

Hecla Junction Flood Mitigation and Stream Restoration Concept Plan

Arkansas Headwaters Recreation Area



Hecla Junction Alluvial Fan, August 2006

Prepared for:
Colorado Division of Parks and Outdoor Recreation
In Cooperation With
Colorado Water Conservation Board, Flood Protection Section

Prepared By:
C. J. Schott
J. P. Carey, P.E.



Executive Summary

Heavy rains during August 11-12, 2006 in Chaffee County caused several ephemeral tributaries in the upper Arkansas River valley, including a tributary flowing through Hecla Junction, to experience unusual flash flooding. Hecla Junction is within the Brown's Canyon reach of the Arkansas River Headwaters Recreation Area (AHRA), and is one of the most popular raft take-out area in Colorado, and arguably one of the most popular in the nation. Fortunately, there were no injuries or fatalities related to the flood, but damages to man-made facilities and to the environment were quite significant. Immediately following the flood event, State Parks personnel worked feverishly to repair the most critically damaged areas in order to restore basic operations at the site, however the band-aid solutions are quite temporary in nature and a sustainable mitigation project is required to reduce future vulnerability.

The AHRA is managed by Colorado Division of Parks and Outdoor Recreation (State Parks) to emphasize its natural resources, resource sustainability, and the standards for public land health, recognizing and respecting private property, while embracing numerous recreational, educational, and commercial activities (USDI 2001).

The first step in restoring Hecla Junction is to take a holistic approach and to find a balance between ecological integrity, recreation access, and continued function of natural environmental processes. Alluvial fans are a dynamic force of nature and serve an ecological purpose, refreshing sediment in the Arkansas River. This Flood Mitigation and Stream Restoration Concept Plan uncovers opportunities and constraints which anticipate sediment transport. Respecting this powerful force of nature should allow for continued recreational use adjacent to a naturally functioning riparian zone. Bio-stabilization techniques are also recommended and described, which may help control sediment loads in addition to restoring habitat values.



Contents

I	Introduction and Background	4
	Study Authorization.....	4
	Study Purpose	4
	Socio Economic Setting.....	4
	Arkansas Headwaters Recreation Area	4
	Rafting Industry.....	5
	Stewardship Ethic.....	5
	Cultural Resources.....	5
	Biological Resources.....	6
	Habitat Diversity.....	7
	Wildlife and Fishery.....	11
II	Watershed Description.....	13
	Environmental Setting	13
	Climate.....	13
	Geology.....	13
	Soils.....	14
	Fluvial Geomorphic Characterization	16
	Hydrologic and Hydraulic Analyses	21
	Erosion/Sediment Transport Analyses	24
	Geomorphic Exacerbation	26
III	Conceptual Restoration Design.....	28
	Coordination.....	28
	Concept Plan Description.....	28
	Concept Plan Development	34
	Anticipated Final Design Process.....	34
	Recommended Plan.....	35
	Construction Process and Timeline.....	35
	Seasonal Constraints.....	36
	Implementation Phasing.....	36
	Project Funding.....	36
	Appendices.....	38
	o A – Concept Plan Cost Estimate	
	o B – Permit Process/ Potential Authorizations Required	
	o C – USFWS Listed Species List	



I. Introduction and Background

Study Authorization

At the request of the Colorado Division of Parks and Outdoor Recreation (State Parks), the Colorado Water Conservation Board (CWCB) funded this restoration and flood mitigation masterplan through the Watershed Restoration Program of its Flood Protection Section. The Flood Protection Section has a history of providing assistance and leadership throughout Colorado for the development of plans and projects intended to enhance or mitigate stream corridors and watersheds based on cooperative agreements typically initiated by local interests. The CWCB also plays a significant role in managing the Colorado Watershed Protection fund and the Fish and Wildlife Resources Fund through statutory authorizations.

Study Purpose

The purpose of this report is to uncover opportunities and constraints, from the river's perspective, that reveal how to allow for natural processes at Hecla Junction while preserving ecological integrity, environmental quality, and maintaining recreational values. This challenging objective requires adaptive management of natural resource use, visitor access, and ecological planning.

Socio Economic Setting

The recreational heritage of the Arkansas River has shaped the character of the communities and provided economic vitality to these communities. The unique scenery of the broad river valley lined with massive peaks offers diverse recreation opportunities that attract visitors from around the world. Communities have embraced this natural resource and continue to recognize its economic importance. The towns of Salida, Buena Vista, and Pueblo have created river recreation parks that have become center pieces to downtown areas. One of the oldest and most popular river festivals is the First in Boating on the Arkansas (FibArk) based in Salida. The FibArk river festival has been held since 1949 attracting worldwide competitors.

Arkansas Headwaters Recreation Area

The AHRA is popular for whitewater rafting, kayaking, fishing, camping, hiking, mountain biking, OHV trail riding, and wildlife viewing. The AHRA encompasses 150 miles of the Arkansas River from the confluence of Lake Fork and the Arkansas River near the City of Leadville to Pueblo State Park. The AHRA is managed by State Parks.

Rafting Industry

The Browns Canyon reach is one of the most heavily used sections on the Arkansas River for commercial rafting trips. This segment offers Class III and IV rapids and a vertical drop of 30 feet per mile (ARWNA).



Other activities include fishing, private boating, camping, and wildlife viewing. The site is managed by AHRA as a lease site. The Browns Canyon Hecla Junction recreation site is used for day use and overnight camping. Facilities include parking, restrooms, picnic sites, grills, tent pads, information signs and a boat launch. The site is primarily used by boaters, anglers and campers. A daily or annual pass is required at this site.

The Arkansas River is Colorado's most popular whitewater destination (Colorado River Outfitters Association, 2006) and one of the most commercially rafted rivers in the United States (State Parks, 2007). In 2006 the Arkansas River had an economic impact of \$64,675,218, which was 46.5 percent of Colorado's market share (Colorado River Outfitters Association, 2006). The industry brought in a record-setting \$139 million during the 2006 season, making it Colorado's number one summer tourism industry.

Stewardship Ethic

Facilitating recreation activities promotes new river stewards. The people that recreate in the river environment are those who strive to protect it. For example, Evan Stafford, a professional kayaker and author of *Whitewater of the Southern Rockies*, 2007 was quoted as saying:

"It is the responsibility of each of us, as paddlers, to protect the watersheds which bring us so much happiness. For many, including myself, kayaking is the fusion of sport and temple. Let's keep our place of worship clean."

Cultural Resources

Evidence for man's existence in Colorado reaches from the present era back to the latter days of the last Ice Age. Throughout this time, the Arkansas River and its immediate environs have provided an ecological constant for human, flora and fauna communities. In addition, the Arkansas River has provided a subsistence refuge during periods of climatic hardship and an area of abundance during more favorable times. As prehistoric groups adapted and changed through time, the record of these dynamics is reflected in archaeological sites scattered along the river corridor. Relatively few of these sites are recorded. They are a fragile and irreplaceable resource.

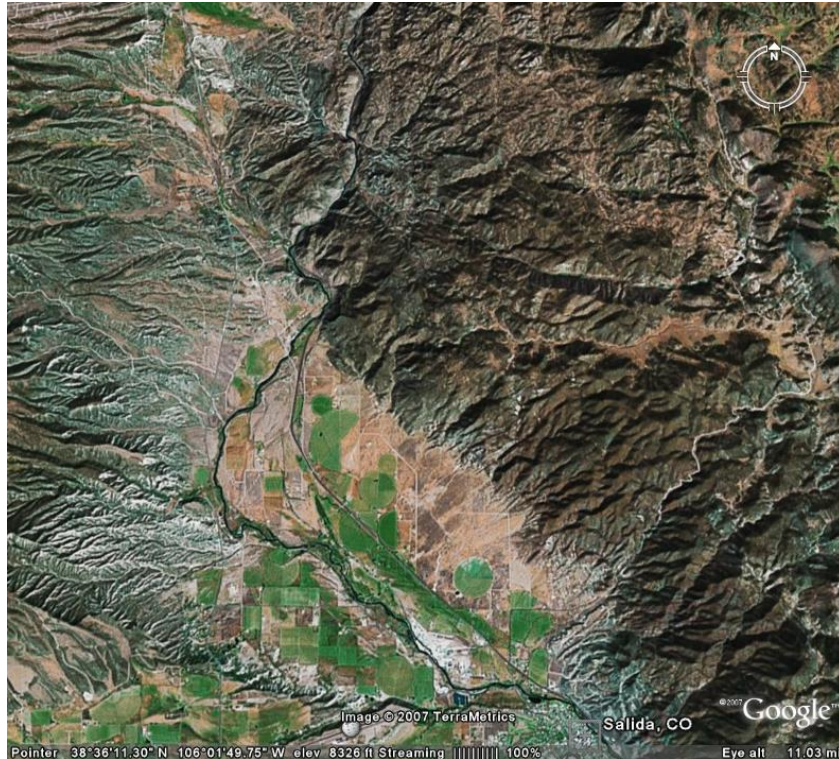
The Arkansas River figured prominently in modern history from the early days of Spanish explorers and French fur trappers to the present industrial era. Many characteristics attractive to aboriginal inhabitants, i.e., permanent water, minerals, rich earth, etc., have contributed to the recent growth in mining, agriculture, ranching, transportation and communication. Some important sites have been recorded and determined to be nationally significant. Many more have not been recorded and/or evaluated. Type of Site Physical Remains of Recent History Transportation Denver to Leadville stagecoach road,; Buena Vista to Leadville stagecoach road; Denver South Park and Pacific Railroad; Colorado Midland Railroad; Denver and Rio Grande Railroad; Santa Fe, Atchinson and Topeka Railroad; DeReemer Forts of the "Railroad War." Mining towns, historic mining districts, kilns, and other remains from the extensive coke industry supported mineral smelting, agricultural farms, herding camps and ranches.



Opportunities exist to interpret these sites "in-situ" and to gain additional information through further inventories.

Biological Resources

The Arkansas River corridor within the Arkansas Headwaters Recreation Area is one of the most diverse river corridors in Colorado. It descends from mountain peaks, and flows through open grasslands, traverses a varied range of impressive and beautiful montane ecosystems on its way down hill and finally ends in a mature river system (USDI 2000) (Location Map 1).



