US 40 BERTHOUD PASS

COLORADO ROCKY MOUNTAIN CORRIDOR PROJECT

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Acronyms

Best Management Practices (BMP)

Biological Assessment (BA)

Biological Opinion (BO)

Endangered Species Act (ESA)

Environmental Assessment (EA)

Environmental Protection Agency (EPA)

Mechanically Stabilized Earth (MSE)

National Environmental Policy Act (NEPA)

National Historic Preservation Act (NHPA)

Threatened and Endangered (T&E)

Works Progress Administration (WPA)

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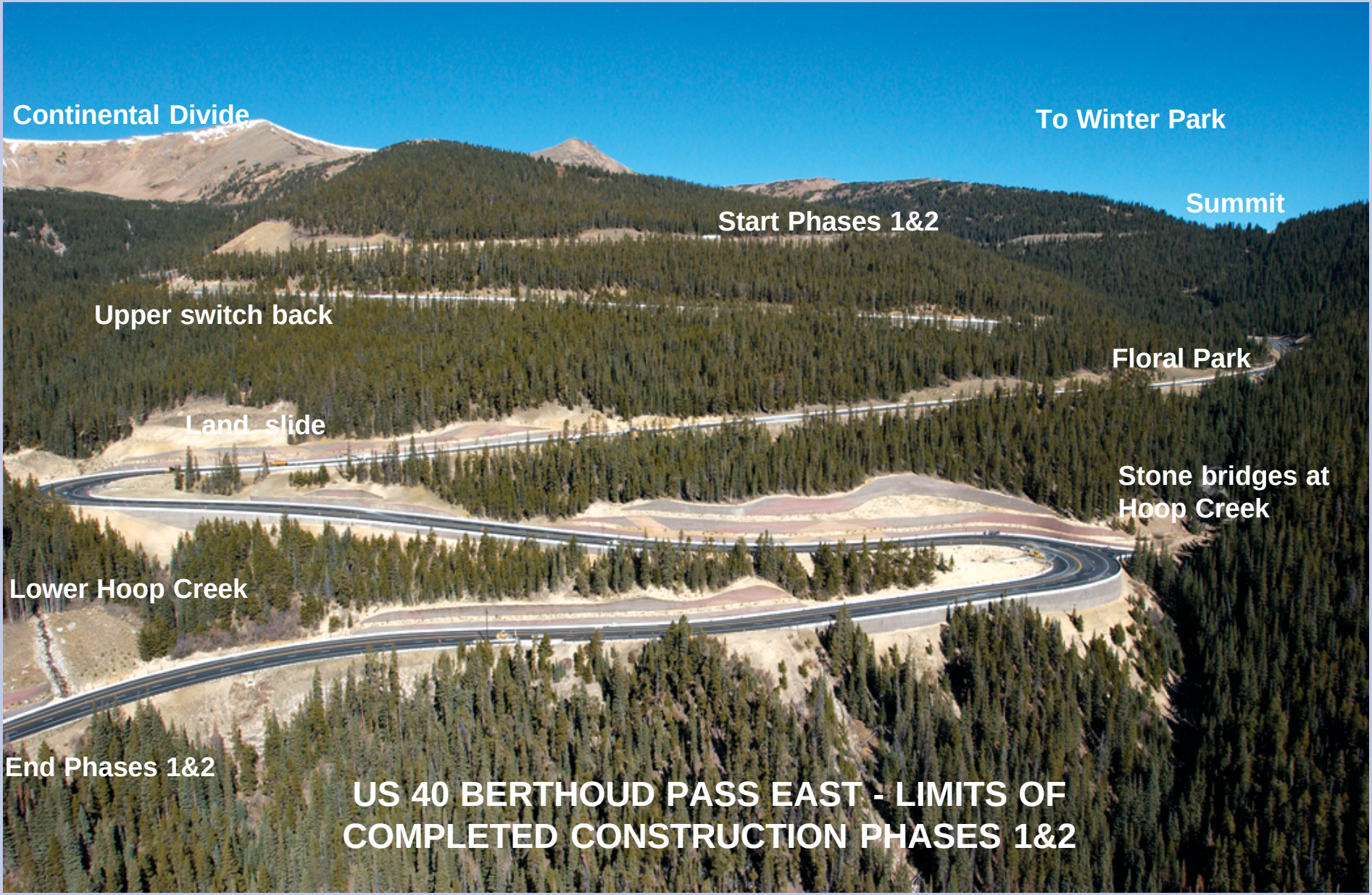
Preface

An Environmental Assessment (EA) for U.S. 40 east of Berthoud Pass in Colorado was completed in 1997. Many environmental and engineering challenges where addressed in the EA. The purpose of this booklet is to discuss the concerns and decisions that ultimately shaped the project design. This project design incorporated input from federal, state and local agencies, creating a transportation corridor that will improve safety, increase travel efficiency, and minimize environmental impact to the Colorado Rocky Mountain environment. Participants in the Berthoud Pass EA, project design and construction specialists and managers describe how they addressed requirements outlined in the EA and this document. Using several authors will result in several writing styles. However, this perspective represents the diverse skills, project issues and teamwork of the Berthoud Pass Project.

Environmental awareness was a significant component in the design of this project. We hope fellow planners, designers, construction managers and resource agency specialists can benefit from this National Environmental Policy Act (NEPA) process that made this Colorado Rocky Mountain highway project a success.

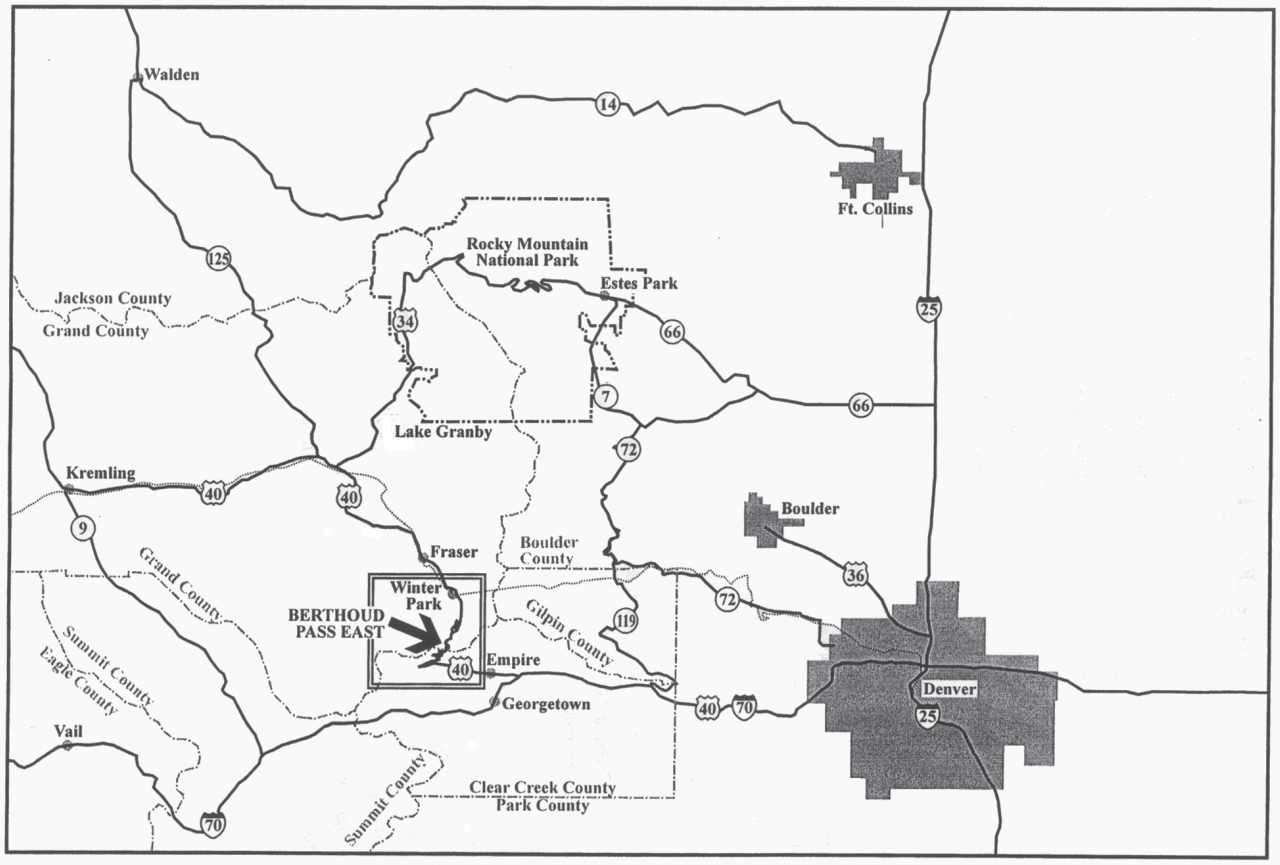


US 40 BERTHOUD PASS EAST - LIMITS OF COMPLETED CONSTRUCTION PHASES 1&2

Overview

Project Description

U.S. 40 over Berthoud Pass is located in North Central Colorado approximately 50 miles west of Denver in Clear Creek and Grand Counties. The project also lies within the Arapaho National Forest. The primary focus of the EA was east of the Berthoud Pass Summit over the Continental Divide to Berthoud Falls, a distance of 6.2 miles.



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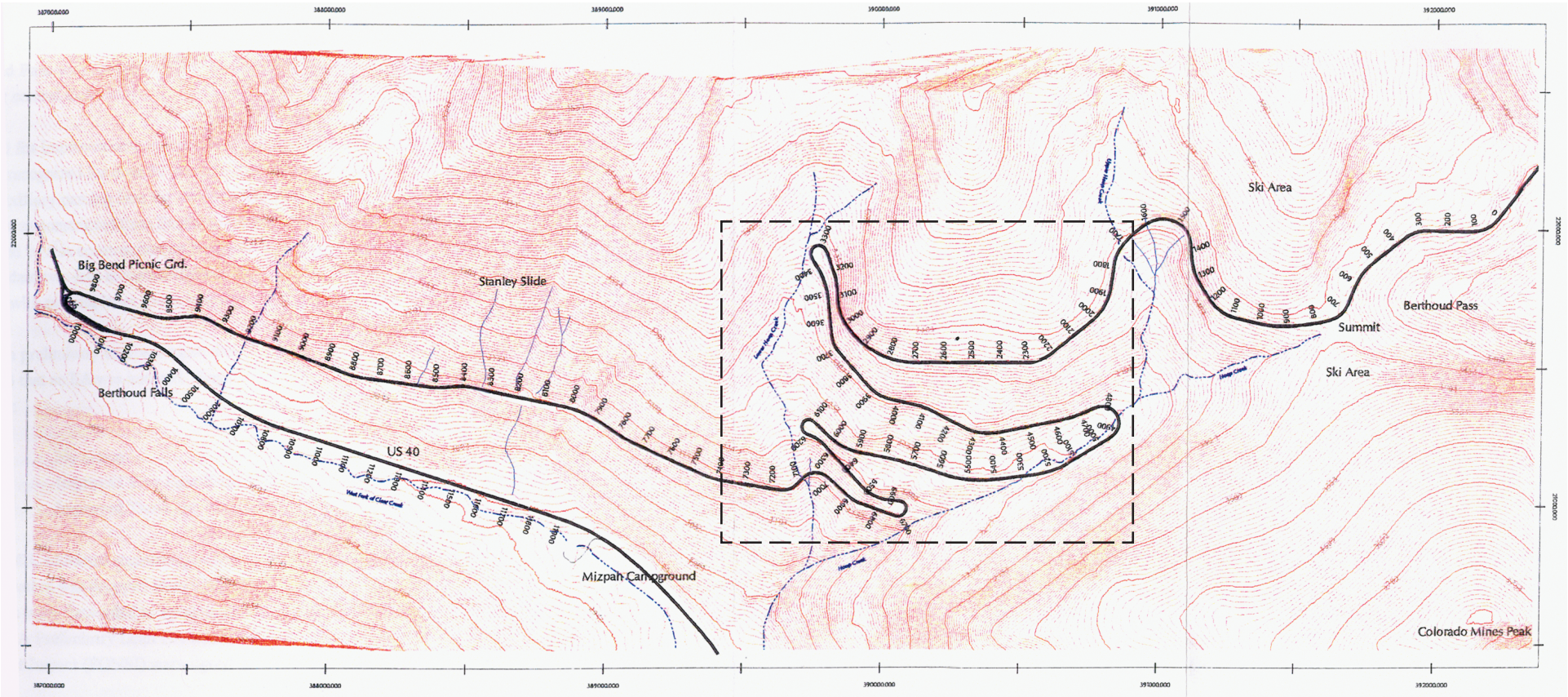
Berthoud Pass East Regional Context



Berthoud Pass corridor study area. Source EA. Dashed line perimeter = completed construction phases 1&2

The Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA) are the lead agencies for this project. The United States Forest Service (USFS) is the main cooperating agency.

Purpose and Need

Project improvements to the template have been a concern for over 30 years. CDOT initiated engineering studies in 1971 and the EA was initiated in 1983. The goal was to widen the template, however funding constraints prevented completion of a three-lane and four-lane widening as presented in the EA.

The EA was updated in 1987 and stated the following purpose: *to construct a feasible improvement which will increase the operation efficiency of U.S. 40 on Berthoud Pass*. A tunnel was even considered by local citizens but to date private funding has not been secured.

Since 1987 the need for safety and traffic-flow improvements have become urgent. Hence, a new EA was created for the present day construction of the corridor. Safety, mobility and resolving roadway deficiencies associated with snow storage; eroded and unstable slopes; surface icing and water quality problems became the main project goals. The key environmental study issues are as follows:

- Water Quality and Erosion Control;
- Slope Stability and Plant Establishment;
- Wetlands;
- Threatened and Endangered Species;
- Avoidance of the Alpine Forest;
- Visual Resources;
- Cultural and Historic Impacts; and
- Social Impacts to the Local Community and Ski Industry.

Constraints and Opportunities

The preferred alternative completed 2002

Is the preferred alternative to the assessment a compromise? The answer is yes. Each agency worked with environmental study objectives and project goals to shape a project suitable for the environment and the traveling public. The chosen alternative is an example of what the NEPA process can achieve. CDOT managers were sensitive to the needs defined in the environmental document. A pure roadway engineering preference would have been the four lane alternative. This widening in glacial till would have greatly altered the landscape with minimal capacity to contain sediment. On the other hand, the no build alternative would not have addressed safety and environmental concerns. The preferred alternative consists of three travel lanes, shoulder and snow storage with barrier and retaining walls. The result is an engineering solution for environment and transportation.

Site conditions presented many challenges. Tight switchbacks, steep slopes, eroded and unstable slopes, glacial till, avalanche paths and landslides required civil engineering, geotechnical and environmental solutions. Approaches to these constraints are discussed further in the booklet by the specialties involved in the development of the project.

U.S. 40 over Berthoud Pass is also a very scenic corridor with views of the Colorado Mountains. The corridor crosses the Continental Divide National Scenic Trail and is a primary route to the Winter Park Ski Area and National Forest recreation access. As stated the project lies completely in alpine forest of the Arapaho National Forest and CDOT was committed to minimizing aesthetic impacts.

A key component of the project is retaining walls. Retaining walls avoid forest impacts, stabilize slopes, improve aesthetic of the corridor and reduce the risk of rockfall. Retaining walls in combination with barrier, snow storage and a third climbing lane are the key environmental mitigation measures used in the alternative chosen in construction.

Furthermore, the collaborative EA process involved the formation of an Environmental Interdisciplinary Team and a Value Engineering Team. Together these teams addressed the concerns and chose the three-lane alternative. The commitments were defined and followed through the entire development process including construction. Each discipline worked together to achieve the project's goals. CDOT construction personnel made those goals a reality.

