

Historic Context

Glenwood Canyon Segment of Interstate Highway 70

Prepared for

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Table of Contents

| | Page |
|---|-----------|
| Summary Statement | 1 |
| 1. Background History | 5 |
| A. Early travel near Glenwood Canyon, 1850-1889 | 5 |
| B. Early road development in Glenwood Canyon, 1890 – 1925..... | 6 |
| C. The U.S. Highway era in Colorado, 1926-1955..... | 8 |
| 2. Beginnings of the Interstate Highway System in Colorado, 1956-1959 | 11 |
| A. Development of a National Interstate Highway System | 11 |
| B. Evolution of the I-70 route in Colorado | 11 |
| (1) Envisioning the route of I-70 across the Rockies and western Colorado | 11 |
| 3. Rise of Environmentalism, New Regulations, and the Vail Pass Precedent, 1960-1973 | 13 |
| A. The rise of environmentalism and its impact on Interstate Highway planning | 13 |
| B. Environmentalism, recreation, and tourism in Colorado..... | 14 |
| C. The Red Buffalo controversy | 15 |
| D. Early planning for Glenwood Canyon | 17 |
| E. The National Environmental Policy Act and its impact on Interstate Highway planning and design | 19 |
| F. The CDOH and early environmental considerations in Colorado | 20 |
| (1) The Vail Pass precedent | 21 |
| 4. Planning I-70 through Glenwood Canyon, 1970-1979 | 23 |
| A. Choosing the route | 23 |
| B. Preliminary design concepts..... | 24 |
| C. Opposition and proposed scenic corridor designation | 28 |
| D. Final design phase | 30 |
| 5. Significant Design, Engineering, and Management Innovations, 1980-1992 | 33 |
| A. Logistical planning for construction | 33 |
| B. Sensitive landscape implementation measures | 34 |
| C. Bridge design..... | 36 |
| (1) Substructure design in Glenwood Canyon..... | 38 |

Table of Contents

- (2) Superstructure design in Glenwood Canyon 39
- (3) Steel box girders 40
- (4) Welded steel girders 42
- (5) Concrete box girders..... 43
- D. Terraced roadway..... 47
- E. Tunnels 50
- F. Retaining walls and erosion control..... 53
- G. Recreational amenities 57
- H. Awards 59
- I. Conclusion 59
- 6. National Register of Historic Places Evaluation 61**
 - A. Boundary description and location 61
 - B. General description/location 61
 - C. Summary of historic district and associated property types within the district 61
 - D. Area(s) of significance 62
 - E. Period of significance 62
 - F. Statement of significance 62
 - G. Condition/modifications 65
 - H. Statement of historic integrity related to significance 66
- Bibliography..... 68**

Tables

- 1 Bridges built between mileposts 118.5 and 130.3 35

Summary Statement

The Glenwood Canyon segment of Interstate Highway 70 (I-70) represents an important part of the history and development of the Interstate Highway System through Colorado. Design and planning for the Interstate Highway occurred during a time of increasing environmental awareness and focus on conservation issues. Additionally, this segment of highway was the final link in Colorado's Interstate Highway System and the last segment of interstate widened from two to four lanes. The final design and engineering of the highway, bridges, retaining walls, recreational amenities, and surroundings, achieved through the integration of landscape architecture principles, resulted in an innovative highway that complemented its natural surroundings and enabled and enhanced outdoor recreational opportunities within Glenwood Canyon. By the 1870s mines in the vicinity of Glenwood Canyon produced large amounts of silver but limited transportation routes in and around the canyon hindered shipping and large-scale expansion of mining operations. A railroad through Glenwood Canyon was completed in 1887, and in 1902 the Taylor State Road was built through the canyon. These early construction projects included blasting portions of canyon walls using dynamite and pushing fragments into the river to build up embankments. Taylor State Road was improved several times between 1913 and 1935 and renamed U.S. Highway (US) 24 in 1936. In 1940 US 6 was rerouted over Vail Pass and extended through the canyon. Discussions about a national Interstate Highway System were underway by this time and the portion between Denver and Utah was completed in various segments, including the Vail Pass segment of I-70 between 1973 and 1978. Planning for the Glenwood Canyon segment of I-70 began in 1960. New legislation and a growing environmental movement led to a robust planning and public involvement effort by Colorado highway officials that lasted nearly two decades. Construction of I-70 through Glenwood Canyon began in 1980 and was completed in 1992. The historic context that follows provides a brief overview of road development in Colorado and highlights the important events and developments related to the design and construction of I-70 through Glenwood Canyon, the final link in the I-70 corridor across Colorado. This highway represents an important balance between engineering and environmental concerns that led to unique highway design solutions that accounted for conservation, transportation, ecology, and recreational opportunities within the canyon.

I-70 extends in an east-west direction across Colorado. From Kansas the highway crosses Colorado's eastern plains, extends through Denver, then enters the foothills and winds its way through valleys and over mountain passes and through Glenwood Canyon on its way to the Utah border. The Glenwood Canyon segment of I-70 is 11.8 miles long. Figure 1 on the next page illustrates the location of Glenwood Canyon and other pertinent landforms and features.

The historic property boundary defined for the segment reflects the location of structures, objects, and buildings associated with the historic significance of the Glenwood Canyon corridor. The boundary is defined as the current I-70 right-of-way, which includes a large portion of the Colorado River, beginning at milepost (MP) 118.5 east of Glenwood Springs and ending at MP 130.3. The boundary is expanded beyond the right-of-way to incorporate the Glenwood Canyon Bike Path and four rest areas associated with the design of the highway segment but are outside of the current right-of-way.

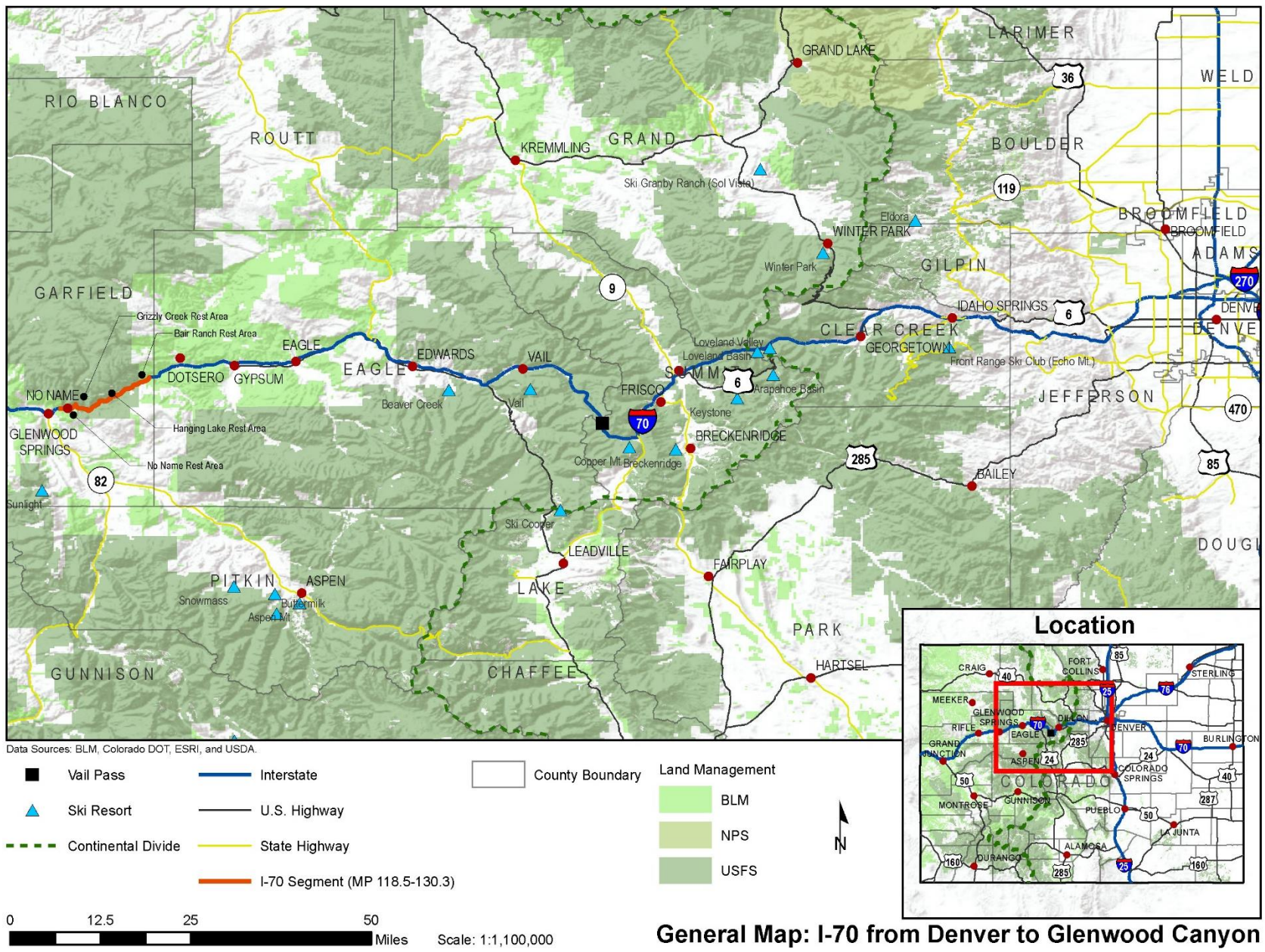
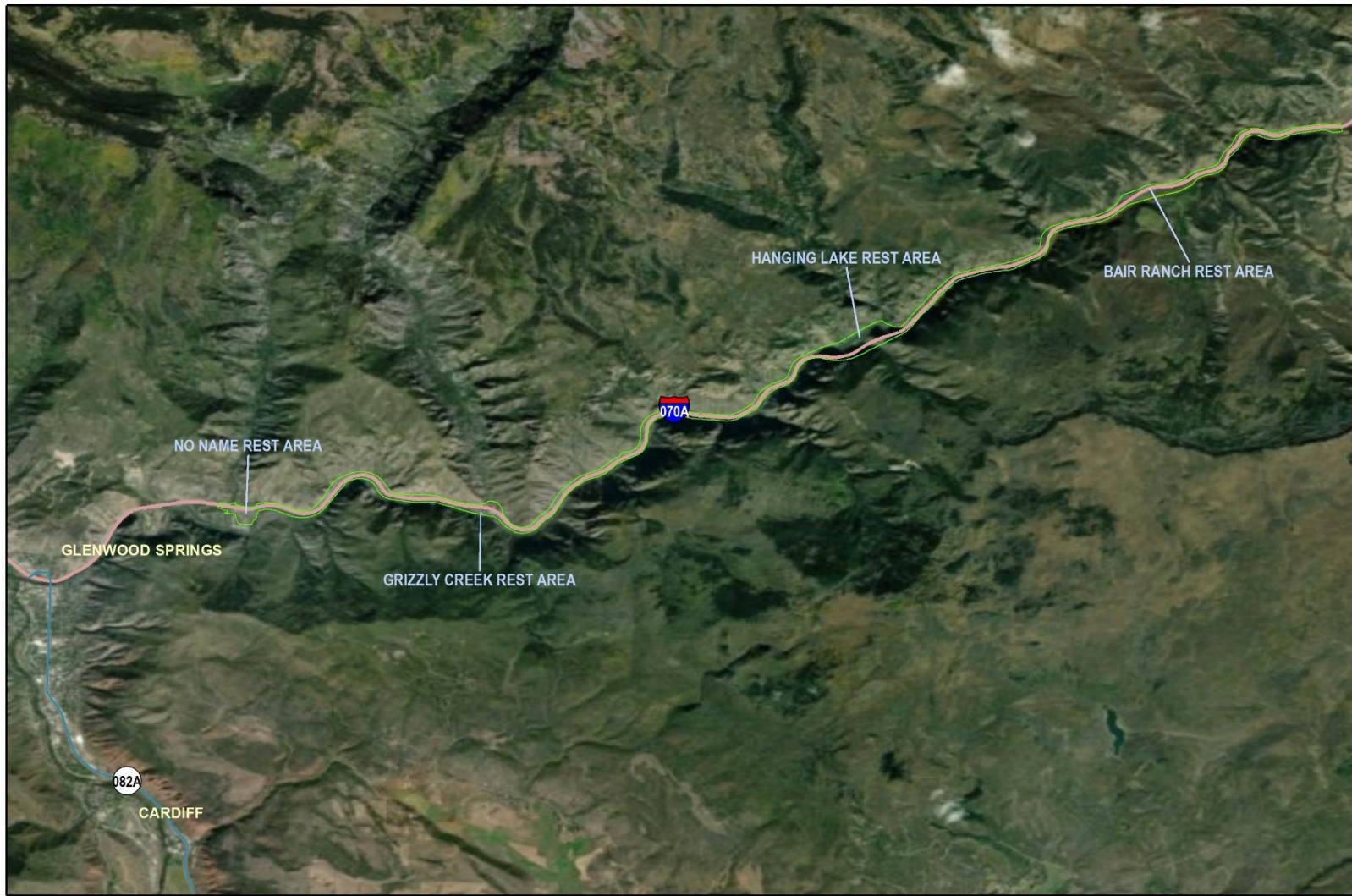


Figure 1. Overview map of the Glenwood Canyon segment of I-70.



Data Sources: BLM, Colorado DOT, ESRI, and USDA.

Scale: 1:100,000 0 1 2 4 Miles

 Glenwood Canyon I-70 Historic Resource Boundary (5GF5099)

 **Glenwood Canyon I-70 Corridor**

Figure 1A. Overview map of the Glenwood Canyon segment of I-70.

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1. Background History

A. Early travel near Glenwood Canyon, 1850-1889

The 12.5-mile Glenwood Canyon was formed by the Colorado River, which flows southwest from Dotsero to its confluence with the Roaring Fork River in Glenwood Springs.¹ By the mid-nineteenth century the flow of the Colorado River (then named the Grand River) extended across most of the canyon floor between steep rock walls with little room for human passage. These conditions made travel through the canyon difficult. The area's early human inhabitants, the Utes, viewed the canyon as a barrier that impeded travel. There is little evidence indicating the Utes or any other Native American tribes used the canyon as a transportation route.²

In the late 1850s prospectors in search of gold and silver deposits led expeditions westward across the Rocky Mountains. By the 1870s several major mining sites had been established within the Roaring Fork Valley near Glenwood Canyon, such as Aspen and Carbondale. Although mines in the Roaring Fork Valley produced a significant amount of silver, the high cost of supplies and limited transportation routes made shipping all but the highest-grade ore economically unviable. Due to these conditions the Glenwood Canyon and Roaring Fork Valley area remained isolated, with few inhabitants in the 1870s and early 1880s. Euro-American settlement in Glenwood Springs began in the late 1870s after James Landis and his family established a homestead west in the area. Landis's land holdings included hot springs near the western opening of Glenwood Canyon. The hot springs had long been used by the Ute Indian and were believed by many to possess healing properties. In 1882 Capt. Isaac Cooper purchased the portion of Landis's land containing the hot springs with the vision of turning the area into a health spa and resort for tourists. Over the next three years a small community developed near the hot springs that contained a collection of temporary structures inhabited by mining prospectors and ranchers who relied on supplies coming from Denver over the mountains. The community was originally named Defiance, but after an election in August 1885 that favored incorporation, the town was renamed Glenwood Springs. Travelers to the area either crossed the Flat Tops north of Glenwood Canyon or utilized one of several stagecoach lines south of the canyon, between Glenwood Springs and Aspen.³

Demand for a direct route to Glenwood Springs increased as the area's mining and tourism industries expanded. Geographically, Glenwood Canyon had the most direct route between Denver and Glenwood Springs, but was not passable. In 1874 a federally funded geological survey team called the Hayden Survey claimed Glenwood Canyon was "impassable to travel," citing the steep canyon walls and dangerous river rapids.⁴ Additionally, surrounding mountainous terrain offered few alternative routes.

¹ Ryan Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon" (Undergraduate Honors Thesis, University of Colorado Boulder, 2013), 14, https://scholar.colorado.edu/honr_theses/472.

² Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 16–17.

³ Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 18–21; Cynthia Hines, *Early Glenwood Springs* (Charleston, S.C.: Arcadia Publishing, 2015), 7, 16.

⁴ Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 22.

The first plan to build a railroad through Glenwood Canyon came in the mid-1880s, when surveyors for the Burlington-Northern Railroad mapped a route on the north side of the Colorado River; the route was never built.⁵ An 1886 silver boom near Aspen led to a race between the Denver and Rio Grande Railroad (D&RG) and the Colorado Midland (CM) to build the first line connecting Denver to Aspen.⁶ In 1887 the CM finished a line from Colorado Springs to Leadville and continued to build west toward Basalt; the CM eventually reached Aspen from the south. During that same year the D&RG, which already had a line from Denver to Leadville, chose to build west along the Eagle River between Red Cliff and Dotsero then along the Colorado River through Glenwood Canyon to Glenwood Springs, which could then connect to Aspen from the north.⁷ The D&RG blasted sections of the canyon's south walls to make room for the railroad line.⁸ The new railroad segment included three tunnels totaling 1,700 feet, and the railbed was constructed of crushed rock laid along the south side of the river.⁹ With the help of Mexican and Chinese laborers, Italian stonemasons also constructed retaining walls of dry-laid stone under and adjacent to the tracks at select locations throughout the canyon.¹⁰ The D&RG completed the canyon segment and the first train arrived in Glenwood Springs along the new route on October 5, 1887.¹¹

B. Early road development in Glenwood Canyon, 1890 – 1925

By the 1890s roads throughout Colorado and the nation were in poor condition and the “Good Roads Movement” emerged in response to the need for a more passable and connected road network. In 1899 Colorado State Senator Edward T. Taylor secured a \$40,000 appropriation to build a wagon road from Denver to Grand Junction; this road included a new road through Glenwood Canyon that was eventually named the Taylor State Road. The road was completed in 1902 at a total cost of \$60,000; over half of the total project cost was spent on the canyon road alone. During construction, portions of the canyon walls were blasted with dynamite and the resulting rock fragments were pushed into the river to build up a roadbed that carried one gravel lane along its north side. Dynamite blasting undoubtedly altered the canyon's natural physical features; however, some concern for the canyon's aesthetic qualities was evident in the original plans for the road, which directed workers to avoid disturbing trees and shrubs when possible. After its completion, roadside advertisements were banned throughout the Glenwood Canyon segment of the Taylor State Road, presumably to avoid distracting from the natural environment. The completed trail was used by freighters and stagecoaches. However, threat of floods, rock slides, and

⁵ Heather McGregor, *A Guide to Glenwood Canyon* (Glenwood Springs, Colo.: Pika Publishing Co., 1993), 30.

⁶ National Register of Historic Places, Multiple Property Documentation Form, “Railroads in Colorado, 1858-1948” (Statewide, Colorado, n.d.), E-41.

⁷ Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 22; “D&RG / D&RGW Aspen Branch History,” *DRGW.Net*, 2011, <http://www.drgw.net/info/AspenBranch>.

⁸ Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 22.

⁹ McGregor, *A Guide to Glenwood Canyon*, 30.

¹⁰ Jim Nelson, *Glenwood Springs: A Quick History Including Glenwood Canyon* (Fort Collins, Colo.: First Light Publishing, 1998), 96.