Location Map 1 - Google Earth 2007

The corridor has remained remarkably pristine despite the fact that it has been modified by a railroad, a busy highway and substantial agricultural, residential and commercial development along much of its length. (USDI 2001)

Habitat Diversity - The Arkansas River portion at Hecla Junction is situated at approximately 7500 ft in elevation in the upper montane life zone, which encompasses slopes and valleys above the foothills. Slopes surrounding the project area are covered mostly in pinyon juniper woodland and sage shrub steppe. The Arkansas River and riparian corridor below the project area is flanked by tall willow/alder shrubland with associated areas of grassy marsh. These riparian habitats are highly valuable to biodiversity. Biological data was collected in 4 habitat plots on April 21, 2007 during early season growing conditions. This survey was conducted to provide a general sense



of habitat diversity and value, and it is recommended that further studies be conducted for the final design process. Initial survey results show the following;

Pinyon Juniper Woodlands Surrounded by Hecla Wash (Plot 1)

Vegetation is dominated by pinyon pine (*Pinus edulis*) and Rocky Mountain juniper (*Juniperus scopulorum*) with ponderosa pine (*Pinus ponderosa*) and douglas fir (*Pseudotsuga menzessii*) sparsely dispersed throughout the woodland. The understory consists of species including silver sage (*Artemisia frigida*), yucca (*Yucca sp*) and native grasses such as blue gamma (*Chondrosium gracile*) and Fescue (*Festuca spp*) as well as other grasses and forbs. The Hecla Wash intermittent stream bed has a narrow riparian fringe, >30% vegetated, and is comprised mainly of narrow leaf cottonwood (*Populus angustifolia*) and rush (*Juncus spp.*). Herbaceous weeds documented include yellow sweet clover (*Melilotus officinalis*) and toadflax (*Comandra umbellata*). Soils are mainly sand, gravel, cobble and boulder, and the intermittent stream bed has clay rich mottled soils in the gully areas.

Cottonwood Gallery Forest Surrounded by Sage Scrub, and Grassland (Plot 2)

Mature cottonwood gallery forest dominates this section of the Hecla Wash with an intermittent stream bed similar to the section described above. The habitat is surrounded by pinyon juniper, sage scrub and herbaceous grassland. A mixture of cool and warm season grasses occur including blue grama, fescue, mountain muhly (*Muhlenbergia montana*) needle and thread (*Hesperostipa comata*), junegrass (*Rostraria cristata*), and various other grasses, which were not identified due to early season growing conditions.

Hydrological influences were indicated by wetland seeps dominated by rush (*Juncus spp*) and have mottled soils. Some areas within the grassland have sparse vegetation and barren rocky patches with pricklypear cactus (*Opuntia polyacantha*).

Floodplain and Riparian Wetland on the Arkansas River (Plot 3)

The riparian community along the Arkansas River at Hecla Junction is composed of willow (*Salix spp*), alder (*Alnus spp*), birch (*Betula spp*) and cottonwood with an understory composed of grasses, sedges, rushes. There are limited amounts of emergent or submergent shoreline vegetation. A narrow fringe of sandbar willow (*Salix Exigua*) and Alder (*Alnus spp.*) occurs with various grasses including fescue, and foxtail (*Phleum spp*) including forbs, which were not identified due to early season growing conditions. Weeds such as thistle (*Cirsium spp*) and dandelion (*Taraxacum officinale*) also occur to some extent.

The extent of riparian and wetland resources within the study area is determined to a large degree by natural geomorphology. The Arkansas River immediately downstream from Hecla Junction is largely bounded by rock and is narrow and confined. The rocky and narrow canyon topography, coupled with high spring flows, limits soil development and plant establishment (USDI et al. 2000).



Riffelpool Stream Complex of the Arkansas River (Plot 4)

The section of the Arkansas River at Hecla Junction includes a rifflepool complex. There is a low sinuous channel with riffles, large pools and long runs, and alternating bars. There are many large boulders from ancient glacial outwashes and bedrock constrictions that form excellent pocket water. The most heavily fished and popular sections of the Arkansas River are downstream of Browns Canyon. The river averages from 70-100 feet wide in most areas with boulders, bends and deep seams creating superb habitat for the trout that reside here (Fly Fishing Connection, 2007).

Figure 1– Pinyon Juniper Woodland and Hecla Wash



Figure 2 – Cottonwood Gallery Forest with Sage Scrub and Grassland



Figure 3 – Narrow Riparian Fringe of the Arkansas River



Figure 4 – Riffle-Pool Complex of the Arkansas River



Wildlife and Fishery

Terrestrial and aquatic habitat values vary from low to high within the project area. Habitats are suitable for a various wildlife species including amphibians, reptiles, birds, and mammals. Field surveys were conducted in December 2006 and in February and April 2007. Surveys within the project area improve our understanding of habitat values, facilitates permitting, and will assist with restoration monitoring.

During field surveys, two federally listed species were observed. The bald eagle (*Haliaeetus leucocephalus*) was observed during field work in December 2006, and the piping plover (*Charadrius melodus*) was observed in April 2007. Surveys also revealed red-tail hawk (*Buteo jamaicensis*), common merganser (*Mergus merganser*), mallard (*Anas platyrhynchos*), Canadian goose (*Branta Canadensis*), American dipper (*Cinclus mexicanus*), cliff swallow (*Hirundo pyrrhonota*) and mountain blue bird (*Sialia currucoides*). In addition to those avian species, a white tailed deer (*Odocoileus virginianus*) and a red fox (*Vulpes vulpes*) were observed.

According to a local District Wildlife Manager for CDOW, juvenile osprey (*Pandion haliaetus*) are known to migrate in the river corridor during spring and fall, and a few pair of resident golden eagles (*Aquila chrysaetos*) nest nearby. In addition secluded rocky cliffs, particularly in the Chalk Creek drainage, provides suitable habitat for listed species American peregrine falcon (*Falco peregrinus*) and Mexican spotted owl (Ron Dobson CDOW April 20, 2007). Sandhill cranes are known to migrate through the area, typically in April, and trumpeter swans are also known to over-winter. Various waterfowl species including great blue heron (*Ardea herodias*) and night heron (*Nycticorax nycticorax*), and pelican (*Pelecanus erythrorhynchos*) have also been documented migrating through the



area. The pinyon juniper habitat supports several breeding bird species essentially restricted to it (Kingery 1998).

Amphibians and reptiles such as the tiger salamander (*Tigium salvinus*), western fence lizard (*Sceloporus occidentalis*), western rattle snake (*Crotalus viridis*), and bull snake (*Pituophis melanoleucu*) occur in the area (Dobson CDOW April 20, 2007) and the pinyon juniper habitat is prime for mountain lion (*Felis concolor*) bob cat (*Felis rufus*), red fox (*Vulpes vulpes*), grey fox (*Urocyon cinereoargenteus*), black bear (*Ursus americanus*), and white-tailed deer (*Odocoileus virginianus*).

A healthy prey base of small mammals exists including Gunnison prairie dogs (*Cynomys leucurus*), northern pocket gopher (*Thomomys talpoides*), squirrels, chipmunks, and rabbits. Other small mammals such as raccoon (*Procyon lotor*), porcupine (*Erethizon dorsatum*), and beaver (*Castor canadensis*) are also typical to the area.

Northern river otter (*Lutra Canadensis*) have been seen in the Arkansas River but none documented in the project area. Listed pebble's jumping mouse (*Zapus princeps*) and Townsends big-eared bat (*Plecotus townsendii*) may also be found in the area (Ron Dobson CDOW April 20, 2007).

Macroinvertebrate populations were likely impacted by the Hecla Flood but populations are thought to have rebounded quickly (Dobson CDOW April 20, 2007).

Brown Trout (*Salmo trutta*) make up over 90% of the fishery in the Arkansas River section at Hecla Junction. Rainbow trout (*Oncorhynchus mykiss*) also inhabit the area to a lesser degree ((Ron Dobson CDOW April 20, 2007).

Threatened, Endangered and Special Concern Species

The following federal, state and BLM special concern species may be found in the AHRA at certain times of the year and require special management attention under the Endangered Species Act of 1973 (Appendix 3). While special concern species are not federally protected, it is policy to manage these species to prevent future listing, thereby affording them the same level of protection as T&E species.

1. Peregrine Falcon: State Species of Special Concern
2. Bald Eagle: Federal Threatened, State Threatened
3. Piping Plover: Federally Endangered
4. Mexican Spotted Owl: Federal Threatened, State Threatened
5. Osprey: State Species of Special Concern
6. Northern River Otter: State Threatened
7. Canada Lynx: Federal Threatened, State Threatened
8. Townsend's Big-eared Bat: State and BLM Species of Special Concern
9. Northern Leopard Frog: State and BLM Species of Special Concern



II. Watershed Description

Location

The Hecla Wash, named herein for convenience, is located near Hecla Junction within the AHRA, on lands managed by the United States Bureau of Land Management (Figure 1 Watershed Map). The Hecla Wash is an ephemeral tributary to the Arkansas River, and is approximately 2.8 miles long flowing eastward to a broad mouth located at the Browns Canyon take-out for the AHRA. The Hecla Wash is an entrenched channel that runs through the Dry Union Formation. An irrigation ditch located at the top of the drainage utilizes the Wash to dump return flows. The irrigation ditch runs under Highway 285 through a 30'' culvert. Deep incision and head cutting is occurring in the upper basin silty-clay deposits. There is v-shaped gully from the north that confluent with the main Hecla Wash approximately mid basin. The road follows a small side drainage from the south that also confluent at mid basin.

Climate

The Hecla Wash watershed is 2 square miles, with an elevation range of 7935 – 7380 feet. The climate is semi-arid with an average annual precipitation of 10 inches per year, average temperature of 45°F, and a growing season of 100 days (USDA, SCS, Soil Survey of Chaffee-Lake Area, Colorado, 1975). There are no discharge or precipitation data collected on the Hecla Wash, although meteorological stations are located in Buena Vista and Salida. Runoff occurs during snowmelt and high intensity precipitation events and irrigation return flows.

Geology

Geologic units that make up the Hecla Wash watershed are primarily sedimentary formations with outcrop exposures of igneous and metamorphic rocks. Sedimentary Rocks of Tertiary Age are the Dry Union siltstone, sandstone and conglomerates (USGS, Northwest Quadrant Colorado Geologic Map). Near the mouth of the Hecla Wash are outcrop exposures of Tertiary Age Igneous intra-ash flow deposits of andesitic lavas. Metamorphic Rocks are felsic and hornblende gneisses with metabasalt derived principally from volcanic rocks of the Precambrian age. Sedimentary lithology makes up most of the watershed. The majority of the southern slopes are sedimentary; which have more rapid erosion, less vegetation cover and more extreme heat flux. Igneous and Metamorphic rocks are primarily located at the higher elevations.