Water - The Constant Challenge

A challenge to each area of expertise in the project development process was the presence of water. Hydrologic issues drove the major revisions during construction. Higher measured groundwater elevations posed many challenges during construction. One of the primary objectives of the project was to store most of the 400 plus inches of annual snowfall. Avoiding construction in the aquatic environments and minimizing construction and permanent sedimentation were also project objectives.

Each design specialty worked with the hydrology of this 10,000-ft elevation mountain environment. Water quality and quantity drove the project. Even the long-term maintenance of the template and drainage system was addressed in the NEPA process. Drainage issues were also a key factor in construction revisions with culverts being added or moved.

The project engineer coordinated the water issues of the project from wetlands to groundwater drains throughout construction. The contractor had to work with water in several of the wall designs. Water levels were anticipated to be lower during the design phase. Consequently, designers, construction engineers and the contractor redesigned walls, added underdrains and made changes to the drainage system to compensate for the ever-changing mountain hydrology. The project started during a wet summer with several additional inches of rain. For example, in 1999, 8.79 inches of rain made August the wettest on record. Despite the new challenges for the project, the result was an improved design to drain the water.

AVERAGE ANNUAL PRECIPITATION 1971-2000, WESTERN REGIONAL CLIMATE CENTER

Average total precipitation (in inches)

JAN	FEB	MAR	APR
3.7	3.23	4.36	4.68
MAY	JUNE	JULY	AUG
4.32	2.02	2.29	2.50
SEP	OCT	NOV	DEC
1.83	2.28	3.39	3.84

Environment and Engineering

The total project costs for the entire East Side of the pass may approach $80 million. To work and be successful in alpine environments requires adequate resources to retain the mountain slopes, protect and preserve the forests and create a safe mountain corridor. Additional requirements include teamwork, technical expertise and a will to create a successful project for the public and the environment.

Completed cut and fill wall at Stone Bridges switchback

INTERAGENCY COOPERATION

Deb Angulski, CDOT Environmental Manager

Agency Involvement

An EA was completed in November 1997 in order to comply with the requirements of the NEPA. CDOT and the FHWA are the lead agencies for this project and the USFS is a cooperating agency. The entire length of the project lies on USFS managed lands. The environmental process started with public and agency scoping meetings, which were held in order to identify issues and alternatives. In order to achieve a high quality and safe roadway, shared decision making is essential. The FHWA and CDOT policy on decisionmaking is to actively involve the public and agencies in a process that is open, cooperative and collaborative.

Federal agencies with jurisdiction on the project include the US Army Corps of Engineers (COE) and the US Fish and Wildlife Service (USFWS). The Colorado Division of Wildlife (CDOW) also provided input. Numerous meetings and field trips were held with all of the involved agencies. Early coordination reduced the likelihood of controversy and delay regarding mitigation and other permitting issues. The COE issued a 404 permit for the entire length of the project. The purpose of the 404 program is to ensure that the biological and chemical quality of waterways is protected from irresponsible and unregulated discharges of dredged or fill material that could permanently alter or destroy valuable resources. The project required a 404 permit because we could not avoid placing fill material in waterways or wetlands. Fill material includes widening of the roadway where portions of the construction are in waters or wetland and protection devices such as riprap and other bank stabilization. In order to obtain the permit CDOT had to 1) show that we had taken steps to avoid wetland impacts where practicable; 2) minimized potential impacts to wetlands; and 3) provided compensation for any remaining unavoidable impacts through activities to restore or create wetlands. The permit will be amended as design moves forward along the corridor. The COE placed many conditions on the permit, some of which require monitoring of wetland restoration and creation success and the submission of yearly status reports.

The USFS was involved in the project because they administer the Endangered Species Act (ESA). The lynx was listed as a threatened species and is protected by the ESA. Refer to the Threatened and Endangered (T&E) section for information on habitat issues.

Collection Agreement between CDOT and USFS

CDOT was on a tight schedule for the project. As work was developed for the EA, USFS approvals were required. USFS environmental specialists had to provide input into all facets of the process. The USFS did not have this project programmed into their budget. They do not really have a budget for the extensive amount of coordination, fieldwork or reviews that a project of this size required. In order to help the USFS work around this potential problem, CDOT entered into a Collection Agreement with the USFS. The agreement programmed enough money to last the USFS for five years of work on this project, getting us through the EA and the start of construction. The agreement transferred money from CDOT to the USFS so that they could pay their staff to work on our project. In this way, the USFS gave the project and CDOT ability to move at the pace we felt we required.

REGIONAL GEOLOGY

Rick Andrew, Yeh and Associates Geologist

Geology

The effects of alpine glaciation dominate the geomorphology of the Berthoud Pass area. Glaciation occurred from the Pleistocene Epoch, 1.8 million to 70,000 years ago to the Holocene Epoch fewer than 10,000 years ago. Recent episodes include the Bull Lake Glaciation that began about 150,000 years ago and the Pinedale Glaciation that probably remained at full glaciation until 15,000 to 20,000 years ago. Depths of glacial materials through most of the study area are estimated to be less than five to over thirty feet thick. Some of the test holes indicate nearly 100 feet of till and colluvial deposits at the transition area from the Phase 2 project to the Phase 3 portion. This material is a medial moraine deposit from the glacier that flowed and subsequently receded, down the Hoop Creek tributary basin.

Bedrock in the area consists of Precambrian Silver Plume Granite and related igneous and metamorphic rocks. Some areas have interlayered granite and biotite gneiss along with migmatite. The primary minerals in these rocks are quartz, feldspars, hornblende, and biotite. There are also numerous accessory minerals, particularly in altered zones. Some of the gneissic rocks show pronounced foliation from millimeters to several inches in scale. In other areas, such as the upper portion of the pass, foliation is not apparent.

Rock cut at upper switchback

Faults have altered much of the bedrock in the area and cross the roadway at several locations. Rock within the fault zones is shattered and/or highly altered with clay gouge and infilling in most of the joints. Evidence of fault-altered bedrock was more apparent along the lower portions of the pass. At times the rock recovered in the core samples was so decomposed that it could be crushed by hand, while the rock fabric was still visible (saprolite). Occasionally secondary mineralization such as calcite and iron staining is also present.

Small faults are visible in some of the rock cuts. Offset, if detectable, is small on these features. Fault gouge was also encountered in several of the drill holes, and may be in excess of 30 feet thick in some areas. The fault gouge in this area generally consists of a very stiff, yellow to gray silty sand with clay and angular gravel- and cobble-sized rock fragments.

Groundwater

Groundwater conditions along the pass vary considerably throughout the year. Many groundwater seeps and springs exist alongside the roadway and some of these are present year-round. Other hydrologic features appear to have less flow during the dry season for this area in late summer and fall.

There may be multiple groundwater tables present along the pass. For example, there may be a natural water table below the depth of bedrock as well as a perched groundwater table that rests on the bedrock surface or somewhere within the overlying materials. Fracture flow within the bedrock is probable and complicates the interpretation of the groundwater surface.

One of the many seeps found throughout project

HISTORY AND ARCHAEOLOGY

OD Hand, CDOT Archaeologist, and Sally Pearce, CDOT Historian

Cultural Resources

Cultural resources include both historic and archaeological remains. Historic resources are standing architectural and engineering features such as buildings, bridges, roads, and railroads that are older than 50 years. Historic sites may also be defined as any structural remnant, trash concentration, or scatter suggesting residential or industrial use of the area. Archaeological resources are defined as any locality exhibiting evidence of past human activity, including associated artifacts occurring within a restricted area. They may also include cultural features, such as stone rings or fire hearths. Archaeological sites may be affiliated with prehistoric and/or historic periods of use, and include surface and subsurface cultural deposits.

Process and Coordination

The process for conducting cultural resource investigations for both history and archaeology as defined in the National Historic Preservation Act (NHPA) of 1966 and 36 CFR 800. It involves research to identify sites and information documented as part of previous cultural resource investigations and histories. A field survey is conducted to identify and document cultural resources within the corridor. Each resource is evaluated in accordance with National Register criteria, as defined by the National Park Service. The research and field investigations are documented in a report format.

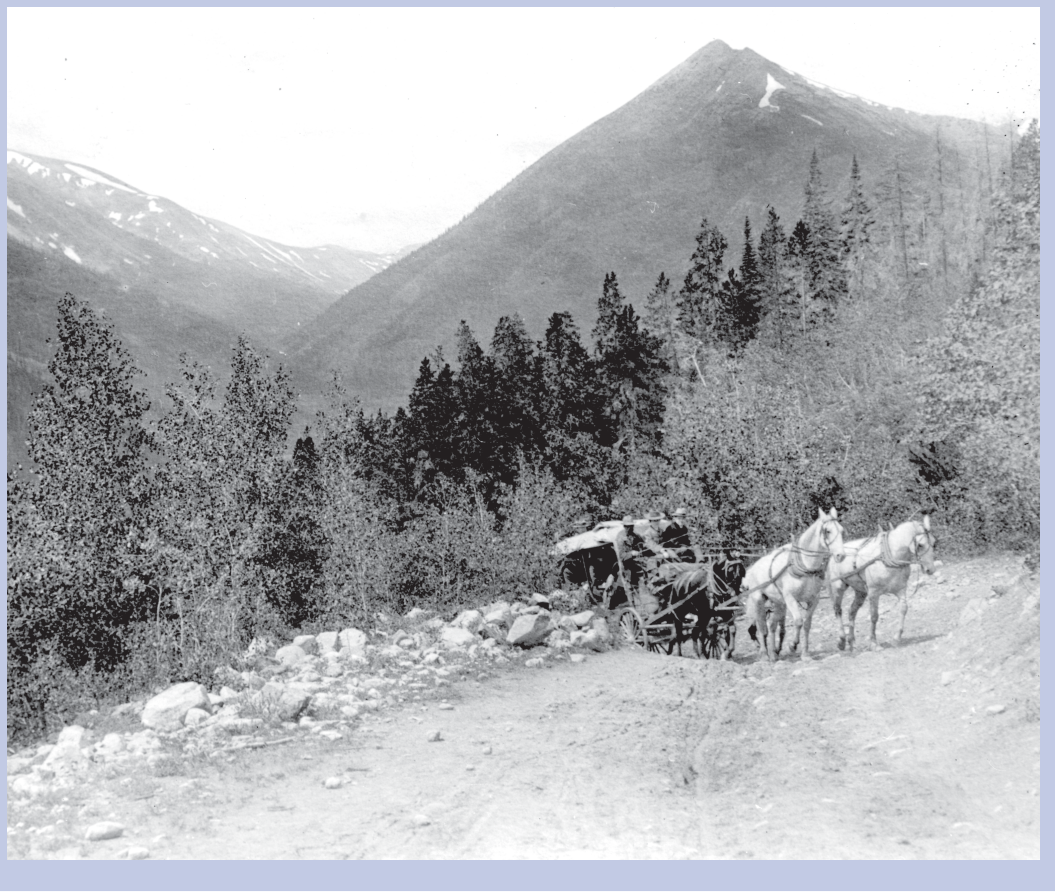
Close coordination with the Colorado State Historic Preservation Officer and involved federal agencies is required to ensure investigations are in compliance with state and federal legislation. The Arapaho National Forest archaeologist was consulted during the Berthoud Pass Project.

In all instances, the preservation of significant cultural resources is the preferred alternative. If significant resources cannot be avoided by project-related activity, it is necessary to mitigate these effects through additional documentation, site modification/stabilization, and/or excavation. Results of these investigations are also documented in a report format.

Cultural History

History

Captain Edward L. Berthoud and famous scout Jim Bridger discovered Berthoud Pass in May 1861 while on an expedition to find a direct mail route through Colorado. The route was surveyed in July 1861 but determined to be unsuitable for both a wagon road and a railroad. It took more than ten years for a road to be built across the pass, with the first toll road opening in 1874.



1874 stagecoach and wagon road

In the fall of 1919, the USFS, the Colorado State Highway Department and the neighboring counties reached an agreement to construct an improved automobile road over the pass. The grand sum of $220,000 was appropriated and construction began in June 1920 under the direct supervision of the U.S. Bureau of Roads. The 16.6 miles of continuous 18-foot wide roadway was completed in 1923. In order to guard against snow and landslides, and possible washouts, the road was constructed with extensive use of rubble retaining walls and rubble ditches to catch basins and corrugated metal culverts.

In the 1930s further improvements were made to the highway – it was widened and paved, and the metal culverts were replaced by stone culverts, typical of the Works Project Administration (WPA) work of that period. In 1961-62, the west side of Berthoud Pass was widened to three lanes. Work on the east side of the pass began in 1983.

Cultural Resource Investigations

Pedestrian surveys for archaeological remains have been conducted in and near the U.S. 40 corridor over Berthoud Pass since the mid 1970s. Due to the generally steep nature of the terrain, known prehistoric sites are limited to the top of the pass and the lower approaches, while historic sites associated with transportation and mining occur randomly throughout the area.

In 1975 the Colorado Department of Highways (later CDOT) surveyed the U.S. 40 corridor from the summit of Berthoud Pass east to the community of Empire. Three archaeological sites were identified in the vicinity of Berthoud Pass, including two small and one large lithic workshop sites. The larger site is affiliated with Archaic and Late Prehistoric occupations, although test excavations identified little subsurface cultural deposition and the site was determined to be not eligible to the National Register. Cultural affiliation for the remaining resources was not established, and additional investigations for these sites may be required.

In 1982 the Colorado Department of Highways conducted a survey at the summit of Berthoud Pass, identifying one prehistoric lithic workshop site, the Berthoud-Bridger Site. Test excavations were conducted at the site, and as a result it was attributed to the Archaic, Late Prehistoric, and Protohistoric cultural periods. However, the site proved to be a remnant of a much larger occupation area, severely impacted by previous highway and ski area construction. It was determined not eligible to the National Register.

There have been numerous historical site surveys conducted as part of the Berthoud Pass Highway project. The first Colorado Department of Highways survey was conducted in 1983 and uncovered the following sites:

The Berthoud Pass Ditch was a stone-lined, three-mile long ditch designed to carry water from the western slope of the Continental Divide to the eastern slope. It was built in 1902 and was originally a part open ditch and part wooden flume. The flume was replaced in 1957 by a metal pipe. Remnants of the original ditch are located at the pass summit, west of U.S. 40.

The Berthoud Pass Chairlift was built in 1947 and is believed to be the world's first double chairlift. It was determined eligible for the National Register, but was outside of the project corridor. Subsequently, ski area owners replaced the lift in 1989.

The Berthoud Pass Ski Area was developed at the top of the pass around 1937 and is believed to be one of the oldest ski areas in Colorado. The original lodge was built by the USFS in 1937 but burned in the mid 1940s. The current lodge was built in 1947 but has gone through significant alterations and is not considered historic.

Berthoud Pass Summit

Empire Middle Park Wagon Road

The USFS conducted a cultural resource survey of the area in 1993 and recorded the Empire Middle Park Wagon Road. Early segments of the road were constructed in 1862, but the majority of the work began in 1874 and was completed in 1875. The old wagon road crosses the current alignment of U.S. 40 at two locations, in a hairpin curve two curves below Floral Park and on a tangent section above Floral Park. The road was officially determined eligible for the National Register.