¹¹ Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 23; John L. Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey* (Greeley, Colo.: Canyon Communications, 1994), 50; “D&RG / D&RGW Aspen Branch History.”

snow earned Glenwood Canyon the reputation as one of the most dangerous routes for travelers in Colorado.¹²

The mass production of automobiles beginning in 1901 and their distribution throughout the country meant Taylor State Road would not remain a wagon trail for long. The advent of the automobile further bolstered public demand for better roads and put pressure on the government to assist in road construction and maintenance.¹³ Reflecting national trends, the citizens of Garfield County began to advocate for improved roads in the area, including the Taylor State Road through Glenwood Canyon.¹⁴ The Colorado State Highway Commission (Commission) was established by the state legislature in 1909 and three individuals—Charles P. Allen of Denver representing the Front Range, Thomas Tully of Durango representing western Colorado, and W.H. Wiley of Holly representing the eastern plains—were appointed as commissioners and took their posts on January 1, 1910. Later that spring and summer the commissioners set off on road trip across Colorado to interact with people across the state to build support for and gauge public interest in establishing a State Highway network; they also identified potential routes along the way. After returning, they mapped out Colorado’s first road system and by years end had designated 1,600 miles of State Highways. Initiatives by the Commission proceeded with road building, bridge replacement, and uniform sign installation activities.¹⁵ In 1913, the state appropriated \$75,000 to improve the Taylor State Road and one year later it was designated part of the Pikes Peak Ocean-to-Ocean Highway.¹⁶ Convict labor completed needed improvements, which included blasting additional portions of the canyon’s north walls to obtain crushed rock for widening the road to two lanes. Traffic increased in the canyon; many motorists were auto-tourists taking advantage of the scenic and recreational opportunities provided by the canyon and nearby Glenwood Springs.

Progress toward establishing road-related agencies and legislation continued throughout the first decades of the twentieth century. In 1915 the Office of Public Roads changed its name to the Bureau of Public Roads (BPR), which was the predecessor to the Federal Highway Administration (FHWA). In 1916 the U.S. Congress passed the Federal-Aid Road Act, committing the federal government to funding highway construction and requiring states utilizing federal funds to set up commissions or departments to oversee highway construction activities. As a result, the Commission was reorganized as the State Highway Department in 1917 and began building and improving mountain pass roads, starting with the 27.5-mile Monarch Pass between 1919 and 1922 and followed by improvements to the Million Dollar Highway in

¹² Nelson, *Glenwood Springs: A Quick History Including Glenwood Canyon*, 97–99; Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 30–31.

¹³ Colorado Department of Transportation, *100 Years of Colorado State Transportation History* (Denver: Colorado Department of Transportation Public Relations, 2010), 12.

¹⁴ Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 32–34.

¹⁵ National Register of Historic Places, Multiple Property Documentation Form, “Historic and Architectural Resources of the Lincoln Highway in Nebraska,” Statewide, Nebraska, Section E, Page 2; Colorado Department of Transportation, *100 Years of Colorado State Transportation History*, 13–15, 109; Associated Cultural Resource Experts and Deborah Dobson-Brown, “Colorado State Roads and Highways” (National Register of Historic Places Multiple Property Submission, 2003), E27–28, http://www.historycolorado.org/sites/default/files/files/OAHP/crforms_edumat/pdfs/645.pdf; “FHWA History,” *Federal Highway Administration, U.S. Department of Transportation*, September 12, 2012, <https://www.fhwa.dot.gov/about/>.

¹⁶ Nelson, *Glenwood Springs: A Quick History Including Glenwood Canyon*, 103.

the San Juan Mountains between 1921 and 1924 and Mount Evans Road just three years later. These roads enabled further automobile tourism by providing more reliable access to some of Colorado's most spectacular scenic areas.¹⁷

C. The U.S. Highway era in Colorado, 1926-1955

In 1926 the American Association of State Highway Officials (AASHO) and the BPR designated a U.S. Highway System by assigning numbers to highways, many of them previously named highways, across the country. The goal of the new system was to connect major roads throughout the nation to better facilitate travel. Despite the new national highway system, no direct route from Denver to Utah existed throughout the late 1920s and early 1930s; the path of roads was dictated by the terrain and generally wound in and around mountain ranges and valleys within the Rocky Mountains.

Senator Edward Taylor continued to advocate for improvements to the route through Glenwood Canyon into the 1930s and was able to secure federal funding from the Works Progress Administration (WPA), a New Deal work-relief program that contributed to road-building projects throughout the United States and Colorado during the Great Depression.¹⁸ Taylor State Road was renamed US 24 in 1936, and through 1938 WPA crews blasted away more of the canyon walls and widened the highway again by dumping debris into the Colorado River.¹⁹ The road was widened to 29 feet, with 25 feet of pavement and 2-foot gravel shoulders on each side.²⁰ Over \$1.1 million was spent on the improvements to the Glenwood Canyon segment and the route reopened in August 1938 as a co-signed segment of US 6 and US 24, both of which extended from Leadville through Glenwood Canyon to Grand Junction.²¹

The increasing demand for more direct road access to destinations throughout Colorado resulted in several important developments between 1940 and the mid-1950s. In 1940 US 6 was rerouted over a mountain pass between Frisco and Eagle, in Summit and Eagle Counties, respectively, and provided a more direct route between Denver and Eagle; the previous route further to the south traveled through Climax, Leadville, and Minturn. The pass was named Vail Pass after State Highway Engineer Charles Vail, who served as director of the State Highway Department between 1930 and 1945.²² By the mid-1940s Colorado had 12,394 miles of official State Highways, and the booming post-World War II (postwar) consumer economy meant an increasingly high number of automobiles traveling on the state's

¹⁷ Associated Cultural Resource Experts and Dobson-Brown, "Colorado State Roads and Highways," E29-32; Colorado Department of Transportation, *100 Years of Colorado State Transportation History*, 18-20; Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System* (Prepared for the Colorado Department of Transportation, April 24, 2002), 5.26-5.27; "FHWA History."

¹⁸ Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 34; McGregor, *A Guide to Glenwood Canyon*, 31.

¹⁹ Associated Cultural Resource Experts and Dobson-Brown, "Colorado State Roads and Highways," E-48.

²⁰ Nelson, *Glenwood Springs: A Quick History Including Glenwood Canyon*, 104.

²¹ Ariana Harner, "The Delicate Salvation of Glenwood Canyon," *Colorado Heritage*, Winter 2000, 23.

²² William Philpott, *Vacationland: Tourism and Environment in the Colorado High Country* (Seattle: University of Washington Press, 2014), 90; National Park Service, *Lincoln Highway: Special Resource Study, Environmental Assessment* (Washington, D.C.: National Park Service, U.S. Department of the Interior, 2004), 5; Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System*, 6-5.

Section 1 Background History

highways. This demand led to several significant road-building projects during this period, including widening and paving US 6 over Loveland Pass in 1950, completion of the Denver-Boulder Turnpike in 1952, and extension of US 6 through Clear Creek Canyon in 1952. Despite these important road projects, most Colorado highways needed major updates by the mid-1950s due to heavy use and deferred maintenance.²³

²³ Associated Cultural Resource Experts and Dobson-Brown, "Colorado State Roads and Highways," E39–41; Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System*, 7–6 to 7–7.

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2. Beginnings of the Interstate Highway System in Colorado, 1956-1959

A. Development of a National Interstate Highway System

The idea for a national Interstate Highway System dates to just after World War I with the objective of linking the entire country for both economic and military purposes. President Franklin D. Roosevelt was keenly interested in an Interstate Highway System and, after coordination with BPR head Thomas H. MacDonald, had that agency prepare an internal study on the need for such a system. At the request of Congress, the BPR prepared an additional report in 1939 entitled “Toll Roads and Free Roads” that contained the first formal concept of an Interstate Highway System. The report discussed development of a national highway system with coordinated contributions by federal and state governments, counties, and municipalities and highlighted its importance to national defense. In 1941 President Roosevelt appointed a National Interregional Highway Committee to investigate creation of a limited-access, national highway system, efforts that were summarized in a 1943 report. This report and several subsequent reports provided the basis for the 1944 Federal-Aid Highway Act, which officially authorized construction of a national system of Interstate Highways; however, this act did not provide funds for construction. By 1947 the first 37,700 miles of Interstate Highways was announced. The Federal-Aid Highway Act of 1952 authorized the first funding ear-marked for construction of the Interstate Highway System. In 1956 the official plan for a National System of Interstate and Defense Highways was introduced under the Federal-Aid Highway Act of 1956. This system of Interstate Highways was conceived of as high-speed and multi-lane facility, with divided roadways used by both civilian traffic and military vehicles as needed for national security.²⁴

B. Evolution of the I-70 route in Colorado

(1) Envisioning the route of I-70 across the Rockies and western Colorado

Early planning for the Interstate Highway System in the 1940s called for I-70 to begin in Washington, D.C., and terminate at Denver. Officials at the BPR hoped to avoid the engineering challenges presented by Colorado’s mountainous topography and saw no economic benefit to crossing the mountains, and therefore did not envision a continuous east-west link across the state. Colorado highway officials swiftly protested the plans as they foresaw a significant downturn in the state’s booming tourism industry should residents and visitors be unable to easily and quickly cross the Continental Divide.²⁵ At the time the only

²⁴ Federal Highway Administration, U.S. Department of Transportation, “Highway History,” *Federal Highway Administration, U.S. Department of Transportation*, n.d., <https://www.fhwa.dot.gov/infrastructure/mcdonaldtoll.cfm>; Federal Highway Administration, “Contributions and Crossroads - Timeline,” *Federal Highway Administration, U.S. Department of Transportation*, n.d., <https://www.fhwa.dot.gov/candc/timeline.cfm>; Richard F. Weingroff, “Public Roads,” *Federal Highway Administration, U.S. Department of Transportation*, February 6, 2018, <https://www.fhwa.dot.gov/publications/publicroads/06mar/07.cfm>.

²⁵ Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado’s Highway System*, 7–9; Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 97–99; Associated Cultural Resource Experts and Dobson-Brown, “Colorado State Roads and Highways,” E-42.

Section 2
Beginnings of the Interstate Highway
System in Colorado, 1956-1959

two existing highways that extended through the mountains between Denver and the Utah state line were US 6 over Loveland Pass and US 40 over Berthoud Pass.

Prior to 1957 no plans for an Interstate Highway across the Continental Divide in Colorado existed, but with tourist dollars and accessibility in mind, interested groups and individuals began advocating for possible routes for such a highway. Two possible routes that received a lot of publicity included US 6 and US 40. These routes traversed the most challenging terrain between and Lawson and Dotsero, near the eastern end of Glenwood Canyon. Local business owners, chambers of commerce, newspapers, booster organizations, local politicians, and even those in communities tangentially linked to each of the highway corridors by secondary roads promoted and lobbied for their respective highway in hopes of tourist dollars once the new Interstate Highway was built. US 6 provided the most direct route but required traversing more mountainous terrain whereas US 40 provided a much less direct route but had only one mountain pass (Berthoud Pass) for engineers to deal with as it generally extended through valleys around surrounding mountains. Arguments for and against each of the highway corridors continued through much of 1956 and cited various factors such as traffic counts, safety, economic development, and others as supporting evidence. Colorado Governor Edwin Johnson became heavily involved in the debate between US 6 and US 40, advocating for the US 40 route and calling for a tunnel through the Continental Divide. Johnson eventually proposed a deal whereby Colorado would pay for a tunnel through the Continental Divide if the federal government extended the highway through the Colorado high country.²⁶ In 1957, amid growing protests by Colorado officials and after over a decade of lobbying and arguing by locals and state politicians, the BPR awarded an additional 547 miles to extend I-70 west from Denver, across the Continental Divide, to I-15 near Cove Fort, Utah. However, the location of the tunnel through the Continental Divide remained undecided.²⁷

²⁶ Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System*, 7–9.

²⁷ Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 108–9, 116–18; Associated Cultural Resource Experts, “Colorado State Roads and Highways,” E42; Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System*, 7-10; Colorado Department of Highways, *I-70 in a Mountain Environment: Vail Pass Colorado* (Prepared for the United States Department of Transportation, Federal Highway Administration Office of Development, 1978), 2; American Association of State Highway and Transportation Officials, *The States and the Interstates: Research on the Planning, Design and Construction of the Interstate and Defense Highway System* (Washington D.C.: American Association of State Highway and Transportation Officials, 1991), 44.

3. Rise of Environmentalism, New Regulations, and the Vail Pass Precedent, 1960-1973

As early as 1960 officials began discussing and formulating costs for constructing an Interstate Highway link between Denver and Utah. This early planning occurred amidst a growing environmental movement that would ultimately impact the design and construction of I-70 through Glenwood Canyon.

A. The rise of environmentalism and its impact on Interstate Highway planning

The environmental movement that emerged in the 1960s had its roots in the values and conservationist activities of the Sierra Club, National Audubon Society, and National Parks movement of the late nineteenth and early twentieth centuries. However, modern environmentalism focused on a broader set of concerns and values than its predecessors and went far beyond natural resource management and preservation of wilderness areas of human recreation. The ecological impact of automobile and industrial pollution, large-scale construction projects, and other destructive human activities led growing support for measures to protect the environment.²⁸

Prior to the 1960s, the BPR and state highway departments around the country gave little consideration to the environmental and scenic impact of highway locations and designs. However, during the early years of Interstate Highway planning and construction, freeway protests emerged over the impacts of Interstate Highway routes on businesses and communities around the country, and new federal policies and legislation were enacted to address these impacts. In 1963 the BPR implemented a new policy requiring states to consider possible impacts of any federal-aid highway project on fish and wildlife resources.²⁹ In 1964 Congress enacted the Land and Water Conservation Act and the Wilderness Act, which created the National Wilderness Preservation System. By 1966 Congress passed the Department of Transportation Act, which created the U.S. Department of Transportation (USDOT) and transferred the responsibilities of the BPR, including overseeing funds and ensuring compliance with regulatory requirements, to the new FHWA.³⁰ The Department of Transportation Act also included a landmark environmental regulation, known as Section 4(f), which required state highway departments to consider impacts to a wide set of resources such as publicly owned parks, recreation areas, wildlife refuges, and historic sites. Section 4(f) required USDOT agencies to justify use of any of these property types by demonstrating that there was “no feasible and prudent alternative” to their use. As further evidence of increased public scrutiny on federal activities, Congress passed the National Historic Preservation Act (NHPA) in 1966, which required agencies using federal funds or permits to review proposed project activities and determine potential effects on cultural resources such as historic buildings and archaeological sites. The NHPA and Section 4(f) required coordinated environmental review for all federal undertakings, including the construction or improvement of Interstate Highways. Additional

²⁸ Richard F. Weingroff, “Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969,” *Federal Highway Administration*, June 27, 2017, <https://www.fhwa.dot.gov/highwayhistory/nepa/index.cfm>.

²⁹ Weingroff, “Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969.”

³⁰ “The Trailblazers: Brief History of the Direct Federal Highway Construction Program,” *Federal Highway Administration*, September 2017, <http://www.fhwa.dot.gov/infrastructure/blazer01.cfm>.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973

environmentalist legislation passed during this period included the National Trails System Act and establishment of the National Wild and Scenic Rivers System in 1968.³¹ The BPR also adjusted its policies on public hearing requirements several times during the course of the 1960s. One change required that two public hearings be held for Interstate Highway projects: one before the BPR's selection of a route and a second hearing after route approval but prior to approval of the design. Together these laws significantly altered the processes by which state agencies planned highway infrastructure.³²

Several other federal initiatives emerged during this period that indicated a growing interest in preserving scenic and aesthetic qualities along the nation's highways, including the Highway Beautification Act of 1965 and a study conducted under the Department of Commerce titled *A Proposed Program for Scenic Roads and Parkways*.³³ Scenic roadbuilding as a concept preceded the Interstate Highway era by several decades; as early as the 1920s urban parkways and highways in scenic destination areas were constructed with careful design considerations to complement their setting and enhance scenic views.³⁴ Highway departments that implemented aesthetically sensitive designs in the early and mid-1960s often enjoyed public praise for their efforts. For example, *Parade Magazine* offered its "Scenic Highway Award" annually to roads that exhibited exceptional aesthetic qualities. Among recipients of the award in the mid-1960s were several Interstate Highway segments, including a 22.5-mile section of I-75 between the Gaylord and Indian Rivers in Michigan and a 30-mile segment of I-87 through the Adirondack Northway in New York. Both segments were designed to enhance views of the scenic landscape with widely separated lanes at different elevations and medians landscaped with trees and natural features to shield the driver's view from oncoming traffic.³⁵

B. Environmentalism, recreation, and tourism in Colorado

Values associated with outdoor recreation and tourism drove the environmental movement in Colorado. The notion that wilderness preservation had a direct correlation to quality outdoor recreational activities was promoted through the activities and writing of various advocates, authors, and officials. Arthur Carhart, who was the U.S. Forest Service's first recreational engineer, a landscape architect, director of wildlife research for the Colorado Game and Fish Department, and one of the most respected conservationists of the time, wrote prolifically on topics related to recreation and natural resources.³⁶

³¹ Weingroff, "Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969."

³² Weingroff, "Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969."

³³ Richard F. Weingroff, "History of Scenic Road Programs," *Federal Highway Administration*, June 27, 2017, <https://www.fhwa.dot.gov/infrastructure/scenichistory.cfm>.

³⁴ Associated Cultural Resource Experts and Dobson-Brown, "Colorado State Roads and Highways," E-76; Weingroff, "History of Scenic Road Programs."

³⁵ "Michigan Freeway Wins Scenic Highway Award," *The Herald-Press*, October 22, 1963; "Adirondack Northway Called 'Unique Link,'" *Poughkeepsie Journal*, September 16, 1967.

³⁶ Bruce Cousins et al., *Interstate 70 Routing Project Economics vs. Aesthetics*, 1967, 2, Available at Colorado Department of Transportation Library; Bureau of Outdoor Recreation, *The Selection of a Highway Route: Choices and Values: A Report on the "Red Buffalo: Section of the Interstate Highway 70 in Colorado*, January 1968, 5-9; Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 51, 92-98, 121, 137-38, 190-91.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973

The mid-twentieth century was a time of great consumerism and the natural environment was not immune to this phenomenon. A certain “recreational consumerism,” as historian William Philpott describes it, developed in Colorado whereby people began to idealize the high-country environment and began molding their lifestyle and activities toward it. Residents and tourists also found new ways to enjoy the environment and profit from it through new outdoor recreational activities, services, and tourism. A prominent example was Colorado’s ski industry, which boomed during the postwar period. Arapahoe Basin and Aspen both opened in 1946 and Buttermilk (near Aspen), Aspen Highlands, and Steamboat Springs opened in 1958. The growing interest and pressure for new places to ski led the U.S. Forest Service to create a master plan for ski resort development in 1959.³⁷ By the 1960s a movement for conservation had coalesced in Colorado. Its supporters viewed recreational development as a means for protecting and maintaining the state’s wilderness and scenic qualities. By this time tourism was a major component of the economy in Colorado’s high country. Boosters were intent on maintaining the natural landscape that had come to define Colorado as a tourist destination. They also promoted increased access to Colorado’s scenery and recreational opportunities, mountain towns, and tourist corridors. Enthusiastic interest in recreation fueled a growing popular interest in the high-country environment.³⁸

C. The Red Buffalo controversy

Controversy over the routing of I-70 between Dumont and Dotsero in the early 1960s set an important precedent for discussions, processes, and decisions related to building I-70 through Glenwood Canyon more than a decade later. Following the BPR authorization of I-70 west of Denver, Colorado Governor Stephen McNichols hired the E. Lionel Pavlo Engineering Company of New York to assess several route options across the Continental Divide, between Dumont and Dotsero, using factors such as traffic flow and geological and slope gradient analysis to provide a recommendation. The “Pavlo Study” was complete by April 1960 and concluded that no route could be achieved without a tunnel through the Continental Divide. . Seven alignments (A through H) were identified but the study assessed only two alignments in detail: one along US 40 and another along US 6 over Vail Pass. The Pavlo Study ultimately recommended that I-70 follow the path of US 6 for most of its route with a tunnel at Straight Creek (eventually named the Eisenhower-Johnson Memorial Tunnel). West of Dillon, however, the planned alignment diverged from US 6 to form a new route, known as “Red Buffalo,” which would pass through the environmentally sensitive Gore Range-Eagles Nest Primitive Area and require a tunnel under the Continental Divide at Gore Range. Although the Red Buffalo route would have been 10 miles shorter, its tunnel requirement made it more expensive, and the highway’s potential to impact a highly sensitive wilderness area drew national outcry. Amid the debate, the Colorado Division of Highways (CDOH), predecessor to the Colorado Department of Transportation (CDOT), held firm on the Red Buffalo option and proceeded with the design process in the mid-1960s. The CDOH and others preferred this option because it provided the most direct route, enabled faster drive times, and ultimately saved motorists

³⁷ Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 51, 92–98, 137–38, 190–91; “Colorado Ski History Timeline,” *Colorado Ski Authority*, 2016, <https://coloradoskiauthority.com/history/ski-resort-timeline/>.