A strike slip fault located near the head of the Hecla Wash at the high point of Highway 285 may cause the large bend in the Arkansas River downstream Hecla Junction (United States Geological Survey, Northwest Quadrant Colorado Geologic Map). This strike slip may also cause the convex hillslope at the top of the Hecla Wash which separates the Wash from Three Mile creek which runs adjacent to the Highway 285.



Soils

The Hecla Wash consists of the soil series Dominson (USDA, SCS, Soil Survey of Chaffee-Lake Area, Colorado, 1975). The Dominson series is a shouldow course soil that overlies cobbles, gravel and sand. These soils form in gravelly-moderately coarse textured outwashes. A representative profile is 6 inches of gravelly sand loam. The next layer is about 5 inches of very gravelly sand loam. Below these layers are mixed gravel and cobbles that extend to a depth of 60 inches or more. Permeability in these soils is very rapid and the available water capacity is low. Soil permeability ranges from 2-5 in/hr with a shouldow depth to bedrock of 11-60 inches (USDA, SCS, Soil Survey of Chaffee-Lake Area, Colorado, 1975).

Gravelly alluvial land is located near the mouth of the Hecla Wash. This soil unit consists of highly stratified deposits of gravel and sand with little fine soil material. This unit is mainly at toe slopes and fans of rock outcrops, and is subject to periodic deposition (USDA, SCS, Soil Survey of Chaffee-Lake Area, Colorado, 1975).

The majority of the watershed is designated Rough Broken land that consists of sediments of the Dry Union Formation. The Rough Broken land unit is made up of highly stratified, gray, brown, and pinkish-yellow silty clay with lenses of sand, gravel and cobbles. The strata of these materials vary from a few inches to many feet in thickness. A thin cap of gravels and cobbles cover most of the surface of the Rough Broken unit which helps reduce the potential erosion of fine materials when there is no headcutting. Surface runoff is rapid and the hazard of erosion is high (USDA, SCS, Soil Survey of Chaffee-Lake Area, Colorado, 1975).

Higher percent slopes are designated Rock Lands with very shouldow soils, low available water capacity, and sparse land cover. Surface runoff is rapid and the hazard of erosion is moderate (USDA, SCS, Soil Survey of Chaffee-Lake Area, Colorado, 1975).



Fluvial Geomorphic Characterization

The Hecla Wash has four distinct fluvial geomorphic reaches. Reach 1.) The Upper Basin is highly incised in soft yellow-pink silty-clay deposits (Photograph 1). The Upper Basin has a small drainage area; incision and head cutting are evident and most likely initiated by irrigation practices. Reach 2.) The Channel Storage reach is the mainstem, upstream of the canyon, which includes two tributaries. The v-shaped north gully and the south tributary, which has mine tailing dumps and the main road. Both tributaries confluence near the lower end of Reach 2.

The mainstem reach is incised about 4 feet to bedrock. The north tributary is now perched above the mainstem and susceptible to headcutting. The south tributary appears to be stable and is controlled from headcuts migrating from the main channel by a road culvert. Reach 2 appears to store sediments within the channel, as well as builds channel banks with accreting deposits (Photograph 2). Reach 3.) The Canyon Reach is encroached by the road (Photograph 3). The narrower channel transports upstream supply, and supplies broken bedrock and larger sized material to the channel. Reach 4.) The Deposition Reach opens up downstream of the canyon (Photograph 4). This reach spreads out the deposits onto the alluvial fan and transports sediments to the Arkansas River. The Browns Canyon Take-out Recreation area is staged at the mouth of the Deposition Reach.

The colluvial hillslopes are composed of rock outcrops with talus slopes of non-cohesive coarse grained sediments. The large variation in size and loose material makes for less cohesive slopes which supply large grain size material to the Hecla Wash channel. During precipitation events, the shouldow soils and rapid surface runoff rates create a hydrograph with a short time of concentration.

Debris flows occur in the Hecla Wash during high intensity precipitation events. High intensity thunderstorms are common during the summer months when dry soil conditions are prevalent. The rapid infiltration rates (2-5in/hr) and shouldow depth to bedrock (11-60 inches) of the Hecla Wash soils may facilitate the mobilization of channel sediment. Quick saturation of soils lead to greater weight and reduced internal stability. The shouldow coarse soil rapidly becomes saturated near the bedrock surface causing sliding and instability of the matrix above it. The weakened matrix starts out rolling and sliding with a rapid domino effect into a large mass.

However, the bedrock control limits the extent of scour and gulying that may occur in the Hecla Wash. The process of debris flows in Hecla Wash is the build up of sediments within the channel, then transport of sediments out of the channel. During high intensity events, the channel may have more transport capacity than sediment supply as indicated by the exposed bedrock throughout the channel of Reaches 2, 3 and 4.



Photograph 1: The Upper Basin Reach 1



Photograph 2: The Channel Storage Reach 2



Photograph 3: The Canyon Reach 3



Photograph 4: The Deposition Reach



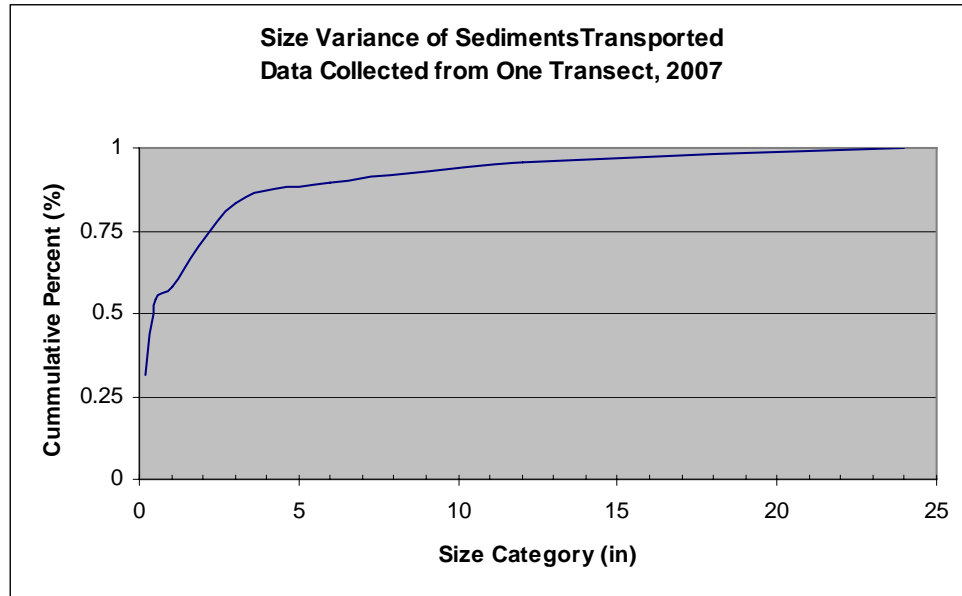
Photograph 5 shows the Wolman pebble count cross section on Reach 4.



Table 1 shows an example of the size variation of sediments deposited during these events. On April 20th, 2007, data was collected at one transect in Reach 4, upstream of

the dip x-ing (RiverRestoration.org, 2007). Size classes ranged from 0.22-24in; data shows a threshold at 3in, 83% of the material is finer. Most of the volume of sediments transported are sand and gravel size classes; although, large angular rock was present indicating colluvial erosion of bedrock slopes. The large rock in adjacent terrace gravels is very rounded. The terrace gravels are likely a different deposit, an ancient terrace of the Arkansas River, and not from the existing alluvial fan.

Table 1 Cumulative % Frequency Curve of Debris Flow Deposits August 11th-12th 2006



The high energy and steep gradient of the Hecla Wash alluvial fan transports large materials into the Arkansas River system. Large materials deposit at the downstream Arkansas River riffle. In return, this riffle helps hold the grade of the alluvial fan. This relationship shows the dynamic equilibrium that fluvial sediment transport needs to maintain without refreshing the riffle in the River. The River may downcut causing greater head cutting to migrate through the upstream washes.

The steep gradient at the broad mouth outlet to the Arkansas River helps prevent the extreme build up of the alluvial fan and thus promotes the continuity of transport into the river. The Hecla Wash sediment supply is an important component to the physical and biological habitat of the Arkansas River. Bed sediments are a major component of stream systems as it influences both physical and biological processes and patterns, such as channel morphology, riparian regeneration, macroinvertebrate abundance, spawning habitat, and groundwater interaction. Too much fine sediment buries the bed of the channel, smothers Brown Trout and fall spawning fish eggs, as well as fills interstitial spaces essential to macroinvertebrate habitat. Conversely, too little sediment supply can



lead to River channel incision, coarsening and eventually armoring of the River bed. Sediment supply is a balanced natural phenomenon; the balanced amount helps prevent bed armoring, helps mobilize bed sediments, refreshes spawning gravels and macroinvertebrate habitat, and builds up floodplains and bars for vegetation establishment and channel equilibrium.

Particles have different probability of motion depending on flow energy, size, position, and size relative to surrounding particles (Knighton, 1998). The framework of particles is important in how they support each other. For example, a channel bed with uniform sand may have greater packing and cohesion. Conversely, if there is a sand matrix between gravels and cobbles the sand acts as a lubricant. The critical shear stress decreases as the sand content increases (Wilcock, 2001). This transport mechanism may be influencing the bed load mobility of the Arkansas River. Sand size material supplied from tributaries may act as a lubricating tool; preventing armoring, refreshing bars and features critical for habitat quality.

On April 20th, 2007, low water observations of the Arkansas River were made downstream of Hecla Wash to the confluence of Three Mile creek. Sandy deposits were evident in pools, behind large boulders and bedrock constrictions, where sand deposits might be expected. Clean uniform cobble beds in the runs and riffles were also observed. There are a number of small tributaries to the Arkansas River between the Hecla Wash and Three Mile Creek; however none of the other tributaries appeared to be incised and all had stored sediments at the channel mouth.

Hydrologic and Hydraulic Analyses

Hydrologic Analysis

Ayres Associates completed field surveys along with hydrologic and hydraulic analyses under contract to the CWCBC in support of the mitigation planning effort for Hecla Junction. The purpose of this section is to summarize the hydraulic analysis and the results.