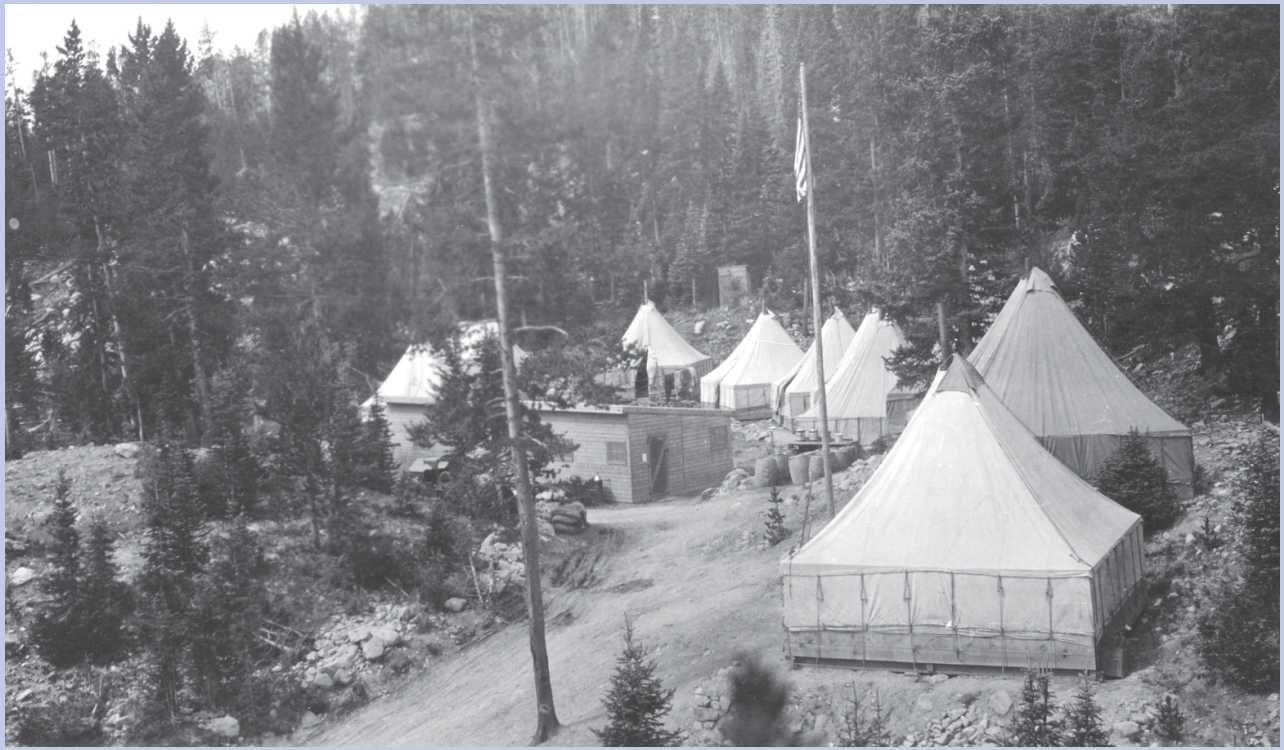
The same 1993 investigation identified a historic habitation site just above U.S. 40. The site exhibits depressions, dugouts, stone walls, earthen platforms, and trash deposits. Dating between the 1860s and 1920s, the site is probably associated with construction and travel along the wagon road and, later, the highway. This site was determined potentially eligible to the National Register.

Dugout at historic mining camp

The CDOT Cultural Resource Report for the Berthoud Pass Widening Project was updated with a new survey in 1996. During that survey, several new segments of the road and related structures and sites were recorded. The four new sections were determined to be noncontributing to the National Register-eligible wagon road due to a loss of integrity resulting from numerous alternations. No additional historic sites were identified.

In 1990 and 1996, CDOT conducted surveys along the U.S. 40 corridor on the west side of Berthoud Pass. However, the steep and rocky nature of this portion of the corridor is not conducive to cultural use, and as such, no cultural resources were identified.

Surveys by Partners for Access to the Woods (PAW), an organization working to develop the Berthoud Pass Research Corridor for Universal Design, have uncovered additional features related to the historic wagon road, including what appears to be a work camp from the 1920-21 crews that improved the road and a bridge.



Work camp 1920

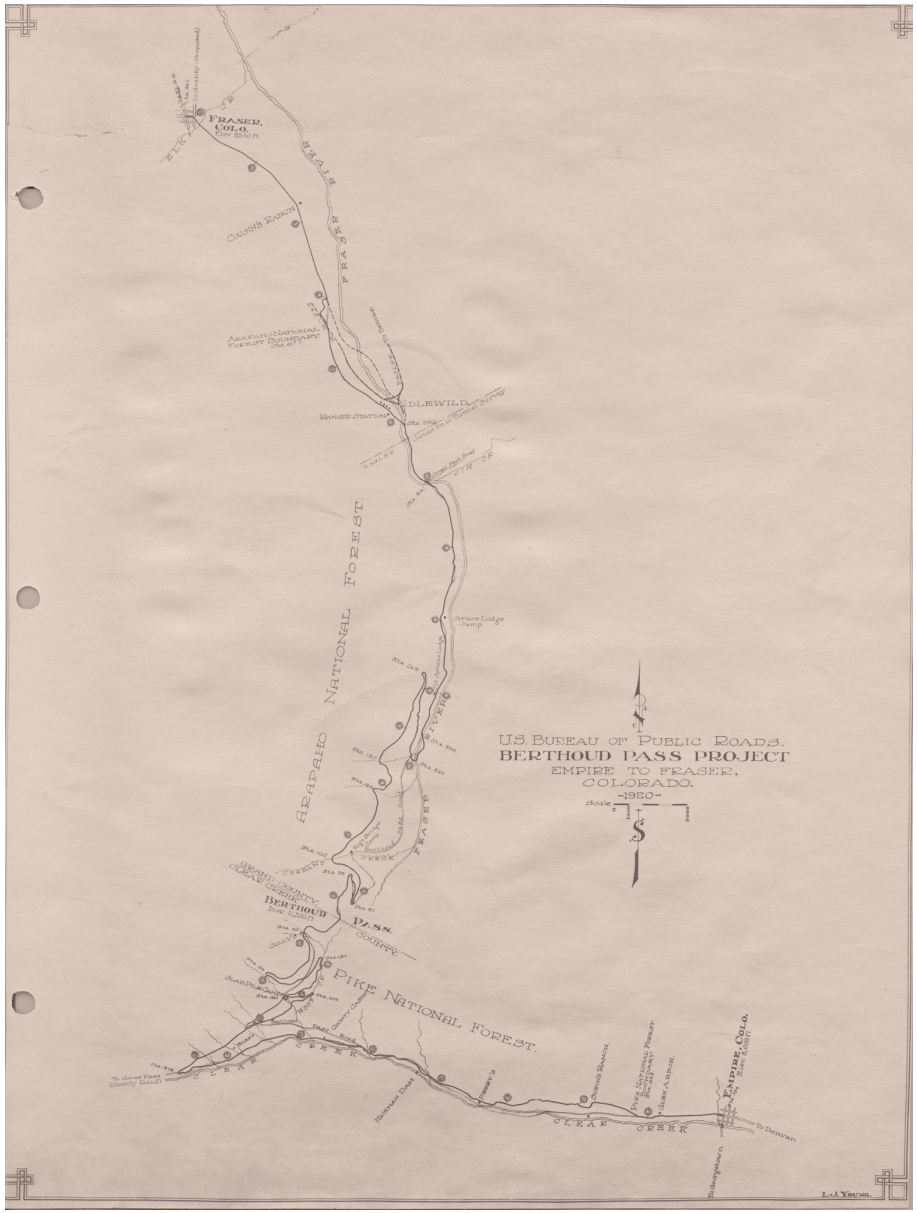
The Hoop Creek Stone Bridge was built in 1921 as part of the new automobile road over Berthoud Pass. Stonework was added to the bridge in 1926 as part of a maintenance job. This section of road was abandoned in 1930, and in 1935, the USFS decided to make the bridge area into a park. Design plans were developed in 1935 by the USFS and apparently implemented based on existing plant materials.

As a result of the above-referenced cultural resource investigations, the current CDOT Berthoud Pass Project required little additional survey. Previously documented sites were relocated and evaluated with reference to current project design plans. As an extension of this project, U.S. 40 from Berthoud Falls to Interstate 70 was surveyed by CDOT in 2001. This survey reevaluated two prehistoric lithic workshop sites, and the Empire Middle Park Wagon Road. Newly recorded resources included historic retaining walls associated with the early highway, isolated mine adits, and prehistoric isolated finds.

THE HOOP CREEK RESTORATION PROJECT

Carol Hunter, Partners for Access to the Woods (PAW)

Regional Map,1920



Past

The Hoop Creek Bridge (Stone Bridges) has always been an important, but little known part of America's transportation history. Clyde E. Learned, Senior Highway Engineer wrote in his 1924 Final Report for Seasons 1920-23 of the *Construction of Berthoud Pass Forest Road by Day Labor Construction:* " The Midland Trail, the main East and West transcontinental highway of the State of Colorado, upon which the total Berthoud Pass Project is located, has been designated by the State as a part of the primary system of Federal Aid Highways." In the same report, he also wrote: "The Project is 20 miles in length, and is a section of the main East and West Highway of the State of Colorado. The highway crosses the Continental Divide at an elevation of 11,306 feet above sea level, this being the highest point on the Midland Trail, or the more recently named Victory Highway." Maps advertising the Midland Trail state that it went from Washington to San Francisco a total of 2,930 miles. It stated the distance by railroad as 3,110 miles. It traversed 12 states, touched nine state capitals, 123 counties, and 91 county seats.

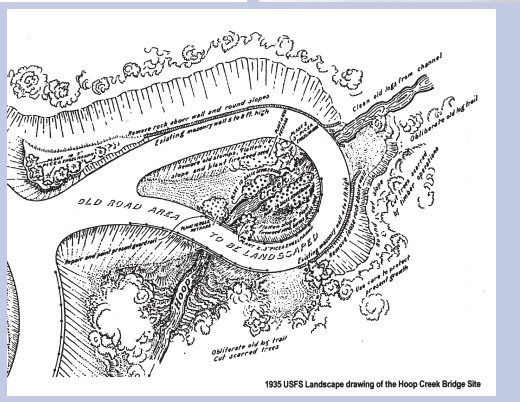
The Victory Highway was planned as a monument to the "American Heroes of the World War". An article in the December 1925, Colorado Highways states: "When the Victory Highway is completed it will constitute the greatest monument in all history...

Across Colorado, the Victory Highway essays the Continental Divide over Berthoud and Rabbit Ears passes on a government built road which supplies a wide and safe line of easy grade through the most inspiring scenery to be found on any of the cross country highways topping a region between Denver and Salt Lake…"

The actual Hoop Creek Bridge was part of both of these designated highways and is located on the east side of Berthoud Pass on the first switchback above the Stanley avalanche chute. The bridge was built in 1921 using a simple design of a concrete slab with pipe railings and had a distance of 18 feet between the railings. The retaining walls were made from loose rubble. Photos taken in1925 of the Bridge show that wooden guardrails had been added. In 1926, the stone walls of moss rock were added to the bridge and mortar was added to the loose rock of the retaining walls as part of a maintenance project. The distance between the walls was increased to 26 feet. In 1930, the curve containing the Bridge was abandoned as part of an improvement project. A USFS landscape drawing dated 1935 shows plans to make the abandoned bridge and the surrounding area into a recreation use area. Little was done from this period until the present. Locals and visitors to the site used the bridge site over the years because of the exceptional beauty of the waterfall and surrounding mountains.

Hoop Creek or Stone Bridges 1930's

1935 Landscape drawing



1935 USFS Landscape drawing of the Hoop Creek Bridge Site

Present

In the mid 1990s Partners for Access to the Woods (PAW) approached the USFS about restoring the stone bridge to its 1935 design as a recreation area. Over the years, logs, rocks and other debris had filled in the channel under the bridge. Each spring, as Hoop Creek rushed down the mountain, it leapt over the back wall of the bridge and spilled into the old road bed, flowing out both sides of the bridge, destroying a little more of the bridge each spring.

Many partners and interested individuals have become part of the restoration of this little bridge. CDOT has been a lead partner in its protection and restoration. The Hoop Creek Bridge and the surrounding site were added to the State Register of Historic Properties for the State of Colorado on June 14, 2000. The students of the Colorado School of Mines conducted several projects at the site including soil samples, water flow studies, along with tests for relocating the original retaining walls that had been buried by landslides. The Adolph Coors Foundation helped with dollars needed to pay for a contractor, Darrel Jones & Son, to do the delicate work of removing the debris from the back and under the bridge. On October 17, 2000, water flowed for the first time in over 30 years under the bridge.

During this first period several agencies and individuals supplied written records and photos of the construction of the road and the Hoop Creek Bridge. The FHWA staff gave many hours to the project by researching their archives for the photos and construction documents that became the backbone of the restoration project. The Sanborn Postcard Company also gave generous use of their collection.

Hoop Creek (Stone Bridges) 2002

The next phase of the restoration is currently going on as part of a grant from the Colorado Historical Society's State Historical Fund. On May 20, 2002, PAW received a grant for the conceptional and construction drawings for the restoration. Dana Leavitt of Vignette Studios of Ft. Collins received the contract. Also as part of this phase, the students of the Colorado School of Mines are providing a structure analysis of the bridge. The USFS is providing the environmental studies needed for the permits that are necessary before the actual restoration can begin. Once all the partners have signed the conceptual plan and the permits are in place, the actual restoration can begin. Funding is being sought for this phase. Rocky Mountain National Park's Road and Bridge crew, which maintains the historic stone structures along Trail Ridge Road, will do the actual restoration work.

Future

On April 17, 2000 the Berthoud Pass Research Corridor for Universal Design was created. Its members include:

- Arapaho Roosevelt National Forest;
- Easter Seals Colorado;
- Sol Vista/ Berthoud Pass Ski Area;
- Clear Creek County;
- Colorado Department of Transportation;
- Colorado School of Mines;
- Henderson Climax Molybdenum;
- Phelps Dodge;
- National Sports Center for the Disabled;
- Partners of Access to the Woods;
- Sanborn, LTD and
- Town of Empire.

Other partners are being added. The purpose of the Corridor is to conduct research and provide an outdoor classroom for students interested in studying universal design. Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. Universal design benefits people of all ages and abilities. It will also be available to teachers who have students from K-12 that are interested in Colorado's transportation history. The first two sites that are being developed for the Corridor are the Hoop Creek Bridge and the Empire-Middle Park Wagon Road. Both of these will be restored as part of the Corridor. The Hoop Creek Bridge site will become an outdoor classroom on exhibit designs that include persons of all ages and abilities. New methods will be tested at the site for tactile – touchable exhibits that can withstand the elements of Berthoud Pass and include the needs of persons with special needs including visual impairments. It is hoped that by the time one is reading this report of the future goals of the Hoop Creek Restoration Project, many will have been accomplished.