³⁸ Cousins et al., *Interstate 70 Routing Project Economics vs. Aesthetics*, 2; Bureau of Outdoor Recreation, *The Selection of a Highway Route: Choices and Values: A Report on the “Red Buffalo: Section of the Interstate Highway 70 in Colorado*, 5–9; Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 121.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973

money based on the projected cost per one-way trip. The CDOH's decision to endorse the Red Buffalo route generated a lot of controversy and public outcry over potential environmental impacts.³⁹,

Throughout the 1960s the BPR adjusted its policies on public hearing requirements. One change required that two public hearings be held for Interstate Highway projects: one before the BPR's selection of a route and a second hearing after route approval but prior to approval of the design. Together these laws significantly altered the processes by which state agencies planned highway infrastructure, including those involving the Red Buffalo route, and later Glenwood Canyon.⁴⁰ To comply with BPR policies regarding Interstate Highway-related public hearings, the highway department held a public meeting in 1966 to discuss the various alternative routes

In response, environmentalist groups and concerned citizens became more organized to voice their opposition to the Red Buffalo route; a coalition of environmental organizations eventually formed the Colorado Open Space Coordinating Council (COSCC) and led the fight.⁴¹ The debate over Red Buffalo effectively ended in 1968, when the United States Secretary of Agriculture Orville Freeman denied the CDOH an easement through the Gore Range-Eagles Nest Primitive Area within the Arapaho and White River National Forests.⁴²

Amid the criticism of Red Buffalo, highway engineers began to understand the broad scope of changes in their profession. Known as experts in traffic studies, cost estimating, and developing bridge and highway plans, the engineers had experienced very little criticism in the past when members of the public thanked them for building highways to solve transportation problems and rarely questioned their decisions. But now they regularly encountered citizens and groups demanding a voice in highway planning decisions. This resulted in a new era for engineers who had to adapt and collaborate with government agencies, politicians, and residents.

Notable CDOH personnel involved in designing I-70 who learned to work with new stakeholders on Vail Pass and other projects included Richard Prosenice and Charles Shumate. Prosenice was a civil engineer who oversaw design development for the Red Buffalo route and was instrumental in identifying the eventual path of the highway. He developed cost estimates for I-70 and was involved with most I-70-

³⁹ Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System*, 11–70 to 11–71; Richard E. Prosenice, "Building I-70: The Story of the Development of Interstate Route 70 Between the Utah-Colorado State Line and the Continental Divide in Western Colorado," n.d., 30, 34–35, Available at Colorado Department of Transportation; Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 235, 294, 386; Cousins et al., *Interstate 70 Routing Project Economics vs. Aesthetics*, 3; Bureau of Outdoor Recreation, *The Selection of a Highway Route: Choices and Values: A Report on the "Red Buffalo: Section of the Interstate Highway 70 in Colorado*, 5–9; W. J. Barton, "Transcript of Proceedings of Public Hearing on Interstate 70 Vail Pass Design," June 19, 1972, Available at Region 3 Office, Colorado Department of Transportation, Grand Junction, Colorado.

⁴⁰ Weingroff, "Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969."

⁴¹ Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 231.

⁴² Associated Cultural Resource Experts, *Highways to the Sky: A Context and History of Colorado's Highway System*, 11–71.

related discussions and decisions between 1960 and the early 1980s, including construction through Glenwood Canyon. Shumate began working for the State Highway Department in 1924 in southwestern Colorado and in 1951 relocated to Denver to work as an Administrative Engineer at the headquarters office. By 1960 Shumate was promoted to Chief Engineer. He became CDOH's Executive Director in 1968 and oversaw construction of the Eisenhower Memorial Tunnel between 1968 and 1973, and was involved in early discussions regarding the design and construction of I-70 through Glenwood Canyon.⁴³

D. Early planning for Glenwood Canyon

The controversy surrounding the Red Buffalo route and the public discourse over its potential impacts on the environment provided an important parallel for activities related to early planning for I-70 through Glenwood Canyon. As early as 1960 officials began formulating costs for constructing the final link in the interstate across Colorado, west of Dotsero. The first public hearing on such a project occurred in Glenwood Springs in July 1963. Attendance was around 250 and included mayors from several nearby towns, Glenwood Springs Chamber of Commerce, Club 20 (representing western Colorado communities and business leaders), geologists, engineers, foresters, interested community members, and representatives from several environmental groups such as the Sierra Club and Rocky Mountain Center for the Environment. However, most comments focused on eliminating a sharp and dangerous curve in the road, known as "Horseshoe Bend," located approximately one mile east of Glenwood Springs rather than concerns about broader impacts to the canyon environment. Research is unclear whether environmental concerns were expressed and ignored by CDOH officials or if these groups were not yet aware of recent environmental legislation. The CDOH took action after the meeting and drafted plans to bore twin tunnels west of No Name through the ridge around which Horseshoe Bend extended to eliminate this stretch of road altogether. This plan received little opposition nor was there much discussion about architectural or aesthetic decisions related to the tunnels. Another public hearing in March 1964 focused on a six-mile stretch of new highway extending from the western portals of the proposed tunnels to Glenwood Springs.⁴⁴

Between 1963 and 1965 CDOH crews completed construction of the twin tunnels west of No Name (see Figure 2) and a two-mile segment of I-70 through the westernmost end of Glenwood Canyon. During construction, crews utilized typical construction techniques of previous decades by blasting rock from the canyon walls and cut-and-fill activities that consisted of pushing debris into the river to build up the embankment for the new four-lane roadway. Initially, the project received little opposition or criticism; it seemed most people assumed I-70 would be constructed through Glenwood Canyon with standard Interstate Highway designs and construction methods for a four-lane roadway.

⁴³ Prosenca, "Building I-70: The Story of the Development of Interstate Route 70 Between the Utah-Colorado State Line and the Continental Divide in Western Colorado," 6, 30; Colorado Department of Transportation, *100 Years of Colorado State Transportation History*, 86–87, 112; John Stroud, "'Father of Canyon' Part of Important Transition," *Glenwood Post*, October 9, 1992, 20.

⁴⁴ Harner, "The Delicate Salvation of Glenwood Canyon," 24; Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 101.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973



Figure 2. The twin tunnels located west of No Name were completed in 1965. Mead & Hunt, Inc. photograph.

In 1966 Shumate, then Chief Engineer for the CDOH, suspended all work on I-70 in Glenwood Canyon until the Red Buffalo route controversy was resolved and the path of I-70 between Dumont and Vail had been chosen. Work on other segments of I-70 did continue east of Glenwood Canyon, through the Eagle River Valley, and west of Glenwood Canyon, between Grand Junction and the Utah state line.⁴⁵ At the same time the growing environmental movement focused on preventing adverse environmental impacts to Glenwood Canyon during future construction. Between 1966 and 1968 local protests, rallies, editorials, and eventually more public hearings highlighted public interest in plans for I-70 through Glenwood Canyon. In 1968, under public pressure, the Colorado General Assembly passed Joint Resolution No. 16, which created a Citizen's Advisory Committee (CAC) to monitor and advise the CDOH on matters related to the design and planning for I-70 through the canyon. As stated in the resolution, the "interests of the people of this state will be best served by a highway so designed that, to the fullest extent, the wonders of human engineering will be tastefully blended with the wonders of nature."⁴⁶ The CAC consisted of an architect, conservationist, landscape planner, three consultants, and an outdoor enthusiast and served as a predecessor to the passing of the National Environmental Policy Act in 1969,

⁴⁵ Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 101; Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 293; Colorado Department of Transportation, *100 Years of Colorado State Transportation History*, 86–87.

⁴⁶ Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 72.

which had an indelible impact on the planning, design, and construction of I-70 through Glenwood Canyon over the next two decades.⁴⁷

E. The National Environmental Policy Act and its impact on Interstate Highway planning and design

By the late 1960s the environmental movement had succeeded in influencing major policy changes at the federal level. Officially signed into law by President Richard Nixon on New Year's Day of 1970, only a year and a half after the end of the Red Buffalo route controversy, the National Environmental Policy Act (NEPA) demonstrated that the federal government recognized the destructive effects of human activities on the environment, and it aimed to prevent future environmental damage and foster a greater understanding of the ecosystem and natural resources. NEPA was an "umbrella" regulation that established a federal regulatory body in the Council on Environmental Quality (CEQ) and incorporated a wide set of requirements on federal agencies, including the development of an "interdisciplinary approach" to integrating the use of the "natural and social sciences and the environmental design arts" to address potential environmental impacts, consultation with CEQ to develop procedures for addressing environmental considerations, and the development of a "detailed statement" (later named Environmental Impact Statement [EIS]) to be included with all reports and proposals for major federal actions. EISs were to include analyses of potential and unavoidable environmental impacts and proposed alternatives for project plans. Through the process of development and review of EISs, NEPA also required consultation with various agencies at the federal, state, and local levels that held legal jurisdiction or "special expertise" regarding potential environmental effects of federal actions.⁴⁸ These requirements transformed the highway planning process.

As implementation of the law began in 1970, many agencies attempted to avoid compliance. Some argued that the burden of completing environmental impact analysis should be the responsibility of the newly created CEQ, but the regulatory council countered that it should become an integral part of the agencies' decision-making process rather than something imposed by outsiders. During NEPA's first year, the CEQ worked to further clarify and define the law's provisions and establish guidelines for compliance. The CEQ attempted to clarify which projects would require intensive environmental analysis, which NEPA defined as "major Federal action significantly affecting the quality of the human environment." By the fall of 1970 the FHWA began issuing draft guidelines for developing EISs and clarified "significantly affecting" as "likely to be highly controversial on environmental grounds." Environmental effects were defined broadly and included human factors (e.g., increased noise pollution, major population displacement or disruption of established communities), scenic or aesthetic factors (e.g., impacting visual elements of a scenic or unique landscape), and biological factors (e.g., altering wildlife behavior patterns or habitats, increasing air or water pollution, or contaminating public water supplies or treatment facilities). Although still in draft form, state highway departments were to immediately

⁴⁷ Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 73; Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 112.

⁴⁸ "The National Environmental Policy Act of 1969, as Amended," January 1, 1970, https://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/Req-NEPA.pdf.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973

implement the guideline procedures for any federally funded projects. By August 1971 the FHWA issued a notice with final procedures for developing EISs.⁴⁹

NEPA's review process initially frustrated many highway engineers. Highway departments complained of a number of issues the new laws imposed including delays and increased costs. NEPA also required a significant change in the interrelationships between highway departments and other state and federal agencies, some of which now had authority to impose specific restrictions on highway builders. Although public hearings had been a part of the Interstate Highway planning process for some time, NEPA required that the demands and recommendations of the public and various stakeholders be considered as part of the environmental review process. For example, highway departments developed alternatives to proposed projects upon which interested parties were allowed to comment. The input of citizens and stakeholders now significantly influenced the consideration of Interstate Highway location alternatives and design concepts.

The indifference of some highway departments toward the new regulations was reflected in the quality of early EIS documents. Regulators criticized states for minimizing potential environmental impacts and overemphasizing the potential benefits of highway projects. Additionally, some states attempted to skirt around environmentally sensitive issues by "piece-mealing" or submitting multiple EIS documents for short highway segments rather than a single submission for a longer segment that together would have a significant impact. Project delays were common as highway departments adjusted to the new requirements of NEPA and attempts to avoid or minimize the requirements caused further delay. However, following a series of lawsuits in the early 1970s, state highway departments began to understand it was in their best interest to devote enough resources and attention to NEPA regulations to meet compliance early in the process. Eventually, NEPA and environmental stewardship became an integral part of highway planning, and state agencies that were once staffed primarily with engineers were now developing into interdisciplinary organizations with planners, biologists, ecologists, historians, archaeologists, and other specialists.⁵⁰ As a result, consideration of impacts to the natural environment became evident in the locations and designs of various Interstate Highway segments and structures constructed after 1970, including I-93 through Franconia Notch in New Hampshire (1973), I-95 over Snoqualmie Pass in Washington (1971-1981), and I-15 through the Virgin River Gorge in Arizona (1973). These highway segments utilized new design techniques and aesthetic treatments to reduce environmental impacts and create a sense of harmony with the surrounding landscape.⁵¹

F. The CDOH and early environmental considerations in Colorado

The designs of I-70 segments constructed west of Denver and at the westernmost end of Glenwood Canyon in the early to mid-1960s reflected the traditional highway engineering focus on cost and user benefit ratios and included straight alignments, vertical rock cuts with drill marks, exposed areas with little

⁴⁹ Weingroff, "Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969."

⁵⁰ Weingroff, "Addressing the Quiet Crisis: Origins of the National Environmental Policy Act of 1969."

⁵¹ Federal Highway Administration, "Final List of Nationally and Exceptionally Significant Features of the Federal Interstate Highway System," *Environmental Review Toolkit | FHWA*, accessed August 5, 2018, https://www.environment.fhwa.dot.gov/env_topics/historic_pres/highways_list.aspx.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973

or no attempt to revegetate, and cut and fill activities that encroached on adjacent streams and rivers. However, by the late 1960s designs began to reflect subtle adjustments that reflected environmental considerations such as curves to avoid historic sites, revegetated construction areas, and wildlife underpasses. Increased attention to visual impacts and aesthetic considerations were also evident along portions of I-70 east of Glenwood Canyon. The Genesee Park Interchange, for example, included a bridge with one long span engineered without a center pier to provide an unobstructed view of the Colorado Rocky Mountains.⁵² In the wake of the Red Buffalo controversy, the CDOH released a publication intended for the general public that highlighted the agency's efforts to protect environmental resources along I-70. The booklet, titled *Through the Colorado Rockies: Interstate Colorado 70* opened with the following statement:

Many of our highways extend through or near open spaces, parks, fishing areas, historic sites, and other tracts of great value. The development of a highway certainly can be compatible with the preservation of such national wonders by virtue of early overall planning. The highway must not only protect these resources, but also fit the plans of other agencies responsible for developing recreation and conservation in our rural regions. Today, as land more and more becomes a scarce and valued commodity, our federal state highway efforts must be directed increasingly toward such cooperation.⁵³

After the passage of NEPA, Shumate, who by this time had become CDOH Executive Director, appointed a landscape architect named Harvey Atchison to head up a new environmental unit called the Environmental Research Analysis Section and develop the CDOH's first NEPA Action Plan. The Action Plan addressed all steps in the environmental review process and had to be approved by the FHWA. Early environmental reviews often caused delays and slowed the construction of highway projects, but the newly appointed environmental staff slowly demonstrated the importance of successful environmental clearances.⁵⁴

(1) The Vail Pass precedent

After the passage of NEPA in January 1970, the Vail Pass project became an opportunity for the CDOH to fully demonstrate the possibilities of careful environmental planning and design. Construction on Vail Pass began in 1973. Landscape architects and engineers assigned to the project used innovative methods to meld the transportation corridor of I-70 into the natural environment, such as sensitive earthwork and slope molding techniques, sculpted rock cuts to match natural outcroppings, revegetation with native flora, and selective placement of "natural" features such as boulders, stumps, and old logs along the highway slopes. Unique retaining wall styles were used to blend into the landscape, incorporate plantings, and create visual interest. The precast, segmented, concrete, post-tensioned, box girder bridges used on Vail Pass were the first of their kind Colorado and among the earliest used in the country. Due to their assembly method of construction, the use of precast elements reduced construction

⁵² Federal Highway Administration, "Final List of Nationally and Exceptionally Significant Features of the Federal Interstate Highway System"; Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 291–92.

⁵³ Colorado Division of Highways, *Through the Colorado Rockies: Interstate Colorado 70* (Denver: Colorado Department of Highways, c 1970), 1.

⁵⁴ Colorado Department of Transportation, *100 Years of Colorado State Transportation History*, 73–74, 87; Barton, Stoddard, Milhollin, and Higgins, *Vail Pass Environmental Study I-70 2(19), Vail To Wheeler Junction* (Prepared for the Colorado Division of Highways, 1972), 8.

Section 3
Rise of Environmentalism, New Regulations,
and the Vail Pass Precedent, 1960-1973

time and minimized impacts to vegetation. Their placement and orientation enabled trees to grow between bridge decks and only the area immediately surrounding the piers was disturbed. In addition to crossing creeks and streams, bridges were also used on hillsides and side canyons along Vail Pass to minimize terrain disruption. The use of bridges instead of the typical treatment involving major fill and culverts for drainage minimized visual effects to the natural landscape and enabled wildlife to cross the highway beneath the structures. Bridges, retaining walls, and some culverts were finished with iron oxide to create a reddish-pink hue to match the natural outcroppings of the Vail Valley. In addition, some culverts featured a “barnwood” texture on their concrete headwalls and wingwalls. Vail Pass served as an important precedent for how designers and engineers balanced Interstate Highway safety and efficiency standards with geologic and geometric constraints in Glenwood Canyon.

4. Planning I-70 through Glenwood Canyon, 1970-1979

By 1970 the CDOH started to discuss Glenwood Canyon again, amidst growing concerns by individuals and groups over the environmental impact of building I-70 through Glenwood Canyon. The first official meeting of the CAC was on June 3, 1970; in attendance were representatives of the BPR; U.S. Forest Service; Colorado Game, Fish, and Parks; and Charles Shumate and his staff. The CDOH had prepared preliminary cost estimates, traffic projections, and plans, but some members remained uncertain over how suitable Glenwood Canyon was for a new superhighway. As a result, some CAC members suggested an outside firm be brought in to study the feasibility of other alignment options. Shumate was unreceptive to the suggestion, stating an outside firm “would only come up with cost estimates, or maybe changes in alignment.”⁵⁵ In spite of much debate and hesitation on the part of the CDOH, the CAC issued Resolution 2 stating that “State Highway Department talents, energies, and appropriated budgets be expended to study alternative routes, that a corridor hearing thereon be held as soon as possible...”⁵⁶ Emboldened by recent environmental legislation, environmental groups like the Colorado Open Space Council and the Rocky Mountain Center on Environment stood with the CAC and were publicly critical of proposals by state highway planners. Their efforts resulted in the CDOH moving forward with an analysis of options that was also in compliance with NEPA.⁵⁷

A. Choosing the route

The Chicago firm of De Leuw, Cather & Company was hired to conduct an alternatives analysis for this last leg of I-70 in Colorado; a draft EIS was prepared in July 1971 and the final EIS was submitted in March 1972. After some requested revisions by Colorado’s Secretary of Transportation John Volpe, the final EIS was revised and submitted to the CDOH in July 1972. It was the first EIS completed for a Colorado highway project. In compliance with NEPA, the EIS considered a total of three routes. The first alternative followed the path of existing US 6 through Glenwood Canyon. The second alignment option went through the Flat Tops Wilderness Area to the north of Glenwood Canyon, reaching an elevation of over 10,000 feet and crossing a wilderness area with mountain lakes, streams, canyons, and large migratory elk and deer populations. Cottonwood Pass was the third alternative and passed through Eagle and Garfield Counties, extending southwest from Gypsum to Carbondale and then north to Glenwood Springs; this option would require a continuous six percent grade over an eight-mile segment. The Cottonwood Pass option would also add 9.4 miles to the route and require additional right-of-way acquisition. Each alignment extended through an environmentally sensitive area but ultimately the EIS concluded that the Glenwood Canyon option was the only feasible option and was shorter and cheaper, and would have the least environmental impact of the three alignments. The EIS also included assurances that maintaining the natural beauty of Glenwood Canyon would be a top priority of his alternative.⁵⁸

⁵⁵ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 112–13.