The normally dry creek at Hecla Junction experienced a flash flood on the night of August 11, 2006 due to an extreme rainfall event. In nearby Centerville, Colorado 3.5 inches of rain were recorded. Flow in the Arkansas River, measured at USGS gage 07091200, located at the mouth of the creek of interest, jumped from 700 cfs to more than 4,000 cfs in a matter of hours. There is some question as to the accuracy of recorded flows at the gage site due to alluvial fan build-up from the flood that may have impacted the rating curve at the measuring station. In any case, flows returned to about 1,000 cfs the following morning.

Several State Parks structures and facilities were damaged or destroyed during the event including, but not limited to, a portion of CR 194, a parking area, and bathroom facilities at Hecla Junction. The flash flood moved a large amount of sediment and debris,



resulting in sediment deposition at the mouth of the creek that extended about 30 feet into the Arkansas River.

Ayres Associates provided twenty surveyed cross sections of the tributary creek beginning about 4,040 feet upstream from the confluence with the Arkansas River. Ayres Associates also provided a detailed survey of the centerline of CR194 adjacent to the stream, from about 200 feet upstream of the confluence to about 1800 feet upstream of the confluence. A road crosses the creek bed approximately 525 feet upstream from the confluence, creating a downstream drop in elevation of about 4 feet. Five observed high water marks were surveyed. These survey components were utilized for modeling the post-flood conditions.

In general, this reach of creek has a steep bed slope, averaging approximately 3%. A wide, shouldow bankfull depth channel is discernable in the survey cross sections, varying in width from about 45 feet at the most upstream surveyed cross section to about 90 feet, 150 feet upstream of the confluence with the Arkansas River. Hydraulic simulations of the existing conditions were made using version 3.1.2 of HEC-RAS, the Corps of Engineers' current modeling software for 1-dimensional analysis. A series of Manning's "n" coefficients were analyzed. Channel Manning's "n" values examined included 0.04,

0.05, 0.055, 0.06, 0.07, and 0.08. Overbank Manning's "n" values examined included 0.06, 0.07, 0.08, and 0.09. Discharge values considered in this analysis began at 900 cfs and increased in 100 cfs increments to 3,300 cfs.

Cross-section locations were selected to capture the major changes in topography with respect to hydraulic modeling. The reach lengths in the model varied from 30 to 460 feet. Due to the steepness of the channel, most of the cross sections were defaulting to critical depth in the analysis process. Therefore, in order to generate more resolution and higher accuracy in the computed water surface profiles the cross section interpolation scheme within HEC-RAS was used.

Cross-section locations were selected to capture the major changes in topography with respect to hydraulic modeling. The reach lengths in the model varied from 30 to 460 feet. Due to the steepness of the channel, most of the cross sections were defaulting to critical depth in the analysis process. Therefore, in order to generate more resolution and higher accuracy in the computed water surface profiles the cross section interpolation scheme within HEC-RAS was used. Each coupled channel Manning's n and overbank Manning's n was analyzed over the previously mentioned range of discharges. HEC-RAS computed water surface elevations were compared to the observed water surface elevations. Consistently, observed water surface elevation 2, located approximately 3,600 feet upstream of the confluence, was at least 3 feet higher than the computed water surface. It



was decided that this observed water surface elevation would not be considered in determining the flood flow discharge.

The results show that absolute average error is minimized when channel Manning's $n = 0.04$, overbank Manning's $n = 0.08$, and discharge is equal to 1700 cfs. Depending on the channel Manning's n , the discharge for the August 16, 2006 event ranges from 1100 to 1700 cfs. Had the model been run in mixed flow regime, the required flow rates would have been even greater. Given the extreme sediment load, we believe that a limiting value of Froude number equal to 1.0 is reasonable. Although Jarrett's equation would result in a Manning's n of 0.08 for this channel gradient and flow depth, the 0.04 value is more reasonable given the high sediment load of gravel and finer sizes.

In addition to the indirect discharge analysis, the 100-year flood flow was computed using the regression equation for the Arkansas River Northern Mountains Subregion (ARK-7) and the Arkansas River Northern Foothills Subregion: West of Monument Creek and Fountain Creek (ARK-4) presented in *Guidelines for Determining 100-Year Flood Flows for Approximate Floodplains in Colorado* (Browning 2004). The drainage area of the creek was delineated by inputting the USGS topographical map into the Watershed Modeling System (WMS). The drainage area was determined to be 2 square miles. It should be noted that although the tributary creek geographically fits into the ARK-7 Subregion, use of this regression equation is only valid for tributary streams that have drainage areas between 4 mi² and 330 mi². Additionally, the ARK-7 equation is intended for use with snowmelt driven streams at elevations greater than 7,500 feet. Elevation of the creek in question is slightly less than 7500 feet, though the average elevation of the watershed is about 7700 feet. The ARK-4 Subregion equation is more appropriate for a rainfall driven event. The tributary creek is a borderline case for use of both the ARK-5 and ARK-7 Subregion regression equations, therefore the results of both equations are considered. Based on these results, the 1700 cfs estimate of flow may have been a 100-year event for this channel.

Hydraulic Analysis

Specific stream characteristics should be identified and used to separate Hecla Wash reaches. Four individual reaches have been identified in the project area. These reaches have been determined based on specific characteristics and should be hydraulically analyzed both individually and as a whole system.

A hydraulic model using Hec-Ras computer-assisted modeling should be performed on the channel, based on the model already developed by Ayres Associates. This model will be used to assist in final design features. Hydraulic modeling will deduce a stable channel design that would adequately pass the design storm and associated debris flow.



Any associated open channel and crossing design will be based on the hydraulic analysis. Scour and deposition potential should be based on the velocities computed by the hydraulic analysis.

Erosion/Sediment Transport Analyses

Watershed sediment yield would provide helpful information to estimate the magnitude of sediments that are supplied to the channel. The Revised Universal Soil Loss Equation (RUSLE) could be used to estimate the delivery of sediments to the channel. These estimates may be helpful in determining the yield that occurs between significant storm events. Channel storage estimates could be approximated with subsurface sediment samples.

A Flo 2-D, or a comparable model is recommended for debris flow events. This model would provide key design parameters such as the volume of sediments in the water profile, the magnitude of debris flows, and efficiency of transport. Flo-2D can be used to route a flood hydrograph while predicting floodwave attenuation. It also simulates rainfall/infiltration, evapotranspiration losses, mobile bed and sediment transport, and alluvial fan distributary channels.

Sediment supply from Reaches 2, 3 and 4 does not appear to be significantly destabilized over existing conditions. Reach 1 does exhibit significant gully erosion in silty clay deposits that appears to be exacerbated by the operations of an irrigation canal. However, the lower three reaches have some bedrock in the bed and banks, which limits the extent of channel erosion during major transport events. The transport event on August 11th-12th, 2006 is related to an extreme storm event; the exposed bedrock in the channel indicates that the storm event could have transported more volume of material than was actually supplied (Photograph 10). The north tributary wash joins the main wash at the bottom of Reach 2. Observed on March 13, 2007, this tributary appeared to be completely aggraded with gravely sand material and scattered boulders (Photograph 11). This tributary apparently did not scour during the August 11th-12th 2006 event and may be representative of the primary source of debris flow material.



Photograph 10 shows the exposed bedrock after the debris flow event 10/11-12/06.



Photograph 11 shows sediments stored in the north tributary



It is anticipated that the general process will include the continual loading and aggradations of the main wash channels from smaller storms and irrigation return waters. Occasionally, a large storm event will occur that has the capacity to scour the main channels clean and transport the material all the way to the Arkansas River. Because of the shouldow bedrock, the storm events may have more transport capacity than the supply in the channels, and bank erosion occurs where materials are available or hydraulic forces are severe. However, significant bank erosion from the August 11th-12th, 2006 event was only observed in two locations. At the lower terminus of Reach 2 and at the tightest road bend in the middle of the Canyon (Reach 3). The erosion in the Reach 2 is likely a combination of the fine materials deposited there and significant overbank flows that result from the backwater caused by the downstream canyon constriction. The erosion along the toe of the road embankment is likely due to the encroachment of the road on the channel and the tight bend that the canyon takes at this location.

The most apparent land use impact on sediment erosion in the basin was an irrigation ditch at the upperbasin that apparently dumps return waters down the main wash. Deep gullies have formed in the soft clay deposits at the location of the irrigation return. This practice has probably gone on for a long time as the Ditch appears to predate the Highway alignment. Other land use impacts do not appear to have resulted in significant erosion. The culverts from the main road were observed and do not appear to be creating erosion. Remnant mine tailings appeared to be well stabilized with vegetation. Cattle were observed grazing in the upper reach, but no significant impacts were observed. Highway 285 does not appear to concentrate significant storm runoff into the drainage. Off Road Vehicle tracks were noted but did not appear excessive or significantly eroding. Landfill and shooting ranges appear to be the only other basin developments. Although the shooting range had a number of destabilized, unvegetated and exposed slopes, significant signs of erosion were not observed; however these destabilized slopes should be seeded with erosion control native grass mix.

Geomorphic Exacerbation

Gully formation is a sign of exacerbated geomorphic processes. A gully is an incised, steep-sided channel, with an eroding headcut and slumping sidewalls. Gullying appears to be an erosional process occurring in the Hecla Wash. Gullying is a known geomorphic problem in the Southwest United States (Istanbulluoglu et al, 2005). The gullying process is a symptom of changing relations of rainfall to runoff, and results in a net change in the relation of runoff to erosion (Leopold, 1959). Many Southwest drainages that run through soft lithology may once have been stable and in equilibrium with erosional and depositional processes. Many of these drainage are now deeply incising. Once a headcut starts, a threshold is usually crossed. The steeper gradient and concentrated hydraulic flow combine to change the landscape from depositional to eroding. The erosive energy is increased significantly because the sediment transport capacity of the channel exceeds the sediment supply to the channel. A head cut can quickly migrate upstream and propagate throughout a drainage. This process can create large mud and debris flows as the channel itself erodes.