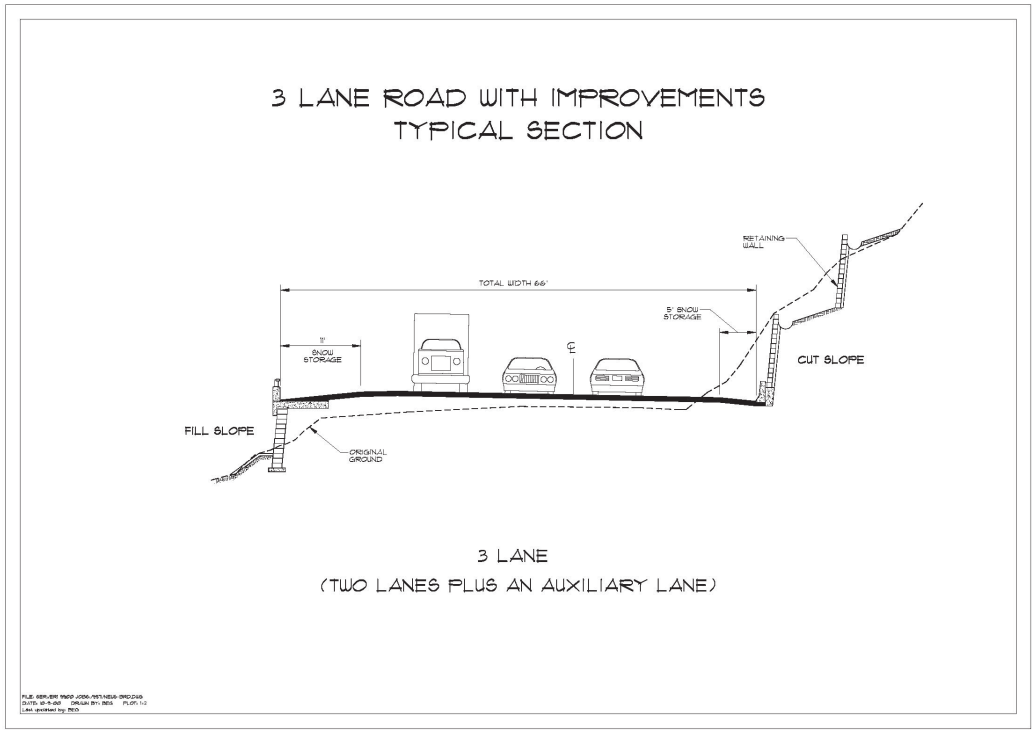
Several sites are planned along the Corridor, but the Hoop Creek Bridge will likely be one of the most important in the public's understanding of the history of transportation over Berthoud Pass.

CIVIL DESIGN OBJECTIVES

Ina Zisman, CDOT Resident Engineer

The use of U.S. 40 between Winter Park and I-70 have increased dramatically in the past 40 years. The original two-lane roadway template has been altered over the years to allow for short stretches of passing lanes on the east side of Berthoud Pass between Berthoud Falls and the top of the pass and continuous three-lane road on the west side.

This increased traffic demand and numerous safety issues instigated the process to fill the gaps and make the entire road a three-lane road. CDOT's approach to this project was to widen the road with the least impact to the surrounding environment. Engineers were presented with a challenge to reconcile and integrate into the project frequently conflicting needs of roadway geometry, wildlife needs, impacts to the forest, visual impacts and water quality requirements. The resulting final roadway template for this project includes three 12-foot lanes, 8-foot shoulders and 5- to 11-foot wide snow storage areas.



Typical Section Drawing

To minimize the impact to the forest, large retaining walls where built on both fills and cut slopes. Soil nail or tieback design of cut side retaining walls with concrete block facing provided for stabilization of the highly erodable and unstable slopes. A massive landslide within project limits was stabilized using tieback anchors and an extensive system of horizontal and vertical drains.

Cut side retaining walls were designed to be tiered if maximum facing height exceeded 12 feet. This allowed top to bottom construction and minimized room required building these walls. As a result, it allowed for a more efficient traffic management during construction. It also produced a more pleasing aesthetic appearance and ability to better landscape the resulting terraces. In addition to being a nice landscaping feature, these terraces are intended to function as additional snow storage areas.

Cut side retaining wall and landscape terraces

The height of the fill side retaining walls varies between 2 and 30 feet. Therefore, Mechanically Stabilized Earth (MSE) wall system with concrete block facing was selected as more cost effective for this application.

The bid documents contained only partial design for both cut and fill slope wall systems. CDOT analyzed global stability of the proposed walls and requested that final design of the wall system, including internal stability, be the responsibility of the contractor. This resulted in a modified design-build concept for this portion of the bid documents. The intent was to involve the contractor's ingenuity to come up with a most cost-efficient wall system.

Terrace wall with vegetation

Construction

Ina Zisman, CDOT Resident Engineer

This project presented countless construction challenges. To begin with, the effective construction season in this area is only June through October. The initial construction document provided for a three-season construction project. A number of changed site conditions extended it into a full fourth season.

Active Construction

Yenter Companies was awarded the contract in the spring of 1999 and commenced construction that summer. In addition to the obvious challenges of building the road in the harsh environment, on a glacial till and under traffic, the contractor was presented with a number of restrictions such as:

- safety of the traveling public during construction operations was to be a number one priority;
- maximum delays to the traveling public were not to exceed 40 minutes;
- no work requiring lane closures was allowed from 2:00 PM on Fridays till 10:00 PM on Sundays;
- road to be open to a two-way traffic for the weekends and holidays;
- restricted time duration for the traffic on a non-paved road surface; and
- no work requiring lane closures was allowed in the late fall and early spring while Winter Park ski area was in operation.

It called for strong partnership and commitment from all parties involved to begin and successfully complete a project of this complexity. Changed site conditions, such as unexpectedly high water table and unanticipated extent and severity of the landslide, put partnership, commitment and creativity of CDOT, JF Sato, Yeh and Associates and Yenter personnel to a test a number of times. To give credit to everyone involved with the project, the strain of these changes resulted in creative solutions to these problems.

During the landslide stabilization process, when the bedrock was not encountered at the specified depth of 30 to 40 feet, designers Yenter, JF Sato and Yeh and Associates jointly developed a new plan to address the problem. The grouted anchors became 140 feet long and an elaborate horizontal and vertical drainage system allowed for a less costly design of the surrounding walls and improved stability of the roadway.

Stone Bridge access at swithcback

Also, as a result of the team's creativity and cooperative effort, two fill side retaining walls, originally designed as foam filled walls, were redesigned to become a more cost efficient and easier to construct combination of the conventional MSE walls and reinforced slopes. The alignment of two retaining walls at the historic bridge site was changed to allow an access to this bridge.

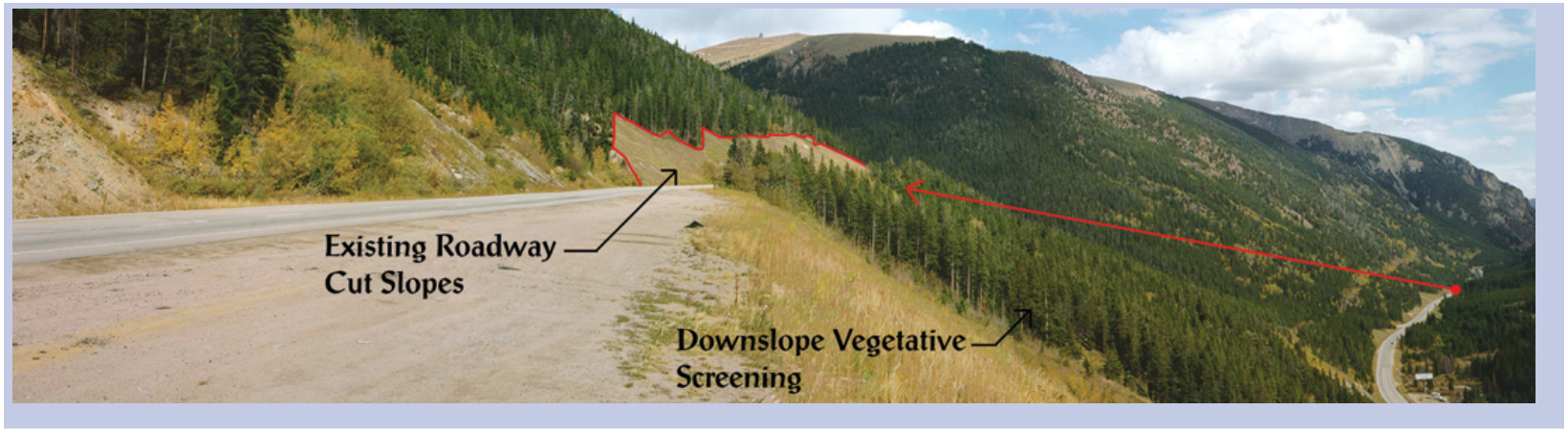
Some earth moving operations were conducted at nighttime to minimize the impact to travelers and to provide for safety of the motorists during earth excavating operations on the cut side slopes. Substantially reduced traffic flow during nights allowed the contractor to stop traffic in both directions for 30 minutes and perform excavation on the cut slopes without any danger of escaped rock hitting a passing vehicle.

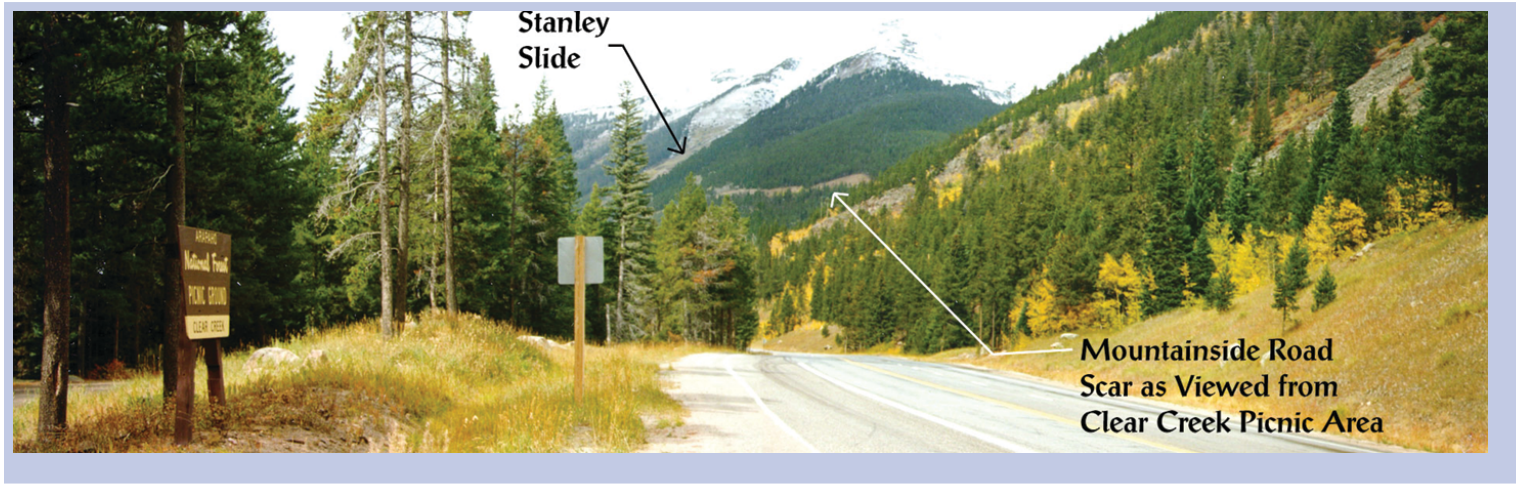
Active Construction

VISUAL RESOURCES

Teresa O'Neil, JF Sato and Associates and Glen France, USFS

Initial visual issues associated with the proposed widening of U.S. 40 centered on how the loss of roadside vegetative screening and the introduction of walls into the forest setting would alter the characteristic landscape and views from the road and recreation areas.





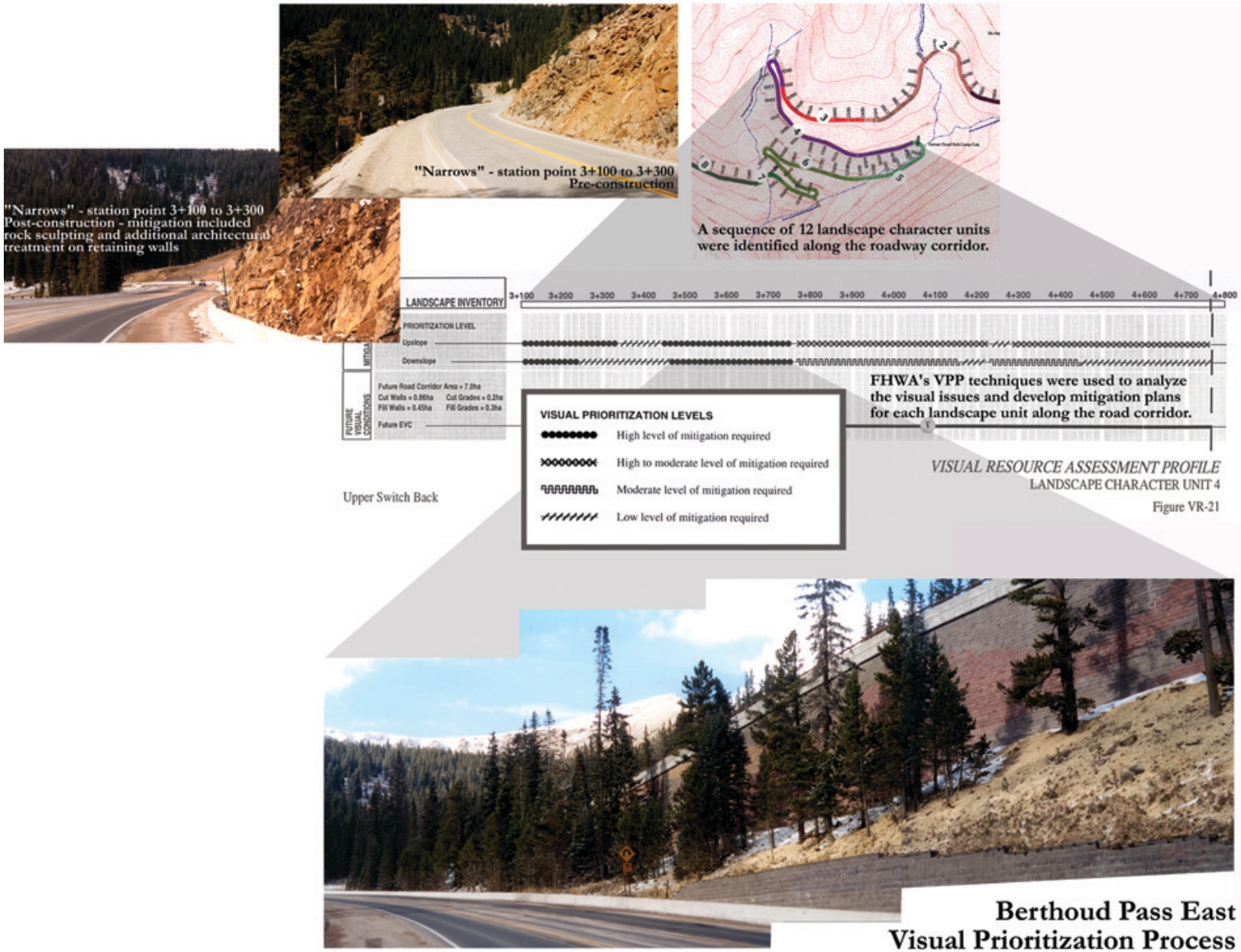
The visual influence of U.S. 40 included roadside and distant recreation views

A primary goal during design was to maintain roadway widening within the existing treeline of the roadway corridor, thereby minimizing visual impacts from vegetation clearing and major new cut slopes into the adjacent forest. Of specific concern was the mitigation of visual scars created in the initial highway construction.

Preconstruction road edge conditions

A detailed visual analysis was conducted as part of the EA, which documented the landscape character and existing visual conditions throughout the corridor as well as sensitive views within and adjacent to the corridor. The visual resource analysis included photo documentation of the road corridor; computer visibility analysis of the road corridor from recreation sites and trails based on topographic data; wall proportion and scale studies; and photo simulations.

