrate materials forces water to pass over the log directing it toward the center of the river.
Riverbank Root Wad	A root wad fan should exceed 3 ft in diameter having at least a 12 ft attached trunk. The trunk should be buried in a trench or pushed into a soft clay/silt bank so the root fan is upstream at an angle that slightly defects surface water currents toward the center of the stream. The top of the root wad should be about 1 ft above bankfull discharge and placed flush against the stream bank.
Horizontal Parallel Log/ Root Wad	Horizontal logs are best suited for riffle and run habitats. The log should be at least 2 ft in diameter and exceed about 12 ft in length. Depending upon riverbank stability, it may be necessary to place an appropriate fabric material extending from the river substrate up to about bankfull elevation. The top of the horizontal log is placed against the fabric at about bankfull elevation and parallel to the stream flow. The space between the bottom of the log and the river substrate creates overhead trout cover. The support system for the horizontal log is site specific. If the log has an attached root wad this supports one end of the log. On the other end of the log, small flat boulders or another log placed perpendicular to the river flow and secured into the riverbank supports the log. It is important that the horizontal log is suspended only on each end. This helps maintain water velocities high enough to keep river-transported sediments from accumulating along the underside of the horizontal log and reducing areas trout use as overhead cover. In over width river channels or where the log does not fit snug against the bank, a second, usually smaller diameter, log is placed behind the horizontal log at a slightly lower elevation. The area between the channel substrate at the base of the riverbank, over the lower elevation log to the top of the horizontal log, is covered with fabric material and backfilled using soils capable of supporting riparian vegetation. If available, riparian grass/willow sod is placed on the fill material out to the front edge of the horizontal log. This results in a natural appearing structure that creates overhead trout cover under both logs.

C. Descriptions of boulder treatments used to reduce riverbank erosion

Bank erosion treatments	*Restoration treatment descriptions*
Cross Vane	Usually a cross vane is placed at the upper end of an excavated pool to create a diversity of trout habitats and direct river flows toward the center of the channel. This structure helps reduce riverbank erosion along the outside curve. The first few boulders forming each side of the structure upstream are placed on a 20°–30° angle from the riverbank. The rest of the boulders are placed across the channel resembling an upstream facing arch across the river. Embed the first boulder into the riverbank at about 1 ft above bankfull elevation. A fabric material placed behind this boulder helps reduce future riverbank erosion. This first boulder keys the structure and directs the water current away from the eroding riverbank. Depending on boulder shapes and the way the water is directed from the bank, each succeeding boulder is placed lower in the water column than the previous one. The lowest elevation boulder is located near mid-channel at about 25% of bankfull elevation. The hydraulic jump, the difference in water surface elevation between the upstream and downstream side of a boulder, is usually no more than 12–15 inches. Boulder elevations near mid-channel are then gradually increased until reaching the opposite side of the river. The final boulder is embedded and blended into the top elevation of the constructed point bar, which is usually less than bankfull discharge. Erosion is seldom an issue on the point bar side of the river channel because point bars are usually depositional areas.
Single Boulder Deflector	Single boulder deflectors should have a somewhat flat side and be tall enough to extend from a shallow pocket in the channel substrate to about 12–15 inches above bankfull elevation. This treatment is best suited for eroding riverbanks still containing clumps of riparian vegetation and having a bank top elevation near bankfull elevation. Single boulder deflectors can be used to divert river flows away from tall eroding riverbanks but does not help the riverbank healing process if void of vegetation.During installation, excavate a depression to fit the shape of the bottom side of the boulder and remove riverbank soil to match the shape of the boulder side to be embedded into the eroding riverbank. Place an appropriate fabric material into the depression and along the riverbank where the boulder will be placed. The upstream end of the boulder is embedded deeper into the riverbank while the downstream end extends slightly into the river. The single boulder deflector gently deflects surface water currents toward the center of the river. The boulder deflector reduces riverbank erosion a short distance downstream, depending on the deflection angle and the curvature of the riverbank. After the first single boulder defector has been installed, the location for the second is obvious by observing the river surface flows. The distance where the river surface current returns to the riverbank becomes the site for the next boulder deflector. This treatment works best where riverbank erosion is not so severe and enough riverbank vegetation remains to protect the riverbank between boulder deflectors. If riverbanks are severely eroded, revegetation may be necessary between boulder deflectors.
Hard Point	This treatment mimics a stable riverbank between the low river flow and bankfull elevation. It is best suited for a riffle reach on an outside curve. The treatment requires substrate material or imported material sized so it will not be easily eroded when placed on the slope of the riverbank. The material is placed from about the river substrate near the low-flow water surface up the riverbank to slightly below bankfull elevation. When placed on the non-vegetated channel substrate below bankfull elevation it protects the toe of the exposed riverbank and helps reduce future riverbank erosion. This treatment helps reduce erosion by decreasing the riverbank angle. This treatment can be shaped to deflect high water from the riverbank toward the center of the river. The treatment normally extends the length of an eroding riverbank where additional riverbank protection is necessary. When installed properly this treatment has a natural appearance.