The catalysts that have initiated the widespread gullying seen throughout the Southwest are not completely understood. Gullying is likely a response to both land use changes and climatic changes and possibly tectonic changes. Gully erosion typically occurs in concentrated flow channels or has its beginnings in heavily used livestock trails on highly erodible soils (Howard and Higgins, 1997). Widespread grazing in the late 1800s impacted much of the native grasslands that were stabilizing small drainage areas and hillslopes. Livestock tend to graze on steep >30% slopes. Vegetation plays a dynamic role in the stability of geomorphic processes (Collins et al., 2004). Unfortunately, the expansion of pinyon-juniper woodlands in the western United States in the last 100 years has led to accelerated erosion, threatening long-term ecosystem stability and productivity (Wilcox et al., 1996). The cause is competition-induced loss of the subcanopy and subsequent weakening of the protective vegetative soil cover. Climatic changes may also have influenced the establishment of less stable vegetation and may have changed both the interval and intensity of storms.

The time scale of the gullying process also appears to be more isolated than geologic time scales. Observations of ongoing gullying show that channels are continuing to erode and vegetation is not establishing. Some drainages show the beginning of interior floodplain development where the channel has eroded so wide and deep that the transport capacity threshold is crossed again. Gullying channels will eventually erode out to the point where hydraulic forces are reduced, the gradient flattens and deposition in the channel can begin again. When gullies mature the landscapes would exhibit channels with high alluvial terraces and mature interior floodplains. Final design considerations for Hecla Wash mitigation should consider geomorphic factors to the extent possible.



III. Conceptual Restoration Design

Coordination

Our environmental site planning adheres to guidance and policies from the state and federal government including law and policy outlined in Appendix B. In summary, we aim to ensure river management is consistent with BLM Browns Canyon WSA prescriptions, and adheres to USACE 404 regulations and guidelines in addition to National Environmental Policy Act (NEPA), Endangered Species Act and other regulation. We have coordinated with US Fish and Wildlife Service and CDOW relating to biological considerations.

Concept Plan Description

A concept plan has been developed to put a frame around opportunities and constraints of the Hecla Wash mitigation project. Further analyses in the final design phase are required to provide site specific features and details related to this concept plan.

Although sediment deposition at the AHRA take-out is a nuisance; depositional events at this location are natural and should be anticipated to reoccur in the future. Therefore, opportunities are focused on operating the take-out adjacent to a dynamic natural hazard while minimizing the impacts to the boating and recreation operations at the site. There are some constraints that may need to be addressed such as: the Canyon road alignment, vegetation water needs, parking areas, and continual sediment transport.

The concept plan (Figure 2 & 3) has four main goals:

1) Stabilize sediment sources in Reach 1

Maintain sediment transport: for healthy channel functions and quality habitat and stabilization of Reach 1 by reducing fine sediment supply and gullying process.

Reach 1 has been destabilized by land use practices, most notably an irrigation return dump that has resulted in substantial gully formation. The Concept Plan proposes stabilization measures throughout the Reach 1 including energy dissipation for the irrigation dump and grade controls at specific locations.

Irrigation management could include stilling basin, energy dissipation, and grade control of irrigation return flows would reduce exacerbated erosion caused from concentrated return flows

2) Promote sediment transport through Reaches 2, 3, and 4

Large event based sediment sources from Reach 2 appear to be those materials that have accumulated in the main channels. The stabilization of sediment sources in Reach 1 will help reduce the rate of accumulation of sediments in Reach 2. However, the events are storm driven and therefore episodic. Some bio-stabilization techniques are recommended in Reach 2 including a live crib wall at one intermediate deposit area and planting of erosion control grasses. Other land use management techniques may be recommended



for Reach 2 such as closing ORV tracks or fencing for cattle funneling access to the channel.

Reach 3 is confined by a bedrock canyon. The complication in Reach 3 is that the road encroaches on the channel because of the narrow space in the canyon. Reach 3 has extreme hydraulic forces and is very effective at transporting sediments. Furthermore, colluvial boulders are likely added to the debris flows coming through Reach 3. The main problem with Reach 3 is an isolated bend that is experiencing erosion at the toe of the road slope. This location can be further stabilized with large boulders. Furthermore a relief channel may be constructed on the inside terrace that would reduce some flows and hydraulic forces along the eroding toe.

Reach 4 is the depositional area between the canyon and the Arkansas River. Because of the more open topography, this is also where the recreational facilities, parking and boat ramp are staged. The main problem in Reach 4 is the deposition of debris flows interfering with recreational structures. The high traffic volume makes looping access ideal from a recreational standpoint. Unfortunately, it requires two crossings of the main channel wash to loop vehicles. Currently both crossings are low water crossings (e.g. fords) that are susceptible to scour and deposition. At the upper low water crossing (exit portion of the access road) heavy deposition was observed upstream; however, immediately downstream of the crossing, the wash had scoured to bedrock indicating higher flow velocities and the ability to transport sediments. This concept plan proposes mimicking the transport process either by converting the vehicle crossing into a bridge or by installing a more permanent (concrete) low water crossing, similar to the one located at the Parkdale Recreation site. Two scour vanes would be installed upstream of the proposed low water crossing. The scour vanes would help deposit sediments upstream and transport them downstream. The proposed vehicular crossing would have to be structurally designed since high sediment loads are anticipated to continue. A transport channel using a concrete pan along the swale would be designed and constructed to continue to move sediment loads from the upstream vehicular crossing down to the river.

It is anticipated that the transport channel would not be as effective below the low water crossing (entrance portion of the access road) however, this will be further analyzed in design phase. Upstream of the proposed low water crossing, riparian vegetation is currently supported in the deposition zone. This is likely supported by high ground water as noted by a spring near the top of Reach 4. Vegetation in the deposition zone would be augmented with dense riparian plantings on the sides of an approximate transport channel width.

The cottonwood/willow islands in the stream channel would be protected and restored with additional riparian vegetation. Bio-complexity adds habitat value for small mammals and neo-tropical songbirds. The vegetation is anticipated to help transport in the main channel and promote beneficial deposition in the riparian fringe. Because the sediment loads are anticipated to be periodic, this Concept Plan anticipates utilizing the second dip crossing similar to existing with anticipated maintenance after a major event.



The concrete sill of the existing boat ramp was partially destroyed from the last event. This concept plan proposes repairing the ramp to pre-event conditions.

- Toe protection at canyon road could also reduce bank erosion
- Relief of the channel inside tightest road bend: reduce constriction, road encroachment, and backwater erosion.
- Sediment deposits provide microhabitat for trout with the food, cover, water depth, velocity, discharge, and temperature they need to survive and the riverbed should conform to their needs (Hunter 1991).

3) Implement bio-stabilization techniques including bio-degradable fabrics, erosion control plantings, etc.

Riparian and upland habitat value is low in Hecla Wash and could be restored to high through the use of bio-stabilization techniques.

Vegetation establishment in deposition areas can be encouraged with straw and woodchip reservoirs, which help with water storage for longer periods of time in arid areas. Upland native grass establishment and coarse woody material on disturbed upper basin slopes may also provide erosion control.

Bio-stabilization is a natural way to slow velocity by captured fine particles in addition to providing habitat for wildlife. Vegetation and coarse woody material provides life cycle requirements to a variety of resident and migrating wildlife species by offering security and cover, as well as food-chain support. Supplying an organic foundation by providing surfaces for microbial activity can be used by vegetation and insects. Structure from bio-stabilization provides pockets where small mammals can reside or where water can collect for insect larvae development.

Macro-invertebrates, brown and Rainbow trout, beaver, river otter, mink, muskrat, and other small riparian mammals benefit from refugia, as well as from the food-chain support offered. Fish and small mammals in turn offer prey base for carnivorous mammals, and raptors associated with riparian corridors such as the mink, fox, bald eagle, and osprey.

Riparian habitats offering high food-chain support generally have well vegetated stream banks and evidence of organic growth on log surfaces including captured debris/litter.

Coarse woody material can also be used to stabilize streambanks, where needed, and to expand a higher level riparian habitat. Mimicking the accumulation of wood in natural riparian systems can help foster the life cycle components and food-chain support necessary for a larger number of wildlife species. Coarse woody material also results in microhabitat to foster riparian vegetation, leading to better vegetated stream banks and habitat connectivity.



One project aim is to grow a more stable riparian system with greater integrity and with measurable functional values including, bank stabilization and sediment control, enhanced flood-flow attenuation, groundwater recharge and conjunctive flow, wildlife habitat, and food-chain support

4) Facilitate Recreational Use and Use Best Management Practices

- Promote stewardship by interpretive signage. Educational signs are an important amenity to natural recreation areas because they provide public information about the unique natural setting of each site. Restoration of the Hecla Wash could provide an opportunity to educate the public on the importance of a balanced supply of sediment to river habitat.
- Establish pool and pocket water access for bank and wade fishing access approx every 200yds (Bill Andree, DOW suggestion). This will help protect backwaters areas for juvenile fish and water fowl in addition to vegetation establishment,
- Create vehicular crossings for bus, truck, and car traffic that provide reliable access and egress and reduce channel erosion. Wildlife crossing should be considered during peak traffic hours.
- Reduce random trampling by restoration signage and thorny vegetation
- Use Best Management Practices throughout the project area.

Figures 2 and 3 show a plan view concept drawing.