The visual analysis focused on identifying existing elements to be protected or enhanced. Early in the Berthoud Pass East assessment, it was recognized that in order to minimize the overall influence and environmental impact of roadway widening, retaining walls would be required. Once the design parameters were set, the goal of mitigation planning and design for the Berthoud Pass East project focused on visual absorption of the project elements into this national forest setting. FHWA's Visual Prioritization Process (VPP) was implemented in the Berthoud Pass East assessment. This process is intended to focus mitigation in response to visual impacts and visual goals, by identifying the variety in scenery and sensitivity of a given corridor. The VPP process was applied in the assessment stage of the project to determine


"Narrows" - station point 3+100 to 3+300
Pre-construction
"Narrows" - station point 3+100 to 3+300
Post-construction - mitigation included
rock sculpting and additional architectural
treatment on retaining walls
A sequence of 12 landscape character units
were identified along the roadway corridor.
LANDSCAPE INVENTORY
3+100 3+200 3+300 3+400 3+500 3+600 3+700 3+800 3+900 4+000 4+100 4+200 4+300 4+400 4+500 4+600 4+700 4+800
PRIORITIZATION LEVEL
Upslope
Downslope
MITIGATION
FUTURE VISUAL CONDITIONS
Future Road Corridor Area = 7.0ha
Cut Walls = 0.86ha
Cut Grades = 0.2ha
Fill Walls = 0.45ha
Fill Grades = 0.3ha
Future EVC
FHWA's VPP techniques were used to analyze
the visual issues and develop mitigation plans
for each landscape unit along the road corridor.
VISUAL PRIORITIZATION LEVELS
High level of mitigation required
High to moderate level of mitigation required
Moderate level of mitigation required
Low level of mitigation required
Upper Switch Back
VISUAL RESOURCE ASSESSMENT PROFILE
LANDSCAPE CHARACTER UNIT 4
Figure VR-21
Berthoud Pass East
Visual Prioritization Process

significant visual resources, select the alternative with the least visual impact, and identify mitigation measures. Visual priority levels were based on distance from the viewer, key landscape areas, existing visual condition and magnitude of the proposed change. The outcome of the visual resource assessment and mitigation planning evolved into more detailed solutions through the design process.

Design Evolution

The design goals resulting from the EA for Berthoud Pass East were to enhance the national forest setting by addressing existing roadside scars, and to minimize contrast of project elements and activities. In order to achieve these goals, all attempts were made to provide for aesthetic treatment of walls, grading and landscape treatment that provide visual continuity with surrounding elements by repetition of compatible colors, textures, lines and forms of the characteristic landscape.

Walls

Because walls are a dominant part of the Berthoud Pass East roadway template, the scale, proportion, and general appearance of these structures were a critical issue addressed from an aesthetic and structural standpoint in the EA and design process. A terraced wall configuration with landscaped benches between the walls was determined to best reduce the overall visual effect of the walls. Numerous wall and terrace configurations were analyzed for their ability to accommodate roadway widening in mountainous terrain while maintaining an appropriate scale. In addition to aesthetic considerations related to wall proportion, the functionality of the wall terraces for snow storage was also an important aspect in determining the wall and terrace proportions.

Mitigation of structure contrast included the use of colors and textures on wall surfaces that provide visual continuity with surrounding elements by repetition of attractive colors, textures and forms. Additional architectural detail and/or surface treatment was used on walls in select areas, including patterning created with a variety of colored block to break up the strong horizontal line imposed by the retaining walls.

Regarding aesthetic appearance, the USFS expressed a preference to avoid surface treatments that might appear urban, as well as designs that might come to appear dated over the life of the project. Therefore, the ability to blend the surface treatment form, line, color, and texture with that of the surrounding landscape became an important factor in making an aesthetic choice. Because the natural landscape has a great variety of visual attributes (especially texture and color), a flat, even wall surface would create strong contrast, appear unnatural, and attract unwanted attention.

The overall design concept for the aesthetic treatment of retaining walls was to compliment attractive features, such as natural rock outcrops, throughout the corridor. The objective in the design was to create the appearance of geologic veins running through the walls in order to both break up the form of the large walls, as well as to provide visual interest and continuity with the setting.

The combination of natural rock and block was considered but replaced with multi-colored block patterning due to the high cost of integrating natural rock into the wall façade.

Concrete masonry block was chosen as the preferred treatment due to the flexibility that it provides in both color and patterning. Split face concrete block has a rough and random texture that is complimentary of the setting. A major benefit associated with concrete block is the flexibility that it offers in patterning design. While all single tier walls consist of a single dark and receding color, additional architectural detail was used on two tier walls. A total of three colors were used on the two tiers to achieve an undulation pattern that continued from the lower wall into the upper wall, helping to break up the strong horizontal appearance of these structures along the roadway. Colors and patterns were selected from native rock outcrops and soils found within the corridor. By matching these native elements, the colors chosen blended to the degree that wall segments and patterns appear as natural extensions of the surrounding landscapes.

The use of integral color allowed for variation inherent in integral color, which appears more natural than paint. In addition to integral color within the concrete, *flashing* or a random surface coat of color provided even more variability in the appearance of the block and better blends with the variability in the natural setting.

To obtain the desired visual effect and wall patterns during construction, inspectors were assigned to oversee the work. The surface flashing, which provided a more random appearance even within a single block color required more effort from the contractor. Every effort was made to achieve random placement of the blocks and avoid large splotches or lines of darker blocks. The contractors had multiple pallets of colored block to draw from in order to ensure a random coloration within each block color. Plans illustrating block by block pattern layouts were developed to assist the contractor. Additionally a test wall was constructed for the engineer to approve the block colors, flashing appearance and ability to replicate the patterning provided in the plans.

To lessen the visual impacts of the walls, they were terraced and landscaped. This provided the opportunity to incorporate rocks, trees and native plants on the wall terraces. With these elements being introduced, drainage, planting, plant survival, wall structural integrity and snow storage were all considered.

Implementation and Lessons Learned

The design goal for the color of structures on Berthoud Pass East was to blend with the landscape setting. Contrary to this intent, the white efflorescence on walls contrasts greatly. Efflorescence is a white chalky appearance that results when evaporation of salt-laden water deposits salt crystals on the wall surface. On the Berthoud Pass East retaining walls, efflorescence is primarily a result of calcium and carbon in the gravel *baggie system* behind the block facing. While some efflorescence was expected to occur (as it does on all exterior concrete surfaces), the extent and its adverse visual effect is a

concern. Subsequent construction phases will use a new attachment system to connect the facing with the structural wall, eliminating the gravel behind the wall and reducing efflorescence in the block.

Barriers and wall caps are also a visual distraction throughout the corridor. While the color of the walls are complimentary colors within the forest setting, and are relatively dark and receding, the bright gray barrier and wall caps are highly contrasting. This color is anticipated to darken over time and thus contrast less with age. A preferable surface treatment might have utilized integral color in the barriers and wall caps, similar to the wall colors.

Treatment of wall ends has been reconsidered since the first phase of construction. Originally there was no attempt to blend the wall ends back into the slope. This creates an unfinished appearance and allows visibility into ditches behind the walls. In future construction, walls will be tapered back into the slope.

Rock Sculpting

A variety of boulders, rock outcrops and rock formations were encountered during construction. Mitigation techniques utilized in the first phase of construction included rock sculpting. Natural joints and fracture angles of existing stable rock formations were emulated to obtain natural-appearing irregular rock face. Depending on the stability of the rock, scaling was performed to remove overburden and emphasize the rock strata or features. This worked to increase the margin of safety for rock fall reduction and emphasized the diversity and scenic beauty of the rockforms. Boulders were also placed on cut slopes, and on terraces between retaining walls to provide visual interest and help with slope stability. This provided a cost savings to the contractor through not requiring the rock to be hauled off site.

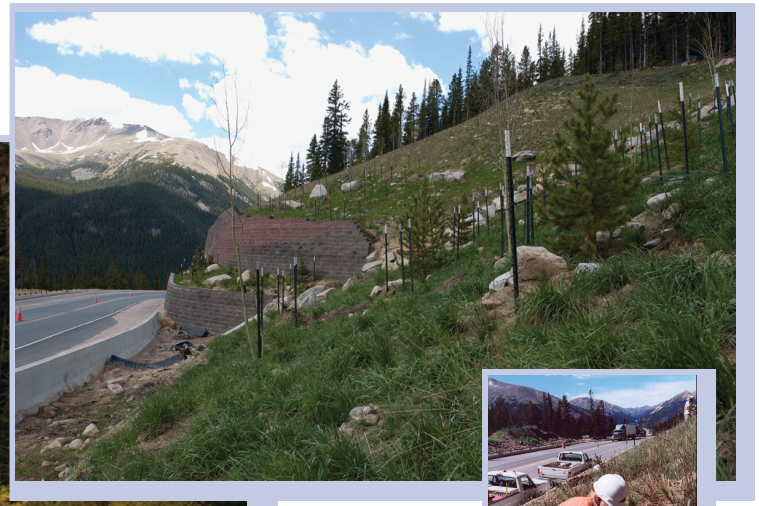
Landscape Treatment

A primary goal for the Berthoud Pass East project was to establish plantings that would result in a sustainable landscape and that will provide for vegetative cover, aesthetic enhancement, and partial screening of walls. To be sustainable, landscape treatment must first respond to the environmental conditions of the setting, including:

- elevation and climate;
- suitable vegetation;
- slope orientation or aspect;
- soil and geologic conditions;
- plant palate; and
- slopes and terraces.

Landscape Construction

Mike Banovich, CDOT Project Landscape Architect



Terrace and slope planting

Landscape plantings along Hoop Creek and Floral Park wetland mitigation area

During the design and construction of the Berthoud Pass landscape planting plan several innovative requirements were incorporated to enhance plant establishment. First, the design allowed for field layout of the planting material (native trees and shrubs). The contractor and the field landscape architect located plants to best fit site conditions. Planting the wall terraces was a concern of the contractor. Wall plantings favored deciduous trees and shrubs that could tolerate snow storage. Evergreen trees were reduced in areas where snow storage could impact the plantings. Methods of snow removal will also be evaluated over time and the affect removal has on plant material.

Second, trees were collected within 1000 feet of elevation to increase adaptation of the alpine environment. Lastly, a plant establishment incentive was included in the project budget and specifications. If the survival rate of trees and shrubs is achieved, the contractor will be awarded the incentive after the two-year period. During this period the contractor is responsible for plant survival and maintenance.

Plant list included in the incentive:

● Englemann spruce	2-6 ft. ht balled and burlaped (collected)
● Lodgepole pine	2-6 ft. ht balled and burlaped (collected)
● Aspen	1.5 inch caliper (collected)
● Common Juniper	5 gallon container
● Squaw current, Woods rose, Mountainlover, Alpine prickly currant	5 gallon container

Plants were installed during the 4.5-year construction period. The landscape contractor was paid to water the material during construction. During the two-year warranty period all provisions required to establish the material is provided and paid for by the contract if the plant incentive is awarded.

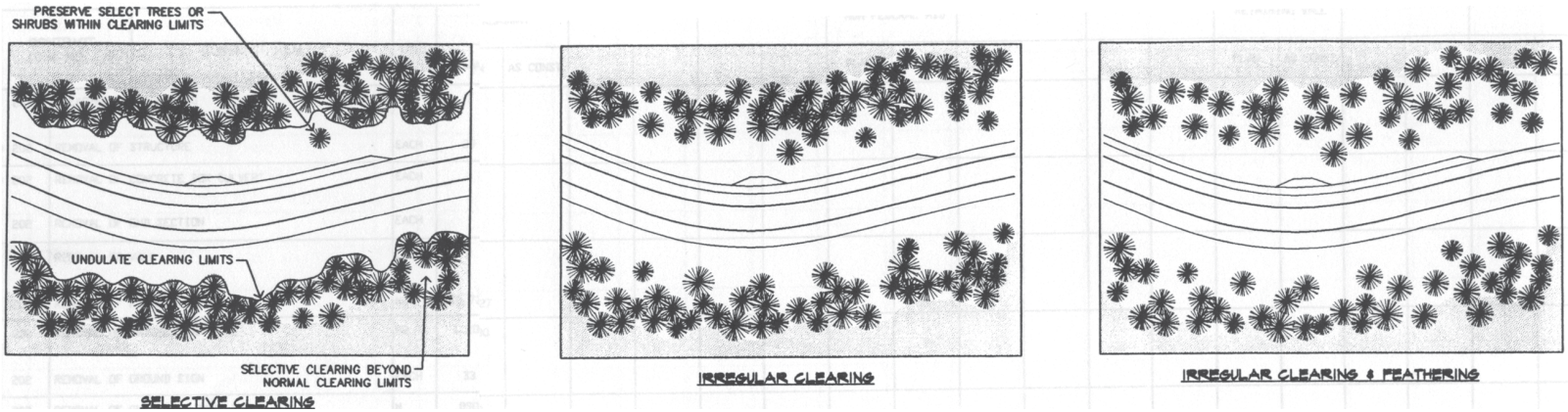
Implementation and Lessons Learned

An objective of the EA and the project was to utilize the lower bench for snow storage. This resulted in damage to vegetation from these maintenance activities and accumulation of sand. To resolve this issue, hardier plant species and modified maintenance procedures will be implemented to allow the plants to succeed. In the EA and design process, much consideration was given to the appropriate width of the terraces, to address the proportions of the walls to terraces, and to allow for planting on these terraces. However due to the difficulty of construction in the unconsolidated glacial till, maintaining appropriate wall width was difficult and terraces widths were diminished. This narrowed template has also been detrimental to plant survivability. To address this issue, on future construction phases the number of trees on terraces will be reduced and the number of shrubs will be increased.

Slopes, Grading and Selective Clearing

Another goal for the Berthoud Pass East project was to emulate natural topography by undulating cut lines to emphasize ridges and draws, and transitioning cut and fill slopes into the natural grade thereby avoiding harsh cuts and fills. All cut and fill slopes were blended with the surrounding terrain through slope rounding, layback and warping techniques. Slope rounding occurred at the top of all cuts, except in rock. Slope warping was used in order to attain a more natural-appearing transition between two unlike surfaces. Slope warping is a further refinement of slope blending and works to vary the pitch of the cut slopes. This involved slope rounding in both vertical and horizontal forms as a more natural extension of landform surface configurations. Additionally, boulders encountered while excavating slopes were either left in place or transported to alternate locations to assist with slope stability as well as add visual interest.

Prior to planting any new vegetation, selective thinning and clearing was implemented to emphasize natural vegetative patterns and avoid vertical vegetation wall or *tunnel effect*. Replanted areas (cut and fill slopes, terraces between retaining walls) were also planted to emphasize natural vegetation patterns.



Selective Clearing Techniques – Plan Views

Walls minimize impact to existing trees

WETLANDS

Kris Meiring, CDOT Wetland Biologist

Design

Early in the EA process wetlands were delineated as required by the COE guidelines. Wetlands were mapped utilizing color infrared aerial photos and field surveys. They were identified by type as required by FHWA. The total wetland area within the project corridor (800-meter width) was calculated by type. Wetland delineations were coordinated with appropriate state and federal agencies. Early coordination with the COE, Environmental Protection Agency (EPA), USFWS as well as the CDOW was essential to identify any agency concern well in advance and determine the least damaging alternative to the numerous water-related resources associated with this high mountain corridor

Once the wetland maps were complete, they were given to the design engineers to incorporate into their alternative analysis process. Biologists worked with design engineers and agency representatives during the alternative analysis phase to identify high value wetlands and avoid them during the development of the various alternatives.

After alternative selection, biologists, landscape architects, engineers and agency personnel worked together to further avoid and minimize impacts to wetlands associated with the preferred alternative as the site specific design progressed. The team always kept in mind that if a wetland could be avoided then wetland replacement would not be required; a strong incentive in an area where the majority of land was not flat. Everyone knew that wetland mitigation at this elevation would be a formidable task. High elevations, extreme winter temperatures and a greatly reduced growing season would make successful creation or restoration difficult at best. The wetland mapping must be incorporated into the design/bid plans early on to facilitate this process.