C. Descriptions of boulder treatments used to reduce riverbank erosion (continued)

Bank erosion treatments	*Restoration treatment descriptions*
Boulder J Hook	This structure is usually placed at the upper end of pool habitats. It is created using 3–5 ft boulders arranged in a partial upstream-facing semicircle. It also creates a diversity of water depths and water velocities, creates additional trout habitats, and helps maintain adequate pool depths. The first few boulders in a J hook structure reduce water velocities and riverbank erosion. Excavation of a pool habitat is usually necessary. The site for the first boulder is along the outside curve where the pool is excavated. The fabric material is placed where the first boulder is embedded into the riverbank. The fabric forms a seal between the boulder and the riverbank. The top of the boulder is set about 12 inches above bankfull elevation. This boulder is placed to deflect water surface current toward the center of the stream. Footer boulders are placed directly downstream of all boulders placed to form the J-hook structure. Footer boulders prevent the structure boulders from moving downstream during high river flows. Each boulder in the structure is placed to direct surface water flows toward the middle of the stream. The boulder structure starts at an angle of about 30–40 degrees from the riverbank for about 1/3 the distance across the stream, gently curves downstream for about 2/3 the distance across the stream, then curves sharply downstream into the center of the excavated pool. The top elevation of each boulder is decreased and the gap between each boulder increases as the structure is constructed across the river.
Boulder Vane (Half cross vane)	This structure uses three to four rectangular shaped boulders ranging in size from 4–6 ft and 2–3 feet in height. The boulder vane points upstream about 20–30 degrees from the riverbank and directs surface water currents toward the center of the river channel. The top elevation of each succeeding placed boulder decreases and the final boulder rests about 12–15 inches above the channel substrate. Boulder vanes rarely extend more than 20% across the river channel. The hydraulic jump between boulders normally should be less than 1 ft. On the downstream side of each boulder, a footer boulder is embedded into the channel substrate and placed tight against each vane boulder. The footer boulder provides stability to the boulder vane structure and creates additional trout habitat.