Figure 2

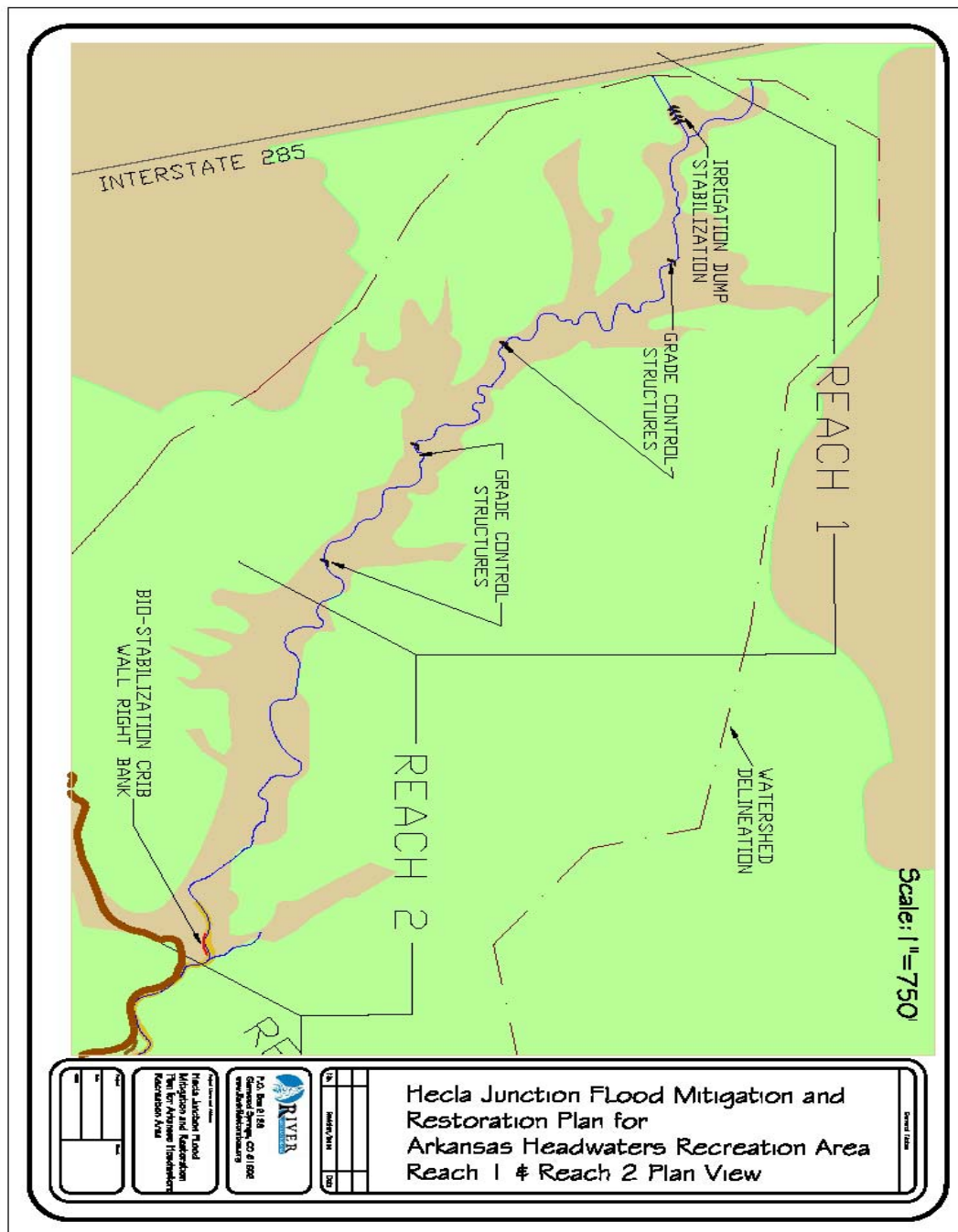
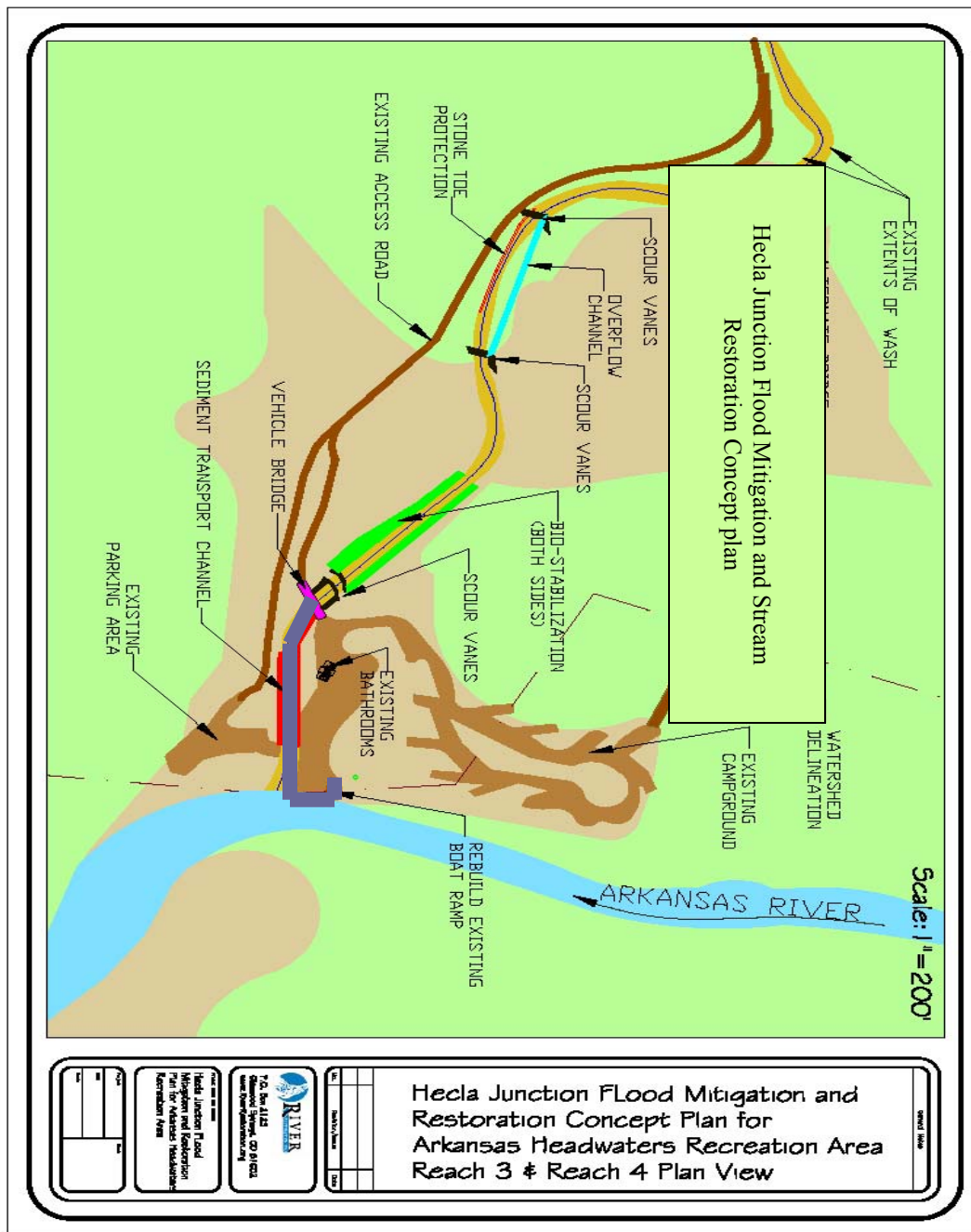


Figure 3



Concept Plan Development

The history of flooding, erosion, and sedimentation problems at Hecla Junction have required regular and frequent maintenance. While the August 2006 storm event was estimated to be greater than a 100-year return interval, smaller but more frequent events still cause significant problems for the recreational site. The Concept Plan presented herein is an intermediate solution that anticipates a low water crossing through the parking lot/access area, including a concrete pan running the length of the swale up to the second low water crossing at the exit area. Some level of maintenance is anticipated following major flood events. The Concept Plan is intended balance cost effectiveness by targeting the low to moderate storm events, but it may not fully handle the large, rare events.

Another alternative to the Concept Plan presented herein would attempt to target the large and rare flood events with the goal of maintaining the looping road access to facilitate the high traffic periods. This alternative would attempt to have less anticipated future maintenance than the Concept Plan. However, the costs associated with such an alternative may be prohibitive.

Anticipated Final Design Process

A thorough inventory and assessment of site conditions is fundamental to developing restoration design. Evaluation of the site should include: hydrographic and topographic survey, wetland delineation, plant species identification, assessments of bank stability and geomorphic processes, surface pebble counts, subsurface volumetric sediment samples, and identification of the physical constraints at the site. The topographic and hydrographic survey should be performed using GPS or with a total station to be digitized for AutoCAD base mapping. Topographic survey base maps should show features in the channel, banks, grade breaks, vegetation, and locate existing facilities and utilities. Hydrographic survey data will be used to calibrate hydraulic models for analysis and design. The survey should include the AHRA recreation Area, cross sections of the Arkansas River and several cross sections of the Hecla Wash. Surface and subsurface sediment data would be used to estimate soil parameters needed for modeling. Additional data collected would provide a basis for planting plans and greater understanding of site conditions.

Recommended Plan

The final plan should be feasible, financially practical, and should accomplish the goals and objectives of the project. Normally, the final plan would be justified through an incremental cost analyses or “benefit/cost” determination.

An engineers opinion of total cost for final design, construction, monitoring and evaluation and operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) would be compiled to provide a detailed assessment of the costs associated with the project.



A monitoring and adaptive management plan would be developed and implemented after construction for aspects of the project such as riparian plantings, in-channel structures, fish and invertebrate effects, and overall functionality. Monitoring and adaptive management has been determined to be an essential element in the overall implementation of the proposed restoration plan because it provides an opportunity to review and evaluate the performance of the project, after construction is complete, and implement minor revisions to the overall project based upon evaluations.

Generally, alternative design would provide an environmentally sustainable project emphasizing minimal long-term OMRR&R. In this sense, OMRR&R requirements reflect an alternative's long-term self-sustainability. Development of OMRR&R cost estimates account for expected upkeep of project features for as long as the project remains authorized. The objective of OMRR&R procedures is to maintain structures or project features to "as-built" conditions, or conditions that provide for acceptable project performance consistent with project objectives.

Construction Process and Timeline

The final design should be based on the hydrographic survey, hydrology, hydraulics, sediment transport, geomorphic, environmental considerations, pedestrian and vehicular flow, permit limitations and all other applicable information gathered. The final design should include plan views of all proposed work, phase delineation, project area delineation, construction staging zones, revegetation plans, BMP layouts as well as channel design cross sections and elevations.

A detailed Plan and Specification package for construction bidding should be completed based on the final design of the project. The plans and specifications for the project will be adequate for the contractor to follow and construct the project to the design and specifications required. The plans should include a full drawing set which adequately describes the project to potential contractors. The specifications package should be a document which adequately describes all specifications of the project including but not limited to the tolerances, material qualifications, applicable permit limitations and best management practices which should be followed.

The Plans and Specifications should be sent out to contractors to bid on. A pre-bid meeting should be held between the engineering design team and potential bidders to clarify the project and answer any questions potential bidders may have. Once a contractor is selected by the client any negotiations with the contractor, client and engineer on the scope of work and costs can be undertaken to adjust cost and scope if necessary.

A construction stake out survey should be undertaken to aid the contractor in constructing the design to the specifications required. Adequate horizontal and vertical control points should be established for the contractor to establish the lines and grades shown on the plans.



Engineering construction services such as material qualification, completed task review, tolerance compliances and all other related engineering construction services should be completed.