⁵⁶ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 114.

⁵⁷ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 114.

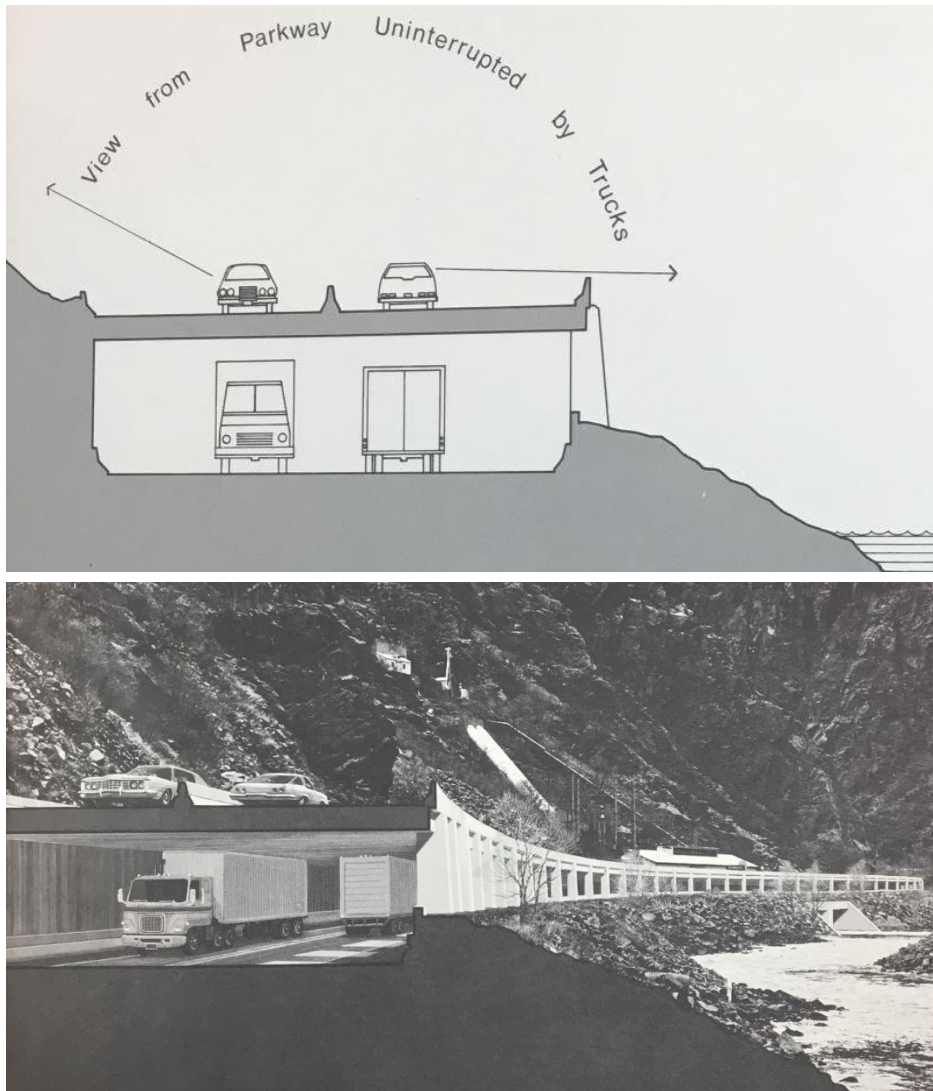
⁵⁸ Matthew Salek, “Glenwood Canyon: An I-70 Odyssey,” *The Highways of Colorado*, August 11, 2002, <http://www.mesalek.com/colo/glenwood/>; U.S. Army Corp of Engineers, Sacramento, California District, *Final Supplemental Environmental Impact Statement, Glenwood Canyon I-70 Project*, 1982, 18; Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 118–19.

B. Preliminary design concepts

Public comments and hearings made clear a new highway through Glenwood Canyon must be environmentally sensitive. In 1972 the CDOH moved forward on selecting consultants to draft preliminary designs for I-70 through Glenwood Canyon in coordination with the CAC and another committee, the Blue Ribbon Advisory Committee, which was appointed by Colorado Governor John Love and included a wide variety of academics, business owners, and community officials. By September 1973 the CDOH commissioned three consulting firms—Vollmer Associates; Howard Needles, Tammen & Bergendoff (HNTB); and Gruen Associates—to design creative options for building I-70 through Glenwood Canyon. By mid-1974 the preliminary designs were complete, and were put on public display at the Hotel Colorado in Glenwood Springs in August 1974. All three firms proposed a four-lane highway, albeit with different design concepts. In addition to public review and comment, a technical review group reviewed the three options and included representatives from the U.S. Forest Service, U.S. Bureau of Outdoor Recreation, U.S. Division of Wildlife, U.S. Geological Survey, D&RG Railroad, Public Service Company of Colorado, and the FHWA. The group focused on the technical aspects of the highway design, speed limits, roadway width, and the design of the rest areas.⁵⁹

In December 1974 the CDOH issued an analysis of all three concepts. Vollmer Associates proposed a truckway-parkway concept at a cost of \$140 million (1974 dollars). This option consisted of a continuous two-level structure to carry automobiles on the top level and trucks on the lower level to minimize truck noise (see Figures 3 and 4). This concept was not fully embraced by the public or CDOH due to safety concerns about trucks meeting on the lower level, potential difficulties for accessing the lower level for accident cleanup, and winter maintenance on the lower level due to icing. However, the plan also included terraced cross sections, rest areas, and overlooks that the CDOH deemed worthy of consideration for the final design.

⁵⁹ Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 90; Haley, *Wooping A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 134; U.S. Army Corp of Engineers, Sacramento, California District, *Final Supplemental Environmental Impact Statement, Glenwood Canyon I-70 Project*, 18.



Figures 3 and 4. Excerpt from Vollmer Associates proposal showing two-level structure separating truck from car traffic.⁶⁰

HNTB and Gruen Associates both proposed a terraced roadway in narrow locations, elevated bridges, and elimination of all encroachments on the river with low retaining walls located immediately adjacent to shoulders (see Figures 5 through 7). Retaining walls would have aesthetic treatments, such as precast, concrete, segmented sections with room for plantings or the addition of barnwood texture, similar to those used on Vail Pass. Concepts introduced in proposals also included a bike path parallel to the roadway, recreational facilities and river access points, rest areas, twin tunnels, and mounds or walls for noise mitigation. Potential issues raised in the analysis report included cost, lack of material storage area near

⁶⁰ Vollmer Associates, Engineers - Architects, Landscape Architects-Planners, *A Design Concept for Interstate 70, Glenwood Canyon, Colorado* (Prepared for the Colorado Department of Highways, June 18, 1974), 10–11.

Section 4
Planning I-70 through
Glenwood Canyon, 1970-1979

the site, the amount of construction material to be moved, lack of ventilation in the tunnels, and permanent visual scars on the canyon walls after construction.⁶¹

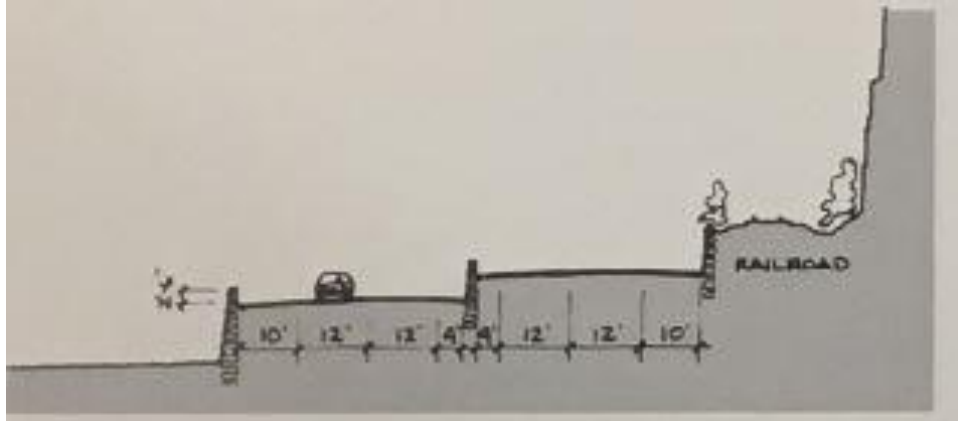


Figure 5. Excerpt from Gruen Associates proposal showing terraced roadway.⁶²



Figure 6. Excerpt from Gruen Associates proposal showing a four-lane roadway in a wider portion of the canyon.⁶³

⁶¹ Colorado Division of Highways, *An Analysis of Design Concept Studies: Interstate 70 Through Glenwood Canyon, Project I 70-2(11), Dotsero-West*, December 1974, 5–49; Gruen Associates, *Design Concept Study for Interstate 70 Through Glenwood Canyon* (prepared for Colorado Division of Highways, July 1974).

⁶² Gruen Associates, *Design Concept Study for Interstate 70 Through Glenwood Canyon*, 53.

⁶³ Gruen Associates, *Design Concept Study for Interstate 70 Through Glenwood Canyon*, 18.



Figure 7. Photograph of a model created for the highway at Hanging Lake to illustrate and analyze the visual impact of the highway. This model exemplifies the dilemma faced by engineers and designers: fitting a four-lane Interstate Highway with on- and off-ramps into a narrow canyon with minimal impacts to the ecology of the Colorado River and Glenwood Canyon.⁶⁴

Following the analysis report, public comment, and input from the various review committees, the consensus was that a combination of concepts developed by the three firms could be used to formulate a final design to construct a four-lane roadway through Glenwood Canyon using methods to avoid permanent damage to the canyon. The CDOH and interested parties also embraced the various recreational facilities and rest areas included in preliminary design concepts.⁶⁵ By 1975 the USDOT had approved the Glenwood Canyon route, signaling completion of another important project milestone.

⁶⁴ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report* (prepared for Colorado Department of Highways and Federal Highway Administration, April 1980), 53.

⁶⁵ Colorado Division of Highways, *An Analysis of Design Concept Studies: Interstate 70 Through Glenwood Canyon, Project I 70-2(11), Dotsero-West*, 56.

C. Opposition and proposed scenic corridor designation

Despite efforts by the CDOH to balance transportation needs with environmental concerns, certain individuals and groups remained opposed to putting I-70 through Glenwood Canyon and were not satisfied with preliminary design concepts. In 1974, in response to the preliminary design options that put a four-lane highway through the narrow canyon, a group of citizens led by Aspen resident Mark Skrotzki formed an advocacy group called Citizens for Glenwood Canyon Scenic Corridor. Skrotzki had many contacts and was well-positioned to organize such an advocacy group. He worked at the Aspen Educational Research Foundation, was a member of many professional societies and organizations, and was active member of the Roaring Fork Valley Sierra Club. Skrotzki also enlisted the support of former Interior Secretary Stewart Udall and singer/songwriter John Denver. He created a national petition for submission to the governor and in the cover letter expressed the overarching concern of the citizen group: “It is impossible to put such a highway through this canyon without permanently scarring the several million year old unique geologic formations and further disrupting the Colorado River headwaters.”⁶⁶ He called for a two-lane road through the canyon but was amenable to some aspects of the design concept put forth by Gruen Associates, agreeing that if constructed, the use of tunnels and an elevated structure were preferable.⁶⁷ Members petitioned to have Glenwood Canyon designated as a “scenic corridor” instead of its existing designation as a “transportation corridor.” Obtaining the designation would enable designers to stray from Interstate Highway design standards for Glenwood Canyon, such as the requirement for a four-lane highway.⁶⁸ However, Richard Prosenice, then District Engineer for the CDOH, maintained that due to safety and traffic concerns, the new highway through Glenwood Canyon must be a four-lane roadway.⁶⁹ To bring further attention to their cause, John Denver staged a media event in the mid-1970s where he threw a rock across the canyon waters to demonstrate its narrowness (albeit he was not successful until the sixth attempt) and the need for a two-lane road.⁷⁰

Over the next few years groups like the Colorado Open Space Council, Colorado White Water Association, Sierra Club, Rocky Mountain Center on Environment, Environmental Defense Fund, and Mark Skrotzki’s Citizens for Glenwood Canyon Scenic Corridor spoke out regarding the Glenwood Canyon project.⁷¹ A consensus amongst most interested parties eventually formed around the idea of I-70 extending through Glenwood Canyon and the focus shifted toward achieving the best and most environmentally sensitive design.⁷² Many viewed the Gruen Associates design concept by Edgardo Contini as innovative, creative, and a great starting point for achieving their goal. Governor Richard

⁶⁶ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 126, 133.

⁶⁷ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 126.

⁶⁸ Harner, “The Delicate Salvation of Glenwood Canyon,” 26; Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 125–26.

⁶⁹ Dan and Joe Lewandowski, “A Canyon Farewell,” *Colorado & the Rocky Mountain West*, February 1979, 27.

⁷⁰ Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 296–97.

⁷¹ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 126.

⁷² Philpott, *Vacationland: Tourism and Environment in the Colorado High Country*, 294–95.

Section 4
Planning I-70 through
Glenwood Canyon, 1970-1979

Lamm eventually spoke out in favor of the scenic corridor designation and believed design elements such as a terraced roadway would help preserve the surrounding environment.

In 1975 Congress designated Glenwood Canyon as a scenic corridor and in 1976 President Gerald Ford signed the Surface Transportation Act, which granted the I-70 Glenwood Canyon project certain variances from otherwise strict design standards.⁷³ That same year, in anticipation of ongoing public interest in the project, the CDOH published the first issue of an external publication called *Canyon Echos* (see Figure 8). The publication was dedicated to providing periodic updates about the project, public hearing notices, decisions, information on people involved in the project, a forum for letters to the editor, and discussion regarding project-related activities and decisions. *Canyon Echos* represented a shift in thinking and practice by the CDOH when it came to public involvement and public engagement.⁷⁴



Figure 8. The CAC and a schematic of the proposed four-lane Interstate Highway is shown on the cover of this 1977 edition of *Canyon Echos*.⁷⁵

⁷³ Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 201.

⁷⁴ Rebhan, "Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon," 88–89; Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 131.

⁷⁵ *Canyon Echos* 1, no. 8 (January 1977).

D. Final design phase

Major considerations for the final design included aesthetics and viewsheds, recreation opportunities, preservation of the river and canyon ecology, safety, and dealing with inevitable construction difficulties. In 1977 Joseph Passonneau and Edgardo Contini were selected as the design team for the new four-lane super highway through Glenwood Canyon and faced the daunting task of accounting for all of the environmental concerns expressed since discussions about the project began more than 15 years earlier. Passonneau was both an architect and engineer and worked for the firm Daniel, Mann, Johnson & Mendenhall (DMJM). By the time he was hired to design the western half of I-70 through Glenwood Canyon, he had more than 22 years of experience in architecture, landscape architecture, and civil engineering and was a highly respected highway designer. His resume included chief of architectural design for the Tennessee Valley Authority and a building program consultant for the U.S. State Department abroad and the National Park Service in the U.S. Contini emigrated to the U.S. in 1939 from Italy and served in the U.S. Army Corps of Engineers during World War II. He also was an architect and engineer, and in 1951 co-founded Gruen Associates. He was responsible for national and international planning and engineering at the firm and played a large role in the drafting of the Gruen Associates design concept for I-70 submitted in 1974.⁷⁶

Passonneau and Contini worked on the design for nearly a year; Passonneau designed the western half of the canyon, west of the Shoshone Hydroelectric Power Plant, and Contini focused on design of the eastern half. Contini came up with the idea to use elevated roadways to protect vegetation and the auto-free zone at the Hanging Lake Trailhead. Passonneau created the terraced alignment that enabled the highway to fit into the narrow canyon and the overhang design atop retaining walls that softened the appearance of the concrete wall with shadows and created the illusion of a shorter wall.⁷⁷ Their draft report was made available to the public in October 1978. After a 45-day comment period, 86 percent of public comments were in favor of the design. The USDOT approved the draft design in September 1979 and the project moved into the final design phase.

The final design for I-70 through Glenwood Canyon was a collaborative effort. Prosenice hired Ralph Trapani to serve as the CDOH project manager; Trapani graduated from the University of Colorado and was just 28 when he was put in charge of the I-70 through Glenwood Canyon design team (see Figure 9).⁷⁸ He also had backgrounds in both civil engineering and architecture. The project benefited from having multiple architect/engineers as key collaborators. Prior to the Glenwood Canyon project, Trapani had worked on the Vail Pass project and aimed to implement lessons learned for the Glenwood Canyon project, such as protective measures for natural features and trees and stiff fines for contractor violations.⁷⁹ Other notable contributors included the firm De Leuw, Cather & Company, which oversaw

⁷⁶ Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 149–52.

⁷⁷ Peter Caughey, "A Road Runs Through It," *Summit Magazine* 12, no. 3 (Winter -1995 1994): 12.

⁷⁸ Caughey, "A Road Runs Through It," 9; Stroud, "'Father of Canyon' Part of Important Transition," 20.

⁷⁹ Caughey, "A Road Runs Through It," 9–11.

Section 4
Planning I-70 through
Glenwood Canyon, 1970-1979

design of the interchanges and landscaping, and Daniel, Mann, Johnson & Mendenhall, which served as a management consultant for more administrative project-related matters and traffic control.⁸⁰



Figure 9. The design team conducts site visit to Glenwood Canyon in 1980.⁸¹

At an initial project cost of \$300 million, the final design included a terraced highway built above the canyon floor whereby the westbound lanes are situated above the eastbound lanes, several tunnels, four rest areas, and specific measures to preserve the natural canyon environment such as painting construction scars on canyon walls to match the natural rock and replanting thousands of trees and shrubs.⁸² After years of public debate and the precedent of Vail Pass, Trapani reminisced in a 1995 *Summit Magazine* article that with the Glenwood Canyon project, the roles of engineers and environmentalist ultimately switched: “The old, hard-line highway engineers were walking around worrying about saving trees and not filling in the river, and the environmentalists were worried about costs and safety” (see Figure 10).⁸³

⁸⁰ Haley, *Wooing A Harsh Mistress: Glenwood Canyon’s Highway Odyssey*, 240–41.

⁸¹ “Architects Report Bridge Study,” *Canyon Echos* 2, no. 1 (Spring 1980): 7.

⁸² Conrad F. Schader, *Glenwood Canyon: From Origin to Interstate* (Golden, Colo.: Regio Alta Publications, 1996), 148–51.

⁸³ Caughey, “A Road Runs Through It,” 10–11.