D. Description of treatments used to enhance mid-channel aquatic and trout habitats	
Aquatic habitat treatments	*Restoration treatment descriptions*
Random Boulders	Boulders exceeding about 3 ft in length and 3 ft in height, with at least one nearly flat surface and with an irregular rectangular shape, make excellent random boulders. First excavate an oversized oval-shaped pit for each boulder. Place the flattest side up. When a variety of random boulders are used in riffle or run reaches, boulder top elevations should range between about bankfull to slightly underwater during low stream flows. The different boulder elevations provide a diversity of water depth and water velocity habitats across a wide range of stream flows. Limited use of random boulders in pools creates additional trout cover. Rivers with high stream transported sediment loads tend to accumulate sediment on the downstream side of boulders and limit their value as trout habitat.
Boulder Cluster	Larger boulders > 5 ft in length and about 3 ft in height are recommended for boulder clusters. In riffle or run habitats, excavate a large oversized oval-shaped pit large enough to accommodate the number of boulders planned for the cluster. A boulder cluster normally contains three boulders but up to seven boulders have been used. The excavated pit should extend several feet beyond the planned size of the boulder cluster. Boulders placed in a cluster arrangement need different spacing and elevations to create a diversity of water depths and velocities. In the middle of the cluster downstream from the three or four most upstream boulders, excavate deeper into the channel substrate to provide additional deeper water trout habitat. If river transported sediment materials are minimal, a boulder can be placed into the deepest water pocket. Create a tail out in the lower end of the boulder cluster.
Rock Garden	A rock garden treatment involves embedding boulders less than 2 ft in diameter into a small/coarse gravel riffle substrate. This treatment is suited for secondary active channels lacking cover or other in-channel structures. Boulders are placed close enough together to create diversities of water velocities that provide habitat cover. This treatment creates additional channel roughness.
Stumps	Stumps are merely root wads with a short trunk. The root fan should exceed 3 ft in diameter and trunk length can be cut to fit the site. Sumps are placed upright in low-gradient runs and riffles or in pools with the root fan resting on the channel substrate. Stumps are anchored with large flat shaped boulders. This treatment is not suitable for high-gradient rivers of in-streams with high sediment loads.
Mid Channel Root Wads	This structure provides mid-channel overhead trout cover. Mid-channel root wads can be placed into low gradient riffle and run habitats or placed into existing or excavated mid-channel pools. Root wads with a root fan diameter greater than 3 ft and having attached trunks > 16 ft in length are placed parallel to the river flow facing the root fan upstream. This structure is anchored using flat-sided 3–6 ft boulders placed on the trunk or root wad. Wherever possible, two root wads should be placed beside each other for better anchoring. This also creates additional overhead trout cover. Depending upon the curvature of the root wad log, the downstream end of the trunk can be buried into the channel substrate and anchored using a large boulder.