Seasonal Constraints

There may be seasonal constraints which limit the construction window. For any construction activities which include discharge in the main channel of the Arkansas River there may be seasonal limits based on high flow times of year and spawning seasons of managed species. For construction in the side wash there may be seasonal limitations based on seasonal precipitation and frequency of flow and debris events.

Implementation Phasing

The project may be broken into multiple phases for implementation. Phase implementation can assist in funding, construction timelines and permitting completions.

Project Funding

The Great Outdoors Colorado (GOCO) invests in outdoor recreation projects that build, maintain or improve state parks. The Hecla Junction Restoration Project may have potential for grant monies. The Browns Canyon Take-out is one of the most utilized recreation areas on the Arkansas River. Restoration opportunities include facilitating recreation with an improved boat ramp and vehicular crossing, education, weed management, and trails. Grant applications are due August 2007.

The Colorado Division of Wildlife offers “fishing is fun” funds for projects that improve sport fishing resources and access to it. The Hecla Junction Restoration Project has potential to meet 3 Project Categories; angler access, habitat development and site improvement, fishing site improvements. The CDOW “fishing is fun” grant applications are due in March. “Fishing is Fun” requires 25% in-kind donations and matching funds.

The CDOW also has money set aside in their education program “Watchable Wildlife” that may be applied for.

Colorado Watershed Protection Fund administered by Colorado Water Conservation Board and Colorado Department of Public Health and Environment’s Watershed Protection Fund (Appendix C5) – A grant application may be submitted for locally-based watershed protection efforts, provided that the applicant is committing to a collaborative approach to the restoration and protection of lands and natural resources within Colorado’s watersheds in concert with economic development.



References

- Ayres 2007:** Ayres Engineering Hydrologic and Hydrolic Analysis
- Andrews & Righter 1992:** Colorado Birds: First Edition. By Robert Andrews and Robert Righter. Denver Museum of Natural History. Denver, CO.
- Browning 2005:** Guidelines for Determining 100-year Flood Flows for Approximate Floodplains in Colorado by Thomas Browning, P.E., Colorado Water Conservation Board.
- CDOW 2005:** Colorado Division of Wildlife Conservation Strategy
- CWCB 2007:** Colorado Water Conservation Board <http://www.cwcb.state.co.us/>
- Istanbulluoglu et al. 2005:** Istanbulluoglu, E., R. L. Bras, H. Flores-Cervantes, and G. E. Tucker (2005), *Implications of bank failures and fluvial erosion for gully development: Field observations and modeling*, J. Geophys. Res., 110, F01014, doi:10.1029/2004JF000145.
- Hunter 1991:** Better Trout Habitat: A Guide to Stream Restoration and Management. Montana Land Reliance.
- Kingery 1998:** Colorado Breeding Bird Atlas. By Hugh E. Kingery. Colorado Bird Atlas Partnership in cooperation with the Colorado Division of Wildlife. Denver, CO
- Collins, D. B. G., R. L. Bras, and G. E. Tucker (2004), *Modeling the effects of vegetation-erosion coupling on landscape evolution*, J. Geophys. Res., 109, F03004, doi:10.1029/2003JF000028.
- Krueglar and Sanderson 2002:** William Krueglar and Matt Sanderson, *Envrionmental Impacts of Grazing on US Grazing Lands*, No 22 November 2002, Council for Agriculture Science and Technology.
- Leopold 1959:** Luna Leopold, *Climatology and the Problems with Western Grasslands*, 1959, USGS reprinted for American Association for the Advancement of Science
- Schumm et. al 1984:** Schumm, S. A., M. D. Harvey, and C. C. Watson (1984), *Incised Channels: Morphology, Dynamics and Control*, 200 pp., Water Resour. Publ., Highlands Ranch, Colo.
- Wilcox et. al. 1996:** Wilcox, B. P., J. Pitlick, C. D. Allen, and D. W. Davenport (1996), *Runoff and erosion from a rapidly eroding pinyon-juniper hillslope, in Advances in Hillslope Processes*, vol. 1, edited by M. G. Anderson and S. M. Brooks, pp. 61– 78, John Wiley, Hoboken, N. J.
- SCS 1979:** Soil Survey of Chaffee-Lake Area, Colorado, Parts of Chaffee and Lake Counties, October 1979; United States Department of Agriculture Soil Conservation Service in cooperation with Colorado Agricultural Experiment Station.
- Nature Serve 2004.** Information at <http://www.natureserve.org>



USGS 2001: Northwest Quadrant Colorado Geologic Map, United States Geological Survey

Arkansas River Recreation Management Plan (January 2001)

USDI et al. 2000: Arkansas River Waters Needs Assessment (July 2000). A cooperative effort of the USDI Bureau of Land Management, US Bureau of Reclamation, USDA Forest Service and Colorado Department of Natural Resources.

USDI 2001 Arkansas River Recreation Management Plan.

USGS Gauging Station

USFWS 2006: US Fish and Wildlife Service Listed Species Lists by county from the regional office in Grand Junction. December 2006.



Appendices

A – Concept Plan Cost Estimate

B – Anticipated Permit Process/ Authorizations Required

C – USFWS Listed Species List



Appendix A – Concept Plan Cost Estimate

Description	Quantity	Unit	Unit Cost	Total Cost	Totals
Best Management Practices					
Traffic Control Takeout Area	1	LS	\$1,200	\$1,200	
Traffic Control Canyon Road	7	Days	\$300	\$2,100	
BMPs Other	1	LS	\$10,000.00	\$10,000	
Protect In Place Trees	1	LS	\$5,000	\$5,000	
					\$18,300
Grade Control Structures/ Rock and Fabric					
Grade Control Structures/ Rock and Fabric	12.00	EA	\$12,000	\$144,000	
					\$144,000
Rebuild Boat Ramp					
Care of Water	1	LS	\$15,000	\$15,000	
Concrete	10	CY	\$400	\$4,000	
					\$19,000
BioStabilization					
Live Crib Wall	218	LF	\$20	\$4,360	
Riparian Plantings	1	AC	\$3,500	\$1,750	
Erosion Control Grasses	25	AC	\$500	\$12,500	
					\$18,610
Transport Channel Enhancement					
Imported Rock Placement	900	LF	\$90	\$81,000	
Excavation General	900	CY	\$30	\$27,000	
					\$108,000
Vehicular Crossings/Concrete Pan					
Low water crossings	2	EA	\$30,000	\$60,000	
Longitudinal concrete pan	20	CY	\$300	\$6,000	
					\$66,000
SUBTOTAL					\$373,910
DESIGN FACTOR (CONCEPT)					\$150,000
CONSTRUCTION SUBTOTAL					\$523,910
Construction Monitoring Services (2%)					\$10,478
Construction Survey (2%)					\$10,478
Construction Bonding/Ins (3%)					\$15,704
Mob and Demob (5%)					\$26,196
Monitoring & Evaluation	5	YR	\$2,500	\$12,500	
OMRR&R					\$50,000
SUBTOTAL					\$112,856

(Continued on next page)



Hecla Junction Flood Mitigation and Stream Restoration Concept Plan

Design Procedures

Grant Writing	\$10,000	
Survey Control Network	\$2,200	
Design Survey	\$8,000	
HTRW Survey	\$3,500	
Cultural Resource Survey	\$3,500	
Wetlands Survey	\$3,500	
Geotechnical Investigation	\$3,500	
Environmental Assessment (mainly BLM)	\$10,000	
Lands and Easements	\$0	
Engineering Design	\$50,000	
Permitting	\$4,200	
Plans and Specifications for bid	\$25,000	
		\$123,400
<hr/> TOTAL COST OPINION		<hr/> \$760,166 <hr/>



Appendix B – Permit Process/ Potential Authorizations Required

An Environmental Assessment (EA) should be required for the project due to the project limits including federally owned land or potentially the use of Federal Monies. An EA evaluates: short and long term environmental impacts; cultural resources; hazardous, toxic or radioactive wastes; socioeconomic impacts; and an evaluation of alternatives in comparison with the No-Action alternative. An EA may include a “Future Without-Project Conditions” statement to give an indication of further deleterious processes that may be experienced with the “No-Action” alternative. Alternatives may be evaluated for an incremental cost benefit to find the “best buy” alternative. An EA also creates a public process with public review periods.

An Environmental Assessment requires a Finding Of No Significant Impact (FONSI). If it is found that the project potentially has significant impacts, it would be required to complete an Environmental Impact Statement (EIS). A FONSI will state “in light of the general public interest it has been determined that the work would not constitute a major federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969. An Environmental Impact Statement covering the proposed work is not required. Weighing potential benefits that may be accrued as a result of implementing the action alternatives against the reasonable foreseeable detrimental effects, it is concluded that the Project as proposed, is in the public interest.

A project that requires federal monies or action on lands will be under the jurisdiction of the National Environmental Policy Act and therefore requires an Environmental Assessment (EA) be performed. This project is on lands managed by the Bureau of Land Management and will require an EA.

The State Historic Preservation Office (SHPO) should be contacted to conduct a file search of known listed resources in the area and other surveys that have been performed. A Cultural Resources Survey on the ground will be required. Furthermore if cultural resources in the project area are discovered during construction and cannot be avoided, construction activities would be suspended in that area until the properties can be evaluated for listing in the National Register of Historic Places in consultation with Colorado SHPO.

A Phase 1 Environmental Site Assessment should be performed to see if there are concerns and possibly additional field survey if Phase 1 results warrant. If Phase 1 results warrant, a Hazardous Toxic Radioactive Waste (HTRW) survey should be performed on the project site,

A Wetland survey of the project site should be performed, There are some springs along the wash and a wetland evaluation should be performed to delineate for protection any determined wetland areas.

All proper land and easement coordination should be determined and executed. The site is located wholly on Bureau of Land Management (BLM) land. Depending on funding



sources it is sometimes required that money used for projects on federal land requires the site be maintained in perpetuity.

For the construction of a boat ramp or any other work in the main channel of the Arkansas River below the ordinary high water line, the project should be required to have an Army Corps of Engineers Section 10, 404 permit for “discharge of materials into waters of the U.S”. It is anticipated that the proposed project would qualify for a Nationwide 42 permit for Recreational Features. The Nationwide Permit 42 must include at a minimum a letter describing the activity, the purpose and need of the activity and the cumulative impacts, as well as a location map, plan view sketches and cross-section sketches.