Section 4
Planning I-70 through
Glenwood Canyon, 1970-1979

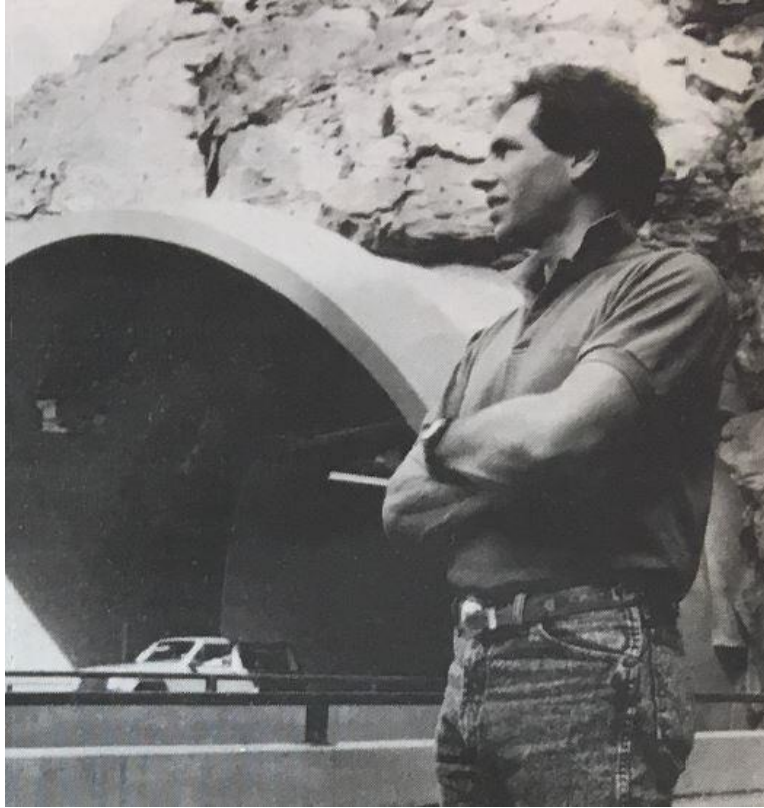


Figure 10. CDOH Project Manager Ralph Trapani oversaw construction of the massive highway project.⁸⁴

⁸⁴ John Stroud, "Canyon Project a Trial by Fire for Trapani," *Glenwood Post*, October 9, 1992, 8.

5. Significant Design, Engineering, and Management Innovations, 1980-1992

Construction of I-70 through Glenwood Canyon began in 1980 and was officially opened to traffic on October 14, 1992. The 12.5-mile long canyon is over 2,000 feet deep and its narrow width provided a limited amount of on-site material resources for construction, such as backfill or gravel, few places for disposing of unused materials, and limited space for building a new four-lane Interstate Highway. The canyon also had minimal space for maneuvering the construction equipment and vehicles needed to complete the project. Little geologic testing in the canyon occurred before 1980, which resulted in some surprises during construction. The east end of the canyon had an underlying layer of gray, silty, goopy material that behaved like, as Trapani put it, a “tube of toothpaste;” as soon as weight was added, the material began squeezing out. There were also very large boulders buried just below proposed sites for bridge piers and 25 feet below talus slopes where engineers discovered cave-like geologic voids. As such, construction of I-70 through Glenwood Canyon required a number of design and engineering innovations, some of which had never been utilized in the U.S. Project planners also used several innovative management solutions to achieve a transportation facility that met traffic and safety needs with minimal impacts to the natural environment of the canyon.⁸⁵

A. Logistical planning for construction

Building I-70 through Glenwood Canyon was conceived as a multi-stage construction program. Work was concentrated in select areas at certain stages to keep traffic moving through the narrow canyon and to accommodate the movement of equipment and materials adjacent to and above traffic. Multiple contractors worked on the project simultaneously, with approximately 200-300 contractor personnel involved with the project.

The CDOH utilized a cooperative traffic maintenance program to move motorists, construction workers, and equipment through the canyon during construction. During the day, one lane of US 6 was used for construction vehicles and the other for one-way highway traffic. Normal daytime operations allowed up to 250 vehicles through at a time and the maximum delay was usually only 20 to 30 minutes. Although the work zone included multiple contractors, it was operated as a single system, which meant motorists only experience one delay rather than multiple delays. At night, the road opened to two-way traffic.⁸⁶

Logistical planning included identifying areas where natural materials could be recycled. For example, dirt and rocks excavated for tunnels were used as backfill material behind retaining walls and leftover boulders from rock excavations were used for landscaping throughout the canyon. Plans called for construction of retaining walls and bridges to be performed concurrently so earthwork could be staged

⁸⁵ Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, Interstate 70, Glenwood Canyon, The Final Link, 8, Available at Colorado Department of Transportation; Caughey, “A Road Runs Through It,” 12.

⁸⁶ Walter D. Munn, “Glenwood Canyon - A Showcase of Innovation,” *Highway & Heavy Construction*, no. May (1986): 31–32; Claude Powe, “An Articulated Gantry Pivots Into the Curves,” *Engineering News-Record*, July 7, 1988, 36.

and excavation from one structure used to backfill another; this reduced the need to stockpile natural building materials and limited the amount of material to be moved.⁸⁷ The CDOH developed innovative “flex posts” to absorb the impact of falling rocks and protect the roadway. Each post was composed of bundled strands of flexible steel encased in a steel pipe and set into a concrete foundation. Fencing of ordinary wires extended between the posts and enabled them to bend under pressure without permanently damaging or deforming the posts.⁸⁸

B. Sensitive landscape implementation measures

Prior to construction, landscape architects and university professors from Colorado State University in Fort Collins collected baseline vegetation data to develop an inventory of all plant species. The ultimate goal was to stabilize disturbed soils and restore the appearance of the natural environment in an authentic and ecological manner.⁸⁹ Landscape architects also developed a table of monetary damages based on the size, age, and species of the tree or plant, which was used to determine the fine amount imposed on contractors that violated directives to avoid trees and shrubs. Sample penalties included \$30 for raspberry bushes, \$45 for scrub oak, and \$22,000 and up for blue spruce and cottonwood trees. If a contractor willfully destroyed vegetation, they could be fired from the project. Over the course of 12 years, fines totaled less than \$150,000 and all were due to accidents.⁹⁰

Clear physical limits for construction activities were also established up front, which restricted work areas, access, and staging areas. The CDOH and Trapani were intent on preventing contractors from inadvertently destroying vegetation adjacent to the highway as had happened during the Vail Pass project. With the Vail Pass project ribbons were tied around trees with the hope that bulldozers would avoid them; with the Glenwood Canyon project, construction workers built fences around trees and vegetation, tagged them, and posted signs with lettering stating: “save this tree.”⁹¹

⁸⁷ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 30.

⁸⁸ Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 9.

⁸⁹ P.K. Graham De Leuw, Cather & Company, *The Early Years: Glenwood Canyon Revegetation Design, 1976-1981*, n.d., 1–2.

⁹⁰ Caughey, “A Road Runs Through It,” 11–12; A. Ray Chamberlain and Carl T. Sorrentino, “I-70 Through Glenwood Canyon: ‘Showcase’ Public Architecture of the 20th Century,” *AASHTO Quarterly* 70, no. 2 (April 1991): 5.

⁹¹ Caughey, “A Road Runs Through It,” 11.

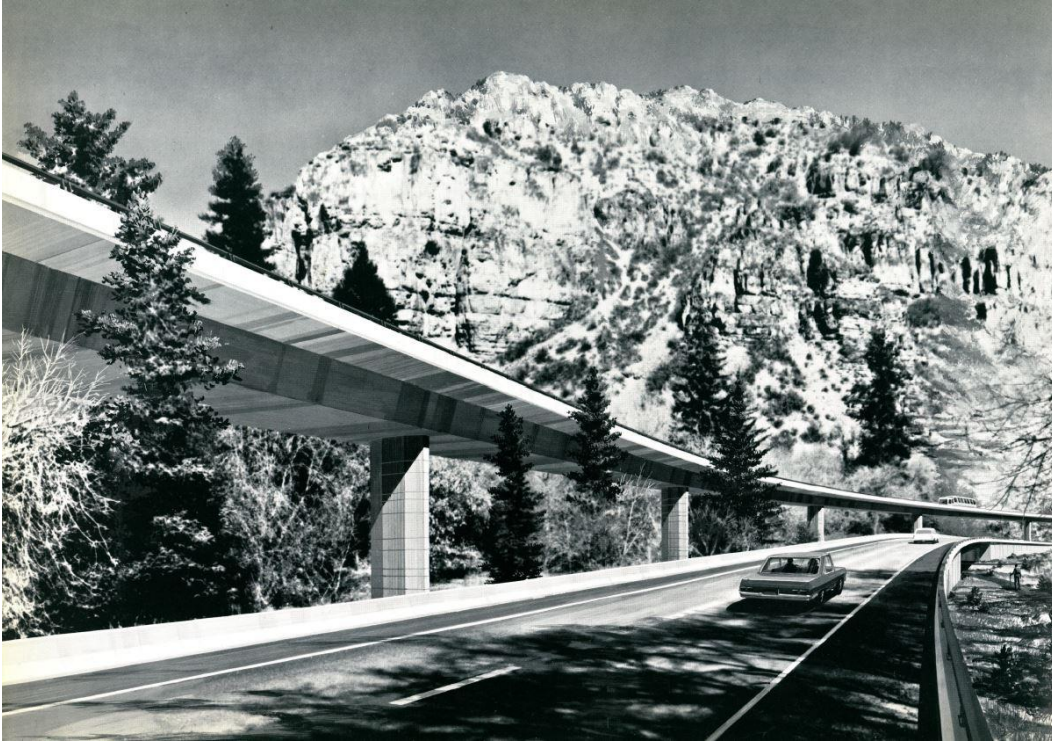


Figure 11. Sketch illustrating how landscape designers envisioned the integration of the highway with the natural environment.⁹²

Additionally, CDOH engineers worked with landscape architects to integrate aesthetic considerations into various features of the Glenwood Canyon (see Figure 12). Where blasting was necessary, explosives were placed strategically so it would result in no visible evidence of such activity. Any newly exposed rock faces were painted with an “ager” stain to give them a weathered appearance; this dye consisted of a photo-chemical dye that darkened in the sunlight.⁹³ Leftover boulders from blasting were eventually used for landscaping or placed in the river to enhance fish habitat. Grading operations to recreate stable slopes for revegetation and the alignment of bridges were often adjusted by inches to avoid disturbing natural features.

⁹² Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 68.

⁹³ Munn, “Glenwood Canyon - A Showcase of Innovation,” 31.



Figure 12. Example of successful integration of the highway into existing landscape. Mead & Hunt, Inc. photograph.

Special plant-growing contracts were awarded to nurseries to ensure an adequate supply of plant material. The project ultimately required 150,000 new plants and irrigation systems were installed to make sure they became well established within the landscape. One of the largest nurseries in the state was established at Dotsero for growing replacement trees and shrubs.⁹⁴ Test plots were used to simulate the various conditions found throughout the canyon and to field test planting techniques proposed for use during revegetation efforts. Preservation and revegetation of the natural environment also enabled the reintroduction of bighorn sheep into the canyon as a result of the project; the Colorado Division of Wildlife had removed the resident herd in the 1970s due to a growing issue of vehicle striking the animals. In the early 1990s the agency transplanted herds from Estes Park and Gunnison to Glenwood Canyon.⁹⁵

C. Bridge design

Thirty-nine bridges were constructed on the Glenwood Canyon segment of I-70 (see Table 1). Bridges were not built solely for river or stream crossings; where there were natural draws or side hills, designers chose bridges over high fills or retaining walls that would destroy or detract from the natural environment. Bridges were designed and constructed in a manner that enabled the natural landscape to sweep underneath the structures. For this reason, both the substructures and superstructures for bridges were

⁹⁴ Colorado Department of Transportation, *I-70 Glenwood Canyon, The Final Link: Fun Facts*, Press Release (Available at Colorado Department of Transportation, N.d.); Chamberlain and Sorrentino, "I-70 Through Glenwood Canyon: 'Showcase' Public Architecture of the 20th Century," 5.

⁹⁵ McGregor, *A Guide to Glenwood Canyon*, 3; P.K. Graham De Leuw, Cather & Company, *The Early Years: Glenwood Canyon Revegetation Design, 1976-1981*, 1-2.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

an important design consideration for the CDOH. The planning and design process included erection of full-size plywood models of bridges and piers at their proposed locations to enable visualization of impact on viewsheds prior to construction.⁹⁶

Table 1. Bridges built between mileposts 118.5 and 130.3

| Bridge Type | Abbreviation | Quantity | Structure Number | Milepost | Feature Crossed |
|---|--------------|----------|------------------|----------|----------------------------|
| Concrete box girder, prestressed | CBGP | 3 | F-07-AX | 120.192 | Hillside |
| | | | F-07-AZ | 121.128 | Grizzly Creek |
| | | | F-08-AG | 121.82 | Hillside |
| Concrete box girder, continuous prestressed | CBGCP | 3 | F-07-AW | 119.72 | Hillside |
| | | | F-08-AK | 124.401 | Wagon Gulch |
| | | | F-08-AY | 128.317 | Draw |
| Concrete box girder, continuous | CBGC | 14 | F-07-AO | 120.525 | Deer Park Depression |
| | | | F-07-AP | 120.644 | Deer Park Depression |
| | | | F-07-AQ | 120.712 | Deer Park Depression |
| | | | F-07-AU | 120.925 | Ramp, Draw |
| | | | F-07-AR | 120.921 | Ramp, Draw |
| | | | F-07-AV | 120.988 | Hillside |
| | | | F-07-AT | 120.989 | Hillside |
| | | | F-08-AC | 121.256 | Ramp |
| | | | F-08-AW | 121.22 | Ramp, Grizzly Creek, Draw |
| | | | F-08-AF | 121.4 | Hillside |
| | | | F-08-AU | 127.497 | French Creek |
| | | | F-08-AE | 128.284 | Road, Draw |
| | | | F-08-AD | 128.272 | Road, Draw |
| | | | F-08-AZ | 1280.317 | Road, Draw |
| Concrete box girder, segmented | CBGS | 10 | F-07-AK | 119.609 | Hillside |
| | | | F-07-AL | 119.712 | Hillside |
| | | | F-07-AN | 120.228 | Hillside |
| | | | F-08-AB | 121.125 | Access Road, Grizzly Creek |
| | | | F-08-AA | 121.094 | Grizzly Creek |
| | | | F-08-AS | 125.805 | Railroad, Colorado River |
| | | | F-08-AR | 125.812 | Railroad, Colorado River |
| | | | F-08-BJ | 125.963 | Hillside |

⁹⁶ Chamberlain and Sorrentino, "I-70 Through Glenwood Canyon: 'Showcase' Public Architecture of the 20th Century," 5; Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 18; Hermann Guenther, "Memo Regarding Glenwood Canyon Facts and Costs," October 2, 1992, Colorado Department of Transportation.

Table 1. Bridges built between mileposts 118.5 and 130.3

| Bridge Type | Abbreviation | Quantity | Structure Number | Milepost | Feature Crossed |
|--------------------------------------|--------------|----------|------------------|----------|--------------------------------|
| | | | F-08-AV | 127.152 | Hillside |
| | | | F-08-BH | 127.461 | French Creek |
| Steel box girder, Continuous | SBGC | 4 | F-08-BA | 121.398 | Colorado River |
| | | | F-08-AH | 122.614 | Access road, Colorado River |
| | | | F-08-AI | 122.622 | Access road, Colorado River |
| | | | F-08-BC | 122.66 | I-70, Colorado River |
| Welded girder continuous & composite | WGCK | 5 | F-08-AL | 124.684 | Colorado River |
| | | | F-08-BI | 124.967 | Ramp, Railroad, Colorado River |
| | | | F-08-AM | 125.014 | Ramp, Railroad, Colorado River |
| | | | F-08-AN | 125.081 | Colorado River |
| | | | F-08-BD | 126.986 | Colorado River |

(1) Substructure design in Glenwood Canyon

Bridges in Glenwood Canyon crossed various landforms, including talus slopes and rock formations. At select locations existing bridge foundation material consisted of layers of river gravel, clay, and boulders that could not carry the heavy loads of a modern Interstate Highway; these materials were also problematic for traditional methods of pile-driving and drilling caissons. Engineers solved this problem through a method called core-drilling that enabled detonation of explosives in a confined space, creating an interior column of debris through which steel “H” piles could be easily driven. Another technique used to stabilize bridge foundations and address settlement, a potentially catastrophic event for a large-scale bridge, was injecting grout into talus slopes to create a single mass of material to support loads.⁹⁷

Designers also utilized single-column piers for all bridges throughout the canyon. The majority of piers were rectangular and approximately 10 feet wide. The use of tall open piers instead of the typical treatment involving major fill and culverts for drainage minimized visual effects to the natural landscape and enabled wildlife to cross underneath the highway. Piers were rusticated with deep grooves spaced in random patterns to reflect the patterns on rock joints within the canyon and had a warm tan or light brown color (see Figure 13). This approach minimized visual impacts from approach roadways, the river, and the Glenwood Canyon Bike Path. Designers also developed a pier cap integrated with exterior steel girders to give the illusion that outer girders float between piers.⁹⁸

⁹⁷ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 19.

⁹⁸ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 19, 82–83.

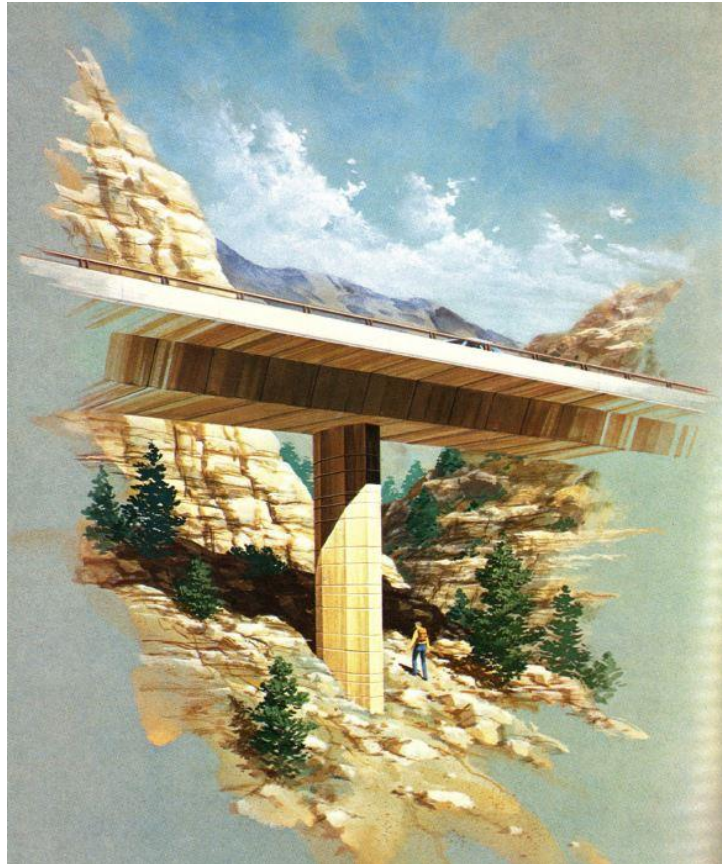


Figure 13. Design concept for piers incorporating rusticated detail and grooves to match nearby canyon walls and geologic features.⁹⁹

(2) Superstructure design in Glenwood Canyon

Preliminary planning activities for bridges through Glenwood Canyon were conducted in four phases and considered the length, function, and location of bridges based on environmental, architectural, structural, and economic factors. Phase 1 of preliminary bridge studies identified and evaluated feasible bridge types in both typical and special study areas within the canyon. Phase 2 evaluated bridge types identified in Phase 1 in more detail and concluded with recommendations for bridge types by location. Phase 3 evaluated the compatibility of bridge design with other roadway elements. Considerations for bridge types at specific locations was based on topography, geology, vegetation, existing and proposed adjacent land use, architectural design and visual appearance, potential construction problems, cost, traffic control, and the impact on the Colorado River. Phase 4 included preparation of a bridge type study report prepared by HNTB, nationally recognized bridge and highway engineering consultants.¹⁰⁰

⁹⁹ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 82.

¹⁰⁰ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, summary page.