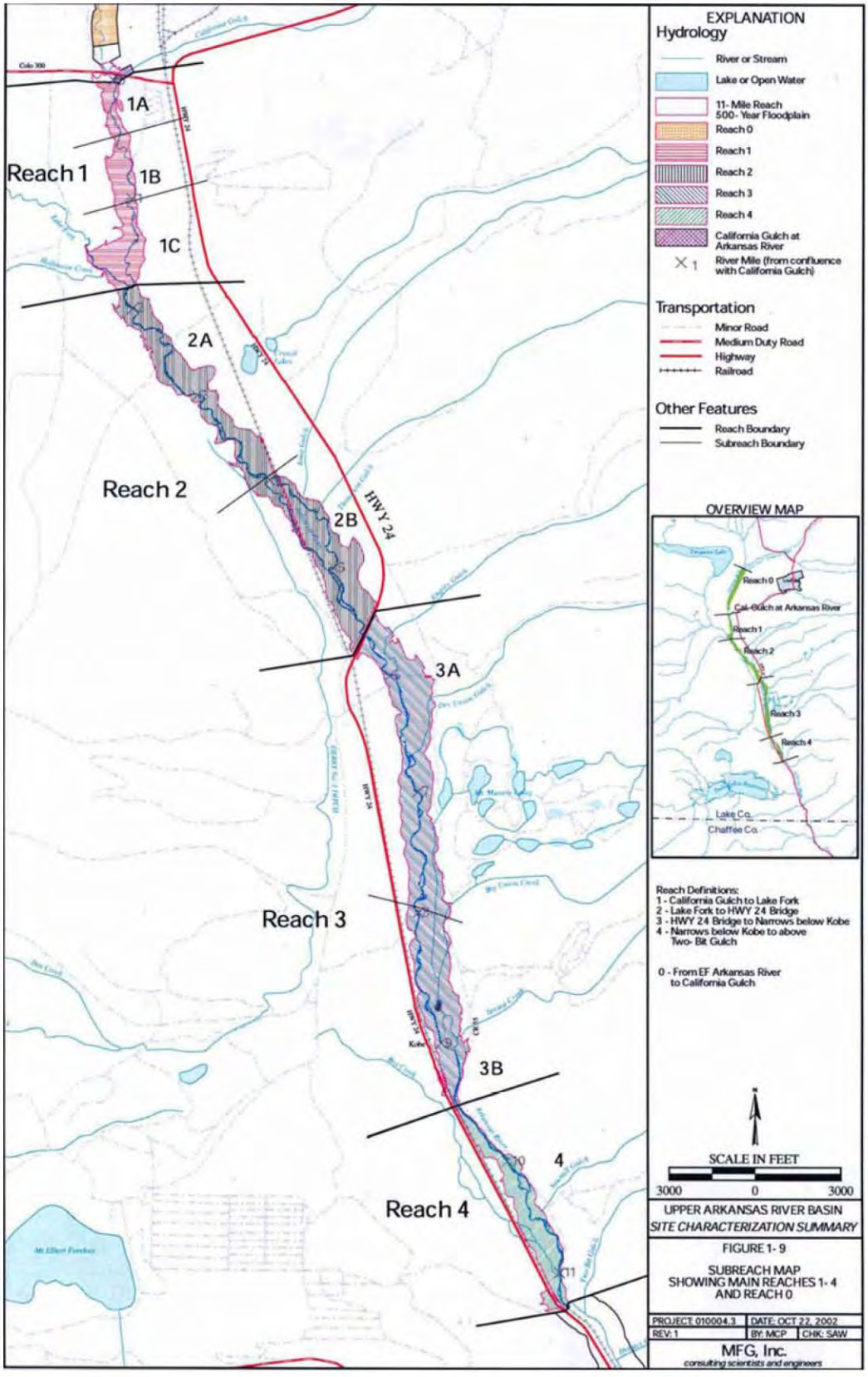

Figure A.1. Reaches 1–4 in the 11-mile reach of the Arkansas River below the confluence with California Gulch.

A.3 In-Stream Restoration Activities

Figures A.2–A.9 provide examples of the types of in-stream restoration activities that may be employed.

Figure A.2. Elevating riffle substrate.

Figure A.3. Reducing channel width by adding fill.

Figure A.4. Creating a point bar.

Figure A.5. Add riparian vegetation.

Figure A.6. Excavate a pool.

Figure A.7. Add overhead trout cover.

Figure A.8. Add a riparian bench with a cobble toe.

Figure A.9. Add a riparian bench with a stone/boulder toe.

A.4 Bank Erosion Treatments

Figures A.10–A.18 provide examples of the types of bank erosion treatments that may be employed.

Figure A.10. Log spur.

Figure A.11. Log vane.

Figure A.12. River bank root wad.

Figure A.13. Horizontal parallel log.

Figure A.14. Cross vane.

Figure A.15. Half cross (boulder) vane.

Figure A.16. Boulder J hook.

Figure A.17. Hard point.

Figure A.18. Single boulder deflector.

A.5 Aquatic Habitat Treatments

Figures A.19–A.23 provide examples of the types aquatic habitat treatments that may be employed.

Figure A.19. Rock garden.

Figure A.20. Boulder cluster.

Figure A.21. Stump.

Figure A.22. Random boulders.

Figure A.23. Mid-channel root wad/log.

The Trustees received comments during the January 13, 2010 to February 26, 2010 public comment period from two entities:

1. Lake County Conservation District

2. Aurora Water.

This section summarizes those comments and provides Trustee responses. The comment from Aurora Water is included at the back of this appendix. The comment from Lake County Conservation District was provided in a telephone conversation and is not included here.

Comment

The Lake Fork Conservation District had three specific comments about the RP/EA. Two comments were specific to the Arkansas River In-Stream Habitat Restoration project. The first comment expressed concern that the proposed budget was insufficient for work to be completed on private land. The second comment suggested that the RP/EA language clearly indicates that restoration work will be designed to work within the confines of BOR releases from Turquoise Lake. The third comment pointed out that mountain goats were introduced to Colorado in the 1950s and should not be listed as historically present in the area; the comment also suggested that the scientific name for bears be limited to the genus only, since specific bear species were not listed.

Trustee response

The budget for the Arkansas River In-Stream Habitat Restoration project has been increased in this final RP/EA to reflect the costs needed to complete the project on private land. The project summary also has been revised to address concerns about BOR releases from Turquoise Lake.

Chapter 4 has been revised to remove mountain goats from the list of native species and to note the scientific name for bear as Ursus spp. instead of Ursus americanus.