CDOT/FHWA had committed to replacing all wetlands on a one to one basis in the EA. Given the topography of the project area, replacement of all impacted wetlands on-site was not going to be easy. Colorado also has very strict water rights that limit where wetland mitigation can occur. During the EA/404 processes several potential wetland creation and restoration sites were identified in coordination with state and federal agencies. Sites were identified both within the project corridor and for some distance downstream of the confluence of Hoop Creek and the West Fork of Clear Creek.

During final design, engineers, landscape architects, and biologists worked together to determine the final wetland impacts. In cooperation with state and federal agencies, they then developed the wetland mitigation plans for inclusion in the bid plans. Flexibility was essential as this process progressed. Design changes meant less wetland impacts in some cases and more impacts in others. This resulted in three amendments, over a period of several years, to the 404 individual permit that was obtained at the end of the final design process. The water right issue made it impractical for CDOT to create or restore more wetlands than were impacted during

construction. Also, if ways to avoid or reduce impacts to wetlands during construction could be found, they were rewarded by a reduction in the amount required to be replaced.

Approximate Wetland Impacts and Mitigation for Phases I, II and III:

Construction Phase	Permanent Impacts	Temporary Impacts	Mitigation
I & II completed 2002	0.612	0.182	0.648 (0.1 preservation credit)
III	0.604	0.010	0.55
Total	1.2 acres	0.192 acres	1.2 acres

Wetland Construction Phases I & II

Floral Park/ Hoop Creek wetland mitigation and stream restoration

Wetland mitigation area planted with onsite transplant plugs and willow cuttings

Rock and geomembrane grade control in Hoop Creek

Creativity is an important factor in identifying wetland replacement sites. Sometimes it is important to *think outside the box* in order to find a suitable wetland mitigation site.

If a potential wetland mitigation site requires some excavation and it generates topsoil that the project needs, that results in the decreased cost of the wetland and a source of cheap topsoil for the project. In the case of Berthoud Pass, a portion of Hoop Creek ran right at the toe of the roadway fill at one location and was being negatively impacted by sediment and salt ladened run-off. The solution was to move the creek away from the road, which also gave us the opportunity to mitigate for riparian wetlands lost at other locales.

A landscape architect in the field closely supervised construction of wetland mitigation, stormwater management and erosion control, and restoration plantings with coordination from other environmental specialists and the project engineering staff. It was essential to make sure that construction was not left to those familiar only with roadway construction. Notes and plans that look perfectly understandable to a biologist or landscape architect may not be recognizable when constructed by someone whose margin for error may be measured in feet and not in inches, so critical to wetland hydrology.

The Berthoud Pass completed wetland mitigation sites are being monitored yearly in accordance with the 404 permit conditions. It is anticipated because of the high altitude and extremely short growing season, full success will take several years. After two years, progress is slow, but moving forward. Colorado's current drought situation was useful to construction for erosion control purposes, but did not benefit the wetland mitigation sites.

Because this project is being built in phases, there is opportunity to tinker with any wetland mitigation site that needs help under the next phase. The ability to come back and correct a grade elevation, stabilize a slope or replace dead plant material is extremely important to the success and rate of success of these wetland mitigation sites.

THREATENED AND ENDANGERED (T&E) SPECIES

Andrea Sever, CDOT T&E Biologist and Jerry Powell, T&E Specialist

Introduction

Environmental changes, either manmade or natural, can be the cause of population declines for animal and plant species. Every species fulfills a niche and is an integral part of the cycle of life. As one species declines, another will proliferate and grow. But the delicate balance of the ecosystem is dependent upon gradual changes. Manmade disturbances are often sudden and impose a drastic change on the surrounding environment and ecosystem.

As development grew and humans began to notice declines in specie populations, laws were enacted to help protect and ultimately aid in the recovery of declining species. The Endangered Species Act of 1973 (as amended) protects species listed by the USFWS as threatened or endangered.

Both the ESA and NEPA provided guidelines CDOT followed to ensure environmental issues were not overlooked during the planning and construction phases or impacted by the actions resulting from the Berthoud Pass Project.

Process and Coordination

The process for both informal and formal consultation between federal agencies and the acting agency regarding threatened and endangered species is defined in the ESA. It involves research to identify critical habitat, species presence, and level of disturbance created by the action, both short and long term. Field surveys are conducted to identify and document species and/or habitat presence within the corridor. If there is a threatened or endangered species, and/or its critical habitat is present, a Biological Assessment (BA) is prepared by the acting agency, or a consultant hired by the acting agency, and submitted to the USFWS. If the action is likely to adversely affect a listed species or its habitat, formal consultation is initiated. Formal consultation with the USFWS requires the service to formulate a Biological Opinion (BO) and incidental take statement.

In all instances, avoidance of critical habitat and the listed species is the preferred alternative. If a species cannot be avoided by project-related activity, it is necessary to mitigate these effects in the BA.

Species Information

Habitat

The Berthoud Pass Project is located in the ecoregion identified as the Southern Rocky Mountain Steppe – open woodland- coniferous forest – alpine meadow province of the dry domain (Bailey 1995). This ecoregion is characterized by annual temperatures ranging from 2° to 7° C (35° to 45° F), a considerable amount of precipitation is in the form of snow and can equal up to 102 cm (40 inches) per year (Bailey 1995). Vegetation changes with altitude, the project area lies between approximately 3,000 meters (9,850 feet) to 3,450 meters (11,315 feet) above mean sea level. Vegetation at and around the project area is characterized by a subalpine fir (*Abies lasiocarpa)*, Engelmann spruce (*Picea engelmanii*), lodgepole pine (*Pinus contorta*), aspen (*Populus tremuloides*), and upland willows (*salix* spp.) over story with a vaccinium (*Vaccinium* sps.) and grassland under story.

The native habitat in which the project area is located provides good to excellent montane and subalpine habitat for all species that would commonly use these habitat types. Habitat available in and around the project area includes riparian, river and forest (spruce/fir and lodgepole pine).

Species Occurrence

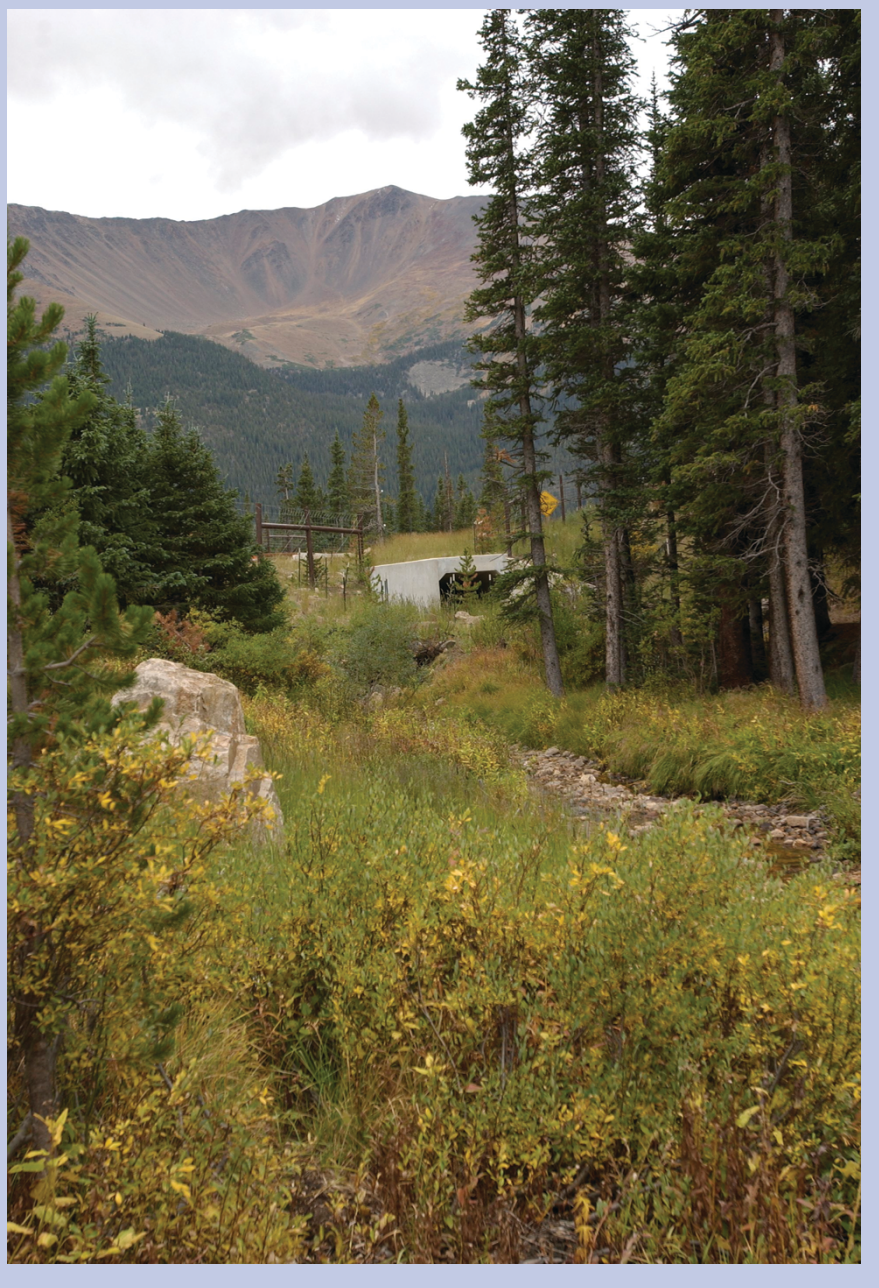
The Berthoud Pass project area is home to many species, two of which were identified in the BA as Federally listed species. The Bald Eagle (*Haliaeetus leucocephalus*) and the Canada Lynx (*Lynx canadensis*) are both Federally Threatened, occur in the area and require protection under the ESA.

Bald eagles inhabit coniferous and deciduous forests near rivers and streams. They nest in trees and cliffs and mostly feed on fish, carrion, waterfowl and prairie dogs. Some bald eagles do nest in Colorado but most migrate through the area. Marginally suitable habitat is present in the project area but migrating eagles are likely to pass over the area to more suitable nesting grounds. No bald eagles were observed in the area during field surveys and no historical nesting sites are known to be in either Gilpin or Grand Counties. On July 6, 1999, the USFWS proposed to remove the recovering bald eagle from the List of T&E species in the lower 48 states of the United States. Removal has not yet occurred. The project was found to have no affect on the bald eagle.

Historically, lynx occurred above 2,700 meters (9,000 feet) in the Park, Gore, San Juan, and La Plata Mountains, and the White River Plateau. Although the CDOW has no record of lynx within a three-mile radius of the project area, the southeast side of Berthoud Pass serves as a link between two large areas of relatively undisturbed, suitable lynx habitat (Indian Peaks and the

Williams Fork drainage). The willows in the project area are an important food source for the snowshoe hare (*Lepus americanus*), the lynx' primary prey. Lynx have been reintroduced to Colorado by CDOW during the winters of 1999 and 2000. It is important to the success of this reintroduction effort to maintain forested travel corridors between suitable lynx habitat in Colorado. The project introduces short-term effects to lynx in the form of noise and activity disturbance. Long-term effects include loss of habitat, loss of travel corridors, and habitat fragmentation. There is also a concern of increased mortality as a result of animal/vehicle collisions due to higher speeds and a wider highway. Measures were taken through mitigation to limit the impact this project has on the lynx.

The presence of listed species and the probability of impact to the lynx opened up formal consultation between CDOT, on behalf of FHWA, and the USFWS. Due to the habitat and the wildlife corridors that exist in the project area, the Berthoud Pass project area is important to many forms of wildlife. Deer, elk, and moose seasonal movements, as well as smaller species like fox, bobcat and coyote need to be considered when a barrier such as a highway is being expanded.



Animal crossing at Floral Park

Deer Fence

Mitigation

CDOT committed to a wide range of mitigation measures to reduce the environmental impact of the Berthoud Pass project. These measures are outlined in depth in the EA. General project mitigation measures include:

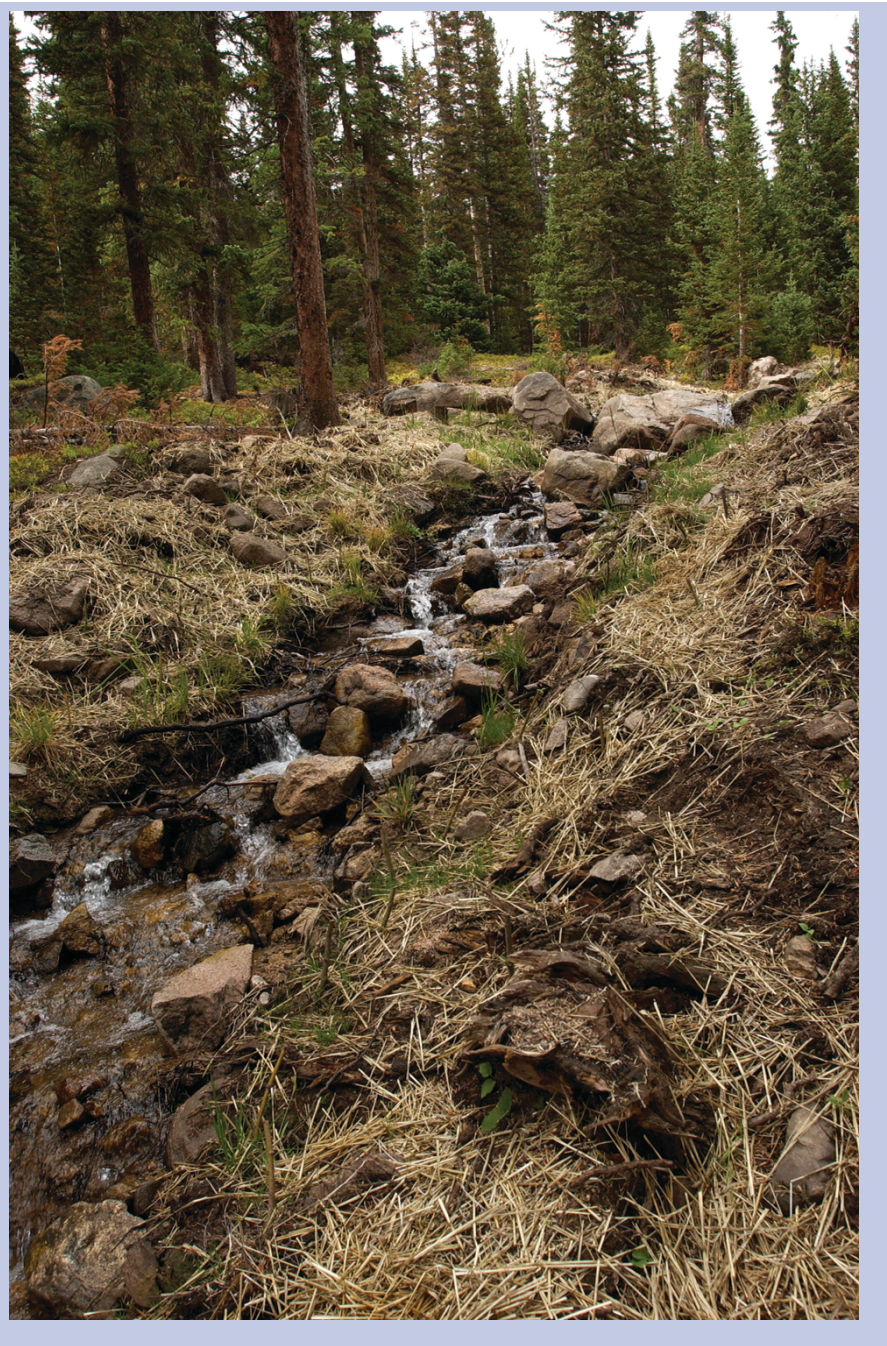
- Best Management Practices (BMP's) designed to limit erosion and lessen the impact to vegetation;
- wetland habitat conservation;
- requirements for construction vehicles to stay within the existing right-of-way (ROW) to limit impact to vegetation;
- use of salvaged trees and shrubs from the construction area;
- revegetation of all post-construction soil surfaces;
- use of native seed mixes for revegetation; and
- only trees acclimated to the elevation were used in revegetation.