Four bridge types generally met project needs and the various criteria used to analyze options. These types included steel girder, steel box girder, segmental concrete box girder, and cast-in-place concrete box girder. The project ultimately included fabrication and erection of bridges that ranged in length from 85 feet to 6,397 feet.¹⁰¹ Bridge types constructed included steel box girders, welded steel girders, and concrete box girders, including segmental, continuous, and prestressed examples; cast-in-place bridges were not chosen in the interest of maintaining the project schedule because they required longer curing times during colder months. The CDOH hired HNTB to prepare a bridge design manual as standard guide for all designers of project bridges.¹⁰²

(3) Steel box girders

Advances in steel bridge technology in the U.S. during the late 1960s included developments in metallurgy, engineering, and computer science. Engineers began to design complex and customized designs for long-span steel girders, particularly with horizontally curved box girders that became useful in building bridges in urban areas where bridges spanned industrial yards or near dense neighborhoods. The type had similar benefits in mountain environments where minimizing impacts to the landscape became important to meet environmental demands.¹⁰³ This bridge type was utilized for the Vail Pass segment of I-70 and was also selected as the bridge type used for four structures in Glenwood Canyon. This bridge type was chosen due to its well-defined lines and lack of exterior stiffeners or bracing found on other steel bridge types that can detract from the surrounding environment.¹⁰⁴

Steel box girders enabled variable span lengths, could be curved to follow the natural contours of the canyon and river, and enabled long spans and a shallow depth that gave the bridges a graceful appearance. Steel could also be erected in the winter and left unpainted to weather and achieve a dark brown color, which complemented the surrounding canyon environment.¹⁰⁵ The lengths of the continuous steel box girder structures through Glenwood Canyon ranged from 787 feet to 1,496 feet. The bridges were designed to be continuous across piers and featured twin trapezoidal boxes made of weathering steel (see Figures 14 and 15).¹⁰⁶

¹⁰¹ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 23, 33, 45, 51, 57, 67, 73; Bridge Management System Unit, *Field Log of Structures* (Prepared for the Colorado Department of Transportation, May 2005), 71, file:///C:/Users/1013tss/Downloads/Final%20Field%20Log%20to%20Web.pdf.

¹⁰² Haley, *Wooring A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 183.

¹⁰³ Subcommittee on Curved Girders: Joint AASHO-ASCE Committee on Flexural Members, "Survey of Curved Girder Bridges," *Civil Engineering - ASCE* 43, no. 2 (February 1973): 54–55.

¹⁰⁴ Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 12; Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 11.

¹⁰⁵ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 11.

¹⁰⁶ Bridge length information is derived from the FHWA's 2018 National Bridge Inventory (NBI) data for structures maintained by the Colorado Department of Transportation.

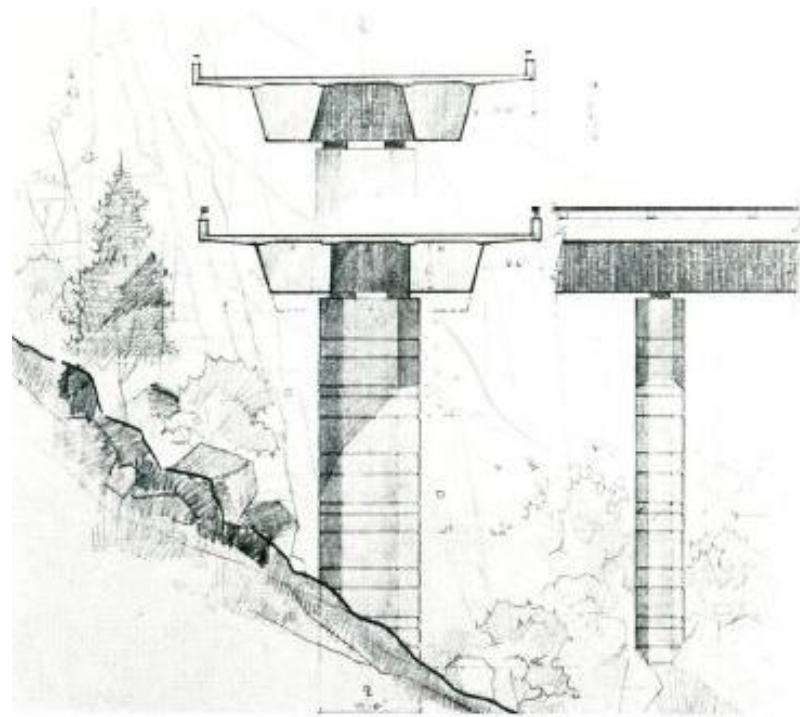


Figure 14. Rendering illustrating cross section and side view of twin steel box girders.¹⁰⁷



Figure 15. View of twin steel box girders near the Shoshone Rest Area. Mead & Hunt, Inc. photograph.

¹⁰⁷ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 69.

(4) Welded steel girders

Welded steel plate girders were a common and economical choice that provided many advantages. Steel plate girders were pre-fabricated off-site and enabled variable span lengths and girder depths, and could be curved to fit the desired road alignment within the narrow canyon. Similar to steel box girders, welded steel plate girders could also be erected in cold weather and, over time, their unpainted surface achieved a brown, weathered look that complemented the surrounding canyon. Welded steel plate girder bridges built in Glenwood Canyon generally had four girders and range in length between approximately 630 and 1,512 feet.¹⁰⁸ As shown in Figures 16 and 17, one bridge of this type erected at Hanging Lake featured variable depth girders, measured approximately 960 feet, and curved to cross the off-ramp, railroad, and river.¹⁰⁹



Figure 16. Welded steel girders on at the west portal of the Hanging Lake tunnels featured variable depth girders. Mead & Hunt, Inc. photograph.

¹⁰⁸ Bridge length information is derived from the FHWA's 2018 NBI data for structures maintained by the Colorado Department of Transportation.

¹⁰⁹ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 8.



Figure 17. Welded steel plate girders enabled the structure to curve in order to follow the contours of the canyon wall and Colorado River. Mead & Hunt, Inc. photograph.

(5) Concrete box girders

The Glenwood Canyon segment of I-70 features three types of concrete box girders, including continuous, prestressed, and segmental examples. Continuous examples range in length from 177 feet to 1,204 feet and prestressed examples include structures with lengths between 89 feet and 338 feet. The concrete segmental box girders used in Glenwood Canyon range in length between approximately 219 and 6,397 feet.¹¹⁰ At the time, concrete segmental box girders were still a relatively new type in the U.S., although they had been constructed along the Vail Pass segment of I-70 just a few years prior.¹¹¹ Segmental concrete box girder bridges were initially designed and built in Europe after World War II. With steel production facilities still recovering from the war, prestressed concrete became the preferred material to quickly rebuild hundreds of major bridge structures destroyed during the war. The U.S. began to adopt the type in the late 1960s, as highway departments across the country were designing the Interstate Highway System, requiring the construction of thousands of concrete and steel bridges to FHWA standards. By 1979 at least 24 precast segmental bridge projects were completed in the U.S., including Vail Pass, indicating the beginning of the widespread adoption of the bridge type by this time.¹¹²

¹¹⁰ Bridge length information is derived from the FHWA's 2018 NBI data for structures maintained by the Colorado Department of Transportation.

¹¹¹ Austin B. Milhollin and Cade L. Benson, "Structure Design and Construction on the Vail Pass Project," *Transportation Research Record* 717 (1979): 31.

¹¹² Walter Podolny Jr., "An Overview of Precast Prestressed Segmental Bridges," *PCI Journal*, n.d., 62, http://www.pci.org/uploadedFiles/Siteroot/Publications/PCI_Journal/1979/DOI_Articles/jl-79-january-february-4.pdf.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

Each single-cell box girder measures nine feet long, six feet deep, 16 feet across the bottom, and 19 feet across the top (see Figures 18 and 19). Each segment had nine-foot cantilever wings to hold the bridge deck that measures 37 feet wide.¹¹³

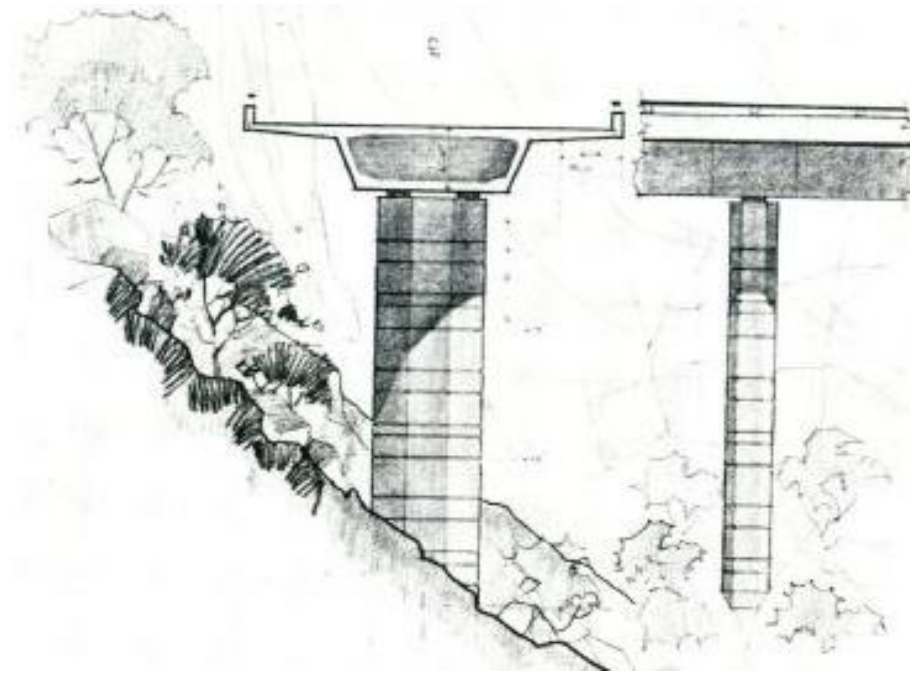


Figure 18. Illustration showing cross section of segmental concrete box girder and side view of the bridge set on a single pier in Glenwood Canyon.¹¹⁴

¹¹³ Munn, "Glenwood Canyon - A Showcase of Innovation," 37.

¹¹⁴ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 11.



Figure 19. Segmental concrete box girder located just west of Reverse Curve Tunnel, view facing northeast. Mead & Hunt, Inc. photograph.

A major advantage of concrete segmental box girders over other types was in the method of construction. Building this type of span over rugged terrain such as Glenwood Canyon did not require falsework and minimized ground disturbance; pre-cast concrete segments were delivered to the site and assembled progressively, with the piers providing the needed support for balancing the cantilevered girders from either end of the pier and connecting them in matched pairs. After the girders were connected to a single pier, the sections between piers were joined together. The procedure was repeated until the sections were constructed and supported by end spans and abutments. The method used to join the sections together was post-tensioning, which involves laying cables within the concrete forms but not tightening the cables until after the concrete had hardened. Post-tensioning closed the gaps between the cantilevered spans. The post-tensioning method became predominant in the U.S. after 1965.¹¹⁵

Many of the concrete segmental bridges in Glenwood Canyon were fabricated in segments off-site at the Flatiron Structures Company's casting yard in Eagle, Colorado. Bridge segments were full-width, 37.5-foot sections and weighed 40 to 55 tons. Bridge segments were transported to the job site on trucks and were lifted into place using a gantry or large crane (see Figure 20). Although this bridge type and construction method was used on Vail Pass, construction of concrete segmental bridges in Glenwood Canyon utilized a different method in response to the sensitivity of the surrounding environment, the

¹¹⁵ Juan A. Murillo, "Modern Bridge Construction and Engineering Services," in *Managing Innovation: Cases from the Services Industries*, ed. Bruce R. Guile and James Brian Quinn (Washington, D.C.: National Academies, 1988), 166; Milhollin and Benson, "Structure Design and Construction on the Vail Pass Project," 31–32; De Leuw, Cather & Company, *Highway Construction Techniques, Working Paper*, Glenwood Canyon I-70 Design Process Working Paper: (Prepared for the Colorado Division of Highways, October 6, 1976), 38.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

minimal space available for moving large equipment, and the need to avoid major traffic disturbances. A specially designed gantry was imported from France for erection of the bridges at French Creek and Hanging Lake. The 350-foot-long, 105-foot-tall, erection gantry was essentially a horizontal crane with four pairs of legs that could be moved between piers. The gantry could also turn on its center legs, enabling it to pivot around trees and geologic features, and lift bridge segments into place from above. This method had been used previously in Austria but was the first time used in the United States. Once each of the bridge segments was in place they were secured with post-tensioning. This method reduced impacts to the environment during construction and shortened construction time since the segments were precast before being assembled on the site.¹¹⁶

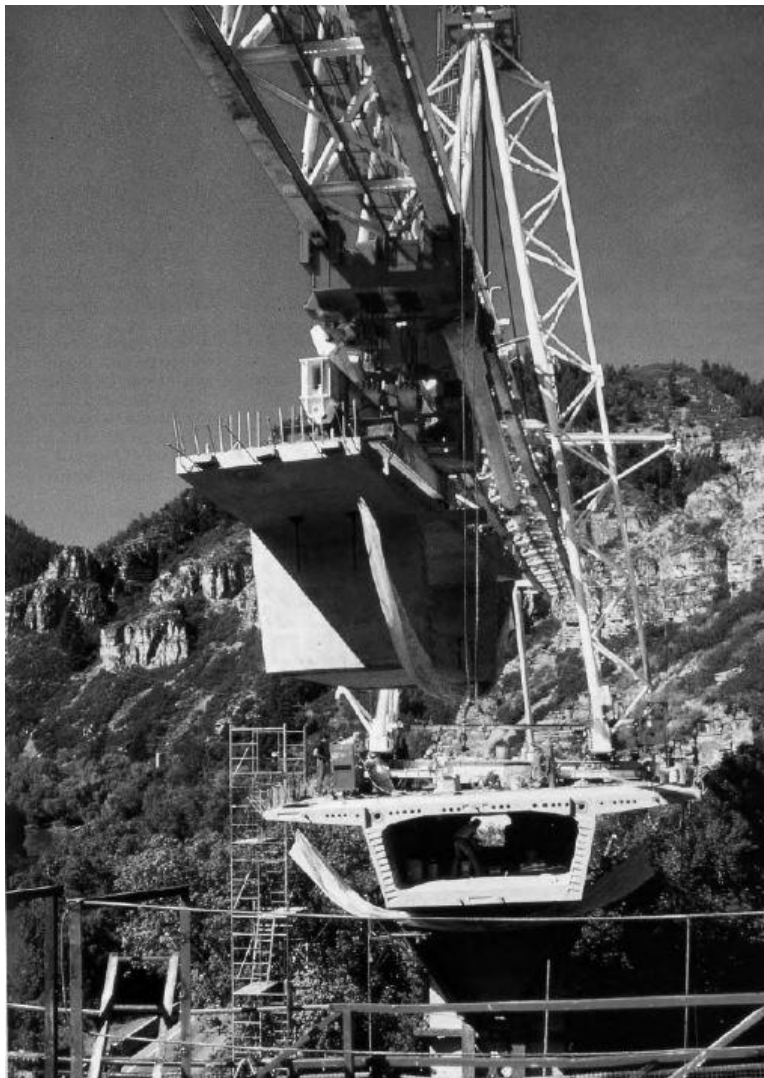


Figure 20. An erection gantry pivots a segmental concrete box girder into place in Glenwood Canyon.¹¹⁷

¹¹⁶ Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 245–55; Schader, *Glenwood Canyon: From Origin to Interstate*, 162–63; Rebhan, “Designed by Nature: Transportation, Tourism, and the Transformation of Glenwood Canyon,” 103–4; Powe, “An Articulated Gantry Pivots Into the Curves,” 34–35.

¹¹⁷ John Prendergast, “Pioneer Highway,” *Civil Engineering* 63 (1993): 37.

During construction of segmental concrete box girder bridges near Hanging Lake, the former two-lane US 6, located below the bridges, had to remain open to through traffic. To achieve this the four-span superstructure was supported by outrigger or “straddle piers,” each spanning approximately 28 feet, that enabled construction above live traffic. These temporary piers were not compatible with other single piers built throughout the project and they were removed and eventually replaced with single piers to match the others.¹¹⁸

D. Terraced roadway

The final terraced design of the I-70 roadway with two lanes situated above and off-center (by varying distances depending on the topography) to two additional lanes below achieved several project objectives. The terraced roadway enabled the road to remain open during winter months; the double-decked design proposed by Vollmer Associates would have left the lower lanes in complete shade and covered in snow and ice during inclement weather, which posed issues to safety and efficient travel through the canyon. The design also required less encroachment on the river and narrowed the “footprint” of the roadway through the canyon. The roadway itself, the travel surface placed on top of the bridge superstructures, was completed using post-tensioned, continuous concrete slabs that were 35 feet wide and 200 feet long (see Figure 21). The foundation materials throughout the canyon varied and included compacted earth, rock, gravel, Styrofoam, muck excavated from tunnel boring, construction debris, and bedrock in places. Structural engineers designed a roadway structure to support the traffic load no matter what the foundation materials by crisscrossing steel cables at 45-degree angles that were tensioned after the concrete was poured into the conduit or form. Where used, these post-tensioned concrete slabs provided the roadway with an operational life that far exceeded previous pavement designs. No evidence suggests this design was used elsewhere in Colorado or the country, nor is it a method used by structural engineers today.¹¹⁹

¹¹⁸ Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 12.

¹¹⁹ Haley, *Wooring A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 254-255–70; Chamberlain and Sorrentino, “I-70 Through Glenwood Canyon: ‘Showcase’ Public Architecture of the 20th Century,” 4; Abraham, Sam, Staff Bridge Branch, Region 3 Unit Leader, Colorado Department of Transportation, Correspondence with Mead & Hunt, Inc., January 9, 2019.



Figure 21. 1986 view of crews installing post-tensioned concrete roadway with steel cables crisscrossed at 45-degree angles.¹²⁰

In many places where space was limited the roadway slabs were situated on top of concrete retaining walls (discussed below) and extended beyond the outer edge of the walls by up to six feet. This cantilever design was a deliberate aesthetic choice as the overhang cast a shadow on the retaining wall surface, softening the harshness of a concrete wall, and gave the illusion that the retaining walls were shorter than their actual height of nearly 40 feet. Bridge-type parapet with weathering steel rail was constructed along the edge of the slabs for traffic safety and to maintain an unobstructed view of the canyon scenery. The terraced roadway also provided a grade separation for safety purposes (see Figures 22 and 23.¹²¹

¹²⁰ Munn, "Glenwood Canyon - A Showcase of Innovation," 36.

¹²¹ Munn, "Glenwood Canyon - A Showcase of Innovation," 36; Powe, "An Articulated Gantry Pivots Into the Curves," 36.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992



Figure 22. 1979 rendering of terraced roadway with retaining walls and landscaping. Note the shadow cast on the retaining wall by the cantilevered roadway; this was an aesthetic choice to soften the visual impact of the retaining wall.¹²²

¹²² Colorado Division of Highways District Three, *Glenwood Canyon I-70 Project I70-2(70), Design Report* (Prepared for Colorado Department of Highways and Federal Highway Administration, March 1979), 2.



Figure 23. View showing terraced roadway, retaining wall, and cantilevered overhang with shadow. Note the location of the recreational path below the cantilevered eastbound travel lanes. Mead & Hunt, Inc. photograph.