Comment

The city of Aurora provided a comment indicating that the city receives a significant portion of its water supply from the Arkansas River Basin. The comment also noted that the city is an important landowner and manager in the 11-mile reach with water rights as well as building rights. The city of Aurora provided three specific comments recommending that the Trustees design restoration projects that will be successful under the flow-regimes allowed by law, that restoration projects should not conflict with future land management and water storage plans on land owned by the city of Aurora, and that restoration projects should not conflict with wetland credit banking plans to be completed on land owned by the city.

Trustee response

The Trustees will work with the city of Aurora and other government agencies as appropriate to ensure the success of restoration projects without violating the land ownership or water rights of other entities. In-stream restoration projects will be designed under the flow regimes that account for maximum withdrawal of water as permitted by law under the current Colorado water rights established for the stream. Restoration projects that include proposed modifications to the city of Aurora's land or streambank will be designed to account for the city of Aurora's land use plans, and will be approved by the city of Aurora prior to implementation. The Trustees have revised the descriptions of restoration projects potentially affected by the city of Aurora land and water uses to more clearly reflect these management decisions.

City of Aurora

AURORA WATER

Water Department
Administration
Phone: 303-739-7370
Fax: 303-739-7491

February 26, 2010

Submitted via email to laura_archuleta@fws.gov

RE: Comments on Draft Restoration Plan and Environmental Assessment for the Upper Arkansas River Watershed dated January 7, 2010

To Whom It May Concern:

Aurora Water has the following comments on the Draft Restoration Plan and Environmental Assessment for the Upper Arkansas River Watershed dated January 7, 2010 (EA), in particular the Tier 1 project titled *Arkansas River in-stream habitat restoration* located along the 11-mile reach:

1. The City of Aurora, with a population of over 310,000, receives approximately half of its water supply from the Colorado and Arkansas River basins. This supply is stored and transported to Aurora through its infrastructure and storage capacity in the Upper Arkansas River basin. Turquoise Reservoir and Twin Lakes Reservoir are integral to several water providers operations, including Aurora. The Bureau of Reclamation and water rights owners should be able to operate and manage their facilities according to their own operating principles and state water law. There should be no additional requirements or restrictions placed on water providers and operators due to any restoration project being proposed in the EA. The in-stream flow habitat restoration design should be engineered for the full range of natural and operated flow volumes, timing, and durations.

2. Aurora purchased the Hallenbeck Ranch for a future water storage site which lies inland and west of the 11-mile reach. Aurora also owns the Hayden River parcel that lies along the west side of the Arkansas River within the 11-mile reach. The design of the future water storage facility has not been completed and may include water intake and/or forebay structures on the Hayden River parcel or utilize the Derry 1 ditch that lies upstream in the 11-mile reach. The design of the structures and future operations should be considered in any proposed restoration project along those same reaches of influence.

3. Aurora may develop wetland mitigation credits on the Hayden River lands. On page 22 of the EA, goal (5) states "construction of riparian benches to extend the width of riparian zone". The "zone" should not include areas that Aurora may utilize for wetland credit banking.

15151 E. Alameda Parkway • Aurora, Colorado 80012 • www.aurorawater.org

Existing water infrastructure and new water supply projects are absolutely necessary for the health, safety, and welfare of Colorado citizens. Turquoise Reservoir, Twin Lakes Reservoir and the Arkansas River are invaluable for water supply operations for both municipalities and agriculture. The in-stream habitat restoration should not eliminate water supply alternatives or create roadblocks to the maintenance, operation, and development of existing and conditional water rights and storage within the Upper Arkansas River basin.

Aurora staff met with Nicole Vieira with the Division of Wildlife (DOW) on February 25th, 2010 and discussed all three of the above comments. Aurora looks forward to working with DOW and others on development of the restoration plans. Should you have any questions or need clarification on these comments or Aurora's water system, please contact me at the phone number or email address below.

Sincerely,

Kathy Kitzmann

Kathy Kitzmann
Senior Water Resources Engineer
303-739-7533
kkitzman@auroragov.org

cc: Joe Stibrich, Deputy Director of Water Resources
Gerry Knapp, Arkansas/Colorado River Basin Manager
Mike McHugh, Environmental Permitting Coordinator
Nicole Vieira, Division of Wildlife.