These mitigation measures reduced the impact to habitats used by the bald eagle and the lynx. The BMP's also mitigated short-term impacts associated with construction.

Mitigation for long-term habitat fragmentation and direct mortality effects include required fencing to restrict highway access and three wildlife underpasses to maintain highway permeability. The most important factor to the success of an underpass is that it is placed in areas where wildlife typically cross the highway. Design is another aspect that influences the use of underpasses. Direct line of sight, a natural substrate floor, and fencing to prevent animals from crossing elsewhere are all desired in the ideal underpass. The three underpasses that were put in during the Berthoud Pass project utilize these features:

- placed at locations where wildlife is known to cross U.S. 40;
- are as open as topography and engineering constraints would allow;
- have good cover screening the approach on both sides of the road;
- are not a pathway for skiing, hiking, and other human activities; and
- do not also act as a stream channel.

Human presence and traffic is likely to be a deterrent to underpass usage by carnivores. It is largely unknown if underpasses can help reduce habitat fragmentation for wide-ranging carnivores. CDOT has committed to monitor the use of these underpasses for three years to rate their effectiveness and make modifications if needed.



Channel change Hoop Creek tributary

WATER QUALITY

Terri Tiehen, CDOT Region 1 Water Quality Specialist

The Hoop Ceek Basin

The Hoop Creek basin is a high elevation, subalpine basin that encompasses a relatively small drainage area of approximately 2.5 square miles. It ranges in elevation from over 13,000 feet to 9,600 feet. Hoop Creek begins just above the summit of Berthoud Pass and continues down though the basin, bisecting the alignment of U.S. 40 in several locations. The stream confluence's with the West Fork of Clear Creek, approximately five miles west of the town of Empire, Colorado. Hoop Creek and its tributaries are the primary surface waters in the vicinity of U.S. 40 and throughout the east side of Berthoud Pass.

These are high gradient streams, with the mainstem of Hoop Creek having an average channel slope of approximately 21 percent. Streamflow is seasonal with peak flows that occur during the spring snowmelt-runoff period from May to June. Increases in streamflow also result from summer thunderstorm events. Streamflow has been observed at the mouth of Hoop Creek to vary from less than 1 cubic feet per second (cfs) up to 73 cfs. Currently, there are no fish populations existing in Hoop Creek or any of its tributaries.

The Hoop Creek basin is located within the Upper Clear Creek Watershed. Protection of surface waters within the Upper Clear Creek Watershed is of prime importance to the many stakeholders that have an interest in maintaining and improving the water quality in the area. The watershed supplies drinking water to approximately 300,000 people in the Denver-metro area and is also utilized for a variety of industrial and agricultural purposes. Numerous efforts have been made in recent years by the stakeholders to address nonpoint and point sources from past mining activities, hazardous material spills, treatment plant discharges, sediment loading, and other land uses. CDOT is a stakeholder in the watershed and is committed to addressing highway-related water quality issues from past and current activities.

In keeping with this approach, CDOT undertook a data collection effort beginning in 1997 to obtain baseline data in anticipation of future construction activities along the U.S. 40 corridor. It was determined at the time that a long-term monitoring program would be needed to assess basin-wide water quality conditions. The monitoring program has been beneficial in assessing potential impacts to surface waters during construction activities and will ultimately be used to assess the overall effectiveness of the permanent Best Management Practices being implemented along the corridor.

The event-based water-monitoring program that has been implemented includes stream flow data and seasonal sampling at strategic locations along U.S. 40, using automated monitoring equipment to analyze storm event and snowmelt water runoff. Other sites along the highway are monitored on an as-needed or diagnostic observational, basis. These diagnostic sites are very useful in stormwater monitoring efforts, especially at highway outfalls. Water quality parameters include (or have included) conductivity, flow, temperature,

turbidity, bedload sediment sampling, totals suspended solids, phosphorus, sodium, chloride and heavy metals. The data is being collected and utilized for the following purposes:

- fulfill mitigation monitoring requirements in the EA;
- assess potential sedimentation impacts to the West Fork of Clear Creek and to downstream water users;
- distinguish between sedimentation from highway-related sand/salt runoff and other sources;
- provide hydrologic monitoring of the Horseshoe Bend Fen area;
- assess the overall effectiveness of erosion control BMPs during construction; and
- assess the long-term effectiveness of permanent erosion and sediment control BMPs.

Project Drainage Goals And Maintenance Practices

A primary object of the environmental studies was to address impacts from highway runoff and sanding operations. The constructed highway template was designed to contain 50-60 % of the traction sand, provide snow storage and collect traction sand via the construction of 12 sediment basins (5 miles of highway, phases 1-3). Furthermore, under drains and cross culverts prevented clean off-site drainage from mixing with highway surface drainage. CDOT was committed to protecting water quality during and after construction.

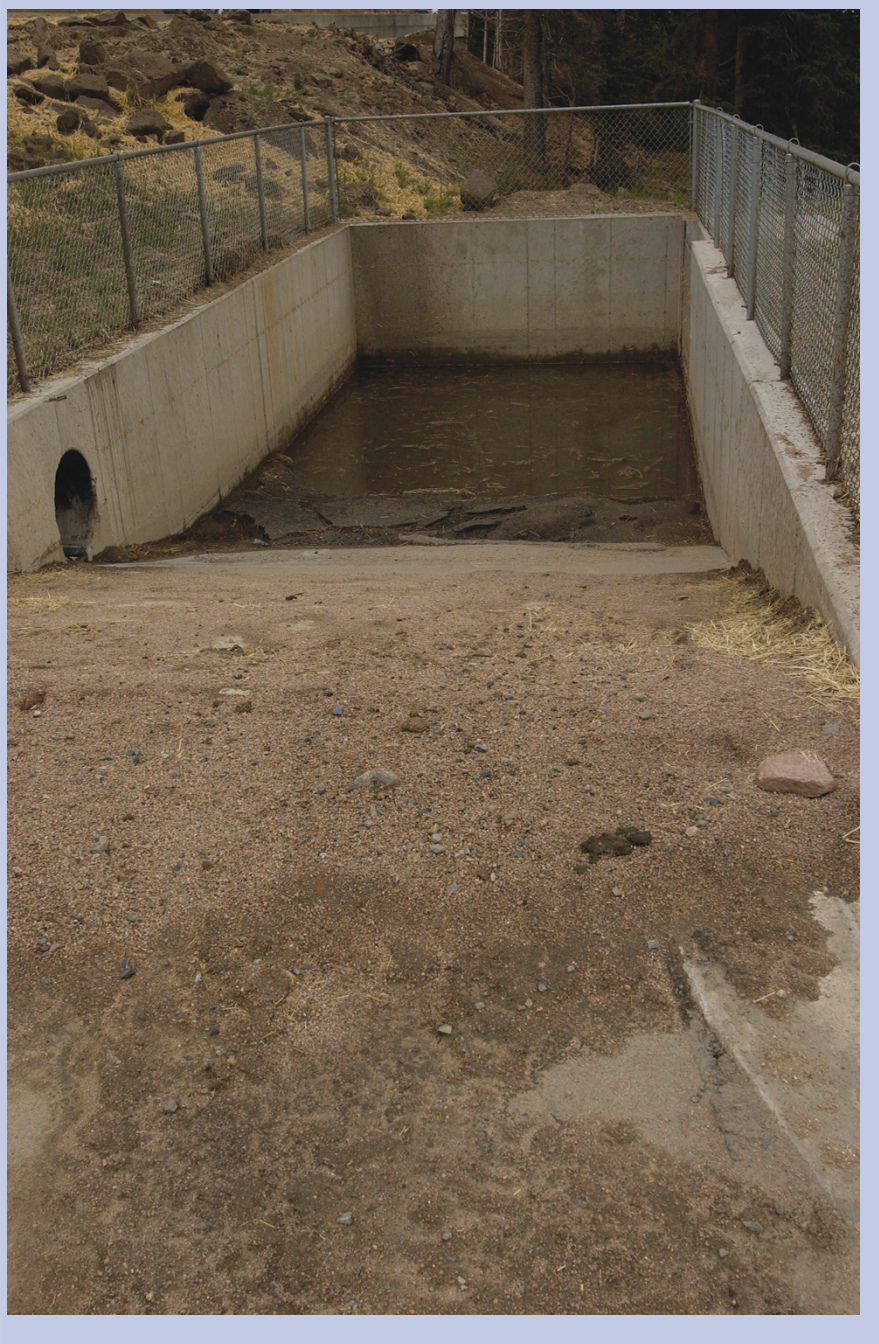
Winter maintenance of U.S. 40 includes snow removal and a sand/salt mixture used for safety purposes. Annual snow accumulation on Berthoud Pass can range from 130 inches to 600 inches in a given winter season. Approximately 3,000 to 4,000 tons of traction sand material are typically placed on the roadway to provide adequate traction for the traveling public. The sand mixture contains approximately a 5% salt content.

The combination of continuous erosion from exposed slopes and traction sand have been identified as contributing to the sediment loading of Hoop Creek and the West Fork of Clear Creek. It is anticipated that as a result of the roadway improvements, sediment loading from the highway corridor will be significantly reduced. Along with sediment and erosion control BMP's, maintenance BMP's are also being implemented along the corridor to ensure the effectiveness of the permanent BMP's. The maintenance MBPs include:

- specific snow storage zones;
- paved ditches;
- barrier or knee walls along cut slopes;
- routine sweeping operations;
- regular inspection and maintenance of culverts, rundowns and sediment basins;
- routine maintenance of roadside vegetation and slope erosion;

- training for maintenance personnel;
- Maintenance BMP Manual; and
- annual meeting of maintenance and environmental personnel.

The amount of sediment material being collected and removed from the sediment control structures and the roadway corridor is being tracked and will be monitored over time. These efforts will be correlated with the water quality monitoring data to evaluate the overall efficiency of the BMP program and ensure the long-term protection of the Hoop Creek basin.



Sediment Basin

Finished highway with snow storage and new template snow storage

EROSION AND SEDIMENTATION CONTROL

Mike Banovich, CDOT Project Landscape Architect

Meeting minutes discussing many drainage and water issues during early construction:

BERTHOUD PASS ENVIRO ISSUES:Thursday, August 05, 1999

Reviewed project with R-1 (CDOT Region 1) *hydraulic expert: Mr Mommandi- 8-3-99*

3+100 reconsider proposal to shift stream 20 meters rt of
Existing channel- check with USFS, Dames and Moore and Deb Angulski.
Work would require minimal structural changes and create More wetland.

Document where seeps and springs are currently flowing and add underdrian per plans

Floral park underdrain design of 150 mm needs to be sized for current
Seep flowing from toe below cut.

A diversion ditch needs to maintain adjacent to the floral park cut.
Contractor wall access did not compensate for clean water diversion
And water was diverted across road into hoop creek. Wes Goff agreed with
problem and proper diversion of water.

Floral park check structures will require geomembrane to achieve objective of raising ground water elevation.

New pipe at 5+850 is draining over triple future wall- consultant should address problem.

Wes stated to straighten rundown at 7+200 where landscape arch installed fancy bend in channel. Channel can be widened to
comp curve. Also need to excavate to box invert , stake wing walls and then tie in rundown into
Invert. Consider moving cbc up hill 4 meters. Upper wing wall will require Rip rap protection.
Propose to place topsoil over edge to channel and adjacent side slopes at 7+200.
In general, designers should address drainage issues so they can learn from their (our) mistakes…

Erosion Control and Drainage issues during construction:

The project review notes reveal the complexity of issues experienced during construction. Various water tables, porous material, steep terrain and alpine rainfall created a variety of challenges. The improved template provided sediment control, however the new drainage system did not become operational, even in part until 2001. Consequently clean water diversion, erosion control and water quality monitoring plans were addressed and revised throughout construction.
Best Practices which provided successful erosion control and water quality:

- on-site erosion control contractor supervisor;
- on-site CDOT engineer and landscape architect/erosion control specialist;
- constant project management of erosion and sediment control issues;
- reviews by CDOT drainage specialists;
- phased native seeding and mulching to stabilize project disturbances quickly;
- avoidance of existing vegetation adjacent to the work zone;
- increased effort to maintain good housekeeping;
- improved effort to handle materials and concrete washout;
- documentation of erosion control and sediment efforts.
- clean water diversion- preventing clean offsite water from mixing with on site water;
- the use of backhoe equipment hours to create best practices in the field;
- creating a template which ultimately recaptured 60-70% of the applied traction sand and protected the forest with 33 retaining walls; and
- commitment in the EA to implement a water quality plan.

Stormwater runoff

Fill wall construction with soil retention blanket below wall slope

Seeded fill slope- Primary Grass Species: Slender wheatgrass, Mountain brome, Sheep fescue, Alpine timothy

Aerial of phased seeding

If you can achieve your project goals and not remove a tree or disturb the ground, drainage or stream, then you can lessen environmental impacts. The avoidance and minimization principal was applied in the design and construction process prior to considering mitigation of impacts.

When it was determined that altering the environment was required, then mitigation design was implemented. The project team determined it would be beneficial for the roadway and the stream to move a 300-ft. reach of the Hoop Creek tributary. The result was a new reach cut into the forest with minimal impact to the terrain and forest.

During the construction of wetland mitigation at Floral Park, the project team determined that fewer check structures were needed for grade control in Hoop Creek and several large englemann spruce trees should be protected. The result was less on-site mitigation, 0.6 acres to 0.41 acres of mitigation, but preservation of forest and existing riparian was increased. The additional required mitigation was moved downstream on future projects.

Channel change at Lower Hoop Creek

THE SOCIAL AND ECONOMIC IMPACTS OF THE BERTHOUD PASS WIDENING PROJECT

Mairi Nelson, CDOT Public Relations

In 1999, CDOT began to widen three miles on the east side of Berthoud Pass. The construction took place over a mountain pass, which is the main route for residents and visitors to reach Grand County. There are no alternative routes comparable in time and distance for residents and tourists to use in traveling to Grand County.

The construction widened and improved a three-mile segment that had not seen major repairs since 1938. The two-lane road was as narrow as 25 feet in some places with no shoulders. Sharp curves and tight switchbacks characterized the three miles. The mountain abutted the road on one side and the other side was a steep drop off with no guardrail or shoulders. This configuration left one lane for the contractor's personnel and equipment and one lane for traffic.

Traffic volumes are significant over Berthoud Pass since it is a gateway to Winter Park Resort, which is the eighth largest destination ski resort in the United States as measured in skier visits. In summer, Berthoud Pass is the gateway to a multitude of recreational opportunities in Grand County, Winter Park Resort and Rocky Mountain National Park.

Traffic delays of 30 to 40 minutes were the result of this mix of large traffic volumes and one-lane traffic through a winding mountain pass. From April to November each year of construction, traffic delays were the norm. In 1999 and 2000, motorists also had to plan their trips around night closures of the pass that took place some weeks from Sunday through Thursday nights from 9:00 p.m. to 6:00 a.m. Drivers could pass through the construction project at 12:15 a.m. and 4:00 a.m. In addition, the winter of 2000-2001 saw night work on Berthoud Pass and traffic delays as the contractor pushed to complete the project in four years.