A consistent system of median and shoulder barriers was another factor considered by designers for both safety and aesthetic reasons. Achieving visual continuity and minimal distraction from the surrounding scenery was of utmost importance to designers. Moreover, these permanent traffic barriers enabled trees, rocks, and other natural features to be as close to the road as possible without becoming obstacles. The New Jersey type of concrete barrier served as a basis for their design. Modifications included a non-standard barrier that was not full height with a railing added to provide containment characteristics for the upper portion of the barrier; this helped maintain unobstructed views of the natural scenery at high speeds and facilitated a stronger connection between drivers and their natural surroundings.¹²³

E. Tunnels

A total of three tunnels were constructed as part of the project. Blasting techniques for the twin-bore tunnels at Hanging Lake consisted of drilling holes in a staggered pattern along prominent joints in existing rock formations, then packing the holes with dynamite and blasting the rock. The result was portals that appeared to be naturally occurring cuts in the rock. Crews also rappelled along canyon walls to knock loose any boulders that posed a danger to motorists, which resulted in canyon walls that simulated a natural, erosive appearance. Design for the tunnel portals included parabolic curves that created distinct shadow lines to highlight and complement the jagged geologic formations within the canyon. The cast-in-place concrete tunnel portals also included large protective “lips” along their top

¹²³ Gerald E. Arndt, *Shoulder/Median Barrier System in Glenwood Canyon* (prepared for Glenwood Canyon Phase Two Design Team by De Leuw, Cather & Company, July 6, 1977), 1–2.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

edge to protect motorists from falling rock (see Figure 24). The well-lit interiors were finished with a light-brown-colored ceramic tile to complement the natural setting. The twin tunnels constructed at Hanging Lake were state-of-the-art at the time in terms of their design and operational technology. A new construction technique used on these structures consisted of rock reinforcements, or “bolts,” placed around the circumference of the tunnels that helped reinforce existing rock surrounding the tunnel openings and provided a permanent structural support. This type of structural support was unique among other U.S. tunnels at the time and far cheaper than other existing systems that used steel and concrete arches. An incident detection and management system were also installed for monitoring traffic in the tunnels that utilized a complicated computer algorithm to enable several systems to operate simultaneously and in sync based on various types of operational, environmental, and physical condition detectors in the tunnels and along the approach roadways. The computer system estimated the time each car would enter and exit 16 traffic control zones within the tunnel; if the timing was off an incident response was issued. ¹²⁴



Figure 24. View of east portals for the Hanging Lake Tunnels, view facing west. Mead & Hunt, Inc. photograph.

While the Eisenhower Memorial Tunnel (1973) and Johnson Memorial Tunnel (1979) near Dillon utilized portal buildings for control features at each end, the Hanging Lake Tunnels instead featured a centralized control center within the hillside (see Figure 25). A complex network of sensors and cameras tied into a central control room with control panels, and computerized monitoring system. The centralized complex included numerous devices intended to help monitor traffic and environmental conditions in the tunnels,

¹²⁴ Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 10; Hermann Guenther, “Blending the Wonders of Engineering and Nature,” *TR News* 153 (April 1991): 8; Craig A. Frey, Scott L. Danielson, and Douglas M. Slakey, “Glenwood Canyon Tunnel Aesthetic Design,” *Transportation Research Record*, Transportation Aesthetics, 1996, 61–63.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

including traffic loop detectors and closed circuit television for 24-hour traffic monitoring, regular and over-height vehicle detectors, lane use signals, heat detectors, fire alarm boxes, AM/FM rebroadcast system, carbon monoxide and weather detectors, fuel oil leak detectors, and sensors for measuring ice on the roadway. The tunnels also featured eight reversible ventilation fans with a 10- to 12-foot diameter.¹²⁵



*Figure 25. View of centralized control center within the Hanging Lake Tunnel structure, which was state-of-the-art at the time.*¹²⁶

The third tunnel, a 690-foot-long structure known as the Reverse Curve Tunnel located approximately 1.3 miles east of the Hanging Lake Tunnels, served only the westbound lanes and was designed by Parsons Brinckerhoff Quade & Douglas, Inc. (see Figure 26). The rock at this location was very dry and solid and did not require supporting steel ribs; crews drilled rock bolts, sprayed concrete, and installed a concrete lining.¹²⁷

¹²⁵ Chamberlain and Sorrentino, "I-70 Through Glenwood Canyon: 'Showcase' Public Architecture of the 20th Century," 5.

¹²⁶ Joe Kracum, "The Control Center - Nerve Center for the Hanging Lake Tunnels," *Glenwood Post*, October 9, 1992, 35.

¹²⁷ Parsons Brinckerhoff, Quade & Douglas, Inc., *Glenwood Canyon Tunnels, Interstate Route I-70: Supplementary Design Report Tunnel Finish* (Prepared for the Colorado Department of Highways, March 1986), 1; Powe, "An Articulated Gantry Pivots Into the Curves," 36; Guenther, "Memo Regarding Glenwood Canyon Facts and Costs."



Figure 26. View of Reverse Curve Tunnel with eastbound roadway below, view facing west. Mead & Hunt, Inc. photograph.

F. Retaining walls and erosion control

Retaining walls in Glenwood Canyon were an important landscape design feature and aesthetic consideration. Some retaining walls held back earth and others supported the roadway. Walls were painted to match the color of the surrounding canyon walls and had applied textures such as vertical incised grooves and textured concrete block. They also reflected design solutions for stabilizing and building the roadway without permanently damaging the environment. The highway design included three types of retaining walls: tie-back and reinforced earth, both used primarily for retaining earth, and T-section concrete panels, which supported the elevated roadways at select locations and retained natural materials beneath the roadways.

Tie-back walls used small footings and were designed to limit disturbance to the environment uphill and behind the wall; this type of retaining wall featured steel anchors drilled into the canyon wall. One example consisted of a five-tier tie-back system and was the largest of its kind in the U.S. at the time.¹²⁸ One of the first steps to construct this type of retaining wall was to install temporary pre-cast concrete panels to hold back slopes during excavation and construction of footings for permanent walls (see Figure 27). Each of the precast panels weighed 1,300 pounds and measured seven feet high, eight feet long, and eight inches thick, with a four-inch diameter opening near the center. Grand Junction Pipe precast the panels and hauled them to the site where they were then put into place using a hydraulic crane. Post-

¹²⁸ Chamberlain and Sorrentino, "I-70 Through Glenwood Canyon: 'Showcase' Public Architecture of the 20th Century," 4.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

tensioned strands anchored into the canyon walls were then attached to each panel pressure grouted into place and backfill was added behind the panels.¹²⁹



Figure 27. Temporary pre-cast retaining walls installed along the highway in 1986 in preparation for construction of permanent retaining walls.¹³⁰

Once excavation was complete, to make way for the permanent retaining wall (see Figure 28), crews drilled anchor holes down to a depth of 45-60 feet, inserted a PVC pipe with post-tensioning strands into the drilled hole, and filled the pipe with water and mortar. Then footings were poured and formed around these vertical anchors in the ground. The final step was to post-tension the tiebacks once the footing cured.¹³¹ The reinforced earth wall forced compression of clay material underneath by embedding steel strips or mesh into the backfill to stabilize precast retaining wall units and enable settlement without structural failure. Steel reinforcing bars stabilized the soil and a rigid concrete facing was attached to the straps for further strength.¹³²

¹²⁹ Munn, "Glenwood Canyon - A Showcase of Innovation," 33.

¹³⁰ Munn, "Glenwood Canyon - A Showcase of Innovation," 33.

¹³¹ Munn, "Glenwood Canyon - A Showcase of Innovation," 35.

¹³² Haley, *Woiving A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 229–30; Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 10.

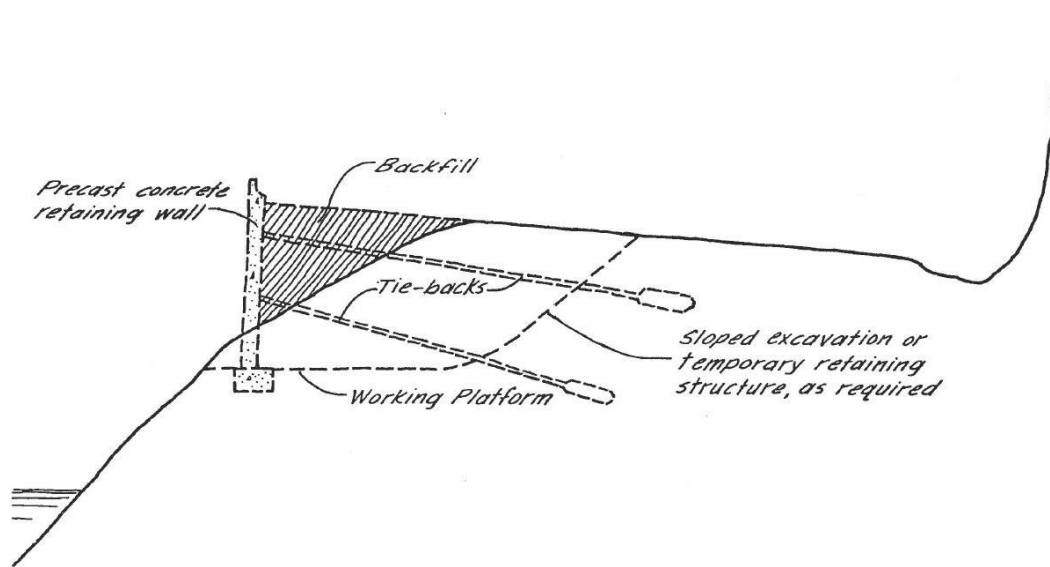


Figure 28. Illustration of permanent retaining walls in Glenwood Canyon.¹³³

The majority of retaining walls used on the project consisted of twin T-section concrete panels, prefabricated off-site by Nucon Construction Corporation in Rifle, Colorado, and customized to the exact measurements for any given location (see Figures 29 and 30). These walls were post-tensioned and tied to the underlying bedrock at the job site. Most of these concrete panels measured 10 feet wide and varied in length/height between 10 and 35 feet.¹³⁴ Some of the retaining walls were capped with parapets and carried the roadway; others supported post-tensioned roadways that are cantilevered beyond the face of the wall by up to six feet. The *Architectural and Planning Design Handbook*, prepared by De Leuw, Cather, & Company, recommended that retaining walls adjacent to river banks or the bike path should have the character of a “garden wall” reflecting the intention that these structures be integrated into the landscape as much as possible.¹³⁵ In addition to retaining walls, erosion control measures included construction of culverts and drainageways through retaining walls. The majority of these small structures were concrete pipe culverts, some with concrete headwalls and wingwalls, and small metal pipe culverts.

¹³³ De Leuw, Cather & Company, *Highway Construction Techniques, Working Paper*, 15.

¹³⁴ McGregor, *A Guide to Glenwood Canyon*, 7; Haley, *Wooing A Harsh Mistress: Glenwood Canyon's Highway Odyssey*, 229–30; Munn, “Glenwood Canyon - A Showcase of Innovation,” 33–34.

¹³⁵ Guenther, “Memo Regarding Glenwood Canyon Facts and Costs”; Munn, “Glenwood Canyon - A Showcase of Innovation,” 34; De Leuw, Cather & Company, *Architectural and Planning Design Handbook, Phase Two - Preliminary Design* (Prepared for the Colorado Division of Highways, May 1977), sec. 4.3.



Figure 29. Construction crews install retaining walls that consist of T-section concrete panels to support the upper roadway and to retain earth.¹³⁶



Figure 30. View of retaining wall with textured concrete panels featuring vertical grooves. Mead & Hunt, Inc. photograph.

¹³⁶ Munn, "Glenwood Canyon - A Showcase of Innovation," 35.

G. Recreational amenities

Designs for I-70 also included provisions to preserve and enhance outdoor activities throughout Glenwood Canyon. Public involvement and values related to outdoor recreation throughout the planning process meant the CDOH had to account for recreational amenities in its design. One such amenity was a 10-foot-wide, paved, multi-use bike/pedestrian path. The path extended the entire length of the canyon and was situated between the highway and the river. To limit encroachment on the river, in places where the narrow canyon limited area for a path, rather than adding more fill designers cantilevered the bike path from adjacent retaining walls just above the river. This design approach also preserved viewsheds toward and from the river.¹³⁷

Prior to construction, motorists along US 6 enjoyed numerous roadside and riverside areas for fishing and picnicking as well as access points for hiking, rafting, and other activities. Construction of I-70 eliminated these areas. However, plans for I-70 included four specially designed rest areas with direct access from the roadway; the rest areas were located at No Name, Grizzly Creek, Hanging Lake, and Bair Ranch (see Figure 31).

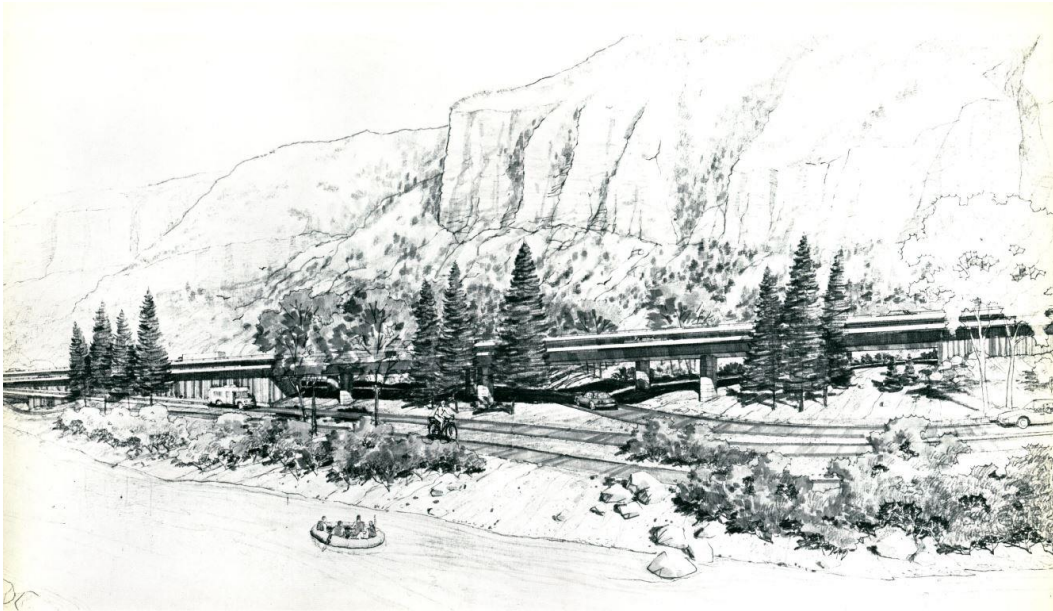


Figure 31. Illustration of a portion of Grizzly Creek Rest Area envisioned to be an oasis for motorists and outdoor recreation that included access to Glenwood Canyon Trail and the Colorado River.¹³⁸

The design and expense for these rest areas was in direct response to public involvement and public values related to outdoor recreation in the canyon and to mitigate the loss of previous recreational areas. Each rest area included landscaped parking areas with natural plants, picnic tables, rest rooms, river overlooks, and access to hiking trails, including the French Creek Trail, Canyon Trail, Hanging Lake Trail,

¹³⁷ Guenther, "Blending the Wonders of Engineering and Nature," 8.

¹³⁸ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 37.

Section 5
Significant Design, Engineering, and
Management Innovations, 1980-1992

No Name Creek Trail, Grizzly Creek Trail, and Glenwood Canyon Trail (see Figure 32). Another option would have been to have numerous pullouts along the new highway, but Contini and Passonneau chose rest areas for safety reasons. Pullouts had the potential to slow traffic flow along the new Interstate Highway. Designs also included launching ramps for commercial or private rafters and kayakers (see Figure 33).¹³⁹ The completed rest areas included earth-sheltered rest rooms; this design choice minimized visual impacts and reduced energy consumption during colder months. At the time of construction, three of the four rest room facilities included composting toilets that required no water to operate, which negated the need to build water treatment facilities in the canyon and the need for dumping discharged water into the Colorado River.¹⁴⁰

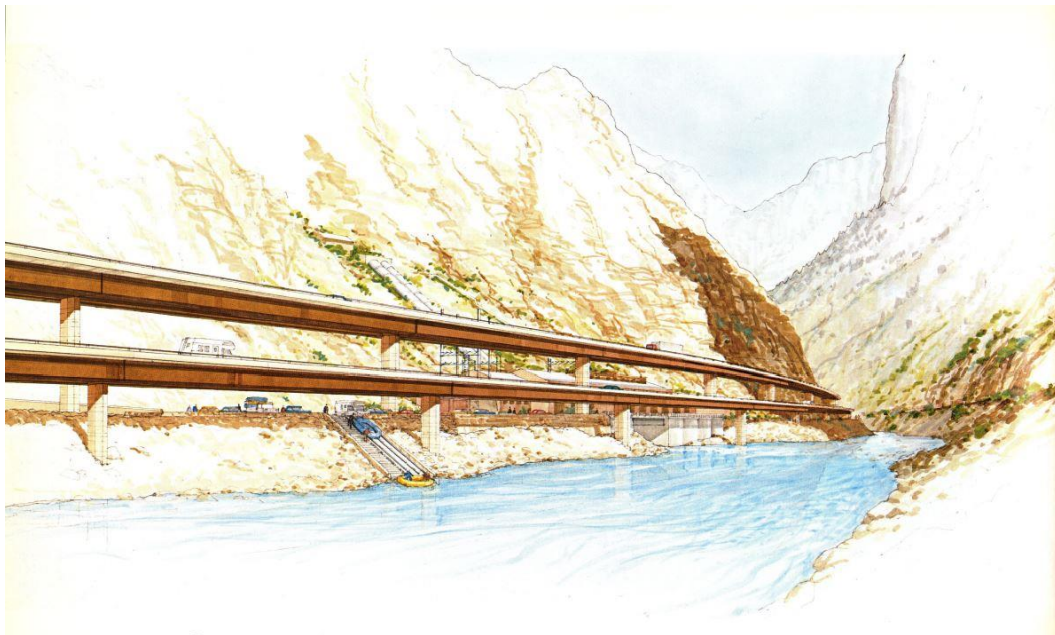


Figure 33. 1980 rendering of Shoshone Hydroelectric Plant with access ramp for rafters and kayaking.¹⁴¹

¹³⁹ Chamberlain and Sorrentino, "I-70 Through Glenwood Canyon: 'Showcase' Public Architecture of the 20th Century," 6; McGregor, *A Guide to Glenwood Canyon*, 2–24.

¹⁴⁰ Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 16.

¹⁴¹ Howard, Needles, Tammen & Bergendoff, *Interstate 70 Glenwood Canyon, Project I-70 - 2(70), Bridge Type Study Report*, 44.



Figure 32. View of the Bair Ranch Rest Area with picnic tables, natural landscaping, and access to bike path and river. Mead & Hunt, Inc. photograph.

H. Awards

Over the course of 12 years, 15 contractors completed more than 40 separate construction contracts at a total project cost of \$490 million.¹⁴² After the completion of I-70 through Glenwood Canyon, the American Society of Civil Engineers awarded the project the 1993 Outstanding Civil Engineering Achievement Award. Awards recognized the completion of I-70 through Glenwood Canyon as the final link in a continuous Interstate Highway across Colorado and reflected a successful balance between engineering needs and environmental considerations. The new highway also preserved and created new recreational opportunities along the highway corridor. Outside agencies have pointed to I-70 through Glenwood Canyon as a result of successful collaborative efforts between the CDOH, various agencies, locals, and environmental advocacy groups, praising the highway for significant innovations in highway and bridge engineering as well as highway landscape architecture.

I. Conclusion

The Glenwood Canyon segment of I-70 represents an innovative highway design achieved through the integration of engineering and landscape architecture principles that came about during a period of increasing public awareness of and activism associated with environmental and conservation issues both nationally and in Colorado. The final design and engineering of the roadway, bridges, retaining walls, and landscape elements complement the natural environment of Glenwood Canyon and also enhanced and created new recreational opportunities throughout the canyon. Construction of the Glenwood Canyon segment of I-70 also coincided with the establishment and expansion of tourism and recreation in the surrounding areas and communities. Recreation I and tourism came to characterize the lifestyle and

¹⁴² Colorado Department of Transportation, *Nomination for American Society of Civil Engineers 1993 Outstanding Civil Engineering Achievement Award*, 18.

pastime of residents and visitors alike in this part of the state. The Glenwood Canyon segment of I-70 also provided an important east-west linkage in Colorado and in the national Interstate Highway System.