The Colorado Department of Health and Environment (CDPHE) would be notified by application of the 404 permit. Colorado Department of Public Health and Environment requires review for 401 Water Quality standards to ensure the river corridor would be respected during construction. Best Management Practices should be specified including temporary and permanent erosion control. The project should be timed not to interfere with the spawning of state managed species. Additionally a Storm Water Management Plan (SWMP) should be submitted to the CDPHE at least 10 days prior to construction. The project may be exempt from an SWMP and that exemption should be acquired.

It is anticipated that FEMA oversight would not be required for the proposed project. The project should be designed and constructed to show no impact to any established flood elevations during a 100yr flow event. The project should also adhere to the CWCB Rules and Regulations for Regulatory Floodplains in Colorado. New or revised floodplain mapping is not expected to be required for this project.

The Colorado Division of Wildlife has been coordinated with during the planning of this project. Any applicable adopted management plans the CDOW has established for the project area should be followed where applicable. Usually the timing of construction activities that may affect fish spawning is regulated by the CDOW.

The federal Environmental Protection Agency (EPA) should be briefed during the planning of this project.

Environmental Laws, Executive Orders, and Other Policies

Table 2 provides a summary of which environmental laws, executive orders, and other policies the Selected Plan may have to comply with. The following sections provide detailed descriptions of compliance with selected laws and executive orders.



Table 2: Environmental Requirements and Protection Statutes

FEDERAL STATUTES		
STATUTE	COMPLIANCE STATUS	
	Selected Plan	
Archeological & Historic Preservation Act	FC	
Clean Air Act of 1977, as amended	FC	
Clean Water Act of 1977, as amended	FC	
Coastal Zone Management Act	NA	
Endangered Species Act of 1973, as amended	FC	
Estuary Protection Act	NA	
Federal Water Project Recreation Act, as amended	FC	
Fish & Wildlife Coordination Act, as amended	FC	
Land & Water Conservation Fund Act, as amended	FC	
Marine Protection, Research & Sanctuaries Act, as amended	NA	
National Environmental Policy Act of 1969, as amended	FC	
National Historic Preservation Act of 1966, as amended	FC	
Rivers and Harbors Act	FC	
Watershed Protection & Flood Protection Act, as amended	NA	
Wild & Scenic Rivers Act, as amended	NA	
Floodplain Management E.O. 11988)	FC	
Protection of Wetlands (E.O. 11990)	FC	
Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	NA	
Analysis of Impacts on Prime & Unique Farmlands (CEQ Memorandum, August 11, 1980)	NA	
Protection & Enhancement of Environmental Quality (E.O. 11514, as amended by E.O. 11991)	FC	
Protection & Enhancement of the Cultural Environment (E.O. 11593)	FC	
Environmental Justice E.O. 12898	FC	

FC = full compliance NA = not applicable NC = non compliance

National Environmental Policy Act (NEPA) of 1969

The EA would be prepared in accordance with the requirements set forth in Section 102 of NEPA (USC §§ 4321 – 4347, as amended). NEPA is the nation's broadest environmental law, and it applies to all Federal agencies and most of the activities they manage, regulate, or fund that may affect the environment. NEPA requires that environmental consequences and project alternatives be considered before a decision is made to implement a Federal project. A reasonable array of alternatives would be considered during the planning process. Potential environmental effects would be



included in the evaluation of the proposed project actions, and all procedural review requirements of the aforementioned regulations would be met.

Clean Water Act (CWA) of 1977

Federal and State laws for the control of water quality establish requirements for adequate planning, implementation, management, and enforcement of actions designed to improve the quality of the nation's water resources, including penalties for non-compliance. The CWA (as amended, 33 USC 1251 *et seq.*) governs pollution control and water quality of waterways throughout the U.S. Its intent, in part, is to restore and maintain the biological integrity of the nation's waters. The goals and standards of the CWA are enforced through permit provisions. Section 401, 402, and 404 of the CWA pertain directly to the proposed project. Section 401 of the CWA requires certification from the State or interstate water control agencies that a proposed water resources project is in compliance with established effluent limitations and water quality standards. Section 402 establishes conditions and permitting for discharges of pollutants under the National Pollution Discharge Elimination System (NPDES). Section 404 of the amended Act authorizes a separate permit program for the disposal of dredged or fill material in the Nation's waters, administered by the Secretary of the Army, acting through the Chief of Engineers.

Clean Air Act (CAA) of 1970

The purpose of the CAA (USC §§ 7401 – 7601, amendments of 1977, 1990, and 1993) is to protect public health and welfare by the control of air pollution at its source, and to set forth primary and secondary National Ambient Air Quality Standards (NAAQS) to establish criteria for States to attain, or maintain, these minimum standards. Section 118 specifies that any Federal activity that may result in discharge of air pollutants must comply with Federal, state, interstate, and local requirements regarding control and abatement of air pollution. Section 176(c) requires that all Federal projects conform to EPA-approved or promulgated State Implementation Plan. Potential impacts resulting from the proposed alternatives would be assessed in the EA. Minor, short-term construction-related and long-term maintenance-related air quality impacts would be identified. The proposed alternative actions would not result in the exceedence of any Federal or State ambient air quality standards.

Endangered Species Act (ESA) of 1973

The purposes of the ESA (as amended, 16 USC 1531 *et seq.*) are to provide a means whereby the ecosystems upon which endangered and threatened species may be conserved and to provide a program for the conservation of such species. The ESA requires that consultation regarding protection of such species be conducted with the U.S. Fish and Wildlife Service (USFWS) prior to project implementation. The selected plan would have no adverse effect upon threatened and endangered species.



Fish and Wildlife Coordination Act (FWCA)

The FWCA (16 USC § 661 *et seq.*) directs the Department of the Interior (DOI) to provide assistance to and foster cooperation among Federal, state, and local agencies in order to promote wildlife conservation in water resource development programs. Agencies must consult with the section of the DOI that has jurisdiction over this project, in this case USFWS, on wildlife conservation measures to be implemented during construction and maintenance of the project.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (1916) (16 USC § 703, as amended), agreed between the U.S. and Canada; the Convention for the Protection of Migratory Birds and Animals (1936), agreed between the U.S. and Mexico; and subsequent amendments to these Acts provide legal protection for almost all breeding bird species occurring in the U.S. These acts restrict the killing, taking, collecting, and selling or purchasing of native bird species or their parts, nests, or eggs. Certain gamebird species are allowed to be hunted for specific periods determined by Federal and state governments. The intent of the Migratory Bird Treaty Act is to eliminate any commercial market for migratory birds, feathers, or bird parts, especially for eagles and other birds of prey. The proposed project would be in compliance with this Act and the project would not facilitate the commercial market of any bird species.

National Historic Preservation Act (NHPA)

A key provision under the NHPA (16 USC §§ 470 *et seq.*) is Section 106, which requires a Federal agency to take into account the potential effect of a proposed action on properties listed on or eligible for listing on the National Register of Historic Places. Under NHPA, the State Historic Preservation Officer and the Advisory Council on Historic Preservation (ACHP) are part of the consultation process. Regulations of the ACHP (36 CFR § 800) outline the procedures used by a Federal agency to meet the requirements of Section 106 of the NHPA. In accordance with 36 CFR 800, a records search and an archaeological survey of the project area would be performed.

Executive Order 11988, Floodplain Management

Under this Executive Order (42 FR 26951, 1997), the USACE must take action to avoid development in the 100-year floodplain unless it is the only practicable alternative; to reduce hazard and risk associated with floods; to minimize the impact of flood on human safety, health, and welfare; and to restore and preserve the natural and beneficial value of the base floodplain. The selected project would be consistent with this Executive Order.

Executive Order 11990, Protection of Wetlands

Section 2 of this Executive Order (42 FR 26961, 1977) states that each agency should avoid undertaking new construction in wetlands unless there is no practicable alternative and that the proposed action should include all practicable measures to minimize harm to wetlands. The survivability and quality of wetlands would be protected.



Executive Order 11593, Protection and Enhancement of the Cultural Environment

Section 1 of this Executive Order (36 FR 8921, 1971) states that the Federal Government should provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the U.S. The alternatives considered would be consistent with this Executive Order.

American Indian Religious Freedom Act

This Act (42 USC § 1996) states that the policy of the U.S. is to protect and preserve for American Indians, Eskimo, Aleut, and native Hawaiians, their inherent rights of freedom to believe, express, and exercise traditional religions. These rights include, but are not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremony and traditional rites. Federal agencies must make reasonable efforts to locate and coordinate with organizations and communities or groups covered by the Act to insure that religious rights are accommodated during project planning, construction, and operation.

Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC §§ 3001 *et seq.*) provides for the protection of Native American and Native Hawaiian cultural items and establishes a process for the authorized removal of human remains, funerary objects, sacred objects, and objects of cultural patrimony from sites located on lands owned or controlled by the Federal government.

Environmental Justice

In sum, environmental justice is the goal to be achieved for all communities and persons across this Nation. Environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work



Appendix C – USFWS Listed Species Lists

**Colorado Field Office County List
Updated December 2006**

<p>Symbols:</p> <p>* Water depletions in the Upper Colorado River and San Juan River Basins, may affect the species and/or critical habitat in downstream reaches in other states.</p> <p>▲ Water depletions in the South Platte River may affect the species and/or critical habitat in downstream reaches in other states.</p> <p>© There is designated critical habitat for the species within the county.</p> <p>T Threatened</p> <p>E Endangered</p> <p>P Proposed</p> <p>X Experimental</p> <p>C Candidate</p>		
<p><i>For additional information contact: U.S. Fish and Wildlife Service, Colorado Field Office, PO Box 25486 DFC (MS 65412), Denver, Colorado 80225-0486, telephone 303-236-4773</i></p> <p><i>U.S. Fish and Wildlife Service, Western Colorado Field Office, 764 Horizon Drive, Building B, Grand Junction, Colorado 81506, telephone 970-243-2778</i></p>		
Species	Scientific Name	Status
CHAFFEE		
Canada lynx	Lynx canadensis	T
Mexican spotted owl	Strix occidentalis lucida	T
Uncompahgre fritillary butterfly	Boloria acrocnema	E
*Piping plover	Charadrius melodus	T

=This list is current as of August 2007 per USFWS Laurie\COSpeciesbyCountyLstforWebPage12-06.doc:120406.

*The piping plover is not listed under Chaffee County on the original County List, however one was observed in the project area, and the USFWS commented that it is likely that they occur in Chaffey County. This table has been amended to reflect their comment.