All of this had real and perceived impacts on the social and economic life of Grand County residents and tourists.

At the outset it must be said that the idea of the construction project was a positive one, especially for the business community. Berthoud Pass had a reputation as difficult to drive and did scare some from considering Grand County as a tourist or ski destination. It was the reality of the construction, with its traffic delays and combination of dirt and equipment everywhere that caused frustration and stress to the business community.

Added to that were other troubling issues. The construction started as Colorado began experiencing severe drought with low snowfall. The situation presented a dilemma. The ski resort and business community wanted their road open for skiers, while CDOT and its contractor needed every day of good weather to make progress on a highly complex and difficult construction project.

By the end of the first year, the construction project was viewed as an obstacle to getting tourists who supported local businesses to Grand County. It was also clear that residents and tourists would have to adjust their travel plans significantly, adding at least an hour to roundtrips over Berthoud Pass. Most people did not have an extra hour in their day to allocate to sitting in traffic. The construction project was changing how people budgeted their time.

This was the scenario during the four years of construction. CDOT did its best to mitigate the impacts by stepping up its communication efforts with Grand County residents, businesses, elected officials and the media. It started by assigning an employee from CDOT's Public Relations Office to serve as a liaison between the project and the community. CDOT also provided a budget to support a public information campaign about the project, and hired a Grand County design firm to do the work.

These efforts gave the public new sources for information: the liaison, stories in the media, displays in public offices and businesses about the project, and a website were now available. Slowly, these efforts changed conversations from focussing entirely on the drawbacks of construction, to discussion about the future benefits of this major improvement to Berthoud Pass.

Local newspaper reporters continued to interview businesses about the economic impact of the construction and the responses were varied. Overall, most business leaders saw the impact as one problem among several affecting Grand County. Poor snowfall, a weakened national economy and a publicly-owned ski resort that could not invest in the same manner as privately- owned resorts were blamed, along with traffic delays on Berthoud Pass.

The greatest social and economic impacts from the widening of the east side of Berthoud Pass will be felt in the future. Grand County and other northwestern Colorado communities are poised to benefit from a safer, modern mountain highway serving as a gateway to incredible beauty and recreational opportunities for residents and visitors alike.

The CDOT team, contractors, local elected officials and business leaders at opening ceremonies

CONSTRUCTION ENGINEER PERSPECTIVE

Brian Gilbert, CDOT Project Engineer

Prelude: In 1998 I was assigned the NH0403-026 Berthoud Falls -West construction Project. In the spring of 1999 we went to work on a mountain pass with project elevations as high as 10,974 ft. It was with much enthusiasm and a great sense of duty to the Department that I accepted this assignment. Tools to work with: A crew of inexperienced consultant inspectors, a new hired CDOT assistant, a prime contractor with no experience as a prime contractor on a CDOT project, and a new, but dedicated Resident Engineer thrown into the fray midway into the project.

October 2002: four years and many gray hairs later this monster is nearing completion. Work was performed late into many an evening and frequently overnight. Weekends were not sacred, as many of those were consumed working on this pass.

Weather conditions were at times best described as bitter. Cold, wet and muddy was a common theme through much of the duration of the work.

The prime contractor, subcontractors and CDOT endured the challenge, worked through many a changed condition, resolved problems, redesigned as required to stay the course, and come to a completion of a finished product that is a much improved travel way not only from a safety standpoint but also from an environmental perspective.

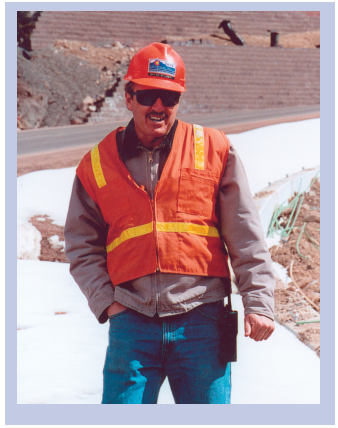
Those of us who lived this ordeal on a daily basis could tell a story about some difficulty experienced with every inch of this roadway on the project.

Through the course of this project, people would tell me what a difference they are witnessing as they come to the Pass periodically. I have to step back to realize how our daily presence has made a difference up here.

As we hurried to wrap this project up and perform the final plantings, roadway striping, delineator installation, etc., the project suddenly has taken on an appearance that gives me a sense of accomplishment that perhaps we hadn't seen until so very near the completion.

I have only now felt I could take a deep breath, stand back and appreciate the vision the design team accomplished in the set of plans they developed.

Conclusion: I am proud of what was accomplished here and everyone should be encouraged by a project such as this. CDOT was able to come to an environmentally sensitive area, upgrade a narrow two lane, virtually shoulderless highway to three lanes with shoulders, and leave with a sense the environment and the traveling public are both winners.



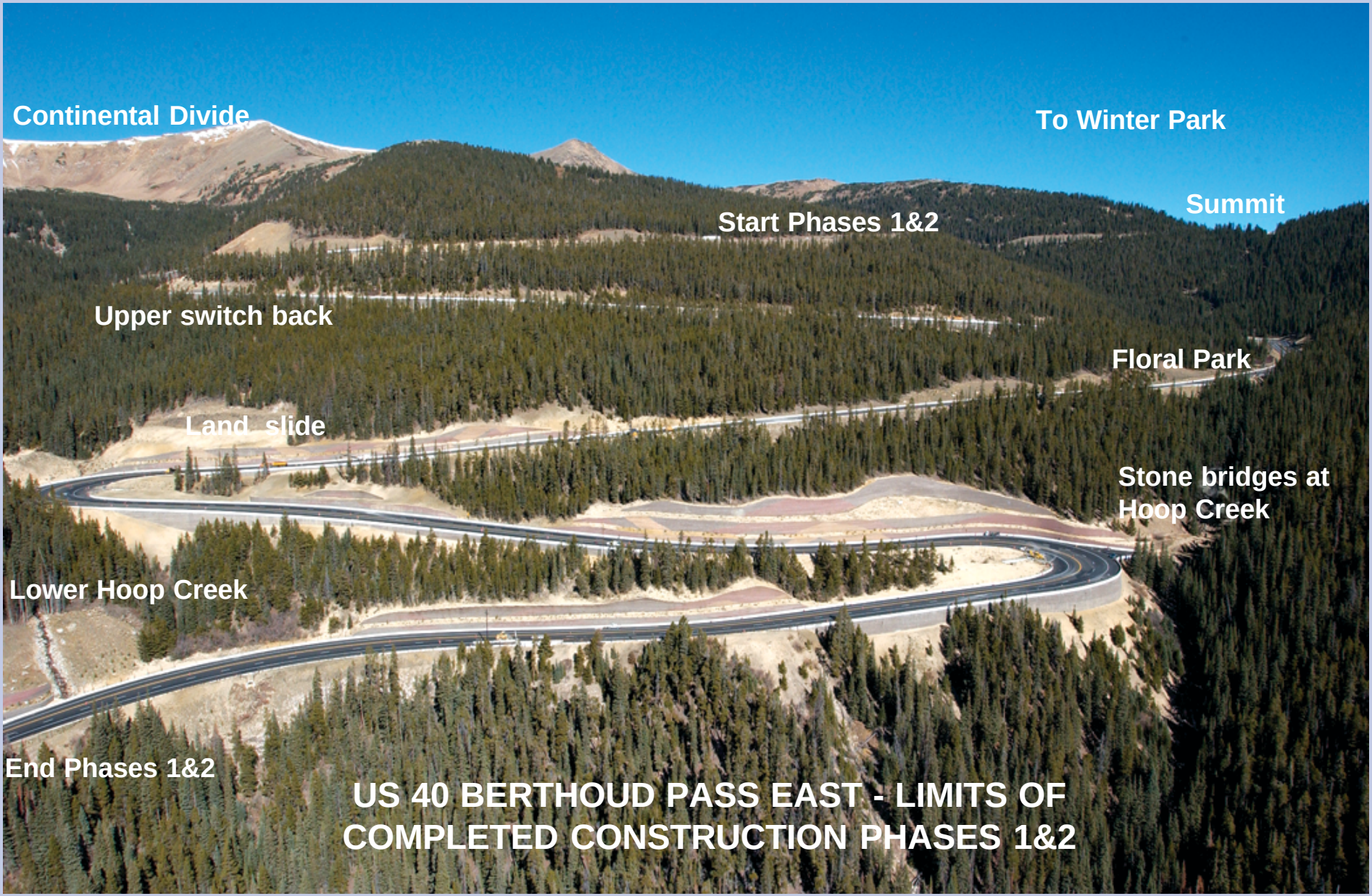
Brian Gilbert

CONCLUSION

Future Phases and Project Goals

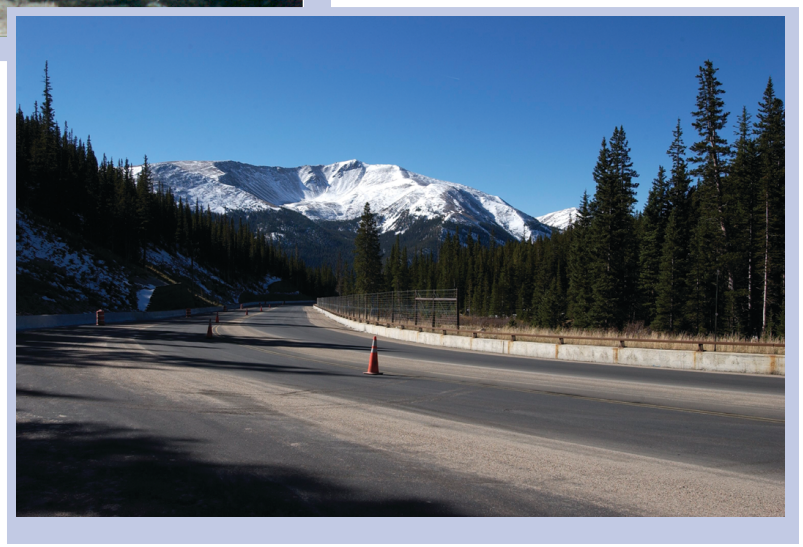
The many lessons learned during construction of Phases I & II Berthoud Pass will be applied to Phase III, the lower segment of the environmental study area. CDOT will partner with the federal agencies (USFS, USDOT, USFWS, EPA, COE) and continue to focus on the needs of the corridor environment.
Phase 3 has been designed and is awaiting funding.
Main environmental objectives:

- install underdrains throughout project;
- continue the review process and coordination with the USFS and regulatory agencies;
- adhere to the commitments in the Environmental Assessment;
- construct a large wildlife crossing (12 ft arch culvert);
- replace wetland impacts at a 1:1 ratio;
- shift the alignment to favor construction of MSE walls and avoid cutting into the unstable cut side of the mountain;
- address Stanley Avalanche Slide Path with possible drift fence construction;
- maintain a constant awareness of project environmental goals and adapt to changes in the field;
- maintain constant communication with CDOT and Consultant Environmental and Design Support; and
- respect the environment and appreciate the beauty of the Colorado Rocky Mountains.



US 40 BERTHOUD PASS EAST - LIMITS OF COMPLETED CONSTRUCTION PHASES 1&2

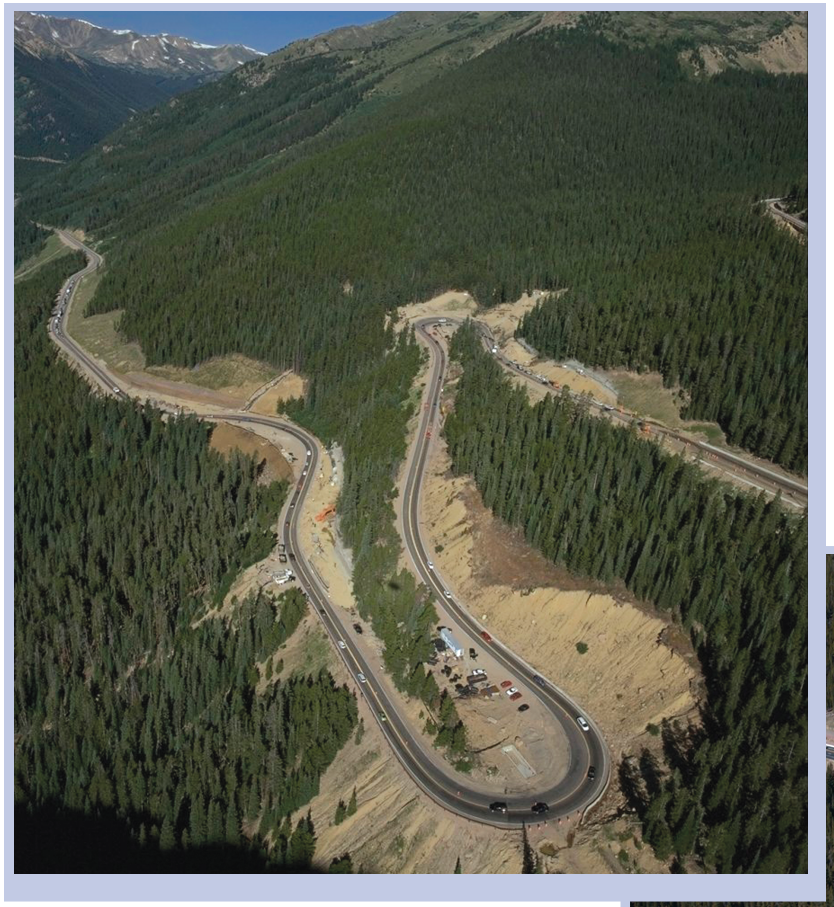
Before proposed snow storage



After

Floral Park

Stone Bridges switchback in foreground



Before

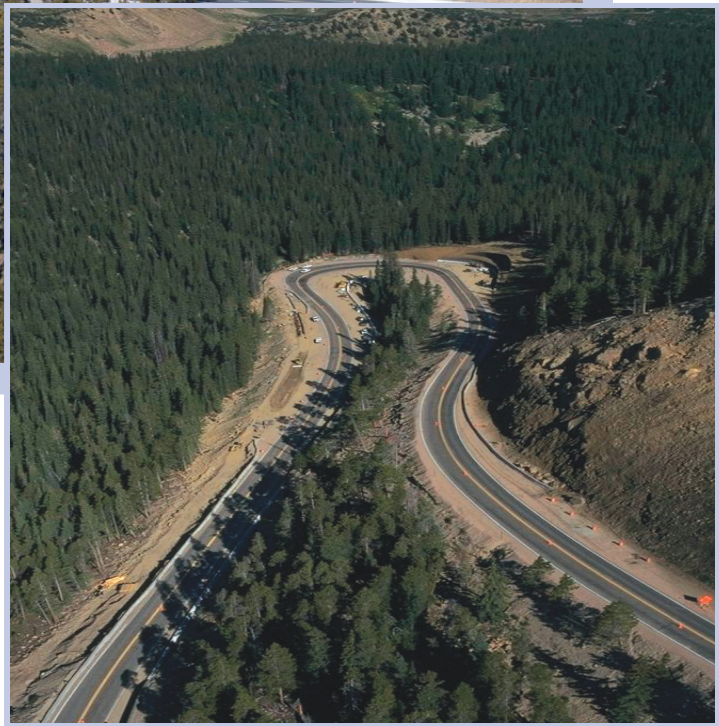
After

Before

After

Triple wall at Stone Bridge switchback

After



Before

Upper Switchback and Narrows

with 22-ft. pavement width before construction and a 66-ft template with climbing lane and snow storage after construction.

From an 1874 stagecoach and wagon road to a modern mountain highway, Berthoud Pass now serves as a stuning gateway to northwestern Colorado.

DOT
DEPARTMENT OF TRANSPORTATION