Since its completion, a number of repair projects have taken place in Glenwood Canyon, particularly for damage to the roadway caused by rockfall and mitigation to prevent future rockfall episodes. Due to the surrounding cliffs, steep slopes, and amount of exposed rock in the canyon, the Glenwood Canyon segment of I-70 has experienced numerous rockfall incidents, with major events occurring near Hanging Lake (the deepest part of Glenwood Canyon) in November 2004, March 2010, and February 2016. Rockfalls typically resulted in closure of one or multiple lanes that lasted for days and created lengthy detours for travelers along US 40 to the north or US 50 to the south. Rockfalls prior to 2016 each cost approximately \$1.5 million to repair damage to elevated roadways, including holes measuring up to 16 feet by 10 feet. Damaged sections of guardrail and median barriers and damaged flex post fences must be replaced with new equipment after rockfall events. The 2016 rockfall near Hanging Lake consisted of vehicle-sized boulders damaging the roadway and crashing into a semi-truck; cleanup and repairs cost between \$2 and \$5 million.¹⁴³ Another rock fence improvement project in 2018 cost \$1.2 million between MP 122 and MP 125.¹⁴⁴

In 2007 a crack was found in the bore of the eastbound tunnel at Hanging Lake. Over the course of 15 years debris and rockfall added excessive weight that opened a crack that grew to approximately 105 feet long. The location of the crack was adjacent to the central command center. The Colorado Department of Transportation (CDOT) closed the tunnel for emergency repairs on March 30, 2007, and the tunnel remained closed until October 2007. Traffic was diverted through the westbound tunnel. Approximately 25 million pounds of dirt was excavated from above the tunnel in order to access the crack. Concrete was added to the top of the crack and shotcrete was applied to the underside. Layers of geo-textile grid were placed over the concrete to help reinforce the soil spread pressure over a larger surface area. The total cost for repairing the crack, correcting drainage issues, backfilling, and reseeding the site was approximately \$6 million.¹⁴⁵

¹⁴³ Terri Cook, "Why Glenwood Canyon Is Prone to Rockfalls: The Story Behind the Longest I-70 Road Closure in Glenwood Canyon's History," *5280 - Denver's Mile High Magazine*, n.d., <https://www.5280.com/2016/02/why-glenwood-canyon-is-prone-to-rockfalls/>; Jesse Paul, "Colorado Highway Rockfall Team Is Sometimes No Match for Hidden Risk," *Denver Post*, February 19, 2016, <https://www.denverpost.com/2016/02/19/colorado-highway-rockfall-team-is-sometimes-no-match-for-hidden-risk/>; David Thomas, "Glenwood Canyon," *Colorado Department of Transportation*, N.d., https://www.codot.gov/programs/geotech/copy2_of_drilling/rockfall/glenwood-canyon.html.

¹⁴⁴ Colorado Department of Transportation, "I-70 Glenwood Canyon Rock Fence Improvements," *Colorado Department of Transportation Projects*, N.d., <https://www.codot.gov/projects/archived-project-sites/i-70-glenwood-canyon-rock-fence-improvements>.

¹⁴⁵ Donna Gray, "Hanging Lake Tunnel Closed Indefinitely," *Aspen Times*, March 30, 2007, <https://www.aspentimes.com/news/hanging-lake-tunnel-closed-indefinitely/>; Pete Fowler, "Top Stories of 2007: Hanging Lake Tunnel Closed," *Post Independent-Citizen Telegram*, December 27, 2007, <https://www.postindependent.com/news/top-stories-of-2007-hanging-lake-tunnel-closed/>; Carol Carder, "Crack Repair At Hanging Lake Tunnel," *Building Design + Construction*, November 12, 2007, <https://www.bdcnetwork.com/crack-repair-hanging-lake-tunnel>.

6. National Register of Historic Places Evaluation

The Glenwood Canyon segment of I-70 (5GF.5099) was evaluated for eligibility for the National Register of Historic Places (National Register) as a Linear Historic District and recorded on Management Data and Linear Component Forms from the Office of Archaeology and Preservation suite of Colorado Cultural Resource Survey forms. The following sections are reproduced from those forms and included with the historic context to support Mead & Hunt, Inc.'s (Mead & Hunt's) determination that the property is a linear historic district considered individually eligible for the National Register under *Criteria A* and *C* applying *Criteria Consideration G* for properties that have achieved significance within the past 50 years.

A. Boundary description and location

The boundary reflects the location of structures, objects, and buildings associated with the historic significance of the Glenwood Canyon segment of I-70. The boundary is defined as the current I-70 right-of-way through Glenwood Canyon, beginning at MP 118.5 east of Glenwood Springs and ending at MP 130.3. The CDOT right-of-way boundary includes a large portion of the Colorado River. The boundary is expanded beyond the right-of-way to incorporate the Glenwood Canyon Bike Path and four rest areas (No Name Rest Area, Grizzly Creek Rest Area, Bair Ranch Rest Area, and Hanging Lake Tunnels Rest Area) that were associated with the construction or design of the highway segment but are outside of the current right-of-way. The boundary and associated resources are shown on the map in the OAHHP site forms.

B. General description/location

The Glenwood Canyon segment of I-70 is located in Garfield County along the Colorado River between just west of the No Name village and the Garfield and Eagle County line. Eastbound and westbound lanes of the Glenwood Canyon segment are situated north of the Colorado River as it winds through the narrow gorge of Glenwood Canyon. The highway setting is largely dominated by steep canyon walls consisting of Precambrian granite, quartzite, sandstone, and limestone. The easternmost portions of the highway are a four-lane, divided highway with a concrete barrier and rail or small landscaped median. Where the canyon narrows, the roadway gradually transitions into a terraced and split-level highway as it continues west. Several tributaries feed into the Colorado River within the canyon along the Interstate Highway segment, including Grizzly Creek, Bear Creek, Deadman's Creek, Devil's Hole Creek, Wagon Gulch, Cinnamon Creek, Dead Horse Creek, French Creek, and Spruce Creek. Vegetation within the canyon includes native species such as gambel oak, golden currants, serviceberry, and wood rose. During and after highway construction, landscapers planted trees and shrubs and reseeded native grasses throughout the segment; replanted species included willow and hairy golden aster.

C. Summary of historic district and associated property types within the district

The Glenwood Canyon segment of I-70 contains a cohesive grouping of designed and engineered structures, buildings, and objects united aesthetically and functionally as a distinctive transportation segment. While the features within the segment lack individual distinction, the assemblage of objects and structures achieves significance as whole under *Criterion A* in the areas of Transportation, Conservation,

and Entertainment/Recreation and under *Criterion C* in the areas of Landscape Architecture and Engineering.

The Glenwood Canyon segment comprises both contributing and noncontributing structures, buildings, and objects. Contributing features are those that were constructed within the period of significance, possess a direct and important association with one or more contextual themes or areas of significance, and retain the integrity necessary to convey significance. Contributing features include the road bed of both eastbound and westbound lanes, bridges, tunnels, retaining walls, culverts, rest areas, on- and off-ramps, variable message signage, and the Glenwood Canyon Trail. Also located within the boundary are features constructed outside the period of significance or features that do not have a direct association to I-70. The Shoshone Hydroelectric Plant was constructed prior to the construction of the I-70 Glenwood Canyon segment (before the period of significance) but is within the historic resource boundary, and is considered noncontributing. These features have been noted on the I-70, Glenwood Canyon Segment, Summary of Features table on the OAHHP site forms.

D. Area(s) of significance

Engineering, Landscape Architecture, Transportation, Conservation, and Entertainment/Recreation.

E. Period of significance

The period of significance is 1980-1992 as these were the years of construction for the Glenwood Canyon segment of I-70.

F. Statement of significance

In 2005 the Advisory Council on Historic Preservation (ACHP) approved an exemption that relieved federal agencies from taking into account effects of their undertakings on the Interstate Highway System, except for a limited number of nationally and/or exceptionally significant elements associated with the system. As part of the Interstate Highway System, I-70 as a whole is exempt from review under Section 106. However, in 2006 the Federal Highway Administration published a list of exceptions to the Interstate exemption known as the “Final List of Nationally and Exceptionally Significant Features of the Federal Interstate Highway System” (Final List), available at https://www.environment.fhwa.dot.gov/env_topics/historic_pres/highways_list.aspx. The Final List included four portions of I-70 in Colorado: the Genesee Park Interchange, Eisenhower-Johnson Memorial Tunnels, Vail Pass highway segment, and Glenwood Canyon highway segment. These features were selected because they are considered to potentially possess exceptional significance.. The entire length of I-70 in Colorado did not rise to the level of exceptional significance to be included on the Final List; therefore, the entire resource is not eligible for inclusion in the National Register.

Mead & Hunt recommends that the Glenwood Canyon segment of I-70, which is defined as the portion from MP 118.5 to MP 130.3, possesses exceptional significance at the statewide level because it represents an important aspect of highway planning, design, and construction in Colorado. The Glenwood Canyon segment of I-70 represents a historic district as it contains a cohesive grouping of designed and engineered structures, buildings, and objects united aesthetically and functionally as a

distinctive transportation corridor. While the features within the segment lack individual distinction, the assemblage of objects and structures achieves exceptional significance as whole under *Criterion A* in the areas of Transportation, Conservation, and Entertainment/Recreation and under *Criterion C* in the areas of Landscape Architecture and Engineering.

Criteria Consideration G

Completed in 1992, the Glenwood Canyon segment of I-70 has not yet reached the 50-year age requirement set forth by the National Park Service. However, under *Criteria Consideration G: Properties that Have Achieved Significance Within the Past Fifty Years*, the Glenwood Canyon segment of I-70 exhibits “exceptional importance” at the statewide level as a resource with direct and significant associations with important events in the development of Colorado transportation networks and early solutions to the conflict between environmental concerns and highway construction that set standards for later Colorado projects.

Criterion A

The Glenwood Canyon segment of I-70 represents a historic district as it contains a cohesive concentration of designed and engineered structures, buildings, and objects united aesthetically and functionally as a distinctive transportation corridor. Under *Criterion A*, the Glenwood Canyon segment of I-70 possesses exceptional significance in the areas of Transportation, Conservation, and Entertainment/Recreation.

In the area of Transportation, I-70 through Glenwood Canyon provided the final link in the I-70 corridor across Colorado, which led to an expanded transportation network in previously remote areas of the Colorado high country in the latter half of the twentieth century. Original Interstate plans had I-70 ending in Denver with no link across the western portion of the state. Years of debate and the efforts of politicians, boosters, and state highway engineers resulted in the 1957 decision to extend I-70 west from Denver across the challenging terrain presented by the Continental Divide and Colorado high country. Subsequently, national controversy emerged over the highway’s planned route through the Gore Range-Eagles Nest Wilderness (near Vail) and Glenwood Canyon. Several options were considered for I-70, between Gypsum and Glenwood Springs, but ultimately the option of extending the highway directly through Glenwood Canyon was selected. The completion of I-70 through Glenwood Canyon made possible a continuous Interstate Highway across Colorado and through previously remote areas of the Colorado high country. Therefore, the highway segment is significant in the area of Transportation.

I-70 through Glenwood Canyon is also significant in the area of Conservation as environmentalists, biologists, water quality specialists, designers, and construction crews developed several innovative solutions to environmental issues presented by the highway’s construction through the narrow canyon and in a highly sensitive natural area. Designers minimized noise and visual effects of the highway at trailheads to enhance the recreational experience. Other solutions included grading for revegetation on a massive scale, improvements to fish habitats through the placement of boulders in the river, and the reintroduction of bighorn sheep to the canyon. Therefore, I-70 through Glenwood Canyon is significant in the area of Conservation.

In the area of Entertainment/Recreation, numerous features along I-70 through Glenwood Canyon were constructed to preserve existing recreational activities or foster new ones in response to public involvement and comments by environmental advocates and outdoor enthusiasts. Elements built as part of the highway relate directly to enjoyment and appreciation of the natural canyon environment, including the rest areas and the access they provide to several hiking trails and the river for fishing, scenic overlooks at rest areas, the pedestrian/bike path, and docking ramps for rafters. These features were constructed in conjunction with I-70 and were specific choices made by designers in response to public comment and in anticipation of large numbers of tourists frequenting the canyon. Therefore, I-70 through Glenwood Canyon is significant in the area of Entertainment/Recreation.

Criterion B

Research did not reveal direct associations between the Glenwood Canyon segment of I-70 and any individual that singularly possesses significance for their association with this segment of I-70 through Glenwood Canyon. The construction of I-70 and the Glenwood Canyon segment was the result of the work of collaborative efforts between numerous individuals, organizations, and agencies rather than a single person. Therefore, this highway does not possess significance under *Criterion B*.

Criterion C

Under *Criterion C*, the I-70 Glenwood Canyon segment possesses exceptional significance in the areas of Landscape Architecture and Engineering as a transportation segment containing a significant linkage of structures and objects united aesthetically and functionally by a planned development. As a historic district, the highway segment and the associated features represent a significant and distinguishable entity whose components may lack individual distinction.

In the area of Landscape Architecture, Glenwood Canyon exhibits a number of exceptionally significant innovations in highway landscape design. While landscape architects had been employed on earlier road projects, such as urban parkways and the Vail Pass segment of I-70, their influence on the setting and design of the landscape in Glenwood Canyon was a key element in the successful completion of this project that balanced engineering and environmental concerns. Unique and innovative landscape elements were integrated into the highway design in order to maintain or restore the natural setting of the canyon post-construction; these elements included staining scars on the canyon wall to match the weathered appearance of surrounding rocks, grading to recreate stable slopes for revegetation with native trees and plants, and placement of boulders into the river to enhance fish habitat. Furthermore, engineered features of the segment such as retaining walls and bridges exhibit qualities influenced by aesthetic principles of landscape architecture. Retaining walls were painted to blend in with surrounding canyon walls. Roadway slabs overhanging the retaining walls were designed to appear as if the upper deck of the highway is floating and to cast shadows to make the retaining walls look shorter than they actually are. Bridges were constructed around geologic formations and trees and with open piers to minimize visual impacts to the segment. An outstanding example of what is now known as context sensitive design, I-70 through Glenwood Canyon is significant in the area of Landscape Architecture.

In the area of Engineering, the Glenwood Canyon segment of I-70 possesses an exceptional level of significance as it represents innovative design solutions that met Interstate Highway safety and efficiency

standards in a geologically constrained area while minimizing environmental and visual impacts to the landscape. The use of bridges with tall open piers instead of the typical treatment involving major fill and culverts for drainage minimized visual effects to the natural landscape and enabled wildlife to cross the highway beneath the structures. The development of a pier cap design that integrated with the exterior steel girders to give the illusion that outer girders float between piers enabled overhanging bridges to have less of a visual impact. The post-tensioned, continuous concrete roadway slabs used along the highway were the first of their kind to be used in the U.S. and provided the roadway with an exceptional operational life, far beyond any previous pavement designs. The method for placing precast, reinforced-concrete bridges and viaduct segments in place with a horizontal gantry was also innovative in that it was the first use of such a method in the U.S., minimized impacts to the canyon floor, and kept traffic lanes open during construction. The Hanging Lake tunnels also incorporated structural design solutions with rock bolts placed around the perimeter of the tunnels for permanent support; previous systems had used steel or concrete. The result of these engineering designs and construction techniques is a highway segment that retains the slopes and valleys of the natural landscape and complements its surroundings, enhancing the views of motorists who are driving on I-70, while providing a safe and efficient transportation facility. I-70 through Glenwood Canyon represents an exceptional example of innovative engineering solutions in highway design in response to environmental constraints and is therefore significant in the area of Engineering.

Criterion D

For a property to possess significance for information potential, the information yielded by the property must answer specific important research questions that cannot be otherwise answered. The technology of highway construction is well understood and documented. As such, this highway is unlikely to yield important information that cannot be discerned from archived plans and other records. Therefore, this highway does not possess significance under *Criterion D*.

G. Condition/modifications

The highway segment has undergone routine maintenance since its completion in 1992 and remains in good operating condition. Rockfalls in November 2004, March 2010, and February 2016 required roadway repairs near Hanging Lake and the Hanging Lake Tunnel underwent emergency repairs in 2007 due to a crack in the tunnel. In addition, some deterioration to retaining walls at the Hanging Lake Rest Area were noted during field observations in August 2018. Overall, alterations to the roadway are consistent with routine maintenance and include repaved and restriped travel surface, replaced guardrails, and added jersey barriers and drainage culverts. Recent projects include the following:

- 2010, 2012: Concrete paving
- 2014: Surface treatment, bridge work, rockfall mitigation
- 2016: Emergency rockslide consultation
- 2017: Rockfall fence improvements
- 2016-2017: Sign replacement, installation of new signage, weather stations
- 2019: Sign replacement, overlay, bridge work, ADA ramp reconstruction in rest areas, drainage improvements, wall repairs

H. Statement of historic integrity related to significance

The Glenwood Canyon segment of I-70 retains a high degree of physical integrity related to its ability to convey significance as an exceptionally designed and engineered Interstate Highway segment associated with expanded transportation segments, conservation, and recreation in the region. While some deterioration, alterations, and additions to individual features are noted, the overall Glenwood Canyon segment retains all aspects of integrity.

Materials, design, and workmanship

As a highway segment in continuous use since 1992, the Glenwood Canyon segment of I-70 has undergone routine maintenance, including resurfacing and restriping of the roadbed and travel surfaces of both I-70 and the recreational path. These replacements appear to have been completed in-kind. While the actual materials of these structures have changed, the impact to overall integrity of materials and design is minimal. The most extensive alterations occurred within the past 18 years due to rockfalls near Hanging Lake and a crack in the Hanging Lake Tunnel in 2007. Based on field review, repairs and rehabilitations associated with these events did not diminish the overall aesthetic design characteristics of the roadway, tunnel, or overall highway corridor. Despite alterations, the alignment and travel surface material of the roadway structure remains the same and retains integrity of design and workmanship necessary to contribute to the significance of the Glenwood Canyon segment. Deterioration was observed on retaining walls at the Hanging Lake Rest Area. This particular concrete-block retaining wall system appears to have failed and is falling forward; steel reinforcing bars have been attached to the front of the wall and some individual units have begun to crumble. While these structural issues and deterioration impact integrity of workmanship of this particular wall, retaining walls throughout the segment still exhibit their unique aesthetic qualities and design that set them apart from standard retaining wall systems. Overall, the Glenwood Canyon segment of I-70 retains its integrity of materials, design, and workmanship. With intact physical features, the segment continues to convey its significance as an Interstate Highway segment designed with careful consideration of the natural environment and use of innovative designs and construction methods.

Location, setting, and feeling

The Glenwood Canyon segment of I-70 retains its integrity of location as it still follows the same alignment as selected for the highway in the late 1970s. Additionally, other contributing features of the highway appear to remain in their original locations as constructed. The highway segment has had few changes that affect its integrity of setting or feeling. Updates to the segment after the period of significance for safety and maintenance have resulted in minor additions such as replaced guardrails and added jersey barriers and drainage culverts. These additions are minimal in nature and do not detract from the overall setting or feeling of Glenwood Canyon. The segment's natural and landscaped features such the Colorado River, canyon walls and rock outcroppings, stained blast areas, creeks and streams, draws, and talus slopes, remain largely unchanged. These intact natural and designed features of Glenwood Canyon continue to convey a sense of time and place and exhibit the aesthetic qualities intended by its designers. Overall, the Glenwood Pass segment retains its integrity of location, setting, and feeling.

Association

Glenwood Canyon retains its integrity of association to historic trends related to its exceptional significance. The segment continues to serve the same function as when it was completed in 1992, and through its recognizable physical elements it continues to convey its significance as a critical link in the I-70 transportation corridor and the final link in the national Interstate Highway System in Colorado. The Glenwood Canyon segment also continues to exhibit significance in its association to conservation efforts as its physical structures (bridges, retaining walls, and culverts) and landscape design features (stained rock cuts, revegetation areas, slope molding, plantings at rest areas, and viewsheds) that were designed to minimize ecological impacts, slow erosion, and reduce adverse visual effects to the natural landscape remain intact and functioning as intended.

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